



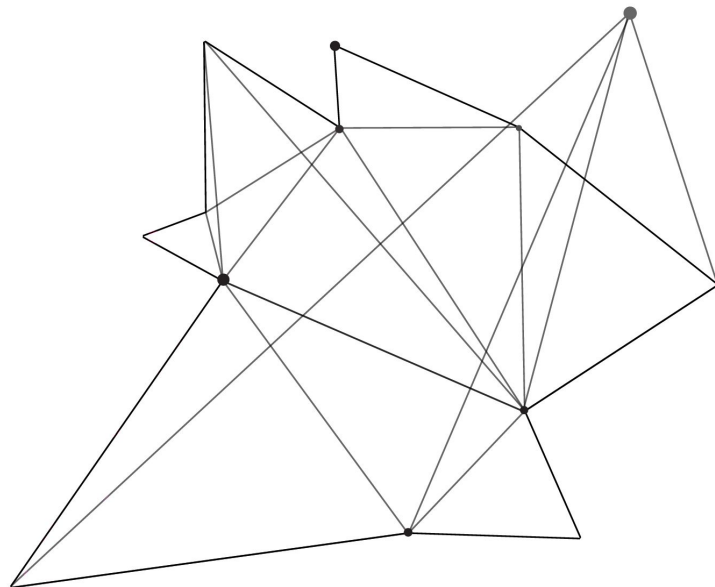
**CATEGORY 1
UNIVERSITY**
BY MHRD, Govt. of India

**KL ACCREDITED BY
NAAC WITH A++
GRADE**

nirf
2023
NATIONAL
INSTITUTIONAL
RANKING
FRAMEWORK

RANKED 28
AMONG ALL
UNIVERSITIES

**43 YEARS OF
EDUCATIONAL
LEADERSHIP**



BACHELOR OF TECHNOLOGY

INTERNET of THINGS

**PROGRAM
HANDBOOK | 2023**
For Students Admitted in Academic Year 2023-24



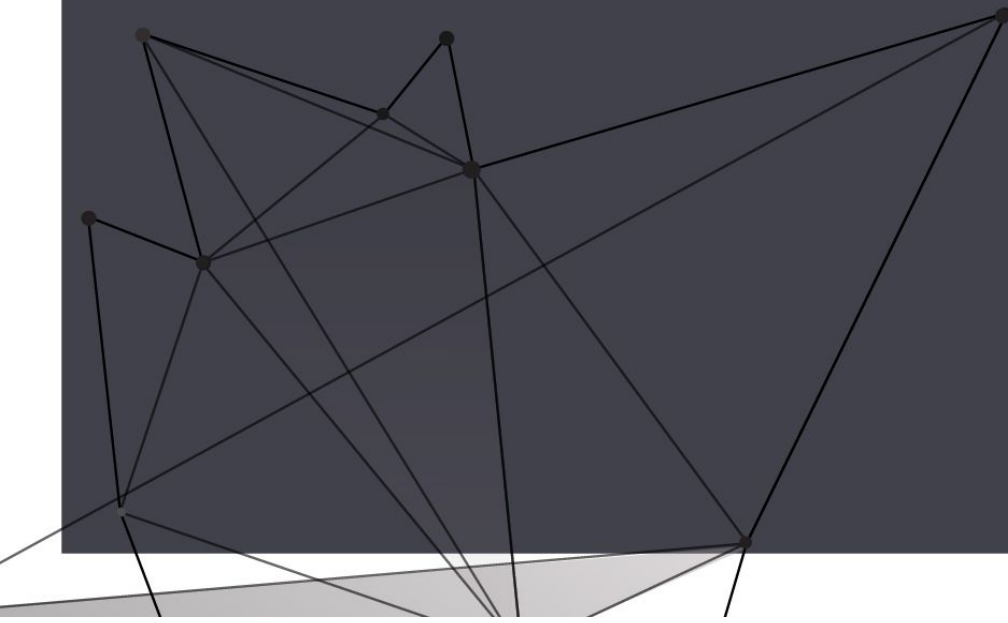


VISION

To be a globally renowned university.

MISSION

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.



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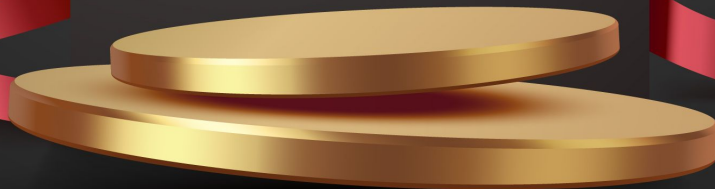
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AWARDS





Koneru Satyanarayana,
Chancellor

Sri Koneru Satyanarayana, BE, FIE, FIETE, MIEEE graduated in Electronics and Communication Engineering in the year 1977. Along with Sri Koneru Lakshmaiah, he is the co-founder of the Institute which was established in the year 1980. He is an educationist of eminence and also an industrialist of great repute. He runs a number of industries in and around Vijayawada.

Dr. K S Jagannatha Rao
Pro Chancellor



Prof. K. S. Jagannatha Rao was one of the leading scientists in neuroscience research in globe. He was the Director on Institute for Scientific Research and Technological Advances (INDICASAT AIP), Republic Panama and contributed lot in building innovation in higher education and research in Panama since 2010. He played a key role in building PRISM (Panamanian Research Institutes of Science and Medicine) in Latin America. Dr. Rao has his research area on Brain Research and established Alzheimer's Centre and published 165 papers in leading Biochemistry and Neuroscience Journals, supervised 19 Ph.D students. He is also adjunct faculty of Biomedical Informatics of UTHS, Houston, and Advisory Board Member of UT- El Paso Minority Health NIH program, USA and Adjunct Faculty, Methodist Research Institute, Houston, USA. He was elected Member of Panamanian Association for the Advancement of Science (APANAC) - Considered as National Science Academy of Panama. He received his undergraduate and Ph.D degrees from Sri Venkateswara University, Tirupati. Later, joined in Central Food Technological Research Institute, Mysore. He received Sir C. V. Raman Award by Karnataka State Council of Science and Technology, 2003.



Prof. G P S Varma
Vice Chancellor

Prof. G P S Varma, Vice-Chancellor, KLEF, is one of the most widely experienced leaders in Indian higher education, known for his commitment to expanding student opportunity, catalyzing academic innovation, and encouraging university's civic engagement and service to society. He adorned the position of Chairman, ISTE (Indian Society for Technical Education)- AP State, TSEM CET Test Committee Member-2021 nominated By Telangana State Govt, APEAMCET Admission Committee Member in 2016 by Andhra Pradesh State Council of Higher Education, Govt. of Andhra Pradesh. He has been a very farsighted Peer Team Visit Member for National Assessment and Accreditation Council (NAAC), Expert Committee Member for University Grants Commission (UGC) Autonomous Visits. He has been an Advisory Council Member for (CEGR) Centre for Education Growth, and Research India International Centre, New Delhi, and Board Member for Big-Data Analytics Forum.

Dr. N Venkatram
Pro-Vice Chancellor



Dr. Venkatram Nidumolu, Pro-Vice Chancellor is High performing, strategic thinking professional with more than 15 years of administration experience and 20 years of teaching experience in KLEF and 30 years overall experience in the higher education sector. He graduated in B.Tech (ECE) from Acharya Nagarjuna University, pursued M.S degree from BITS, PILANI in software Systems. He received Ph.D award from Acharya Nagarjuna University. He held the positions like HOD, Joint Register, Principal, and Dean-Academics before becoming Pro-Vice Chancellor. He was core member of all NBA, NAAC, & other accreditations since 2004 and he has good experience in handling of quality issues and assessment related practices.

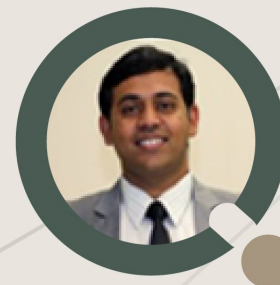


Dr. A V S Prasad
Pro-Vice Chancellor

Dr. A.V.S.Prasad, M.E and Ph.D from JNTU, Hyderabad is a professor in Civil Engineering. He has a rich experience of 33 years in academics which includes 26 years in administration at various cadres ranging from Head of Department, Dean, Principal, Director and Pro-Vice Chancellor. Dr. Prasad has served as Director of Audisankara group of institutions and Narayana Group of Institutions for 18 years and was instrumental in getting these institutions accredited by NAAC, NBA, Autonomous and gained many laurels from the State Government, JNTU etc. He has served as Pro-Vice Chancellor of K.L. University for 3 years.

Dr. Prasad has extensive knowledge of administrative system, maintaining statutory norms of bodies like AICTE, UGC etc and has a good understanding of NBA, NAAC procedures and norms. He has to his credit many papers published in indexed journals. He has experience in organizing various National Level Events, Workshops and Conferences. He served as Member, Chairman of Board of Studies at JNTU(A), KLCE(Autonomous) and K.L. University. Above all he is soft spoken, congenial and an effective team worker and team leader.

OFFICE OF DEAN ACADEMICS



Hari Kiran Vege
Dean (Addl) Academics



Dr. V N Sailaja
Associate Dean Academics
(Curricular Aspects)



Dr. P Kasi Visweswara Rao
Associate Dean Academics
(Curricular Aspects)



Dr. M Kameswara Rao
Associate Dean Academics
(Academic Registrations)



Dr. K Uday Kiran
Associate Dean Academics
(Academic Registrations)



Dr. M Venkata Naresh
Associate Dean Academics
(Strategic Planning & Policy Making)



Dr. N V K Ramesh
Associate Dean Academics
(Teaching & Learning Process)



Dr. Aravindhan Alagarsamy
Associate Dean Academics
(Teaching & Learning Process)



Dr. Padmanabhan K
Associate Professor, CSE



Dr. B Chaitanya Krishna
Associate Dean Academics
(OBE & Evaluation)



Dr. E Vamsidhar
Associate Dean Academics
(OBE & Evaluation)



Dr. S Balaji
Associate Dean Academics
(Off-campus Operations)



Dr. P Vidya Sagar
Associate Dean Academics
(Projects, Academic Research & Internships)



Mr. A Gopi
Assistant Dean Academics
(Projects, Academic Research & Internships)



Dr. Fazal Noor Basha
Associate Dean Academics
(Academic Counselling)



Dr. M Latha
Associate Dean Academics
(Academic Counselling)



Dr. A S Chandra Sekhara Sastry
Controller of Examinations



Dr. Ch V Ramana Murthy
Addl. Controller of Examinations



Dr. Chakka Raghava Prasad
Addl. Controller of Examinations



Dr. Chetty Manna Sheela Rani
Addl. Controller of Examinations



Dr. Sreevardhan Cheerla
Addl. Controller of Examinations



Dr. Kallakunta Ravi Kumar
Addl. Controller of Examinations



Dr. M V V K Srinivas Prasad
Asst. Controller of Examinations



Dr. Kallipalli Venkata Raju
Addl. Controller of Examinations

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VISION

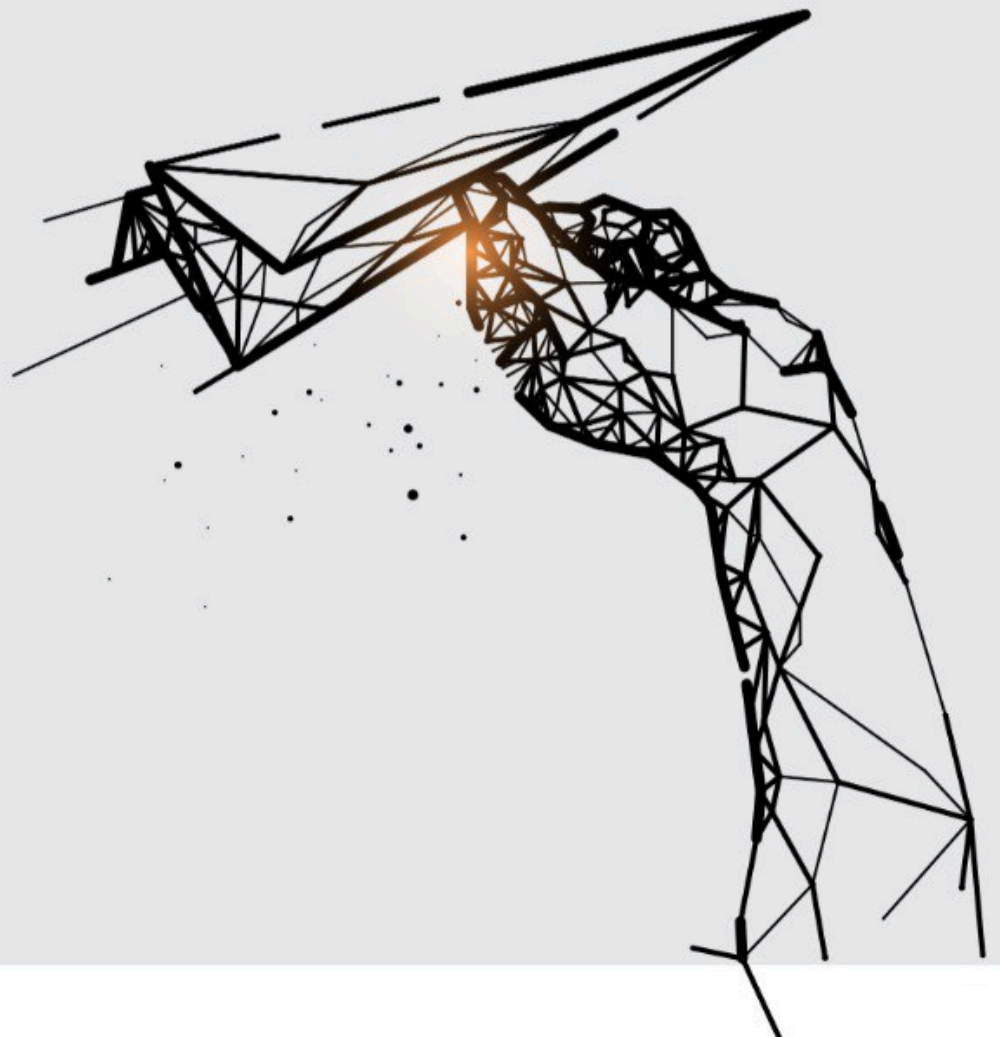
To evolve into a globally recognized department in the frontier areas of Electronics & Communication Engineering.

MISSION

To produce graduates having professional excellence.

To carry out quality research having social & industrial relevance.

To provide technical support in transforming the learners into entrepreneurs.





(DEEMED TO BE U N I V E R S I T Y)

Y23: B.Tech. - Internet of Things

Program Handbook

Program Educational Objectives (PEOs)**PEOs**

PEO	PEO Description
1	Practice engineering in a broad range of industrial, societal and real-world applications.
2	Pursue advanced education, research and development, and other creative and innovative efforts in science, engineering, and technology, as well as other professional careers.
3	Conduct themselves in a responsible, professional, and ethical manner.
4	Participate as leaders in their fields of expertise and in activities that support service and economic development throughout the world.

Program Outcomes & Program Specific Outcomes (PO & PSO)

PO & PSO

PO/PSO	PO/PSO Description
P01	Engineering Knowledge: An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization for the solution of complex engineering problems in engineering
P02	Problem Analysis: An ability to identify, formulate, research literature, analyze complex engineering problems in engineering using the first principles of mathematics, natural sciences and engineering sciences
P03	Design/ development of solutions: An ability to design solutions for complex engineering problems and system component or processes that meet the specified needs considering public health & safety and cultural, societal & environment
P04	Conduct investigations of complex problems: An ability to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to obtain solutions to engineering problems.
P05	Modern tool usage: Ability to create, select and apply appropriate techniques, resources and modern engineering activities, with an understanding of the limitations.
P06	The engineer and society: Ability to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
P07	Environment and sustainability Ability to demonstrate the knowledge of engineering solutions, contemporary issues understanding their impacts on societal and environmental contexts, leading towards sustainable development.
P08	Ethics: An ability to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
P09	Individual and team work: An ability to function effectively as an individual, and as a member or leader in diverse teams and in multi- disciplinary settings.
P010	Communication: Ability to communicate effectively oral, written reports and graphical forms on complex engineering activities.
P011	Project management and finance: Ability to demonstrate knowledge and understanding of engineering and management principles and apply those ones own work, as a member and leader in team, to manage projects and in multi-disciplinary environments
P012	Lifelong learning An ability to recognize the need for and having the preparation and ability to engage independent and life-long learning in broadest context of technological change
PSO1	An ability to Understand the theoretical and mathematical concepts to analyze real time problems and develop the systems to resolve.
PSO2	An Ability to Design and Analyse systems based on theoretical foundation, Professional Knowledge and Practical Skills.

Program Rules & Regulations

Admission Eligibility Criteria

A Pass in 10+2 or equivalent examination with 60% in aggregate and 60% and above (or) equivalent CGPA in Group subjects - Physics, Chemistry and Mathematics.

Program Structure and Curriculum

For each academic program, the curriculum serves as a framework that specifies the credits, course category, codes, titles, and delivery methods (Lectures, Tutorials, Practice, Skills, Projects, Self-Study, Capstone Design, etc.) under the **Choice-Based Credit System (CBCS)**. The curriculum is designed, implemented, and assessed following the **Outcome-Based Education (OBE)** framework. In designing the curriculum, we ensure the integration of key contemporary and traditional values by embedding Indian Knowledge Systems (IKS), Sustainable Development Goals (SDGs), and Design Thinking principles into courses at their inception.

- Each **Academic Year** consists of two regular semesters, each approximately 20 weeks including classwork and exams:
 - **Odd Semester:** July to December
 - **Even Semester:** December to May
- A **Summer Term** may be offered from May to June but is not considered a regular semester for calculating program duration.
- Students have the flexibility to choose courses as prescribed by KLEF.
- Each course has a **Lecture-Tutorial-Practice-Skill (L-T-P-S)** component.

Course Credit Structure:

Credits are allocated to courses based on the **L-T-P-S** structure:

- Every **Lecture** or **Tutorial** hour equals **1 credit**.
- Every **Practical** hour equals **0.5 credits**.
- Every **Skill-based practice** hour equals **0.25 credits**.

Course Precedence:

The following are the guidelines for registering into courses with pre-requisites.

- A course may have one or more of its preceding course(s) as pre-requisite(s).
- To register for a course, the student must successfully be promoted in these course(s) earmarked as pre-requisite(s) for that course.

Academic Flexibilities

Major Flexibilities:

- **Honors:** Honors can be awarded if students complete additional courses from their core program and earn 20 extra credits through specified category of courses.
- **Honors through Research:** Honors through Research offers students the chance to explore their chosen field of study in greater depth, cultivate valuable research skills, and make meaningful contributions to their specific area of interest. Students can be awarded this Degree upon fulfilling the requirement of earning an additional 20 credits through specified category of courses.

- **Honors through Innovation:** Honors through Innovation emphasize the exploration of innovative ideas, problem-solving, and creative thinking within a particular field of study. It may provide opportunities for students to engage in innovative projects, research, or entrepreneurial activities. Students can be awarded their degree upon successful completion of additional courses from their core program and earning an extra 20 credits through specified category of courses.
- **Honors through Experiential Learning:** Honors through Experiential Learning focuses on hands-on, practical experiences that complement and enhance traditional classroom learning. Students will be eligible for the degree upon the successful completion of additional courses from their core program and the attainment of 20 extra credits through specified category of courses.

For the above said categories, if a student fails to meet the CGPA and SGPA requirements, at any point after registration, she/he will be dropped from the list of students eligible for the specified Degree, then student will receive B.Tech. Degree only. However, such students will receive a separate grade sheet mentioning the additional courses completed by them.

Program Add-ons:

- **Specialization:** Specialization degree can be awarded if student completes five professional electives and one skill development course in the same track of his/her interest.
- **Minor:** Minor degree can be awarded if student fulfills all the program requirements of their discipline and are successful in completing a specified set of courses from another discipline through which they earn an additional 20 credits are eligible to get minor degree in that discipline.
- **Double Major:** Double Major degree can be awarded if student earns 40 additional credits from the selected second major stream in addition to fulfilling the requirements of their first major.

	No Major Flexibility	Major Flexibility Honors	Major Flexibility Honors through Research	Major Flexibility Honors through Innovation	Major Flexibility Honors through Experiential Learning
No Program Add-On	B.Tech.	B.Tech. (Honors)	B.Tech. (Honors through Research)	B.Tech. (Honors through Innovation)	B.Tech. (Honors through Experiential Learning)
Program Add-On Specialization	B.Tech. with Specialization	B.Tech. (Honors) with Specialization	B.Tech. (Honors through Research) with Specialization	B.Tech. (Honors through innovation) with Specialization	B.Tech. (Honors through Experiential Learning) with Specialization
Program Add-On Minor	B.Tech. with Minor	B.Tech. (Honors) with Minor	B.Tech. (Honors through Research) with Minor	B.Tech. (Honors through Innovation) with Minor	B.Tech. (Honors through Experiential Learning) with Minor
Program Add-on Double Major	B.Tech. with Second Major	B.Tech. (Honors) with Second Major	B.Tech. (Honors through Research) with Second Major	B.Tech. (Honors through innovation) with Second Major	B.Tech. (Honors through Experiential Learning) with Second Major

Registration Process

Key Guidelines:

- **Course Availability:** Students are permitted to register only for courses offered in the specific semester of enrollment.
- **Prerequisites:** Any prerequisite courses must be successfully completed before registering for subsequent courses.
- **Timely Registration:** Students must register on the designated registration day. KLEF reserves the right to deny late registrations.
- **Add/Drop/Change Period:** Students have a one-week window from the start of classes to add a course and two-weeks to drop or change courses.
- **Credit Limits:**
 - The recommended credit load is 22-24.
 - The maximum credit load per semester is 30.
 - If a student finds the standard load overwhelming, they can opt for deceleration, taking fewer courses now and making up the credits in a future summer semester.
 - Students in honors programs or pursuing a minor may be allowed to take on a heavier load through overloading, subject to eligibility criteria.
- **Elective Course Availability:** KLEF may cancel elective courses with low enrollment within the first week. Students will be able to switch to another elective if they meet its prerequisites.
- **Re-registration:** If a student wants to improve their grade in a course, they can re-register for it with approval from the Dean of Academics.
- **Registration Cancellation:** KLEF can cancel a student's registration for disciplinary reasons or plagiarism.
- **Timetable Clashes:** Students are responsible for resolving any timetable conflicts. They should contact their Department Year Coordinator immediately if any clashes arise.
- **Irregularities:** If any irregularities are found in a student's registration later on, KLEF may cancel their registration for a course or even the entire semester.

Registration Flexibilities:

- **Choice of electives:** Students have the flexibility to choose from a diverse set of elective courses that align with their personal interests or career objectives.
- **Choice of faculty:** Students have the flexibility to choose their preferred faculty members for certain courses, depending on departmental policies and course availability.
- **Acceleration & Overloading:** Students can accelerate their progress by taking courses from the next semester in advance, or overload by taking more credits than the standard limit. Prior permission from the Dean of Academics is required for either of these.
- **Deceleration & Underloading:** If students need to lighten their course load, they can decelerate by postponing some courses to the next semester, or underload by taking fewer credits than usual. Students who do not register on time, may also be forced to decelerate to compensate the classwork that they missed due to late registration. In both the cases of deceleration, permission must be sought from Office of Dean Academics through proper channel.

- **Special Purpose Semesters:**

- **Innovation Semester:** An Innovation Semester is a dedicated academic term focused on cultivating a culture of creativity, problem-solving, and entrepreneurial thinking. It provides students with the opportunity to develop innovative solutions to real-world challenges.
- **Product Development Semester:** A Product Development Semester is an academic term dedicated to the process of creating new products or improving existing ones. It provides students with hands-on experience in the entire product lifecycle, from ideation to market launch.
- **Rapid Prototyping Semester:** A Rapid Prototyping Semester is an academic term dedicated to the practical application of rapid prototyping techniques to create physical models or prototypes of products or designs. It provides students with hands-on experience in transforming digital designs into tangible objects.
- **Research Semester:** A research semester is a dedicated period within an academic program focused on independent research or scholarly inquiry. It provides students with the opportunity to delve deep into a specific research topic or project under the guidance of a faculty mentor.

Summer Term Registration:

The Summer Term is designed to help students catch up or get ahead. Here are the guidelines:

- **Eligibility:** Students can register for summer courses if they have backlogs to clear, need to fulfill pre-requisites, or have been approved for acceleration.
- **Credit Limit:** The maximum credit load for the summer term is 12.
- **Timetable Clashes:** Students should ensure there are no conflicts in their summer course schedule.
- **Attendance & Promotion:** The same policies apply as in regular semesters, except that attendance condonation is not available in the summer.

Course Categories

- **Humanities, Arts and Social Sciences (HAS):** The Humanities, Arts, and Social Sciences (HAS) category encompasses a diverse range of academic disciplines designed to broaden students' perspectives beyond their core areas of study. As part of the undergraduate curriculum, students can choose from a variety of courses within this category, including Foreign Language Electives and Management Electives. These courses offer valuable opportunities for students to develop skills in communication, cultural understanding, and management, complementing their technical education and fostering a well-rounded academic experience.
- **Basic Science Courses (BSC):** The Basic Science category covers key courses in subjects like Mathematics, Physics, and Chemistry, providing a strong scientific foundation for undergraduate students. This category includes Mathematics Electives and Science Electives, offering students the flexibility to choose courses that align with their interests. These courses help develop essential problem-solving and analytical skills, which are critical for understanding advanced concepts in their field. Basic Science courses also play a vital role in applying scientific principles to real-world engineering and research challenge.
- **Engineering Science Courses (ESC):** The Engineering Science category comprises foundational engineering courses that introduce students to essential principles and methods used in various engineering fields. These courses provide the necessary technical background and practical knowledge required for more advanced study and specialization in engineering disciplines.
- **Professional Core Courses (PCC):** Professional Core Courses (PCC) are essential courses within each engineering discipline that provide foundational knowledge and skills critical to the field. These courses are integral to the curriculum and ensure that students acquire the core competencies necessary for their professional practice.

- **Flexi Core Courses (FCC):** Flexi Core Courses offer students a degree of flexibility within their core curriculum. These courses are designed to complement the professional core courses while allowing students to select topics that align with their career goals and personal interests. Flexi Core Courses are integral to ensuring that students receive a comprehensive education while exploring specialized areas that may not be covered in the traditional core courses.
- **Skill Development Courses (SDC):** Skill Development Courses are designed to equip students with practical, hands-on skills that enhance their employability and professional capabilities. These courses often focus on soft skills, technical proficiency, and industry-relevant competencies, such as communication, teamwork, leadership, digital literacy, and industry-specific software tools. By offering both theoretical knowledge and practical training, these courses help bridge the gap between academia and the professional world.
- **Professional Elective Courses (PEC):** Professional Elective Courses (PEC) are required for students who wish to pursue a specific specialization within their field of study. These courses allow students to focus on advanced topics and gain in-depth knowledge in their area of interest, tailoring their education to align with their career goals. By completing the designated PECs, students can achieve a degree of specialization that enhances their expertise and prepares them for specific roles or industries in their professional journey.
- **Project Research and Internship (PRI):** Project Research and Internship courses provide students with real-world experience by engaging them in research projects and internships in industry or academia. These courses are essential for developing practical problem-solving skills, fostering innovation, and giving students the opportunity to apply the theoretical knowledge gained in the classroom to real-life scenarios. Through internships and research projects, students can gain industry exposure, improve their technical skills, and prepare themselves for professional careers or advanced studies.
- **Open Elective Courses (OEC):** Open Elective Courses offer students the flexibility to explore subjects outside their core discipline, fostering interdisciplinary learning and intellectual diversity. Available across all university programs, these courses encourage students to integrate knowledge from various fields, promoting innovation and a holistic understanding of global issues. Open Electives play a key role in broadening student academic perspectives and preparing them for multifaceted professional challenges.
- **Value-Added Courses (VAC):** Value-Added Courses are designed to enhance employability by providing students with training that leads to globally recognized certifications or specialized skills. These courses focus on industry-relevant knowledge and practical applications, ensuring students are well-prepared for current job market demands. By offering advanced skills and certifications, Value-Added Courses give students a competitive edge in their careers.
- **Social Immersive Learning (SIL):** Social Immersive Learning (SIL) is an informal learning approach facilitated through the Student Activity Centre, where students earn credits by actively participating in a wide range of events. These include Extension, Social & Outreach Events, Technology Club Events, Literary, Hobby & Cultural Events, Innovation, Incubation & Entrepreneurship Events, and Health & Well-Being Events. SIL emphasizes experiential and activity-based learning, fostering personal growth and social engagement. The course is evaluated based on the points students accumulate through their involvement, offering a flexible, real-world learning experience that complements their formal education.
- **Bridge Courses:** Bridge Courses are designed to address academic gaps and ensure continuity between Basic Sciences, Engineering Sciences, and Professional Courses. These courses, identified through gap analysis and stakeholder feedback, serve as a foundation for students, helping them transition smoothly between academic levels or disciplines. Bridge Courses reinforce fundamental concepts and skills, preparing students for more advanced coursework in their academic programs.
- **Audit Courses (AUC):** Audit courses are courses that students can attend without receiving a formal grade or credit towards their degree. These courses are often chosen by students who want to learn a subject for personal enrichment or to gain knowledge in areas outside of their major.

- **Honors Flexi Core Courses (HFC):** Honors Flexi Core Courses (HFC) provide students pursuing honors programs with the flexibility to choose from a range of core courses tailored to their specific academic interests and career goals. These courses are designed to offer advanced content and greater depth in core subjects, allowing students to personalize their academic journey while fulfilling the requirements of their honors program.
- **Honors Through Research Courses (HRC):** Honors Through Research Courses (HRC) enable students to engage in in-depth research projects as part of their honors curriculum. These courses focus on developing student research skills, critical thinking, and analytical abilities, allowing them to contribute original knowledge to their field of study. Through hands-on research experiences, students gain valuable insights and prepare for advanced academic or professional pursuits.
- **Honors Through Innovation Courses (HIC):** Honors Through Innovation Courses (HIC) emphasize creativity and innovation within the honors program framework. These courses encourage students to explore cutting-edge technologies, develop novel solutions to real-world problems, and engage in entrepreneurial activities. By focusing on innovation, students can apply their learning to create impactful projects and drive advancements in their areas of interest.
- **Honors Through Experiential Learning Courses (HEC):** Honors Through Experiential Learning Courses (HEC) integrate practical, hands-on experiences with academic study. These courses offer students opportunities to apply theoretical knowledge in real-world settings through internships, fieldwork, or community projects. HEC courses aim to enhance student learning by providing experiential opportunities that complement their honors education and contribute to their personal and professional development.
- **Minor Degree Courses (MIN):** Students pursuing a Minor Degree must complete a designated set of Minor Degree Courses. These courses are carefully selected to provide a structured and cohesive understanding of the minor subject, complementing the student's major field of study. By fulfilling these requirements, students gain specialized knowledge and skills in an additional discipline, which enhances their overall academic profile and broadens their career opportunities.
- **Minor Skill Development Courses (MSDC):** Minor Skill Development Courses (MSDC) must be completed as part of the selected minor degree. These courses are designed to provide targeted skill-building opportunities relevant to the minor field, focusing on practical and industry-specific competencies. By engaging in MSDC, students develop specialized skills that complement their major and enhance their overall expertise, making them more versatile and competitive in their chosen career paths.
- **Second Major Flexi Core Courses (SMFC):** Second Major Flexi Core Courses (SMFC) are designed for students pursuing a second major, offering flexibility in selecting core courses that meet the requirements of both their primary and secondary majors. These courses allow students to integrate and balance the demands of two distinct fields of study, providing a comprehensive educational experience across discipline.

Requirements for the award of Degree

To be eligible for the award of a B.Tech. degree, a student must successfully fulfill the following criteria:

- **Credit Requirements:** Earn the minimum number of credits specified in the program structure.
- **Focused Training:** Successfully undertake specific training in focused areas that enable students to be successful in their chosen career tracks. The focused areas are: (a) Employment in MNCs, (b) Civil Services (c) Higher Studies (d) Research and (e) Entrepreneurship.
- **Certifications:** Successfully complete at least three global certifications or value-added courses in the chosen discipline, along with one in yoga, sports & games, or fine arts.
- **Internships:** Complete both a Social Internship and a Technical Internship.

- **Audit Courses:** Successfully complete all audit courses outlined in the program structure.
- **Minimum CGPA:** Achieve a minimum Cumulative Grade Point Average (CGPA) of 5.25 by the end of the program.
- **Extra Courses:** Students with extra courses having 'DT' or 'F' grades can still graduate if they meet all other requirements. However, these courses will be factored into the CGPA calculation.
- **Time Limit:** Complete all requirements within:
 - A minimum of 8 regular semesters (excluding summer terms)
 - A maximum of 8 years

Note: The student is awarded a B.Tech. (Honors / Specialization / Minor / Double Major) degree based on the chosen academic flexibility, provided they fulfill all the credit and outcome requirements specified for each degree (refer to degree-wise requirements under Design your own Degree) in addition to meeting the regular B.Tech. degree requirements mentioned above.

Multiple Entry and Exit System

Multiple Entry and Exit System (MEES) empowers students to make their own academic decisions, allowing them to rejoin their studies at a later point and achieve their career goals. As per NEP guidelines, undergraduate degrees can be three or four years long, with multiple entry and exit points. Students can earn certificates, diplomas, or degrees based on their progress.

Entry and Exit Options:

- 1st Year (Level 5 - Undergraduate Certificate):
 - Entry: Secondary School Leaving Certificate (Grade 12/Intermediate)
 - Exit: Certificate in Computational Thinking & Engineering Science (40 credits + 4 skill development credits)
- 2nd Year (Level 6 - Undergraduate Diploma):
 - Entry: Completion of the first year with a certificate.
 - Exit: Diploma in the respective discipline (80 credits + 4 skill development credits, with at least 40 credits at Level 6)
- 3rd Year (Level 7 - Bachelor's Degree):
 - Entry: Completion of two years with a diploma
 - Exit: Bachelor of Science in the respective discipline (120 credits + 4 skill development credits across Levels 5, 6, and 7)
- 4th Year (Level 8 - Bachelor's Engineering Degree):
 - Entry: Completion of a three-year B.Sc. degree with a minimum CGPA of 7.5.
 - Exit: B.Tech. degree (minimum 160 credits from Levels 5 to 8).

Note: These degree levels align with the NHEQF. While the student is provided with MEES, the maximum time limit for completion of degree must still be adhered for the award of degree.

Branch Transfer

A student admitted to a particular Branch of the B.Tech. Program will normally continue studying in that branch until the completion of the program. However, in special cases the KLEF may permit a student to change from one branch to another after the second semester, provided s/he has fulfilled admission requirement for the branch into which the change is requested.

The rules governing change of branch are as listed below:

- (a) Top 1% (based on CGPA until 2nd semester) students will be permitted to change to any branch of their choice within the program discipline.
- (b) Apart from students mentioned in above clause, those who have successfully completed all the first and second semester courses and with CGPA greater than or equal to 8 are also eligible to apply, but the change of Branch in such case is purely at the discretion of the KLEF.
- (c) All changes of Branch will be effective from third semester. Change of branch shall not be permitted thereafter.
- (d) Change of branch once made will be final and binding on the student. No student will be permitted, under any circumstances, to refuse the change of branch offered.
- (e) Students in clause (a) and (b) may be permitted subject to the availability of seats in the desired branch.

Academic Bank of Credits

- ABC helps the students to digitally store their academic credits from any higher education institute registered under ABC in order to award Certificate/Diploma/Degree/Honors based on the credits earned by the student.
- All the credits acquired by the students are stored digitally by registering into Academic Bank of Credits (ABC) portal. It also supports retaining the credits for a shelf period and continue their program study with multiple breakovers.
- Students may exit from their current program of study due to any unforeseen reasons or to focus on their chosen career path. In such cases, the student may break for a period of time (preferably not in the middle of an academic year) and may continue with the program of study at a later stage.
- Students must be able to complete their program by not exceeding the maximum duration of the program. If not, they may be issued with a Certificate, diploma, degree or honors based on the credits acquired over the period of time for all the programs approved by UGC.

Award of Class

A student having cleared all the courses and met all the requirements for the award of degree with:

- **Pass class:** CGPA greater than or equal to 5.25 and lesser than 5.75.
- **Second class:** CGPA greater than or equal to 5.75 and lesser than 6.75.
- **First class:** CGPA greater than or equal to 6.75 and lesser than 7.75
- **First class with Distinction:** CGPA greater than or equal to 7.75, provided the student has cleared all the courses in first attempt and must have fulfilled all the program requirements in program specified minimum years duration.

Award of Medals

KLEF awards Gold and Silver medals to the top two candidates in each program after successful completion of their study. The medals are awarded based on their CGPA during the Annual Convocation with the following constraints:

- The grade obtained through betterment/ supplementary will not be considered for this award.
- He/She must have obtained first class with distinction for the award of Gold or Silver-medal.

Course Flexibilities

In line with the institution's commitment to personalized learning, courses are offered in multiple modes, allowing students to tailor their academic journey based on personal preferences, career goals, and learning styles. The available modes include:

- **Regular Mode:** It is the traditional method of learning, involving in-person classroom instruction, a structured curriculum, and traditional assessments. This mode provides students with a structured and predictable learning environment, facilitating direct interaction with professors and classmates. It is suitable for students who prefer a traditional learning approach and value face-to-face interaction.
- **Advanced Mode:** This mode is designed for students seeking a more rigorous academic experience, this mode offers additional credits, in-depth theoretical studies, research projects, and complex problem-solving evaluations. It is particularly suitable for students participating in honors programs.

- **Experiential Mode:** This mode emphasizes practical learning through real-world projects, lab work, or industry interactions. It offers variable credits based on the extent of practical involvement and assessments centered around project outcomes and presentations. Honors students pursuing experiential learning often choose this option.
- **MOOCs Mode:** Massive Open Online Courses (MOOCs) are utilized to support independent learners, such as students engaged in internships or practice school. Students can earn credits by completing accredited online courses at their own pace. Assessments in this mode may include online quizzes, certifications, and institutional evaluations.
- **Work-in-lieu Mode:** It allows students to substitute certain coursework with relevant work experience, internships, or on-the-job training. Credits are awarded based on the work performed, and evaluations are typically centered around performance reports, supervisor evaluations, and reflective essays. This mode is ideal for students who want to gain practical experience while fulfilling academic requirements.

Attendance calculation in a course

- **Attendance calculation for LTPS:** Attendance of a student on a course is calculated based on the credit-weighted average of the student's attendance in each of the LTPS components of the course.
- **Attendance start date:** Attendance is counted from the class commencement date. However, for transferred or newly admitted students, attendance in their admitted semester is counted from the date of admission.

Attendance requirements leading to promotion

- **Minimum Attendance:** 85% attendance is required for course promotion and appearing for the semester-end exam.
- **Condonation:** Up to 10% condonation by Principal, College of Engineering, is possible for medical emergencies with proper documentation submitted within a week. Students will be levied a condonation fee to appear for the semester-end exam.
- **Marginal Cases:** Attendance slightly below 75% due to severe medical or valid reasons may be considered for further relaxation by the condonation board appointed and headed by the Vice-Chancellor.

Attendance-based marks

- **Optional Marks:** Course coordinators can allocate up to 5% of the total marks for attendance, clearly stated in the course handout and approved by the Dean of Academics through proper channel.
- **Mark Distribution:** Marks are awarded based on attendance ranges: 85-88% = 1 mark, 89-91% = 2 marks, and so on. Below 85% results in zero marks, even with condonation.
- **Applicability:** Attendance marks, if given, apply to all L-T-P-S components cumulatively, not just the theory part.

Attendance waiver

- **Eligibility:** Students with a CGPA and SGPA of 9.00 or higher in the previous semester can get an attendance waiver for up to three courses in the next semester, with prior approval from the Dean of Academics through proper channel.
- **Conditions:** Students using the attendance waiver can participate in all assessments and evaluation components without being marked ineligible due to attendance-based regulations.

Compensatory (Extra) attendance policy

- **Eligibility:** Students representing KLEF in events or participating in co-curricular / extracurricular activities can get compensatory attendance with prior written approval.
- **Limit:** Compensation is limited to 10% of total classes per course per semester and doesn't apply to the summer term.

Course-based promotion and detention policy

- **Minimum Attendance:** Students must meet the minimum attendance requirement to be promoted in a course. If a student fails to meet this requirement, their grade in the course will be marked as "DT", indicating that the student is detained in the course.
- **Next Steps after detention:** Student must re-register in a detained course and study it completely by attending the classwork, submitting all assessments, taking all evaluation components

Eligibility for appearing Sem-End Examination

A Student registered for a course and got promoted is eligible to write the Semester End Examination for that course unless found ineligible due to one or more of the following reasons:

- Shortfall of attendance.
- Acts of indiscipline.
- Withdrawal from a course.
- Non-payment of examination fees.
- Without a hall ticket.

Assessment & Evaluation

The assessment in each theory subject consists of Sem In Exams, in class quizzes/tutorials/home-assignments/Active Learning Methods (continuous assessment) and the Semester End Examination (SEE). Students are advised to refer to the course handout to get more detailed information on assessment.

- Sem In Examinations and the Semester End Examinations will be conducted as per the Academic Calendar.
- As per the necessity, the Supplementary examinations will be conducted at the discretion of Dean Academics with the approval of the Vice Chancellor.
- Students may have to take more than one examination in a day during Sem In exams, Semester End Examinations /Supplementary examinations.

College / School Name	Semester-In Evaluation (Weightage in percent) (A)	Sem End Examination (Weightage in percent) (B)	Minimum requirement for pass percent	
			(A+B)	B
College of Engineering	60	40	40	40

Semester-In Evaluation

The following guidelines are followed for the Semester In evaluation.

- The process of evaluation is continuous throughout the semester
- The distribution of marks for Semester In evaluation is 60 percent of aggregate marks of the course.
- The distribution of weightage for various evaluation components are decided and notified by the course coordinator through the course handout after approval by the Dean Academics, prior to the beginning of the semester.
- In order to maintain transparency in evaluation, answer scripts are shown to the students for verification, within one week of conduct of exam. If there is any discrepancy in evaluation, the student can request the course coordinator to re-evaluate.
- The solution key and scheme of evaluation for all examinations are displayed by the Course Coordinator in the appropriate web portal of the course, on the day of the conduct of examination.
- In case the student is unable to appear for any evaluation component owing to hospitalization, participation in extra/ co-curricular activities representing KLEF/ state/ country; the Dean Academics can permit to conduct of re-examination for such students.
- In case a student has missed any of the two in semester evaluations, S/he is eligible for and will be provided with an opportunity of appearing for re-examination.
- The pattern and duration of such examination are decided and notified by the Course Coordinator through the Course handout, after approval from the Dean Academic.
- To maintain transparency in evaluation, answer scripts are shown to the students for verification. If there is any discrepancy in evaluation, the student can request the Controller of Examinations to re-evaluate.
- If a student earns F grade in any of the courses of a semester, an instant supplementary exam (for only Semester End Exam component) will be provided within a fortnight of the declaration of the results.

Semester-End Evaluation

The following guidelines are followed for the End Semester evaluation.

- The end-semester evaluation typically includes a variety of components such as Sem End Exams, projects, presentations, or practical assessments, skill assessments as detailed in the course handout.
- Each component is evaluated based on the criteria outlined in the course handout.
- The distribution of weightage for various evaluation components are decided and notified by the course coordinator through the course handout after approval by the Dean Academics, prior to the beginning of the semester.
- To pass in a course, student must meet or exceed the minimum passing marks specified for each end semester summative assessment component mentioned in the course handout.
- The key and scheme of evaluation for all examinations are displayed by the Course Coordinator in the appropriate web portal of the course, on the day of the conduct of examination.
- In case the student is unable to appear for any Sem end summative evaluation component owing to hospitalization, participation in extra/ co-curricular activities representing KLEF/ state/ country; student can request for re-examination by taking prior permission from Dean Academics.
- If a student earns F grade in any of the courses of a semester, an instant supplementary exam (for only Semester End Exam component) will be provided within a fortnight of the declaration of the results.

Absence in Assessment and Examination

If a student misses a formative assessment component (quizzes, assignments, etc.) due to illness or other valid reasons, no retakes will be permitted, and a score of zero will be recorded. However, in cases of an excused absence, the instructor may allow the student to retake the assessment, subject to written approval from both the Principal and the relevant Head of Department.

Make-up Exams:

A student's absence from Semester In or Semester End Exams will only be considered for a make-up exam under the following circumstances.

- Pre-approved participation in university/state/national/international co-curricular or extracurricular activities.
- Illness or medical emergencies resulting in hospitalization, with a doctor's certification explicitly stating the student's inability to attend the exam within the designated period.
- Death of an immediate family member.

Remedial Exams:

- Remedial exams are conducted for students who score less than 60% on Semester In Exam I and have attended at least 85% of the remedial classes.
- For courses without remedial classes, no remedial exam will be scheduled.
- If a student does not take or scores less than 60% on Semester In Exam I, they must attend remedial classes and maintain a minimum 85% attendance to be eligible for the remedial exam. The remedial exam score will then be considered.
- The number of remedial classes will be 33% of the regular classes held prior to Semester In Exam I. However, there are no remedial exams for Semester In Exam II or laboratory exams.

Remedial Classes Policy

The following categories of students are recommended to attend Remedial classes:

- Students who did not attend or obtain a minimum of 60 percent marks in the Sem In exam1.
- Students for whom CO1/CO2 is (are) not attained in Sem In Exam 1
- Any other student may also be permitted to attend remedial classes as per the discretion of the principal.

The following are the guidelines to conduct remedial classes:

- Remedial classes which are scheduled to be conducted usually one or two weeks post conclusion of Sem In exam1.
- The number of remedial classes to be conducted shall be 33 percent of regular classes held till the Sem In exam I.
- Remedial classes MUST NOT be scheduled during regular class work hours.

Assessment of Project/Research based Courses

- All project or research-based subjects must have a defined time limit for completion.
- The specific time limits for completion and schedule for monitoring and evaluation of performance of students will be announced each term.
- The final project report, after getting the plagiarism certificate, only will be considered and evaluated by the panel of examiners.
- Student project reports must follow the guidelines prescribed by the office of Dean Academics.

Grading Process

At the end of all evaluation components based on the performance of the student, each student is awarded based on absolute/relative grading system. Relative grading is only applicable to a section of a course in which the number of registered students is greater than or equal to 25. Choice of grading system is decided by the Course Coordinator with due approval of Dean Academics and is specified in the course handout.

(i) Absolute Grading:

The list of absolute grades and its connotation are given below:

Performance	Letter Grade	Grade Point	Percentage of marks
Outstanding	O	10	90 - 100
Excellent	A+	9	80 - 89
Very Good	A	8	70 - 79
Good	B+	7	60 - 69
Above Average	B	6	50 - 59
Average	C	5	46 - 49
Pass	P	4	40 - 45
Fail	F	0	0 - 39
Absent	AB	0	Absent

(ii) Relative Grading:

The following table lists the grades and its connotation for relative grading:

Letter Grade	Grade Point	Grade Calculation
O	10	total marks $\geq 90\%$ and total marks $\geq \mu + 1.50\sigma$
A+	9	$\mu + 0.50\sigma \leq \text{total marks} < \mu + 1.50\sigma$
A	8	$\mu \leq \text{total marks} < \mu + 0.50\sigma$
B+	7	$\mu - 0.50\sigma \leq \text{total marks} < \mu$
B	6	$\mu - 1.00\sigma \leq \text{total marks} < \mu - 0.50\sigma$
C	5	$\mu - 1.25\sigma \leq \text{total marks} < \mu - 1.00\sigma$
P	4	$\mu - 1.50\sigma \leq \text{total marks} < \mu - 1.25\sigma$ or ≥ 40
F	0	total marks $< \mu - 1.50\sigma$ or total marks ≤ 39
AB	0	Absent

μ is the mean mark of the class excluding the marks of those students who scored greater than or equal 90 percent and less than or equal 40 percent after rounding the percentages to the next highest integer. σ is the standard deviation of the marks.

Course handout

A course handout is a document that provides essential information about a specific course. It's like a roadmap that guides you through the course, helping you understand the expectations, assignments, and grading criteria.

Significance of Course Handout:

- **Clarity and Organization:** Course handouts help you stay organized and focused by outlining the course structure, topics, and deadlines.
- **Expectations:** They communicate the instructor's expectations for your participation, assignments, and overall performance.
- **Grading:** Course handouts outline the grading criteria, so you know exactly how your work will be evaluated.
- **Resources:** They often list valuable resources, such as textbooks, articles, or online tools, that can aid your learning.

Expectations from the course handout:

- **Course Description:** A brief overview of the course, its goals, and its relevance to your studies.
- **Learning Outcomes:** Clear goals for what you should be able to do by the end of the course. These outcomes will help you understand the skills and knowledge that are expected to gain.
- **Instructor Information:** Contact details, office hours, and specific communication preferences.
- **Course Schedule:** A tentative timeline of topics, assignments, and exams.
- **Required Materials:** A list of textbooks, articles, or other materials essential for the course.
- **Assessment Methods:** A breakdown of how your final grade will be determined, including the weight of assignments, exams, and participation.
- **Assignment Guidelines:** Detailed instructions for each assignment, including due dates, submission requirements, and expectations.

Effective use of the course handout:

- **Refer to it regularly:** Check back to keep track of important dates and assignments.
- **Highlight key points:** Make notes or highlight sections that are particularly important to you.
- **Ask questions:** If something isn't clear, bring it up in class or during office hours.

Betterment

- A student may reappear for the semester-end examination for betterment, only in the theory part of a course to improve their grade, provided that the student has passed the course, his/her CGPA is less than or equal to 6.75 and the grade in the respective course is equal to or lower than a 'C'. In case of reappearing for a course, the best of the two grades will be considered.
- A student may re-register for any course in any semester during the program to improve their grade if the current grade in the course is lower than 'B+', with the approval of the Dean Academics and in accordance with academic regulations.
- A student cannot reappear for the semester-end examination in courses with an L-T-P-S structure such as 0-0-X-X, 0-0-X-0, 0-0-0-X, Social Internship, Technical Internship, Seminar, Term Paper, Project, Capstone Project, Practice School, Industrial Internship.
- A student is not eligible for the award of a Degree with Honors if they opt for the betterment option.

Supplementary

- A student is eligible for a supplementary exam if they don't meet the minimum passing marks for a course or if they fail any component of the end-of-semester assessments listed in the course handout.
- If a student has failed courses from a previous odd semester that are not offered in the current semester, the supplementary exams for those courses will be scheduled for the summer supply.

- As per the end semester assessment components listed in the course handout (i.e. end semester summative) if student fail any component, they are eligible for a supplementary exam. Only the component(s) student failed will be considered for this supplementary attempt, though in some cases, you might be allowed to retake all components to improve your marks.
- If a student fails any of the end-of-semester examinations in an odd semester, supplementary exams for the current semester's courses will be conducted within one month after the release of the results. These supplementary exams will only cover the courses offered in that specific odd semester.
- In cases where there is a clash between odd semester supplementary exams and other scheduled exams, students may take the supplementary exams during the summer supply.
- If a student fails any of the end-of-semester examinations in an even semester, supplementary exams will be scheduled either within one month after the release of the results (i.e. summer supply) or during the summer term.
- Student must register for supplementary exams within a specified period after the results are declared.
- Student may be required to pay a supplementary exam fee. Details on the fee structure and payment process will be provided along with the supplementary exam notification.
- A student is not eligible for the award of a degree with first class with Distinction, if they opt for the Supplementary option.

Revaluation

Students desirous of seeing their Semester End Examination answer scripts have to apply online to the COE for the same within the timeframe as declared by the COE by paying the prescribed fee through ERP. Student applications must be forwarded by the Head of the Department and the Principal of the School and then re evaluation fees are to be paid. The application along with the attached fee receipt must be submitted to the office of the COE.

- There is no provision for re evaluation in case of Lab/Practical/skilling exams, project, viva voce exam or seminar / design / mini project courses.
- The final grades awarded to each course shall be announced by the COE and the same will be made available to students through the website/notice boards.

Credit Transfer

Credit transfer between KLEF and other Institution:

Credit transfer from other institutions to KLEF or vice versa is permitted only for undergraduate program.

Credit transfer from KLEF to other institutions: Student studying in KLEF can take transfer to another institution under the following conditions:

- KLEF has signed MOU with the institution
- However, a student, after seeking transfer from KLEF can return to KLEF after a semester or year. Based on courses done in the other institution, equivalent credits shall be awarded to such students.

Credit transfer from another institution to KLEF:

A student studying in another institution can take transfer to KLEF under the following conditions:

- When a student seeks transfer, equivalent credits will be assigned to the student based on the courses studied by the student.

- To determine the equivalent credits for a course from a previous institution on a 10-point scale at KLEF, the number of credits of the course is multiplied by the equivalent grade point of the previous institution and then divided by the number of credits of the corresponding course at KLEF.
- If a course from the previous institution has zero credits and no grade assigned, the student must sit for the final examination for the equivalent course at KLEF.
- A transfer student seeking improvement in any course can take the final examination at KLEF, where the grade received at KLEF becomes the final grade recorded on their grade sheets.
- The student, when transferred from other institutions, must stick to the rules and regulations of KLEF.
- To graduate from KLEF, a student must study at least half of the minimum duration prescribed for a program at KLEF.

Credit Transfer Through MOOCs:

- Undergraduate students can get credits for MOOCs courses recommended by KLEF up to a maximum of 20% of their minimum credits required for graduation. The discretion of allocation of MOOCs courses equivalent to the courses in the curriculum lies with the office of the Dean Academics.
- A student may also be permitted to obtain 20 credits through MOOCs in addition to the minimum credits required for graduation. These 20 credits can also be utilized to acquire a Minor degree or an Honors degree if the courses are pronounced equivalent to those specified for the respective degrees by the office of the Dean Academics. These additional credits through MOOCs if to be considered for CGPA/Minor/Honors degree must be approved by Dean Academics prior to enrollment in the respective MOOCs.
- Students acquiring additional credits for Honors/Minor degree must adhere to the rules governing the award of the respective degree, otherwise, a student applying for registering into additional credits through MOOCs must possess a minimum CGPA of 7.5 till that semester.

Semester Promotion policy

Promotion is only course-based. Semester-based promotion is not applicable for B.Tech. students.

Counselling procedure

KLEF is committed to fostering a supportive and nurturing environment for our students, addressing not only their academic needs but also their psychological well-being. To achieve this, KLEF is implementing a comprehensive Mentor-Mentee Scheme aimed at providing holistic support through academic, career, and psychological counselling. To achieve this, KLEF implement a comprehensive Mentor-Mentee Scheme and establish the Central Academic Counselling Board (CACB) in addressing academic, career and student-psychological issues.

The Mentor-Mentee Scheme aims to provide personalized guidance and support to students throughout their academic journey. Each student shall be assigned a mentor from the faculty, who will act as a guide, counselor, and advocate for the student's academic and personal growth. The mentor-mentee relationship is intended to facilitate communication, goal-setting, and problem-solving.

The primary objectives of the Mentor-Mentee Scheme are:

- To facilitate a strong and positive mentor-mentee relationship that supports students' academic growth, personal development, and psychological well-being.
- To offer career counselling, guiding mentees in exploring career options, developing professional skills, and making informed career-related decisions.

- To provide psychological counselling, offering a safe space for mentees to discuss psychological concerns and providing appropriate support or referrals when needed.
- To provide tailored academic counselling, helping mentees set academic goals, plan their course of study, and navigate academic challenges effectively.

Academic Counselling:

The mentors oversee the following academic counselling activities which are not limited to:

- Providing guidance during academic registration sessions
- Monitoring attendance and addressing attendance-related concerns
- Communicating attendance and marks information to parents/guardians
- Addressing concerns related to backlogs and providing advice
- Advising on domain specializations and academic flexibilities
- Assisting students in exploring study abroad opportunities
- Conducting student and parent meetings to address academic concerns

Career Counselling:

The mentors oversee the following career counselling activities which are not limited to:

- Recommending technical skilling courses and certificate programs
- Facilitating internship opportunities and competitive exam preparations
- Guiding students through term papers, projects, hackathons, and coding challenges
- Providing information on higher education options and entrance exams
- Encouraging entrepreneurship awareness and guiding start-ups initiatives
- Assisting students in preparing for placements and future career goals
- Conducting student and parent meetings to discuss career aspirations

Psychological Counselling:

The Mentors oversee the following psychological counselling activities which are not limited to:

- Providing guidance on time management and classroom activities
- Addressing anti-ragging issues and promoting a positive attitude
- Providing support for managing mental stress and promoting well-being
- Addressing hostel, room, home, and food-related concerns
- Conducting student and parent meetings to address personal well-being

Mentor-Mentee allocation

- The Department Academic Counselling Board (DACB) is responsible for assigning approximately 20 students to each faculty member, who will act as their mentor. The mentors will guide and support their assigned students throughout their academic journey.
- For engineering students, the procedure includes a specific approach: during their first year, faculty members from the Fresh Engineering Department (FED) will be designated as counsellors/mentors. From the second year onwards, counsellors/mentors will be appointed from the students' respective parent departments, and these faculty members will continue as mentors until the students complete their course.
- The counselling program aims to help students develop their character, academic abilities, professional skills, and social responsibilities. Mentors play a vital role in this process by:
 - Maintaining detailed records of mentor-mentee interactions in the ERP system. Mentors are required to update the ERP with counselling remarks for both students and their parents every fortnight.
 - Providing regular updates to parents about students' academic progress, career developments, and physiological status through various communication channels, including phone calls, SMS, WhatsApp, and Telegram.
 - Ensuring that counselling remarks are accurately recorded in the ERP system, and reflecting these updates in DACB monthly reports and CACB semester reports.

Academic Counselling Board

- Academic Counselling Board is constituted by the Dean Academics. This board shall comprise of the Chairman, Convener, Principal/Director, HOD and Professor/Associate Professor. A student will be put under Academic Counselling Board in the following circumstances:
 - Has CGPA of less than 6.00.
 - Has F grade or Detained in multiple courses.
- The first level of Counselling such students will be done by the Mentor of the student and the HoD followed by the ACB and the list of students who have to undergo the ACB counselling be forwarded by the HoD to the Office of Dean Academics.
- The students undergoing the Academic Counselling Board process may be allowed to register only for a few courses based on the recommendation of Academic Counselling Board.

Rustication policy

A student may be rusticated from the KLEF on disciplinary grounds, based on the recommendations of any empowered committee, by the Vice Chancellor.

Malpractice penalty policy

The following actions constitute malpractice during examinations and are subject to disciplinary actions as outlined below:

Clause 1: Possession of unauthorized material in the examination hall (e.g., paper, notebooks, programmable calculators, cell phones, or any material related to the exam subject). This includes any marks on the candidate's body that could be used as an aid.

Penalty: Immediate expulsion from the examination hall, without cancelling the paper.

Clause 2: a) Providing or receiving assistance, or communicating with others via oral means, body language, or electronic devices (such as cell phones), either inside or outside the examination hall. b) Smuggling in or out answer sheets, additional sheets, or arranging to send out the question paper or answer sheets during or after the exam. c) Using objectionable or offensive language in the answer paper or in communication with examiners, or attempting to influence examiners to award passing marks. d) Exchanging answer scripts or additional sheets in the examination hall

Penalty: Expulsion from the examination hall and cancellation of the comprehensive examination performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him

Clause 3: Copying from any unauthorized material (e.g., paper, books, programmable calculators, palm computers) during the exam.

Penalty: Expulsion from the examination hall, cancellation of the exam performance in that subject, and a fine of Rs. 1000.

Clause 4: a) Taking the answer script outside the exam hall, tearing the script or any part of it inside or outside the hall. b) Appearing for the exam in a drunken condition.

Penalty: Expulsion from the examination hall and cancellation of comprehensive examination performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining comprehensive examinations of the subjects of that semester/year.

Clause 5: a) Disobeying examination authorities, creating disturbances, organizing or instigating a walk-out, threatening or assaulting officials, or damaging property inside or outside the exam hall. b) Possession of any lethal weapon or firearm in the examination hall.

Penalty: Expulsion from the exam hall and cancellation of exam performance in all subjects. The student will be debarred from future exams and may forfeit their seat. Outsiders will be handed over to the police.

Clause 6: Impersonation during the examination.

Penalty: Both the impersonator and the original candidate will be expelled from the exam hall. The original candidate's performance will be cancelled in all subjects, including practical and project work, and they will be barred from exams for two consecutive semesters. Continuation in the course is subject to academic regulations. The impersonator (if an outsider) will be handed over to the police.

Clause 7: Repeated offenses.

Penalty: For a second offense, the candidate will face expulsion from the exam hall and cancellation of all exam performances for that term, with a fine of Rs. 1000. Repeated academic dishonesty may result in the issuance of a transfer certificate (TC).

Clause 8: Any other form of malpractice not specified.

Penalty: Punishment will be determined by the Examination Malpractice Committee and approved by the Vice-Chancellor.

Plagiarism Penalty Policy

Plagiarism is considered a serious breach of academic integrity, compromising both the ethical standards of the university and the intellectual development of students. The university enforces a strict zero-tolerance policy regarding plagiarism, and all students are expected to uphold the highest standards of academic honesty.

Penalties for plagiarism will be applied as follows:

First Offense:

- Minor Plagiarism (e.g., improper citation, small portions of copied work): The student will receive a warning and be required to resubmit the work with proper citations. Marks may be reduced up to 50%.
- Major Plagiarism (e.g., copying significant portions, submitting another person's work): The assignment will receive a grade of zero. The student may be required to attend a mandatory workshop on academic integrity.

Second Offense:

- Any second offense, regardless of severity, will result in a zero for the assignment and an official letter of reprimand placed in the student's record. The student will be placed on academic probation.

Third Offense:

- The student will face suspension from the university for one academic term. A record of academic misconduct will be permanently placed in the student's academic file.

Repeated Violations:

- Further violations after the third offense may lead to expulsion from the university.

In cases of group work, if plagiarism is identified, all group members will be held equally accountable unless it can be demonstrated that the act of plagiarism was isolated to specific individuals.

Terminology

Absolute Grading: Absolute grading is a method of assigning grades based on predetermined criteria or standards rather than comparing student performance to other students in the class (See: Relative Grading where the performances are compared).

Academic Bank of Credits (ABC): Academic Bank of Credits, an initiative of Government of India, is a digital platform that stores the academic credits earned by a student throughout their educational journey. It's essentially a virtual repository of a student's academic achievements.

Academic Council: The Academic Council is the highest academic body of the University and is responsible for the maintenance of standards of instruction, education and examination within the University. The Academic Council is an authority as per UGC regulations and has the right to decide all academic matters including academic research.

Academic Year: It is the period necessary to complete an actual course of study within a year. It comprises of two consecutive regular semesters i.e., Odd and Even semesters.

Acceleration: Acceleration of courses refers to a student's ability to progress through their academic program at a faster pace than traditional timelines.

Attendance: Attendance refers to the record of a student's presence or absence in educational institutions. It is a critical factor influencing academic performance, overall development, and future success.

Audited Course: It is a course of study which has zero credits and has a "Satisfactory" or an "Unsatisfactory" grade.

Backlog Course: A course is considered to be a backlog if the student has obtained 'F' grade or detained in the course.

Basic Sciences: The courses of foundational nature in the areas of Mathematics, Physics, Chemistry, Biology etc., are offered in this category.

Betterment: Betterment is a way that contributes towards improving the students' grade in any course(s). It can be done by either (a) re-appearing or (b) re-registering for the course.

Board of Studies: Board of Studies (BOS) is an authority as defined in UGC regulations, constituted by Vice Chancellor for each of the department separately. They are responsible for curriculum design and update in respect of all the programs offered by a department.

Branch of Study: It is a branch of knowledge, an area of study or a specific program (like Civil Engineering, Mechanical Engineering, Electrical and Electronics Engineering etc.)

Bridge Courses: Courses which are required to bridge the continuity among the Basic sciences/Engineering Sciences/professional courses (both core and electives) and are identified through gap analysis carried out using feedback obtained from various academic stakeholders are termed as Bridge Courses. These courses also do not yield any credits but require a "Satisfactory" result to register into the attached professional courses.

Capstone Project: A capstone project is the culminating academic experience for many students, typically undertaken in the final year of a degree program. It's designed to integrate and apply the knowledge and skills acquired throughout the course of study.

Certificate course: It is a course that makes a student gain hands-on expertise and skills required for holistic development. It is a mandatory, non-credited course for the award of degree.

Change of Branch: Change of branch means transfer from one's branch of study to another.

Compulsory course: Course required to be undertaken for the award of the degree as per the program.

Course: A course is a subject offered by the University for learning in a particular semester.

Course Handout: Course Handout is a document which gives a complete plan of the course. It contains the details of the course viz. Course title, Course code, Pre-requisite, Credit structure, team of instructors, Course objectives, Course rationale, Course Outcomes and the relevant syllabus, textbook(s) and reference books, Course delivery plan and session plan, evaluation method, chamber consultation hour, course notices and other course related aspects. In essence, course handout is an agreement between students (learners) and the instructor.

Course Outcomes: The essential skills that need to be acquired by every student through a course.

Course Withdrawal: Withdrawing from a Course means that a student can drop from a course within the first two weeks of the odd or even Semester (deadlines are different for summer sessions). However, s/he can choose a substitute course in place of it by exercising the option within 5 working days from the date of withdrawal.

Credit: A credit is a unit that gives weight to the value, level or time requirements of an academic course. The number of 'Contact Hours' in a week of a particular course determines its credit value. One credit is equivalent to one lecture hour per week or two hours per week of tutorials/ self-learning/ practical/ field work during a semester.

Credit point: It is the product of grade point and number of credits for a course.

Credit Transfer: The procedure of granting credit (s) to a student for course(s) undertaken at another institution.

Cumulative Grade Point Average (CGPA): It is a measure of cumulative performance of a student over all the completed semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

Curriculum: Curriculum is a standards-based sequence of planned experiences where students practice and achieve proficiency in content and applied learning skills. Curriculum is the central guide for all educators as to what is essential for teaching and learning, so that every student has access to rigorous academic experiences.

Deceleration: Deceleration of courses typically refers to a student's decision to reduce their course load or extend the time taken to complete a degree program.

Degree: A student who fulfils all the Program requirements is eligible to receive a degree.

Degree Requirements: Degree requirements are the specific courses, credits, and academic standards that a student must fulfill to earn a particular degree.

Degree with Specialization: A student who fulfils all the Program requirements of her/his discipline and successfully completes a specified set of Professional elective courses in a specialized area is eligible to receive a degree with specialization.

Department: An academic entity that conducts relevant curricular and co-curricular activities, involving both teaching and non-teaching staff and other resources.

Designing Your Own Degree: Designing your own degree is a revolutionary concept that empowers students to create a customized educational path aligned with their passions, career goals, and unique learning styles.

Dissertation: Dissertation is a substantial piece of original research written and defended by a candidate for a degree.

Detention in a course: Student who does not obtain minimum prescribed marks in continuous in-semester evaluation and /or minimum prescribed attendance in a course shall be detained in that course.

Double Major Degree: A double major degree allows students to specialize in two academic fields while earning a single bachelor's degree.

Dropping from the Semester: A student who doesn't want to register for the semester should do so in writing in a prescribed format before commencement of the semester.

End-semester Evaluation: End-semester evaluation is a summative assessment conducted at the conclusion of an academic term to measure students' overall performance.

Elective Course: A course that can be chosen from a set of courses. An elective can be Professional Elective, Open Elective, Management Elective and Humanities Elective.

Engineering Sciences: The courses belonging to basic evolutionary aspects of engineering from Mechanical Sciences, Electrical Sciences and Computing like Engineering Mechanics, Data structures, Network Theory, Signal Analysis.

EPICS: EPICS stands for Engineering Projects in Community Service. It's a unique program that combines engineering education with community service.

Evaluation: Evaluation is the process of judging the academic work done by the student in her/his courses. It is done through a combination of continuous in-semester assessment and semester end examinations.

Experiential Learning: Experiential learning is a process through which students develop knowledge, skills, and values from direct experiences outside a traditional academic setting. It involves learning by doing, where students engage in hands-on activities, real-world problem-solving, and reflective practices to gain deeper understanding and practical application of the concepts they are studying.

Flexi-Core course: A Flexi-Core course typically refers to an elective or optional course within a degree program that offers students flexibility in choosing subjects based on their interests and career goals.

Formative Assessment: Formative assessment is ongoing evaluation of student understanding to inform instruction and facilitate learning.

Flipped Learning: Flipped learning is an instructional strategy that reverses the traditional teaching model. In flipped learning, students are introduced to new content outside of class, usually through video lectures, readings, or other materials. The in-class time is then used for more interactive activities, such as discussions, problem-solving, group work, and applying the concepts learned at home.

Grade: It is an index of the performance of the students in a said course. Grades are denoted by alphabets.

Grade Point: It is a numerical weight allotted to each letter grade on a 10 - point scale.

Grade Point Average (GPA): Grade Point Average is a numerical representation of a student's academic performance. It is calculated by averaging the numerical equivalents of letter grades earned in courses, considering the number of credit hours for each course.

Honors Degree: A student who fulfills all the Program requirements of her/his discipline and successfully completes a specified set of additional courses within the same program is eligible to receive an Honors degree.

Humanities, Arts and Social Sciences (HAS): It is a broad term that groups together the academic disciplines of humanities, arts and social sciences.

Industrial Training: Training program undergone by the student as per the academic requirement in any company/firm.

Industrial Visit: Visit to a company/firm as per the academic requirement.

Internship: Internship is a temporary work experience offered by an organization for a limited period. It provides students, graduates, or career changers with an opportunity to gain practical skills and experience in a specific field.

In-Semester Evaluation: Summative assessments used to evaluate student learning, acquired skills, and academic attainment during a course.

Induction Courses: Student who gets admitted into B.Tech. program must complete a set of Induction courses for a minimum period of 3 weeks and obtain a "Satisfactory" result prior to registering into 1st Semester of the Program.

Innovation Semester: An Innovation Semester is a dedicated academic term focused on cultivating a culture of creativity, problem-solving, and entrepreneurial thinking.

Lecture: A lecture is a formal instructional session where an instructor presents information to a large group of students.

Make-up Test: An additional test scheduled on a date other than the originally scheduled date.

Malpractice: Malpractice typically refers to academic dishonesty or misconduct during examinations or coursework. This can include a wide range of behaviors that compromise the integrity of the evaluation process.

Management elective: A course that develops managerial skills and inculcates entrepreneurial skills.

Minor Degree: A student who fulfills all the Program requirements of her/his discipline and successfully completes a specified set of courses from another discipline is eligible to receive a minor degree in that discipline.

Multiple Entry and Multiple Exit (MEME): It is an educational framework designed to provide flexibility in learning pathways, allowing students to enter and exit educational programs at various stages based on their individual needs, prior knowledge, and career goals.

National Education Policy (NEP): NEP 2020 is a comprehensive framework for transforming India's Education System. It aims to create an equitable and vibrant knowledge society by providing high-quality education to all.

NHEQF: NHEQF stands for National Higher Education Qualifications Framework. It's a comprehensive framework designed to standardize and classify higher education qualifications in India. The primary goal of NHEQF is to ensure that qualifications from different institutions are comparable and recognized nationally and internationally.

Open Elective: This is a course of interdisciplinary nature. It is offered across the University for all Programs.

Overloading: Registering for more number of credits than normally prescribed by the Program in a semester.

Peer Learning: Peer learning is a collaborative learning process where students learn from each other. It involves sharing knowledge, skills, and experiences among peers.

Practical: A practical is a hands-on session where students apply theoretical knowledge in a real-world or laboratory setting. Practical sessions are designed to develop students' technical skills, problem-solving abilities, and understanding of experimental procedures.

Practice School: It is a part of the total program and takes one full semester in a professional location, where the students and the faculty get involved in finding solutions to real-world problems. A student can choose Project/Practice School during his/her final year to meet the final requirements for the award of degree.

Pre-requisite: A course, the knowledge required for registration into higher level course.

Product Development Semester: A Product Development Semester is an academic term dedicated to the process of creating new products or improving existing ones.

Professional Core: The courses that are essential constituents of each engineering discipline are categorized as Professional Core courses for that discipline.

Professional Elective: A course that is discipline centric. An appropriate choice of minimum number of such electives as specified in the program will lead to a degree with specialization.

Program: A set of courses offered by the Department. A student can opt and complete the stipulated minimum credits to qualify for the award of a degree in that Program.

Program Educational Objectives: The broad career, professional, personal goals that every student will achieve through a strategic and sequential action plan.

Program Outcome (PO): Program outcomes are statements that describe what students are expected to know, understand, and be able to do upon completing a specific academic program.

Project: Course that a student must undergo during his/her final year which involves the student to undertake a research or design, which is carefully planned to achieve a particular aim. It is a credit-based course.

Project-Based Learning (PBL): Project-Based Learning is an instructional approach where students actively engage in real-world and personally meaningful projects.

Rapid Prototyping Semester: A Rapid Prototyping Semester is an academic term dedicated to the practical application of rapid prototyping techniques to create physical models or prototypes of products or designs.

Registration: Process of enrolling into a set of courses in a semester/ term of the Program.

Re-Registration: Student who are detained in courses due to attendance or marks criteria as per their regulation are given a chance to re-register for the same and complete it during the summer term.

Relative Grading: Relative grading is a method of assigning grades based on a student's performance compared to the rest of the class.

Remedial Exam: A remedial Exam is an assessment designed to identify specific areas of weakness or gaps in a student's knowledge or skills. It is typically administered after a student has performed poorly on a regular assessment.

Research Project: A research project is a systematic investigation undertaken to answer a specific question or address a particular problem.

Research Semester: A research semester is a dedicated period within an academic program focused on independent research or scholarly inquiry.

Research Seminar: A research seminar is a formal academic gathering where researchers present their ongoing work to a group of peers, faculty, and other interested individuals.

Self-learning: Self-learning is the process of acquiring knowledge and skills independently without formal instruction.

Semester: It is a period of study consisting of 15+1 weeks of academic work equivalent to normally 90 working days including examination and preparation holidays. The odd Semester starts normally in July and even semester in December.

Semester End Examinations: It is an examination conducted at the end of a course of study.

Skilling: It is a process of developing and enhancing specific skills that are essential for performing particular tasks or activities effectively. It involves structured training and practice aimed at equipping individuals with the practical abilities, knowledge, and competencies required for professional success and personal development.

Social Immersive Learning (SIL): Social Immersive Learning is a pedagogical approach that combines the power of social interaction with immersive technologies to create engaging and impactful learning experiences.

Social Service: An activity designed to promote social awareness and generate well-being; to improve the life and living conditions of society.

Student Outcomes: The essential skill sets that need to be acquired by every student during her/his program of study. These skill sets are in the areas of employability, entrepreneurial, social and behavioral.

Substitution of Elective course: Replacing an elective course with another elective course as opted by the student.

Summative Assessment: Summative Assessment is a type of evaluation that occurs at the end of a learning period.

Summer term: The term during which courses are offered from May to July. Summer term is not a student's right and will be offered at the discretion of the University.

Supplementary: A student can reappear only in the semester end examination for the Theory component of a course, subject to the regulations contained herein.

Term paper: A 'term paper' is a research report written by students that evolves their course-based knowledge, accounting for a grade. Term paper is a written original research work discussing a topic in detail. It is a credit-based course.

Tutorial: A tutorial is a small group session designed to provide personalized guidance and support to students. Tutorials often involve discussions, problem-solving activities, and hands-on practice to reinforce concepts learned in lectures.

Under-loading: Registering for lesser number of credits than normally prescribed for a semester in that Program.

Value-Added Courses: Courses leading to global certification and those which are conducted exclusively for employability are referred to as value added courses.

FAQs

Q: What is the Choice-Based Credit System (CBCS) and how does it work?

A: CBCS allows student to choose courses from various categories based on your interests and career goals. Each course has a credit value assigned to it, and you need to earn a minimum number of credits in each category and in total to complete your program.

Q: Can I choose electives based on my interests?

A: Yes, student has the flexibility to choose electives that align with your personal interests and career objectives.

Q: Can I choose my preferred faculty members for certain courses?

A: During registrations prior to commencement of each semester, if a course is offered for multiple sections and if multiple faculty are teaching the same course, you will then have a choice of selecting the section being taught by that faculty under whom you wish to study.

Q: When and how do I register for courses?

A: Student must register for courses on the designated registration day. There is a one-week window for adding courses and a two-week window for dropping or changing them.

Q: Can I get an attendance waiver?

A: Students with a CGPA and SGPA of 9.00 or higher in the previous semester can get an attendance waiver for up to three courses with prior approval.

Q: What is the minimum attendance requirement for promotion?

A: 85% attendance is required for course promotion and appearing for the semester-end exam.

Q: Can I transfer to a different branch?

A: Under special circumstances, you may be permitted to transfer branches after the second semester based on your CGPA and seat availability.

Q: Can I pursue a minor degree?

A: Yes, any student can pursue a minor degree by completing a specified set of courses from another discipline.

Q: Can I study some semesters in abroad?

A: KLEF University may have exchange programs or partnerships with foreign universities, allowing you to study abroad for a semester or year.

Q: Are there any extracurricular activities or clubs available?

A: Yes, KLEF offers various extracurricular activities and clubs, such as sports, cultural events, and student organizations.

Q: What happens if I have less than 85% attendance?

A: Upto 75% attendance, student may be eligible for condonation or marginal case consideration, but need to provide proper documentation and may be subject to fees. But falling below 75% will make you detain in the course.

Q: What happens if I detain a course?

A: Student who detained in a course must re-register for the course and study it again in summer term. If the detained course is not offered by the department, then the student can study other equivalent course from the same category upon taking approval from office of Dean Academics.

Q: What is ABC?

A: ABC enables you to digitally store your earned credits and potentially use them towards future studies at other institutions.

Q: Can I accelerate or decelerate my studies?

A: Students are generally recommended to register for 20 to 24 credits in each semester. Students who cannot cope up with such load, may consult their counsellor and Head of the Department to register in lower number of credits. This process is called "Deceleration". Students who do not register on time, may also be forced to decelerate to compensate the classwork that they missed due to late registration. In both the cases of deceleration, permission must be sought from Office of Dean Academics through proper channel. On the contrary, Students who wish to accelerate can register for upto 30 credits by selecting courses that are usually offered in later semesters and complete them in advance. Students may also use the optional Summer Term for accelerating courses upto 12 credits. In Similarly, a student may also register for credits lower than. However, you'll need approval from the Dean of Academics.

Q: Will I get my degree upon acquiring all the required credits?

A: Apart from fulfilling the total credit requirement, it is required to fulfill category and sub-category wise credit requirements and outcome requirements (which are clearly mentioned in the degree-wise credit requirements section) to be eligible for award of specific degree.

Q: Can I register for a course without promoting in its pre-requisite course?

A: No, student must promote in the pre-requisite course in order to register for a course having pre-requisite.

Program - Degrees(Design your own Degree)

S#	Major Flexibility	Program Addon
1	Honors through Experiential Learning	Minor
2	Honors through Experiential Learning	Double Major
3	Honors through Experiential Learning	Specialization
4	Honors through Experiential Learning	No Add-on
5	Honors through Innovation	Minor
6	Honors through Innovation	Double Major
7	Honors through Innovation	Specialization
8	Honors through Innovation	No Add-on
9	Honors through Research	Minor
10	Honors through Research	Double Major
11	Honors through Research	Specialization
12	Honors through Research	No Add-on
13	Honors	Minor
14	Honors	Double Major
15	Honors	Specialization
16	Honors	No Add-on
17	No Flexibility	Minor
18	No Flexibility	Double Major
19	No Flexibility	Specialization
20	No Flexibility	No Add-on

Degree-wise Credit Requirements

1. Honors through Experiential Learning with Minor

a) Credit Requirement

Total Credit Required: 202

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-SE-1	4	4	1	1	
8	BSC	BSC-SE-2	4	4	1	1	
9	BSC	BSC-SE-3	4	4	1	1	
10	ESC	ESC-CORE	30	30	8	8	
11	PCC	PCC-CORE	31	31	8	8	
12	FCC	FC-1	3	3	1	1	
13	HFC	HFC-CORE	0	16	0	4	
14	HEC	HEC-CORE	8	16	2	4	
15	SDC	SDP-1	2	4	1	1	
16	SDC	SDP-2	2	4	1	1	
17	SDC	SDP-3	2	4	1	1	
18	PEC	PE-1	5	5	1	1	
19	PEC	PE-2	3	3	1	1	
20	PEC	PE-3	5	5	1	1	
21	PEC	PE-4	3	3	1	1	
22	PRI	PRI-CORE	20	20	4	4	PROJECT
23	OEC	OE-1	4	4	1	1	
24	OEC	OE-2	4	4	1	1	
25	OEC	OE-3	4	4	1	1	
26	VAC	VAC-SPORTS	0	0	1	1	
27	VAC	VAC-CERT	0	0	4	4	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
28	AUC	AUC-CORE	0	0	5	6	
29	AUC	AUC-CAREER	0	0	1	1	
30	SIL	SIL-CORE	3	3	3	3	
31	MIN	MIN-CORE	16	16	4	4	MINOR
32	MSDC	MIN-SDP	4	4	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HEC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum One Scopus Journal Publication
- Minimum One Design Patents
- Two Consultancy Projects
- All MIN & MSDC Credits (16 + 4) must be from selected MINOR Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

2. Honors through Experiential Learning with Double Major

a) Credit Requirement

Total Credit Required: 207

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-SE-1	4	4	1	1	
8	BSC	BSC-SE-2	4	4	1	1	
9	BSC	BSC-SE-3	4	4	1	1	
10	ESC	ESC-CORE	30	30	8	8	
11	PCC	PCC-CORE	31	31	8	8	
12	FCC	FC-1	3	3	1	1	DOUBLE MAJOR
13	HFC	HFC-CORE	0	16	0	4	
14	HEC	HEC-CORE	8	16	2	4	
15	SDC	SDP-1	2	4	1	1	
16	SDC	SDP-2	2	4	1	1	
17	SDC	SDP-3	2	4	1	1	
18	PEC	PE-1	5	5	1	1	
19	PEC	PE-2	3	3	1	1	
20	PEC	PE-3	5	5	1	1	
21	PEC	PE-4	3	3	1	1	
22	PRI	PRI-CORE	20	20	4	4	PROJECT
23	OEC	OE-1	4	4	1	1	DOUBLE MAJOR
24	OEC	OE-2	4	4	1	1	DOUBLE MAJOR
25	OEC	OE-3	4	4	1	1	DOUBLE MAJOR
26	VAC	VAC-SPORTS	0	0	1	1	
27	VAC	VAC-CERT	0	0	4	4	
28	AUC	AUC-CORE	0	0	5	6	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CAREER	0	0	1	1	
30	SIL	SIL-CORE	3	3	3	3	
31	SMFC	SMFC-CORE	21	21	5	5	DOUBLE MAJOR
32	SMFC	SMFC-SDP	4	4	1	1	DOUBLE MAJOR

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HEC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum One Scopus Journal Publication
- Minimum One Design Patents
- Two Consultancy Projects
- All 40 Credits (SMFC+OEC+FCC) must be from selected Second Major Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

3. Honors through Experiential Learning with Specialization

a) Credit Requirement

Total Credit Required: 192

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-ME-3	0	0	0	0	
8	BSC	BSC-SE-1	4	4	1	1	
9	BSC	BSC-SE-2	4	4	1	1	
10	BSC	BSC-SE-3	4	4	1	1	
11	ESC	ESC-CORE	30	30	8	8	
12	PCC	PCC-CORE	31	37	8	8	
13	FCC	FC-1	3	3	1	1	
14	HFC	HFC-CORE	0	16	0	4	
15	HEC	HEC-CORE	8	16	2	4	
16	SDC	SDP-1	2	4	1	1	
17	SDC	SDP-2	2	4	1	1	
18	SDC	SDP-3	2	4	1	1	
19	SDC	SDP-4	4	4	1	1	SPECIALIZATION
20	PEC	PE-1	7	7	1	1	SPECIALIZATION
21	PEC	PE-2	3	3	1	1	SPECIALIZATION
22	PEC	PE-3	7	7	1	1	SPECIALIZATION
23	PEC	PE-4	3	3	1	1	SPECIALIZATION
24	PEC	PE-5	3	3	1	1	SPECIALIZATION
25	PRI	PRI-CORE	20	20	4	4	PROJECT
26	OEC	OE-1	4	4	1	1	
27	OEC	OE-2	4	4	1	1	
28	OEC	OE-3	4	4	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-SPORTS	0	0	1	1	
30	VAC	VAC-CERT	0	0	4	4	
31	AUC	AUC-CORE	0	0	5	6	
32	AUC	AUC-CAREER	0	0	1	1	
33	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HEC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum One Scopus Journal Publication
- Minimum One Design Patents
- Two Consultancy Projects
- All PEC and SDP-4 Credits must be from selected specialization
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

4. Honors through Experiential Learning with No Add-on

a) Credit Requirement

Total Credit Required: 183

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-ME-1	4	4	1	1	
5	BSC	BSC-ME-2	4	4	1	1	
6	BSC	BSC-ME-3	4	4	1	1	
7	BSC	BSC-ME-4	4	4	1	1	
8	BSC	BSC-SE-1	4	4	1	1	
9	BSC	BSC-SE-2	4	4	1	1	
10	BSC	BSC-SE-3	4	4	1	1	
11	ESC	ESC-CORE	30	30	8	8	
12	PCC	PCC-CORE	31	37	8	8	
13	FCC	FC-1	3	3	1	1	
14	HFC	HFC-CORE	0	16	0	4	
15	HEC	HEC-CORE	8	16	2	4	
16	SDC	SDP-1	2	4	1	1	
17	SDC	SDP-2	2	4	1	1	
18	SDC	SDP-3	2	4	1	1	
19	PEC	PE-1	5	5	1	1	
20	PEC	PE-2	3	3	1	1	
21	PEC	PE-3	5	5	1	1	
22	PEC	PE-4	3	3	1	1	
23	PRI	PRI-CORE	20	20	4	4	PROJECT
24	OEC	OE-1	4	4	1	1	
25	OEC	OE-2	4	4	1	1	
26	OEC	OE-3	4	4	1	1	
27	VAC	VAC-SPORTS	0	0	1	1	
28	VAC	VAC-CERT	0	0	4	4	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CORE	0	0	5	6	
30	AUC	AUC-CAREER	0	0	1	1	
31	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HEC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum One Scopus Journal Publication
- Minimum One Design Patents
- Two Consultancy Projects
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

5. Honors through Innovation with Minor

a) Credit Requirement

Total Credit Required:

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	4	4	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-SE-1	4	4	1	1	
8	BSC	BSC-SE-2	4	4	1	1	
9	BSC	BSC-SE-3	4	4	1	1	
10	ESC	ESC-CORE	30	30	8	8	
11	PCC	PCC-CORE	31	31	8	8	
12	FCC	FC-1	3	3	1	1	
13	HFC	HFC-CORE	0	16	0	4	
14	HIC	HIC-CORE	8	16	2	4	
15	SDC	SDP-1	2	4	1	1	
16	SDC	SDP-2	2	4	1	1	
17	SDC	SDP-3	2	4	1	1	
18	SDC	SDP-4	3	3	1	1	
19	PEC	PE-1	5	5	1	1	
20	PEC	PE-2	3	3	1	1	
21	PEC	PE-3	5	5	1	1	
22	PRI	PRI-CORE	20	20	4	4	PROJECT
23	OEC	OE-1	4	4	1	1	
24	OEC	OE-2	4	4	1	1	
25	OEC	OE-3	4	4	1	1	
26	VAC	VAC-SPORTS	0	0	1	1	
27	VAC	VAC-CERT	0	0	3	3	
28	AUC	AUC-CORE	0	0	5	6	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CAREER	0	0	1	1	
30	SIL	SIL-CORE	3	3	3	3	
31	MIN	MIN-CORE	16	16	4	4	MINOR
32	MSDC	MIN-SDP	4	4	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses HFC, HIC, HEC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum One Web of Science Journal Publications
- Minimum Two Design Patents & One Utility Patent
- LLP Establishment
- All MIN & MSDC Credits (16 + 4) must be from selected MINOR Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

6. Honors through Innovation with Double Major

a) Credit Requirement

Total Credit Required: 207

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-SE-1	4	4	1	1	
8	BSC	BSC-SE-2	4	4	1	1	
9	BSC	BSC-SE-3	4	4	1	1	
10	ESC	ESC-CORE	30	30	8	8	
11	PCC	PCC-CORE	31	31	8	8	
12	FCC	FC-1	3	3	1	1	DOUBLE MAJOR
13	HFC	HFC-CORE	0	16	0	4	
14	HIC	HIC-CORE	8	16	2	4	
15	HEC	HEC-CORE	0	16	0	4	
16	SDC	SDP-1	2	4	1	1	
17	SDC	SDP-2	2	4	1	1	
18	SDC	SDP-3	2	4	1	1	
19	PEC	PE-1	5	5	1	1	
20	PEC	PE-2	3	3	1	1	
21	PEC	PE-3	5	5	1	1	
22	PEC	PE-4	3	3	1	1	
23	PRI	PRI-CORE	20	20	4	4	PROJECT
24	OEC	OE-1	4	4	1	1	DOUBLE MAJOR
25	OEC	OE-2	4	4	1	1	DOUBLE MAJOR
26	OEC	OE-3	4	4	1	1	DOUBLE MAJOR
27	VAC	VAC-SPORTS	0	0	1	1	
28	VAC	VAC-CERT	0	0	3	3	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CORE	0	0	5	6	
30	AUC	AUC-CAREER	0	0	1	1	
31	SIL	SIL-CORE	3	3	3	3	
32	SMFC	SMFC-CORE	21	21	5	5	DOUBLE MAJOR
33	SMFC	SMFC-SDP	4	4	1	1	DOUBLE MAJOR

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses HFC, HIC, HEC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum One Web of Science Journal Publications
- Minimum Two Design Patents & One Utility Patent
- LLP Establishment
- All 40 Credits (SMFC+OEC+FCC) must be from selected Second Major Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

7. Honors through Innovation with Specialization

a) Credit Requirement

Total Credit Required: 192

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	4	4	1	1	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-ME-3	4	4	1	1	
8	BSC	BSC-SE-1	4	4	1	1	
9	BSC	BSC-SE-2	4	4	1	1	
10	BSC	BSC-SE-3	4	4	1	1	
11	ESC	ESC-CORE	30	30	8	8	
12	PCC	PCC-CORE	31	31	8	8	
13	FCC	FC-1	3	3	1	1	
14	HFC	HFC-CORE	0	16	0	4	
15	HIC	HIC-CORE	8	16	2	4	
16	HEC	HEC-CORE	0	16	0	4	
17	SDC	SDP-1	2	4	1	1	
18	SDC	SDP-2	2	4	1	1	
19	SDC	SDP-3	2	4	1	1	
20	SDC	SDP-4	4	4	1	1	SPECIALIZATION
21	PEC	PE-1	7	7	1	1	SPECIALIZATION
22	PEC	PE-2	3	3	1	1	SPECIALIZATION
23	PEC	PE-3	7	7	1	1	SPECIALIZATION
24	PEC	PE-4	3	3	1	1	SPECIALIZATION
25	PEC	PE-5	3	3	1	1	SPECIALIZATION
26	PRI	PRI-CORE	20	20	4	4	
27	OEC	OE-1	4	4	1	1	
28	OEC	OE-2	4	4	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	OEC	OE-3	4	4	1	1	
30	VAC	VAC-SPORTS	0	0	1	1	
31	VAC	VAC-CERT	0	0	3	3	
32	AUC	AUC-CORE	0	0	5	6	
33	AUC	AUC-CAREER	0	0	1	1	
34	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses HFC, HIC, HEC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum One Web of Science Journal Publications
- Minimum Two Design Patents & One Utility Patent
- LLP Establishment
- All PEC and SDP-4 Credits must be from selected specialization
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

8. Honors through Innovation with No Add-on**a) Credit Requirement****Total Credit Required: 182**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-ME-1	4	4	1	1	
5	BSC	BSC-ME-2	4	4	1	1	
6	BSC	BSC-ME-3	4	4	1	1	
7	BSC	BSC-ME-4	4	4	1	1	
8	BSC	BSC-SE-1	4	4	1	1	
9	BSC	BSC-SE-2	4	4	1	1	
10	BSC	BSC-SE-3	4	4	1	1	
11	ESC	ESC-CORE	30	30	8	8	
12	PCC	PCC-CORE	31	31	8	8	
13	FCC	FC-1	3	3	1	1	
14	HFC	HFC-CORE	0	16	0	4	
15	HIC	HIC-CORE	8	16	2	4	
16	HEC	HEC-CORE	0	16	0	4	
17	SDC	SDP-1	2	4	1	1	
18	SDC	SDP-2	2	4	1	1	
19	SDC	SDP-3	2	4	1	1	
20	PEC	PE-1	5	5	1	1	
21	PEC	PE-2	3	3	1	1	
22	PEC	PE-3	5	5	1	1	
23	PEC	PE-4	3	3	1	1	
24	PRI	PRI-CORE	20	20	4	4	PROJECT
25	OEC	OE-1	4	4	1	1	
26	OEC	OE-2	4	4	1	1	
27	OEC	OE-3	4	4	1	1	
28	VAC	VAC-SPORTS	0	0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0	0	3	3	
30	AUC	AUC-CORE	0	0	5	6	
31	AUC	AUC-CAREER	0	0	1	1	
32	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses HFC, HIC, HEC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum One Web of Science Journal Publications
- Minimum Two Design Patents & One Utility Patent
- LLP Establishment
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

9. Honors through Research with Minor

a) Credit Requirement

Total Credit Required: 202

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-SE-1	4	4	1	1	
8	BSC	BSC-SE-2	4	4	1	1	
9	BSC	BSC-SE-3	4	4	1	1	
10	ESC	ESC-CORE	30	30	8	8	
11	PCC	PCC-CORE	31	37	8	8	
12	FCC	FC-1	3	3	1	1	
13	HFC	HFC-CORE	0	16	0	4	
14	HRC	HRC-CORE	9	12	3	4	
15	SDC	SDP-1	2	4	1	1	
16	SDC	SDP-2	2	4	1	1	
17	SDC	SDP-3	2	4	1	1	
18	PEC	PE-1	5	5	1	1	
19	PEC	PE-2	3	3	1	1	
20	PEC	PE-3	5	5	1	1	
21	PEC	PE-4	3	3	1	1	
22	PRI	PRI-CORE	20	20	4	4	PROJECT
23	OEC	OE-1	4	4	1	1	
24	OEC	OE-2	4	4	1	1	
25	OEC	OE-3	4	4	1	1	
26	VAC	VAC-SPORTS	0	0	1	1	
27	VAC	VAC-CERT	0	0	3	3	
28	AUC	AUC-CORE	0	0	5	6	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CAREER	0	0	1	1	
30	SIL	SIL-CORE	3	3	3	3	
31	MIN	MIN-CORE	16	16	4	4	MINOR
32	MSDC	MIN-SDP	4	4	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HRC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum Three Web of Science Journal Publications
- Minimum One Design Patent
- All MIN & MSDC Credits (16 + 4) must be from selected MINOR Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

10. Honors through Research with Double Major

a) Credit Requirement

Total Credit Required: 207

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-SE-1	4	4	1	1	
8	BSC	BSC-SE-2	4	4	1	1	
9	BSC	BSC-SE-3	4	4	1	1	
10	ESC	ESC-CORE	30	30	8	8	
11	PCC	PCC-CORE	31	31	8	8	
12	FCC	FC-1	3	3	1	1	DOUBLE MAJOR
13	HFC	HFC-CORE	0	16	0	4	
14	HRC	HRC-CORE	9	12	3	4	
15	HEC	HEC-CORE	0	16	0	4	
16	SDC	SDP-1	2	4	1	1	
17	SDC	SDP-2	2	4	1	1	
18	SDC	SDP-3	2	4	1	1	
19	PEC	PE-1	5	5	1	1	
20	PEC	PE-2	3	3	1	1	
21	PEC	PE-3	5	5	1	1	
22	PEC	PE-4	3	3	1	1	
23	PRI	PRI-CORE	20	20	4	4	PROJECT
24	OEC	OE-1	4	4	1	1	DOUBLE MAJOR
25	OEC	OE-2	4	4	1	1	DOUBLE MAJOR
26	OEC	OE-3	4	4	1	1	DOUBLE MAJOR
27	VAC	VAC-SPORTS	0	0	1	1	
28	VAC	VAC-CERT	0	0	3	3	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CORE	0	0	5	6	
30	AUC	AUC-CAREER	0	0	1	1	
31	SIL	SIL-CORE	3	3	3	3	
32	SMFC	SMFC-CORE	21	21	5	5	DOUBLE MAJOR
33	SMFC	SMFC-SDP	4	4	1	1	DOUBLE MAJOR

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HRC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum Three Web of Science Journal Publications
- Minimum One Design Patent
- All 40 Credits (SMFC+OEC+FCC) must be from selected Second Major Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

11. Honors through Research with Specialization

a) Credit Requirement

Total Credit Required: 192

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	4	4	1	1	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-ME-3	4	4	1	1	
8	BSC	BSC-SE-1	4	4	1	1	
9	BSC	BSC-SE-2	4	4	1	1	
10	BSC	BSC-SE-3	4	4	1	1	
11	ESC	ESC-CORE	30	30	8	8	
12	PCC	PCC-CORE	31	37	8	8	
13	FCC	FC-1	3	3	1	1	
14	HFC	HFC-CORE	0	16	0	4	
15	HRC	HRC-CORE	9	12	3	4	
16	HEC	HEC-CORE	0	16	0	4	
17	SDC	SDP-1	2	4	1	1	
18	SDC	SDP-2	2	4	1	1	
19	SDC	SDP-3	2	4	1	1	
20	SDC	SDP-4	4	4	1	1	SPECIALIZATION
21	PEC	PE-1	7	7	1	1	SPECIALIZATION
22	PEC	PE-2	3	3	1	1	SPECIALIZATION
23	PEC	PE-3	7	7	1	1	SPECIALIZATION
24	PEC	PE-4	3	3	1	1	SPECIALIZATION
25	PEC	PE-5	3	3	1	1	SPECIALIZATION
26	PRI	PRI-CORE	20	20	4	4	
27	OEC	OE-1	4	4	1	1	
28	OEC	OE-2	4	4	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	OEC	OE-3	4	4	1	1	
30	VAC	VAC-SPORTS	0	0	1	1	
31	VAC	VAC-CERT	0	0	3	3	
32	AUC	AUC-CORE	0	0	5	6	
33	AUC	AUC-CAREER	0	0	1	1	
34	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HRC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum Three Web of Science Journal Publications
- Minimum One Design Patent
- All PEC and SDP-4 Credits must be from selected specialization
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

12. Honors through Research with No Add-on**a) Credit Requirement****Total Credit Required: 182**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-ME-1	4	4	1	1	
5	BSC	BSC-ME-2	4	4	1	1	
6	BSC	BSC-ME-3	4	4	1	1	
7	BSC	BSC-ME-4	4	4	1	1	
8	BSC	BSC-SE-1	4	4	1	1	
9	BSC	BSC-SE-2	4	4	1	1	
10	BSC	BSC-SE-3	4	4	1	1	
11	ESC	ESC-CORE	30	30	8	8	
12	PCC	PCC-CORE	31	37	8	8	
13	FCC	FC-1	3	3	1	1	
14	HFC	HFC-CORE	0	16	0	4	
15	HRC	HRC-CORE	9	12	3	4	
16	HEC	HEC-CORE	0	16	0	4	
17	SDC	SDP-1	2	4	1	1	
18	SDC	SDP-2	2	4	1	1	
19	SDC	SDP-3	2	4	1	1	
20	PEC	PE-1	5	5	1	1	
21	PEC	PE-2	3	3	1	1	
22	PEC	PE-3	5	5	1	1	
23	PEC	PE-4	3	3	1	1	
24	PRI	PRI-CORE	20	20	4	4	PROJECT
25	OEC	OE-1	4	4	1	1	
26	OEC	OE-2	4	4	1	1	
27	OEC	OE-3	4	4	1	1	
28	VAC	VAC-SPORTS	0	0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0	0	3	3	
30	AUC	AUC-CORE	0	0	5	6	
31	AUC	AUC-CAREER	0	0	1	1	
32	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HRC, SDC, PRI
- No History of Backlogs & No History of Betterment
- Minimum Three Web of Science Journal Publications
- Minimum One Design Patent
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

13. Honors with Minor

a) Credit Requirement

Total Credit Required: 202

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-SE-1	4	4	1	1	
8	BSC	BSC-SE-2	4	4	1	1	
9	BSC	BSC-SE-3	4	4	1	1	
10	ESC	ESC-CORE	30	30	8	8	
11	PCC	PCC-CORE	31	31	8	8	
12	FCC	FC-1	3	3	1	1	
13	HFC	HFC-CORE	8	16	2	4	
14	HEC	HEC-CORE	0	16	0	4	
15	SDC	SDP-1	2	4	1	1	
16	SDC	SDP-2	2	4	1	1	
17	SDC	SDP-3	2	4	1	1	
18	SDC	SDP-4	3	3	1	1	
19	PEC	PE-1	5	5	1	1	
20	PEC	PE-2	3	3	1	1	
21	PEC	PE-3	5	5	1	1	
22	PRI	PRI-CORE	16	16	4	4	
23	OEC	OE-1	4	4	1	1	
24	OEC	OE-2	4	4	1	1	
25	OEC	OE-3	4	4	1	1	
26	VAC	VAC-SPORTS	0	0	1	1	
27	VAC	VAC-CERT	0	0	4	4	
28	AUC	AUC-CORE	0	0	5	6	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CAREER	0	0	1	1	
30	SIL	SIL-CORE	3	3	3	3	
31	MIN	MIN-CORE	16	16	4	4	MINOR
32	MSDC	MIN-SDP	4	4	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HEC, SDC
- No History of Backlogs & No History of Betterment
- Minimum one Scopus Journal Publication
- All MIN & MSDC Credits (16 + 4) must be from selected MINOR Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

14. Honors with Double Major

a) Credit Requirement

Total Credit Required: 207

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-SE-1	4	4	1	1	
8	BSC	BSC-SE-2	4	4	1	1	
9	BSC	BSC-SE-3	4	4	1	1	
10	ESC	ESC-CORE	30	30	8	8	
11	PCC	PCC-CORE	31	31	8	8	
12	FCC	FC-1	3	3	1	1	DOUBLE MAJOR
13	HFC	HFC-CORE	8	16	2	4	
14	HEC	HEC-CORE	0	16	0	4	
15	SDC	SDP-1	2	4	1	1	
16	SDC	SDP-2	2	4	1	1	
17	SDC	SDP-3	2	4	1	1	
18	PEC	PE-1	5	5	1	1	
19	PEC	PE-2	3	3	1	1	
20	PEC	PE-3	5	5	1	1	
21	PEC	PE-4	3	3	1	1	
22	PRI	PRI-CORE	16	16	4	4	
23	OEC	OE-1	4	4	1	1	DOUBLE MAJOR
24	OEC	OE-2	4	4	1	1	DOUBLE MAJOR
25	OEC	OE-3	4	4	1	1	DOUBLE MAJOR
26	VAC	VAC-SPORTS	0	0	1	1	
27	VAC	VAC-CERT	0	0	4	4	
28	AUC	AUC-CORE	0	0	5	5	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CAREER	0	0	1	1	
30	SIL	SIL-CORE	3	3	3	3	
31	SMFC	SMFC-CORE	21	21	5	5	DOUBLE MAJOR
32	SMFC	SMFC-SDP	4	4	1	1	DOUBLE MAJOR

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HEC, SDC
- No History of Backlogs & No History of Betterment
- Minimum one Scopus Journal Publication
- All 40 Credits (SMFC+OEC+FCC) must be from selected Second Major Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

15. Honors with Specialization

a) Credit Requirement

Total Credit Required: 192

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-ME-3	0	0	0	0	
8	BSC	BSC-ME-4	0	0	0	0	
9	BSC	BSC-SE-1	4	4	1	1	
10	BSC	BSC-SE-2	4	4	1	1	
11	BSC	BSC-SE-3	4	4	1	1	
12	ESC	ESC-CORE	30	30	8	8	
13	PCC	PCC-CORE	31	37	8	8	
14	FCC	FC-1	3	3	1	1	
15	HFC	HFC-CORE	8	16	2	4	
16	HEC	HEC-CORE	0	16	0	4	
17	SDC	SDP-1	2	4	1	1	
18	SDC	SDP-2	2	4	1	1	
19	SDC	SDP-3	2	4	1	1	
20	SDC	SDP-4	4	4	1	1	SPECIALIZATION
21	PEC	PE-1	7	7	1	1	SPECIALIZATION
22	PEC	PE-2	3	3	1	1	SPECIALIZATION
23	PEC	PE-3	7	7	1	1	SPECIALIZATION
24	PEC	PE-4	3	3	1	1	SPECIALIZATION
25	PEC	PE-5	3	3	1	1	SPECIALIZATION
26	PRI	PRI-CORE	16	16	4	4	
27	OEC	OE-1	4	4	1	1	
28	OEC	OE-2	4	4	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	OEC	OE-3	4	4	1	1	
30	VAC	VAC-SPORTS	0	0	1	1	
31	VAC	VAC-CERT	0	0	4	4	
32	AUC	AUC-CORE	0	0	5	6	
33	AUC	AUC-CAREER	0	0	1	1	
34	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HEC, SDC
- No History of Backlogs & No History of Betterment
- Minimum one Scopus Journal Publication
- All PEC and SDP-4 Credits must be from selected specialization
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

16. Honors with No Add-on**a) Credit Requirement****Total Credit Required: 182**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-ME-3	0	0	0	0	
8	BSC	BSC-ME-4	0	0	0	0	
9	BSC	BSC-SE-1	4	4	1	1	
10	BSC	BSC-SE-2	4	4	1	1	
11	BSC	BSC-SE-3	4	4	1	1	
12	ESC	ESC-CORE	30	30	8	8	
13	PCC	PCC-CORE	31	37	8	8	
14	FCC	FC-1	3	3	1	1	
15	HFC	HFC-CORE	8	16	2	4	
16	HEC	HEC-CORE	0	16	0	4	
17	SDC	SDP-1	2	4	1	1	
18	SDC	SDP-2	2	4	1	1	
19	SDC	SDP-3	2	4	1	1	
20	PEC	PE-1	5	5	1	1	
21	PEC	PE-2	3	3	1	1	
22	PEC	PE-3	5	5	1	1	
23	PEC	PE-4	3	3	1	1	
24	PRI	PRI-CORE	16	16	4	4	
25	OEC	OE-1	4	4	1	1	
26	OEC	OE-2	4	4	1	1	
27	OEC	OE-3	4	4	1	1	
28	VAC	VAC-SPORTS	0	0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0	0	4	4	
30	AUC	AUC-CORE	0	0	5	6	
31	AUC	AUC-CAREER	0	0	1	1	
32	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 8.00
- Additional credits must be acquired from specified category of courses PCC, HFC, HEC, SDC
- No History of Backlogs & No History of Betterment
- Minimum one Scopus Journal Publication
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

17. No Flexibility with Minor**a) Credit Requirement****Total Credit Required: 182**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	1	1	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-SE-1	4	4	1	1	
8	BSC	BSC-SE-2	4	4	1	1	
9	BSC	BSC-SE-3	4	4	1	1	
10	ESC	ESC-CORE	30	30	8	8	
11	PCC	PCC-CORE	31	31	8	8	
12	FCC	FC-1	3	3	1	1	
13	SDC	SDP-1	2	2	1	1	
14	SDC	SDP-2	2	2	1	1	
15	SDC	SDP-3	2	2	1	1	
16	PEC	PE-1	5	5	1	1	
17	PEC	PE-2	3	3	1	1	
18	PEC	PE-3	5	5	1	1	
19	PEC	PE-4	3	3	1	1	
20	PRI	PRI-CORE	16	16	4	4	
21	OEC	OE-1	4	4	1	1	
22	OEC	OE-2	4	4	1	1	
23	OEC	OE-3	4	4	1	1	
24	VAC	VAC-SPORTS	0	0	1	1	
25	VAC	VAC-CERT	0	0	3	3	
26	AUC	AUC-CORE	0	0	5	6	
27	AUC	AUC-CAREER	0	0	1	1	
28	SIL	SIL-CORE	3	3	3	3	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	MIN	MIN-CORE	16	16	4	4	MINOR
30	MSDC	MIN-SDP	4	4	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 6.75
- All MIN & MSDC Credits (16 + 4) must be from selected MINOR Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

18. No Flexibility with Double Major**a) Credit Requirement****Total Credit Required: 187**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-ME-3	0	0	0	0	
8	BSC	BSC-SE-1	4	4	1	1	
9	BSC	BSC-SE-2	4	4	1	1	
10	BSC	BSC-SE-3	4	4	1	1	
11	ESC	ESC-CORE	30	30	8	8	
12	PCC	PCC-CORE	31	31	8	8	
13	FCC	FC-1	3	3	1	1	DOUBLE MAJOR
14	SDC	SDP-1	2	2	1	1	
15	SDC	SDP-2	2	2	1	1	
16	SDC	SDP-3	2	2	1	1	
17	PEC	PE-1	5	5	1	1	
18	PEC	PE-2	3	3	1	1	
19	PEC	PE-3	5	5	1	1	
20	PEC	PE-4	3	3	1	1	
21	PRI	PRI-CORE	16	16	4	4	
22	OEC	OE-1	4	4	1	1	DOUBLE MAJOR
23	OEC	OE-2	4	4	1	1	DOUBLE MAJOR
24	OEC	OE-3	4	4	1	1	DOUBLE MAJOR
25	VAC	VAC-SPORTS	0	0	1	1	
26	VAC	VAC-CERT	0	0	3	3	
27	AUC	AUC-CORE	0	0	5	6	
28	AUC	AUC-CAREER	0	0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	SIL	SIL-CORE	3	3	3	3	
30	SMFC	SMFC-CORE	21	21	5	5	DOUBLE MAJOR
31	SMFC	SMFC-SDP	4	4	1	1	

b) Outcome Requirement

- Minimum CGPA 7.75
- All 40 Credits (SMFC+OEC+FCC) must be from selected Second Major Degree
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

19. No Flexibility with Specialization**a) Credit Requirement****Total Credit Required: 167**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-ME-3	0	0	0	0	
8	BSC	BSC-ME-4	0	0	0	0	
9	BSC	BSC-SE-1	4	4	1	1	
10	BSC	BSC-SE-2	4	4	1	1	
11	BSC	BSC-SE-3	4	4	1	1	
12	ESC	ESC-CORE	30	30	8	8	
13	PCC	PCC-CORE	31	31	8	8	
14	FCC	FC-1	3	3	1	1	
15	SDC	SDP-1	2	2	1	1	
16	SDC	SDP-2	2	2	1	1	
17	SDC	SDP-3	2	2	1	1	
18	SDC	SDP-4	2	2	1	1	SPECIALIZATION
19	PEC	PE-1	5	5	1	1	SPECIALIZATION
20	PEC	PE-2	3	3	1	1	SPECIALIZATION
21	PEC	PE-3	5	5	1	1	SPECIALIZATION
22	PEC	PE-4	3	3	1	1	SPECIALIZATION
23	PEC	PE-5	3	3	1	1	SPECIALIZATION
24	PRI	PRI-CORE	16	16	4	4	
25	OEC	OE-1	4	4	1	1	
26	OEC	OE-2	4	4	1	1	
27	OEC	OE-3	4	4	1	1	
28	VAC	VAC-SPORTS	0	0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0	0	3	3	
30	AUC	AUC-CORE	0	0	5	6	
31	AUC	AUC-CAREER	0	0	1	1	
32	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 6.75
- All PEC and SDP-4 Credits must be from selected specialization
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

20. No Flexibility with No Add-on**a) Credit Requirement****Total Credit Required: 162**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10	10	5	5	
2	HAS	HAS-FLE	3	3	1	1	
3	HAS	HAS-MGE	4	4	1	1	
4	BSC	BSC-CORE	8	8	2	2	
5	BSC	BSC-ME-1	4	4	1	1	
6	BSC	BSC-ME-2	4	4	1	1	
7	BSC	BSC-ME-3	0	0	0	0	
8	BSC	BSC-ME-4	0	0	0	0	
9	BSC	BSC-SE-1	4	4	1	1	
10	BSC	BSC-SE-2	4	4	1	1	
11	BSC	BSC-SE-3	4	4	1	1	
12	ESC	ESC-CORE	30	30	8	8	
13	PCC	PCC-CORE	31	31	8	8	
14	FCC	FC-1	3	3	1	1	
15	SDC	SDP-1	2	2	1	1	
16	SDC	SDP-2	2	2	1	1	
17	SDC	SDP-3	2	2	1	1	
18	PEC	PE-1	5	5	1	1	
19	PEC	PE-2	3	3	1	1	
20	PEC	PE-3	5	5	1	1	
21	PEC	PE-4	3	3	1	1	
22	PRI	PRI-CORE	16	16	4	4	
23	OEC	OE-1	4	4	1	1	
24	OEC	OE-2	4	4	1	1	
25	OEC	OE-3	4	4	1	1	
26	VAC	VAC-SPORTS	0	0	1	1	
27	VAC	VAC-CERT	0	0	3	3	
28	AUC	AUC-CORE	0	0	5	6	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CAREER	0	0	1	1	
30	SIL	SIL-CORE	3	3	3	3	

b) Outcome Requirement

- Minimum CGPA 5.25
- Must have finished all the above-mentioned requirements in less than twice the period of the program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

Program Structure

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	HAS	HAS-CORE	23UC1203	DESIGN THINKING AND INNOVATION	R	DTI	0	0	4	0	2	4	
2	HAS	HAS-CORE	23UC0026	HUMAN VALUES, GENDER EQUALITY & PROFESSIONAL ETHICS	R	HGP	2	0	0	0	2	2	
3	HAS	HAS-CORE	23UC1101	INTEGRATED PROFESSIONAL ENGLISH	R	IPE	0	0	4	0	2	4	
4	HAS	HAS-CORE	23UC1202	ENGLISH PROFICIENCY	R	EP	0	0	4	0	2	4	
5	HAS	HAS-CORE	23UC0027	LEADERSHIP AND MANAGEMENT SKILLS	R	LAMS	0	0	4	0	2	4	
6	HAS	HAS-FLE	23FL3054	FRENCH LANGUAGE	R	FLG	3	0	0	0	3	3	
7	HAS	HAS-FLE	23FL3055	GERMAN LANGUAGE	R	GLG	3	0	0	0	3	3	
8	HAS	HAS-FLE	23FL3058	JAPANESE LANGUAGE	R	JLG	3	0	0	0	3	3	
9	HAS	HAS-MGE	23MB0003	FINANCIAL MANAGEMENT FOR ENGINEERS	R	FMFE	4	0	0	0	4	4	
10	HAS	HAS-MGE	23MB0005	MANAGING PERSONAL FINANCE	R	MPF	4	0	0	0	4	4	
11	HAS	HAS-MGE	23MB0001	BASICS OF MARKETING FOR ENGINEERS	R	BME	4	0	0	0	4	4	
12	HAS	HAS-MGE	23MB0002	PARADIGMS IN MANAGEMENT THOUGHT	R	PIMT	4	0	0	0	4	4	
13	HAS	HAS-MGE	23MB0004	ORGANIZATION MANAGEMENT	R	OMG	4	0	0	0	4	4	
14	HAS	HAS-MGE	23MB4067	INDUSTRIAL MANAGEMENT & PRODUCTION PLANNING	R	IMPP	4	0	0	0	4	4	
15	HAS	HAS-MGE	23MB4064	SEO AND DIGITAL MARKETING	R	SDM	4	0	0	0	4	4	
16	HAS	HAS-MGE	23MB4065	DIGITAL ECONOMICS AND TOKENOMICS	R	DET	4	0	0	0	4	4	
17	HAS	HAS-MGE	23MB4066	DECENTRALISED FINANCE AND DIGITAL FINANCIAL SYSTEMS	R	DFDFS	4	0	0	0	4	4	
18	HAS	HAS-MGE	23MB4062	CONSTRUCTION PROJECT MANAGEMENT	R	CPM	4	0	0	0	4	4	
19	HAS	HAS-MGE	23MB4063	RESOURCES SAFETY AND QUALITY MANAGEMENT	R	RSQM	4	0	0	0	4	4	
20	HAS	HAS-MGE	23MB4068	INNOVATION MANAGEMENT	R	IMG	4	0	0	0	4	4	
21	BSC	BSC-ME-1	23MT1001	LINEAR ALGEBRA AND CALCULUS FOR ENGINEERS	R	LACE	2	2	0	0	4	4	
22	BSC	BSC-ME-2	23MT2003	MATHEMATICAL MODELLING & NUMERICAL METHODS	R	MMNM	2	2	0	0	4	4	LACE(1)
23	BSC	BSC-ME-3	23MT2007	RANDOM VARIABLES AND STOCHASTIC PROCESS	R	RVASP	2	2	0	0	4	4	MMNM(1)
24	BSC	BSC-ME-4	23MT2004	MATHEMATICAL PROGRAMMING	R	MPG	2	2	0	0	4	4	RVASP(1)
25	BSC	BSC-SE-1	23CS3201	DATA SCIENCE AND STATISTICS	R	DSS	2	2	0	0	4	4	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
26	BSC	BSC-SE-2	22PH1008	PHYSICS FOR ELECTRONIC ENGINEERS	R	PEE	3	0	2	0	4	5	
27	BSC	BSC-SE-3	23CY1001	ENGINEERING CHEMISTRY	R	ECY	3	0	2	0	4	5	
28	ESC	ESC-CORE	23EC1202	DIGITAL DESIGN & COMPUTER ARCHITECTURE	R	DDCA	3	0	2	0	4	5	
29	ESC	ESC-CORE	23EC1203	BASIC ELECTRICAL AND ELECTRONIC CIRCUITS	R	BEEC	2	0	0	0	2	2	
30	ESC	ESC-CORE	23SC1202	DATA STRUCTURES	R	DS	2	0	2	4	4	8	CTSD(1)
31	ESC	ESC-CORE	23ME1103	DESIGN TOOL WORKSHOP	R	DTW	0	0	4	0	2	4	
32	ESC	ESC-CORE	23EC1101	FUNDAMENTALS OF IOT AND SENSORS	R	FITS	3	0	4	0	5	7	
33	ESC	ESC-CORE	23SC1101	COMPUTATIONAL THINKING FOR STRUCTURED DESIGN	R	CTSD	3	0	2	4	5	9	
34	ESC	ESC-CORE	23SC1203R	COMPUTATIONAL THINKING FOR OBJECT-ORIENTED DESIGN	R	CTOD	2	0	2	4	4	8	CTSD(1)
35	ESC	ESC-CORE	23AD2001O	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	O	AIML	3	0	2	0	4	5	CTSD(1)
36	PCC	PCC-CORE	23EC2210A	NETWORK PROTOCOLS AND SECURITY	A	NPS	4	0	4	0	6	8	DDCA(1)
37	PCC	PCC-CORE	23EC2210E	NETWORK PROTOCOLS AND SECURITY	E	NPS	4	0	4	0	6	8	DDCA(1)
38	PCC	PCC-CORE	23EC2210R	NETWORK PROTOCOLS AND SECURITY	R	NPS	3	0	2	0	4	5	DDCA(1)
39	PCC	PCC-CORE	23IN2203R	WIRELESS TECHNOLOGIES FOR IOT	R	WTIOT	3	0	2	0	4	5	NPS(1)
40	PCC	PCC-CORE	23AD2102A	DATABASE MANAGEMENT SYSTEMS	A	DBMS	4	0	4	0	6	8	CTSD(1)
41	PCC	PCC-CORE	23AD2102E	DATABASE MANAGEMENT SYSTEMS	E	DBMS	4	0	4	0	6	8	CTSD(1)
42	PCC	PCC-CORE	23AD2102R	DATABASE MANAGEMENT SYSTEMS	R	DBMS	3	0	2	0	4	5	CTSD(1)
43	PCC	PCC-CORE	23EC2106A	PROCESSORS AND CONTROLLERS	A	PRC	4	0	4	0	6	8	DDCA(1)
44	PCC	PCC-CORE	23EC2106E	PROCESSORS AND CONTROLLERS	E	PRC	4	0	4	0	6	8	DDCA(1)
45	PCC	PCC-CORE	23EC2106R	PROCESSORS AND CONTROLLERS	R	PRC	3	0	2	0	4	5	DDCA(1)
46	PCC	PCC-CORE	23IN2101A	IOT SYSTEM DESIGN	A	IOTPA	4	0	4	0	6	8	FITS(1)
47	PCC	PCC-CORE	23IN2101E	IOT SYSTEM DESIGN	E	IOTPA	4	0	4	0	6	8	FITS(1)
48	PCC	PCC-CORE	23IN2101R	IOT SYSTEM DESIGN	R	IOTPA	3	0	2	0	4	5	FITS(1)
49	PCC	PCC-CORE	23IN2102	ELECTRONIC DEVICES AND INTEGRATED CIRCUITS	R	EDAIC	3	0	2	0	4	5	BEEC(1)
50	PCC	PCC-CORE	23IN3104A	REAL TIME OPERATING SYSTEMS	A	RTOS	4	0	4	0	6	8	DDCA(1)
51	PCC	PCC-CORE	23IN3104E	REAL TIME OPERATING SYSTEMS	E	RTOS	4	0	4	0	6	8	DDCA(1)

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52	PCC	PCC-CORE	23IN3104R	REAL TIME OPERATING SYSTEMS	R	RTOS	3	0	2	0	4	5	DDCA(1)
53	PCC	PCC-CORE	23IN3105A	EMBEDDED SYSTEMS DESIGN	A	ESD	3	0	4	0	5	7	PRC(1)
54	PCC	PCC-CORE	23IN3105E	EMBEDDED SYSTEMS DESIGN	E	ESD	3	0	4	0	5	7	PRC(1)
55	PCC	PCC-CORE	23IN3105R	EMBEDDED SYSTEMS DESIGN	R	ESD	2	0	2	0	3	4	PRC(1)
56	FCC	FC-1	23IN2222F	CLOUD COMPUTING FOR IOT	F	CCIoT	2	0	2	0	3	4	
57	FCC	FC-1	23EC2229F	WIRELESS SENSOR NETWORKS	F	WSN	2	0	2	0	3	4	
58	FCC	FC-1	23EC2224F	DEEP NETWORK ARCHITECTURES	F	DNA	2	0	2	0	3	4	
59	FCC	FC-1	23CS2247F	CRYPTOGRAPHY AND SECURITY	F	CS	2	0	2	0	3	4	
60	FCC	FC-1	23CS2230F	SOLUTIONS ARCHITECTING ON CLOUD	F	SAC	2	0	2	0	3	4	
61	FCC	FC-1	23CS2243F	CLOUD DEVOPS (EPAM)	F	CD-	2	0	2	0	3	4	
62	FCC	FC-1	23CS3203F	QUANTUM COMPUTING	F	QCP	2	0	2	0	3	4	
63	FCC	FC-1	23AD2229F	AI FOR HEALTH CARE	F	RTOS	2	0	2	0	3	4	
64	FCC	FC-1	23EC2228F	BIOMEDICAL ELECTRONICS & IOT FOR HEALTHCARE	F	BEIH	2	0	2	0	3	4	
65	FCC	FC-1	23AD2224F	CLOUD COMPUTING	F	CC	2	1	0	0	3	3	
66	FCC	FC-1	23BT2224F	BIOREACTOR OPERATIONS	F	BO	2	0	2	0	3	4	
67	FCC	FC-1	23CS2229F	APPLICATION DEVELOPMENT ON CLOUD	F	ADC	2	0	2	0	3	4	
68	FCC	FC-1	23CS2231F	VISUAL PROGRAMMING	F	VSP	2	0	2	0	3	4	
69	FCC	FC-1	23CS2240F	.NET PROGRAMMING (EPAM)	F	.NET-	2	0	2	0	3	4	
70	FCC	FC-1	23CS2241F	FRONT END WEB DEVELOPMENT (EPAM)	F	FEWD-EPAM	2	0	2	0	3	4	
71	FCC	FC-1	23ME1001F	ENGINEERING MECHANICS	F	EM	2	1	0	0	3	3	
72	FCC	FC-1	23EE2225F	POWER QUALITY	F	PQ	3	0	0	0	3	3	
73	FCC	FC-1	23EC2223F	FUNDAMENTALS OF ROBOTICS	F	FOR	2	0	2	0	3	4	
74	FCC	FC-1	23CS2242F	SOFTWARE TESTING (EPAM)	F	ST-	2	0	2	0	3	4	
75	FCC	FC-1	23EE2230F	ESSENTIALS OF AUTONOMOUS SYSTEMS	F	EAS	2	0	2	0	3	4	
76	HFC	HFC-CORE	23IN06HF	ADVANCED IOT AND SENSOR BIG DATA ANALYTICS	R	AATA	3	0	2	0	4	5	
77	HFC	HFC-CORE	23IN07HF	DIGITAL FORENSICS	R	DFS	3	0	2	0	4	5	
78	HFC	HFC-CORE	23IN04HF	DEVOPS FOR IOT	R	DFIOT	3	0	2	0	4	5	
79	HFC	HFC-CORE	23IN05HF	IOT BASED HEALTH MONITORING SYSTEM USING FPGA	R	IOTHM	3	0	2	0	4	5	

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80	HFC	HFC-CORE	23IN01HF	5G TECHNOLOGIES FOR IOT	R	5TAI	3	0	2	0	4	5	
81	HFC	HFC-CORE	23IN02HF	DEEP LEARNING FOR COMPUTER VISION	R	DPNV	3	0	2	0	4	5	
82	HFC	HFC-CORE	23IN03HF	AR & VR APPLICATION DEVELOPMENT	R	ARVRAD	3	0	2	0	4	5	
83	HRC	HRC-CORE	23IN03RF	ADVANCED SECURITY OF INTERNET OF THINGS AND CYBER-PHYSICAL SYSTEMS	R	ASICPS	2	0	2	0	3	4	
84	HRC	HRC-CORE	23IN02RF	WIRELESS SENSOR NETWORKS AND THE INTERNET OF THINGS	R	WSNIOT	2	0	2	0	3	4	
85	HRC	HRC-CORE	23IN01RF	ADVANCED IOT APPLIED MACHINE LEARNING	R	AIAML	2	0	2	0	3	4	
86	HRC	HRC-CORE	23IN05RF	ADVANCED SENSOR AND IOT DATA ANALYTICS WITH DEEP LEARNING	R	ASIDADL	2	0	2	0	3	4	
87	HRC	HRC-CORE	23IN04RF	ANTENNAS FOR WIRELESS AND BODY-CENTRIC COMMUNICATIONS	R	AWBCC	2	0	2	0	3	4	
88	HRC	HRC-CORE	23IE01RF	INDEPENDENT STUDY & RESEARCH	R	ISR	2	0	2	0	3	4	
89	HRC	HRC-CORE	23IE02RF	RESEARCH METHODOLOGY, ETHICS & SCIENTIFIC WRITING	R	RMES	2	0	2	0	3	4	
90	HRC	HRC-CORE	23IE03RF	RESEARCH SEMINAR	R	RS	0	0	4	4	3	8	
91	HRC	HRC-CORE	23IE04RF	TERM PAPER	R	TP	0	0	4	4	3	8	
92	HIC	HIC-CORE	23DT01IF	ENTREPRENEURIAL TECHNOLOGY DEVELOPMENT AND PROTOTYPING	E	ETDP	0	0	6	4	4	10	
93	HIC	HIC-CORE	23DT02IF	CUSTOMER DISCOVERY FOR STARTUPS	E	CDFS	0	0	6	4	4	10	
94	HIC	HIC-CORE	23DT03IF	CUSTOMER VALIDATION FOR STARTUPS	E	CVFS	0	0	6	4	4	10	
95	HIC	HIC-CORE	23DT04IF	CUSTOMER CREATION AND MARKETING FOR ENTREPRENEURS	E	CCME	0	0	6	4	4	10	
96	HEC	HEC-CORE	23IN01EF	BLOCKCHAIN TECHNOLOGY FOR IOT	E	BCTI	0	0	6	4	4	10	
97	HEC	HEC-CORE	23IN02EF	DESIGN AND IMPLEMENTATION OF IOT SYSTEMS	E	DIIS	0	0	6	4	4	10	
98	HEC	HEC-CORE	23IN03EF	ADVANCED SENSOR SIGNAL PROCESSING	E	ASSP	0	0	6	4	4	10	
99	HEC	HEC-CORE	23IN04EF	IOT APP DEVELOPMENT	E	IAD	0	0	6	4	4	10	
100	SDC	SDP-1	23SDEC01A	ELECTRONIC SYSTEM DESIGN	A	ESD	0	0	6	4	4	10	FITS(1)
101	SDC	SDP-1	23SDEC01E	ELECTRONIC SYSTEM DESIGN	E	ESD	0	0	6	4	4	10	FITS(1)
102	SDC	SDP-1	23SDEC01R	ELECTRONIC SYSTEM DESIGN	R	ESD	0	0	2	4	2	6	FITS(1)
103	SDC	SDP-1	23SDEC02A	EMBEDDED SYSTEM AUTOMATION	A	ESDA	0	0	6	4	4	10	ESD(1)
104	SDC	SDP-1	23SDEC02E	EMBEDDED SYSTEM AUTOMATION	E	ESDA	0	0	6	4	4	10	ESD(1)

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105	SDC	SDP-1	23SDEC02R	EMBEDDED SYSTEM AUTOMATION	R	ESDA	0	0	2	4	2	6	ESD(1)
106	SDC	SDP-1	23SDEE02A	EMBEDDED SYSTEM DESIGN WITH ARM	A	ESDA	0	0	6	4	4	10	DDCA(1)
107	SDC	SDP-1	23SDEE02E	EMBEDDED SYSTEM DESIGN WITH ARM	E	ESDA	0	0	6	4	4	10	DDCA(1)
108	SDC	SDP-1	23SDEE02R	EMBEDDED SYSTEM DESIGN WITH ARM	R	ESDA	0	0	2	4	2	6	DDCA(1)
109	SDC	SDP-1	23SDIN01A	IOT HARDWARE PROGRAMMING	A	IOTHP	0	0	6	4	4	10	FITS(1)
110	SDC	SDP-1	23SDIN01E	IOT HARDWARE PROGRAMMING	E	IOTHP	0	0	6	4	4	10	FITS(1)
111	SDC	SDP-1	23SDIN01R	IOT HARDWARE PROGRAMMING	R	IOTHP	0	0	2	4	2	6	FITS(1)
112	SDC	SDP-1	23SDIN03A	IOT FULL STACK DEVELOPMENT	A	IOTSDF	0	0	6	4	4	10	IOTHP(1)
113	SDC	SDP-1	23SDIN03E	IOT FULL STACK DEVELOPMENT	E	IOTSDF	0	0	6	4	4	10	IOTHP(1)
114	SDC	SDP-1	23SDIN03R	IOT FULL STACK DEVELOPMENT	R	IOTSDF	0	0	2	4	2	6	IOTHP(1)
115	SDC	SDP-1	23SDCS11A	LINUX ADMINISTRATION AND AUTOMATION	A	LAA	0	0	6	4	4	10	
116	SDC	SDP-1	23SDCS11E	LINUX ADMINISTRATION AND AUTOMATION	E	LAA	0	0	6	4	4	10	
117	SDC	SDP-1	23SDCS11R	LINUX ADMINISTRATION AND AUTOMATION	R	LAA	0	0	2	4	2	6	
118	SDC	SDP-1	23SDCE02A	BUILDING INFORMATION MODELLING	A	BIM	0	0	6	4	4	10	CPM(1)
119	SDC	SDP-1	23SDCE02E	BUILDING INFORMATION MODELLING	E	BIM	0	0	6	4	4	10	CPM(1)
120	SDC	SDP-1	23SDCE02R	BUILDING INFORMATION MODELLING	R	BIM	0	0	2	4	2	6	CPM(1)
121	SDC	SDP-1	23SDBT01A	MEDICAL LAB TECHNOLOGY	A	MLT	0	0	6	4	4	10	CB(1)
122	SDC	SDP-1	23SDBT01E	MEDICAL LAB TECHNOLOGY	E	MLT	0	0	6	4	4	10	CB(1)
123	SDC	SDP-1	23SDBT01R	MEDICAL LAB TECHNOLOGY	R	MLT	0	0	2	4	2	6	CB(1)
124	SDC	SDP-1	23SDBT02A	ANALYTICAL AND OPTICAL INSTRUMENTATION	A	AOI	0	0	6	4	4	10	BCT(1)
125	SDC	SDP-1	23SDBT02E	ANALYTICAL AND OPTICAL INSTRUMENTATION	E	AOI	0	0	6	4	4	10	BCT(1)
126	SDC	SDP-1	23SDBT02R	ANALYTICAL AND OPTICAL INSTRUMENTATION	R	AOI	0	0	2	4	2	6	BCT(1)
127	SDC	SDP-1	23SDME01A	VISUALIZATION AND MODELLING FOR ENGINEERING DESIGN	A	VMED	0	0	6	4	4	10	EG(1)
128	SDC	SDP-1	23SDME01E	VISUALIZATION AND MODELLING FOR ENGINEERING DESIGN	E	VMED	0	0	6	4	4	10	EG(1)
129	SDC	SDP-1	23SDME01R	VISUALIZATION AND MODELLING FOR ENGINEERING DESIGN	R	VMED	0	0	2	4	2	6	EG(1)

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130	SDC	SDP-2	23SDCS12A	FULL STACK APPLICATION DEVELOPMENT	A	FSD	0	0	6	4	4	10	
131	SDC	SDP-2	23SDCS12E	FULL STACK APPLICATION DEVELOPMENT	E	FSD	0	0	6	4	4	10	
132	SDC	SDP-2	23SDCS12R	FULL STACK APPLICATION DEVELOPMENT	R	FSD	0	0	2	4	2	6	
133	SDC	SDP-2	23SDME02A	COMPUTER INTEGRATED MANUFACTURING	A	CIDM	0	0	6	4	4	10	MP(1)
134	SDC	SDP-2	23SDME02E	COMPUTER INTEGRATED MANUFACTURING	E	CIDM	0	0	6	4	4	10	MP(1)
135	SDC	SDP-2	23SDME02R	COMPUTER INTEGRATED MANUFACTURING	R	CIDM	0	0	2	4	2	6	MP(1)
136	SDC	SDP-2	23SDCE01A	VISUALIZATION AND MODELLING FOR STRUCTURAL DESIGN	A	VMSD	0	0	6	4	4	10	CPM(1)
137	SDC	SDP-2	23SDCE01E	VISUALIZATION AND MODELLING FOR STRUCTURAL DESIGN	E	VMSD	0	0	6	4	4	10	CPM(1)
138	SDC	SDP-2	23SDCE01R	VISUALIZATION AND MODELLING FOR STRUCTURAL DESIGN	R	VMSD	0	0	2	4	2	6	CPM(1)
139	SDC	SDP-2	23SDEC04A	DESIGN OF NETWORKS USING NS-3	A	DNN	0	0	6	4	4	10	ESDA(1)
140	SDC	SDP-2	23SDEC04E	DESIGN OF NETWORKS USING NS-3	E	DNN	0	0	6	4	4	10	ESDA(1)
141	SDC	SDP-2	23SDEC04R	DESIGN OF NETWORKS USING NS-3	R	DNN	0	0	2	4	2	6	ESDA(1)
142	SDC	SDP-2	23SDCS13A	CI/CD & CLOUD DEVOPS	A	CICD	0	0	6	4	4	10	FSD(1)
143	SDC	SDP-2	23SDCS13E	CI/CD & CLOUD DEVOPS	E	CICD	0	0	6	4	4	10	FSD(1)
144	SDC	SDP-2	23SDCS13R	CI/CD & CLOUD DEVOPS	R	CICD	0	0	2	4	2	6	FSD(1)
145	SDC	SDP-2	23SDEC03A	BIOSENSOR SYSTEM DESIGN	A	BSD	0	0	6	4	4	10	ESD(1)
146	SDC	SDP-2	23SDEC03E	BIOSENSOR SYSTEM DESIGN	E	BSD	0	0	6	4	4	10	ESD(1)
147	SDC	SDP-2	23SDEC03R	BIOSENSOR SYSTEM DESIGN	R	BSD	0	0	2	4	2	6	ESD(1)
148	SDC	SDP-2	23SDBT05A	COMPUTER AIDED DRUG DESIGN	A	CADD	0	0	6	4	4	10	CB(1)
149	SDC	SDP-2	23SDBT05E	COMPUTER AIDED DRUG DESIGN	E	CADD	0	0	6	4	4	10	CB(1)
150	SDC	SDP-2	23SDBT05R	COMPUTER AIDED DRUG DESIGN	R	CADD	0	0	2	4	2	6	CB(1)
151	SDC	SDP-2	23SDBT06A	GENOMICS DATA SCIENCE & CLUSTERING	A	CADD	0	0	6	4	4	10	CB(1)
152	SDC	SDP-2	23SDBT06E	GENOMICS DATA SCIENCE & CLUSTERING	E	CADD	0	0	6	4	4	10	CB(1)
153	SDC	SDP-2	23SDBT06R	GENOMICS DATA SCIENCE & CLUSTERING	R	CADD	0	0	2	4	2	6	CB(1)
154	SDC	SDP-2	23SDBT03A	BIO-INSTRUMENTATION	A	BI	0	0	6	4	4	10	BCT(1)
155	SDC	SDP-2	23SDBT03E	BIO-INSTRUMENTATION	E	BI	0	0	6	4	4	10	BCT(1)

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156	SDC	SDP-2	23SDBT03R	BIO-INSTRUMENTATION	R	BI	0	0	2	4	2	6	BCT(1)
157	SDC	SDP-2	23SDBT04A	PROCESS ENGINEERING TOOLS	A	PET	0	0	6	4	4	10	BCT(1)
158	SDC	SDP-2	23SDBT04E	PROCESS ENGINEERING TOOLS	E	PET	0	0	6	4	4	10	BCT(1)
159	SDC	SDP-2	23SDBT04R	PROCESS ENGINEERING TOOLS	R	PET	0	0	2	4	2	6	BCT(1)
160	SDC	SDP-2	23SDEE03A	AI TECHNIQUES FOR ELECTRICAL ENGINEERING	A	AITFEE	0	0	6	4	4	10	FITS(1)
161	SDC	SDP-2	23SDEE03E	AI TECHNIQUES FOR ELECTRICAL ENGINEERING	E	AITFEE	0	0	6	4	4	10	FITS(1)
162	SDC	SDP-2	23SDEE03R	AI TECHNIQUES FOR ELECTRICAL ENGINEERING	R	AITFEE	0	0	2	4	2	6	FITS(1)
163	SDC	SDP-2	23SDIN04A	CLOUD COMPUTING FOR IOT	A	IOTPD	0	0	6	4	4	10	IOTPA(1)
164	SDC	SDP-2	23SDIN04E	CLOUD COMPUTING FOR IOT	E	IOTPD	0	0	6	4	4	10	IOTPA(1)
165	SDC	SDP-2	23SDIN04R	CLOUD COMPUTING FOR IOT	R	IOTPD	0	0	2	4	2	6	IOTPA(1)
166	SDC	SDP-2	23SDEC07A	DEEP LEARNING WITH TENSORFLOW FRAMEWORK	A	DLTF	0	0	6	4	4	10	ESDA(1)
167	SDC	SDP-2	23SDEC07E	DEEP LEARNING WITH TENSORFLOW FRAMEWORK	E	DLTF	0	0	6	4	4	10	ESDA(1)
168	SDC	SDP-2	23SDEC07R	DEEP LEARNING WITH TENSORFLOW FRAMEWORK	R	DLTF	0	0	2	4	2	6	ESDA(1)
169	SDC	SDP-2	23SDEC06A	EMBEDDED DESIGN	A	EBD	0	0	6	4	4	10	ESDA(1)
170	SDC	SDP-2	23SDEC06E	EMBEDDED DESIGN	E	EBD	0	0	6	4	4	10	ESDA(1)
171	SDC	SDP-2	23SDEC06R	EMBEDDED DESIGN	R	EBD	0	0	2	4	2	6	ESDA(1)
172	SDC	SDP-2	23SDEC05A	4G - LTE COMMUNICATION SYSTEMS	A	LCS	0	0	6	4	4	10	ESDA(1)
173	SDC	SDP-2	23SDEC05E	4G - LTE COMMUNICATION SYSTEMS	E	LCS	0	0	6	4	4	10	ESDA(1)
174	SDC	SDP-2	23SDEC05R	4G - LTE COMMUNICATION SYSTEMS	R	LCS	0	0	2	4	2	6	ESDA(1)
175	SDC	SDP-3	23SDEC13A	5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS	A	5PIA	0	0	6	4	4	10	ESD(1)
176	SDC	SDP-3	23SDEC13E	5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS	E	5PIA	0	0	6	4	4	10	ESD(1)
177	SDC	SDP-3	23SDEC13R	5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS	R	5PIA	0	0	2	4	2	6	ESD(1)
178	SDC	SDP-3	23SDCS04A	CLOUD BASED SOLUTIONS ARCHITECT	A	CBSA	0	0	6	4	4	10	RTOS(1)
179	SDC	SDP-3	23SDCS04E	CLOUD BASED SOLUTIONS ARCHITECT	E	CBSA	0	0	6	4	4	10	RTOS(1)
180	SDC	SDP-3	23SDCS04R	CLOUD BASED SOLUTIONS ARCHITECT	R	CBSA	0	0	2	4	2	6	RTOS(1)
181	SDC	SDP-3	23SDAD01A	DATA ANALYTICS AND VISUALIZATION	A	DAV	0	0	6	4	4	10	OOP(1)

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182	SDC	SDP-3	23SDAD01E	DATA ANALYTICS AND VISUALIZATION	E	DAV	0	0	6	4	4	10	OOP(1)
183	SDC	SDP-3	23SDAD01R	DATA ANALYTICS AND VISUALIZATION	R	DAV	0	0	2	4	2	6	OOP(1)
184	SDC	SDP-3	23SDAD06A	ANALYSIS OF DIGITAL MARKETING	A	ADM	0	0	6	4	4	10	ML(1)
185	SDC	SDP-3	23SDAD06E	ANALYSIS OF DIGITAL MARKETING	E	ADM	0	0	6	4	4	10	ML(1)
186	SDC	SDP-3	23SDAD06R	ANALYSIS OF DIGITAL MARKETING	R	ADM	0	0	2	4	2	6	ML(1)
187	SDC	SDP-3	23SDCS08A	CLOUD BASED DATA ANALYTICS SPECIALITY	A	CBDAS	0	0	6	4	4	10	DSS(1)
188	SDC	SDP-3	23SDCS08E	CLOUD BASED DATA ANALYTICS SPECIALITY	E	CBDAS	0	0	6	4	4	10	DSS(1)
189	SDC	SDP-3	23SDCS08R	CLOUD BASED DATA ANALYTICS SPECIALITY	R	CBDAS	0	0	2	4	2	6	DSS(1)
190	SDC	SDP-3	23SDCS05A	CLOUD BASED SECURITY SPECIALITY	A	CBSS	0	0	6	4	4	10	NPS(1)
191	SDC	SDP-3	23SDCS05E	CLOUD BASED SECURITY SPECIALITY	E	CBSS	0	0	6	4	4	10	NPS(1)
192	SDC	SDP-3	23SDCS05R	CLOUD BASED SECURITY SPECIALITY	R	CBSS	0	0	2	4	2	6	NPS(1)
193	SDC	SDP-3	23SDEC14A	EMBEDDED PROTOTYPE	A	EPT	0	0	6	4	4	10	ESD(1)
194	SDC	SDP-3	23SDEC14E	EMBEDDED PROTOTYPE	E	EPT	0	0	6	4	4	10	ESD(1)
195	SDC	SDP-3	23SDEC14R	EMBEDDED PROTOTYPE	R	EPT	0	0	2	4	2	6	ESD(1)
196	SDC	SDP-3	23SDEC15A	NATURAL LANGUAGE PROCESSING USING TENSOR FLOW	A	NLPTF	0	0	6	4	4	10	ESDA(1)
197	SDC	SDP-3	23SDEC15E	NATURAL LANGUAGE PROCESSING USING TENSOR FLOW	E	NLPTF	0	0	6	4	4	10	ESDA(1)
198	SDC	SDP-3	23SDEC15R	NATURAL LANGUAGE PROCESSING USING TENSOR FLOW	R	NLPTF	0	0	2	4	2	6	ESDA(1)
199	SDC	SDP-3	23SDIN05A	IOT ANALYTICS FOR THE CLOUD	A	IOTAC	0	0	6	4	4	10	CCIoT(1)
200	SDC	SDP-3	23SDIN05E	IOT ANALYTICS FOR THE CLOUD	E	IOTAC	0	0	6	4	4	10	CCIoT(1)
201	SDC	SDP-3	23SDIN05R	IOT ANALYTICS FOR THE CLOUD	R	IOTAC	0	0	2	4	2	6	CCIoT(1)
202	SDC	SDP-3	23SDIN06A	EMBEDDED AND IOT ROGRAMMING	A	IOTHP	0	0	6	4	4	10	FITS(1)
203	SDC	SDP-3	23SDIN06E	EMBEDDED AND IOT ROGRAMMING	E	IOTHP	0	0	6	4	4	10	FITS(1)
204	SDC	SDP-3	23SDIN06R	EMBEDDED AND IOT ROGRAMMING	R	IOTHP	0	0	2	4	2	6	FITS(1)
205	SDC	SDP-3	23SDAD10A	COMPUTER VISION USING OPENCV	A	CVOCV	0	0	6	4	4	10	
206	SDC	SDP-3	23SDAD10E	COMPUTER VISION USING OPENCV	E	CVOCV	0	0	6	4	4	10	
207	SDC	SDP-3	23SDAD10R	COMPUTER VISION USING OPENCV	R	CVOCV	0	0	2	4	2	6	

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208	SDC	SDP-3	23SDCS07A	CLOUD BASED AI/ML SPECIALITY	A	CBAIMLS	0	0	6	4	4	10	AIML(1)
209	SDC	SDP-3	23SDCS07E	CLOUD BASED AI/ML SPECIALITY	E	CBAIMLS	0	0	6	4	4	10	AIML(1)
210	SDC	SDP-3	23SDCS07R	CLOUD BASED AI/ML SPECIALITY	R	CBAIMLS	0	0	2	4	2	6	AIML(1)
211	SDC	SDP-3	23SDBT08A	DRUG DESIGN: PRINCIPLES AND ENGINEERING	A	DDPE	0	0	6	4	4	10	BI(1)
212	SDC	SDP-3	23SDBT08E	DRUG DESIGN: PRINCIPLES AND ENGINEERING	E	DDPE	0	0	6	4	4	10	BI(1)
213	SDC	SDP-3	23SDBT08R	DRUG DESIGN: PRINCIPLES AND ENGINEERING	R	DDPE	0	0	2	4	2	6	BI(1)
214	SDC	SDP-3	23SDEC11A	BIOMEDICAL SYSTEM INTERFACING AND SIGNAL ANALYSIS	A	BSIS	0	0	6	4	4	10	ESD(1)
215	SDC	SDP-3	23SDEC11E	BIOMEDICAL SYSTEM INTERFACING AND SIGNAL ANALYSIS	E	BSIS	0	0	6	4	4	10	ESD(1)
216	SDC	SDP-3	23SDEC11R	BIOMEDICAL SYSTEM INTERFACING AND SIGNAL ANALYSIS	R	BSIS	0	0	2	4	2	6	ESD(1)
217	SDC	SDP-3	23SDEC12A	NETWORK PROGRAMMABILITY AND AUTOMATION	A	NPA	0	0	6	4	4	10	ESD(1)
218	SDC	SDP-3	23SDEC12E	NETWORK PROGRAMMABILITY AND AUTOMATION	E	NPA	0	0	6	4	4	10	ESD(1)
219	SDC	SDP-3	23SDEC12R	NETWORK PROGRAMMABILITY AND AUTOMATION	R	NPA	0	0	2	4	2	6	ESD(1)
220	SDC	SDP-3	23SDCE04A	PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE	A	PSRBPS	0	0	6	4	4	10	CPM(1)
221	SDC	SDP-3	23SDCE04E	PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE	E	PSRBPS	0	0	6	4	4	10	CPM(1)
222	SDC	SDP-3	23SDCE04R	PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE	R	PSRBPS	0	0	2	4	2	6	CPM(1)
223	SDC	SDP-3	23SDCE03A	ANALYSIS & DESIGN OF MULTI-STORIED STRUCTURES USING ETABS	A	ADMSS	0	0	6	4	4	10	ACAD(1)
224	SDC	SDP-3	23SDCE03E	ANALYSIS & DESIGN OF MULTI-STORIED STRUCTURES USING ETABS	E	ADMSS	0	0	6	4	4	10	ACAD(1)
225	SDC	SDP-3	23SDCE03R	ANALYSIS & DESIGN OF MULTI-STORIED STRUCTURES USING ETABS	R	ADMSS	0	0	2	4	2	6	ACAD(1)
226	SDC	SDP-3	23SDAD08A	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	A	EBCMDC	0	0	6	4	4	10	DWHM(1)
227	SDC	SDP-3	23SDAD08E	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	E	EBCMDC	0	0	6	4	4	10	DWHM(1)
228	SDC	SDP-3	23SDAD08R	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	R	EBCMDC	0	0	2	4	2	6	DWHM(1)
229	SDC	SDP-3	23SDEC10A	INTEGRATED SYSTEM DESIGN AUTOMATION	A	ISDA	0	0	6	4	4	10	ESDA(1)

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230	SDC	SDP-3	23SDEC10E	INTEGRATED SYSTEM DESIGN AUTOMATION	E	ISDA	0	0	6	4	4	10	ESDA(1)
231	SDC	SDP-3	23SDEC10R	INTEGRATED SYSTEM DESIGN AUTOMATION	R	ISDA	0	0	2	4	2	6	ESDA(1)
232	SDC	SDP-3	23SDCS14A	CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS	A	CASW	0	0	6	4	4	10	
233	SDC	SDP-3	23SDCS14E	CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS	E	CASW	0	0	6	4	4	10	
234	SDC	SDP-3	23SDCS14R	CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS	R	CASW	0	0	2	4	2	6	
235	SDC	SDP-3	23SDCS15A	SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING	A	SDCNC	0	0	6	4	4	10	
236	SDC	SDP-3	23SDCS15E	SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING	E	SDCNC	0	0	6	4	4	10	
237	SDC	SDP-3	23SDCS15R	SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING	R	SDCNC	0	0	2	4	2	6	
238	SDC	SDP-3	23SDCS16A	CLOUD INFRASTRUCTURE DESIGN	A	CISD	0	0	6	4	4	10	
239	SDC	SDP-3	23SDCS16E	CLOUD INFRASTRUCTURE DESIGN	E	CISD	0	0	6	4	4	10	
240	SDC	SDP-3	23SDCS16R	CLOUD INFRASTRUCTURE DESIGN	R	CISD	0	0	2	4	2	6	
241	SDC	SDP-3	23SDCS17A	GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES	A	GANI	0	0	6	4	4	10	
242	SDC	SDP-3	23SDCS17E	GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES	E	GANI	0	0	6	4	4	10	
243	SDC	SDP-3	23SDCS17R	GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES	R	GANI	0	0	2	4	2	6	
244	SDC	SDP-3	23SDCS18A	TEXT ANALYTICS	A	TAT	0	0	6	4	4	10	
245	SDC	SDP-3	23SDCS18E	TEXT ANALYTICS	E	TAT	0	0	6	4	4	10	
246	SDC	SDP-3	23SDCS18R	TEXT ANALYTICS	R	TAT	0	0	2	4	2	6	
247	SDC	SDP-3	23SDCS19A	VISUAL RECOGNITION AND SCENE UNDERSTANDING	A	VRSU	0	0	6	4	4	10	
248	SDC	SDP-3	23SDCS19E	VISUAL RECOGNITION AND SCENE UNDERSTANDING	E	VRSU	0	0	6	4	4	10	
249	SDC	SDP-3	23SDCS19R	VISUAL RECOGNITION AND SCENE UNDERSTANDING	R	VRSU	0	0	2	4	2	6	
250	SDC	SDP-3	23SDCS20A	SMART IOT AND SENSOR NETWORKS	A	SISN	0	0	6	4	4	10	
251	SDC	SDP-3	23SDCS20E	SMART IOT AND SENSOR NETWORKS	E	SISN	0	0	6	4	4	10	
252	SDC	SDP-3	23SDCS20R	SMART IOT AND SENSOR NETWORKS	R	SISN	0	0	2	4	2	6	
253	SDC	SDP-3	23SDEC08A	PLANAR ANTENNA DESIGN	A	PAD	0	0	6	4	4	10	ESDA(1)
254	SDC	SDP-3	23SDEC08E	PLANAR ANTENNA DESIGN	E	PAD	0	0	6	4	4	10	ESDA(1)

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255	SDC	SDP-3	23SDEC08R	PLANAR ANTENNA DESIGN	R	PAD	0	0	2	4	2	6	ESDA(1)
256	SDC	SDP-3	23SDEC09E	ROBOTICS AND AUTOMATION WITH WEBOTS	E	RAW	0	0	6	4	4	10	
257	SDC	SDP-3	23SDEE07A	IA HARDWARE PROTOTYPING	A	IAHP	0	0	6	4	4	10	FITS(1)
258	SDC	SDP-3	23SDEE07E	IA HARDWARE PROTOTYPING	E	IAHP	0	0	6	4	4	10	FITS(1)
259	SDC	SDP-3	23SDEE07R	IA HARDWARE PROTOTYPING	R	IAHP	0	0	2	4	2	6	FITS(1)
260	SDC	SDP-3	23SDME03A	FINITE ELEMENT ANALYSIS	A	FEA	0	0	6	4	4	10	ASM(1)
261	SDC	SDP-3	23SDME03E	FINITE ELEMENT ANALYSIS	E	FEA	0	0	6	4	4	10	ASM(1)
262	SDC	SDP-3	23SDME03R	FINITE ELEMENT ANALYSIS	R	FEA	0	0	2	4	2	6	ASM(1)
263	SDC	SDP-4	23SDME05A	3D MODELLING AND DIGITAL PROTOTYPING	A	3DMDP	0	0	6	4	4	10	
264	SDC	SDP-4	23SDME05E	3D MODELLING AND DIGITAL PROTOTYPING	E	3DMDP	0	0	6	4	4	10	
265	SDC	SDP-4	23SDME05R	3D MODELLING AND DIGITAL PROTOTYPING	R	3DMDP	0	0	2	4	2	6	
266	SDC	SDP-4	23SDCI04A	ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES	A	AAMA	0	0	6	4	4	10	
267	SDC	SDP-4	23SDCI04E	ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES	E	AAMA	0	0	6	4	4	10	
268	SDC	SDP-4	23SDCI04R	ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES	R	AAMA	0	0	2	4	2	6	
269	SDC	SDP-4	23SDCS10A	IT VENTURE MANAGEMENT	A	ITVM	0	0	6	4	4	10	
270	SDC	SDP-4	23SDCS10E	IT VENTURE MANAGEMENT	E	ITVM	0	0	6	4	4	10	
271	SDC	SDP-4	23SDCS10R	IT VENTURE MANAGEMENT	R	ITVM	0	0	2	4	2	6	
272	SDC	SDP-4	23SDCS06A	CERTIFIED GAME DEVELOPER	A	CGD	0	0	6	4	4	10	
273	SDC	SDP-4	23SDCS06E	CERTIFIED GAME DEVELOPER	E	CGD	0	0	6	4	4	10	
274	SDC	SDP-4	23SDCS06R	CERTIFIED GAME DEVELOPER	R	CGD	0	0	2	4	2	6	
275	SDC	SDP-4	23SDCE05A	DESIGN OF THE PAVEMENT BY USING MX ROADS	A	DPMX	0	0	6	4	4	10	
276	SDC	SDP-4	23SDCE05E	DESIGN OF THE PAVEMENT BY USING MX ROADS	E	DPMX	0	0	6	4	4	10	
277	SDC	SDP-4	23SDCE05R	DESIGN OF THE PAVEMENT BY USING MX ROADS	R	DPMX	0	0	2	4	2	6	
278	SDC	SDP-4	23SDEC09R	ROBOTICS AND AUTOMATION WITH WEBOTS	R	RAW	0	0	2	4	2	6	
279	SDC	SDP-4	23SDEC17A	ROBOT DESIGN AND ANALYSIS	A	RDA	0	0	6	4	4	10	

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280	SDC	SDP-4	23SDEC17E	ROBOT DESIGN AND ANALYSIS	E	RDA	0	0	6	4	4	10	
281	SDC	SDP-4	23SDEC17R	ROBOT DESIGN AND ANALYSIS	R	RDA	0	0	2	4	2	6	
282	SDC	SDP-4	23SDEC16A	ADVANCED RADIATING SYSTEM MODELING	A	ARSM	0	0	6	4	4	10	
283	SDC	SDP-4	23SDEC16E	ADVANCED RADIATING SYSTEM MODELING	E	ARSM	0	0	6	4	4	10	
284	SDC	SDP-4	23SDEC16R	ADVANCED RADIATING SYSTEM MODELING	R	ARSM	0	0	2	4	2	6	
285	SDC	SDP-4	23SDBT09A	CELL CULTURE TECHNOLOGIES	A	CCT	0	0	6	4	4	10	
286	SDC	SDP-4	23SDBT09E	CELL CULTURE TECHNOLOGIES	E	CCT	0	0	6	4	4	10	
287	SDC	SDP-4	23SDBT09R	CELL CULTURE TECHNOLOGIES	R	CCT	0	0	2	4	2	6	
288	SDC	SDP-4	23SDBT10A	MASS SPECTROMETRY BASED PROTEOMICS	A	MSBP	0	0	6	4	4	10	
289	SDC	SDP-4	23SDBT10E	MASS SPECTROMETRY BASED PROTEOMICS	E	MSBP	0	0	6	4	4	10	
290	SDC	SDP-4	23SDBT10R	MASS SPECTROMETRY BASED PROTEOMICS	R	MSBP	0	0	2	4	2	6	
291	SDC	SDP-4	23SDBT11A	ANIMAL PHYSIOLOGY	A	AP	0	0	6	4	4	10	
292	SDC	SDP-4	23SDBT11E	ANIMAL PHYSIOLOGY	E	AP	0	0	6	4	4	10	
293	SDC	SDP-4	23SDBT11R	ANIMAL PHYSIOLOGY	R	AP	0	0	2	4	2	6	
294	SDC	SDP-4	23SDEE05A	MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS	A	GML	0	0	6	4	4	10	
295	SDC	SDP-4	23SDEE05E	MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS	E	GML	0	0	6	4	4	10	
296	SDC	SDP-4	23SDEE05R	MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS	R	GML	0	0	2	4	2	6	
297	SDC	SDP-4	23SDME06A	GEOMETRIC DIMENSIONING AND TOLERANCING	A	G DAT	0	0	6	4	4	10	
298	SDC	SDP-4	23SDME06E	GEOMETRIC DIMENSIONING AND TOLERANCING	E	G DAT	0	0	6	4	4	10	
299	SDC	SDP-4	23SDME06R	GEOMETRIC DIMENSIONING AND TOLERANCING	R	G DAT	0	0	2	4	2	6	
300	SDC	SDP-4	23SDEE01A	VISUALIZATION AND MODELING OF CIRCUITS	A	VAMC	0	0	6	4	4	10	
301	SDC	SDP-4	23SDEE01E	VISUALIZATION AND MODELING OF CIRCUITS	E	VAMC	0	0	6	4	4	10	
302	SDC	SDP-4	23SDEE01R	VISUALIZATION AND MODELING OF CIRCUITS	R	VAMC	0	0	2	4	2	6	
303	SDC	SDP-4	23SDEE04A	AI & ML FOR SMART GRIDS	A	AIMLSG	0	0	6	4	4	10	
304	SDC	SDP-4	23SDEE04E	AI & ML FOR SMART GRIDS	E	AIMLSG	0	0	6	4	4	10	

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305	SDC	SDP-4	23SDEE04R	AI & ML FOR SMART GRIDS	R	AIMLSG	0	0	2	4	2	6	
306	SDC	SDP-4	23SDEC18A	VLSI SUBMICRON DESIGN AND VERIFICATION	A	VSDV	0	0	6	4	4	10	
307	SDC	SDP-4	23SDEC18E	VLSI SUBMICRON DESIGN AND VERIFICATION	E	VSDV	0	0	6	4	4	10	
308	SDC	SDP-4	23SDEC18R	VLSI SUBMICRON DESIGN AND VERIFICATION	R	VSDV	0	0	2	4	2	6	
309	SDC	SDP-4	23SDCE07A	ARC-GIS (PRO)	A	ARC	0	0	6	4	4	10	
310	SDC	SDP-4	23SDCE07E	ARC-GIS (PRO)	E	ARC	0	0	6	4	4	10	
311	SDC	SDP-4	23SDCE07R	ARC-GIS (PRO)	R	ARC	0	0	2	4	2	6	
312	SDC	SDP-4	23SDAD09A	AUTONOMOUS VEHICLE SYSTEMS	A	AVS	0	0	6	4	4	10	
313	SDC	SDP-4	23SDAD09E	AUTONOMOUS VEHICLE SYSTEMS	E	AVS	0	0	6	4	4	10	
314	SDC	SDP-4	23SDAD09R	AUTONOMOUS VEHICLE SYSTEMS	R	AVS	0	0	2	4	2	6	
315	SDC	SDP-4	23SDCE06A	DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE	A	SAFE	0	0	6	4	4	10	
316	SDC	SDP-4	23SDCE06E	DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE	E	SAFE	0	0	6	4	4	10	
317	SDC	SDP-4	23SDCE06R	DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE	R	SAFE	0	0	2	4	2	6	
318	SDC	SDP-4	23SDCI05A	CLOUD DEVOPS	A	CDP	0	0	6	4	4	10	
319	SDC	SDP-4	23SDCI05E	CLOUD DEVOPS	E	CDP	0	0	6	4	4	10	
320	SDC	SDP-4	23SDCI05R	CLOUD DEVOPS	R	CDP	0	0	2	4	2	6	
321	SDC	SDP-4	23SDEC09A	ROBOTICS AND AUTOMATION WITH WEBOTS	A	RAW	0	0	6	4	4	10	
322	SDC	SDP-4	23SDEE06A	EVT HARDWARE PROTOTYPING	A	EVTHP	0	0	6	4	4	10	
323	SDC	SDP-4	23SDEE06E	EVT HARDWARE PROTOTYPING	E	EVTHP	0	0	6	4	4	10	
324	SDC	SDP-4	23SDEE06R	EVT HARDWARE PROTOTYPING	R	EVTHP	0	0	2	4	2	6	
325	SDC	SDP-4	23SDBT07A	ASPECTS OF BIOCHEMICAL ENGINEERING	A	ABCE	0	0	6	4	4	10	
326	SDC	SDP-4	23SDBT07E	ASPECTS OF BIOCHEMICAL ENGINEERING	E	ABCE	0	0	6	4	4	10	
327	SDC	SDP-4	23SDBT07R	ASPECTS OF BIOCHEMICAL ENGINEERING	R	ABCE	0	0	2	4	2	6	
328	SDC	SDP-4	23SDME04A	ANALYSIS OF ENERGY SYSTEMS	A	AES	0	0	6	4	4	10	
329	SDC	SDP-4	23SDME04E	ANALYSIS OF ENERGY SYSTEMS	E	AES	0	0	6	4	4	10	

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330	SDC	SDP-4	23SDME04R	ANALYSIS OF ENERGY SYSTEMS	R	AES	0	0	2	4	2	6	
331	SDC	SDP-4	23SDCS21A	HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY	A	HSCISS	0	0	6	4	4	10	
332	SDC	SDP-4	23SDCS21E	HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY	E	HSCISS	0	0	6	4	4	10	
333	SDC	SDP-4	23SDCS21R	HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY	R	HSCISS	0	0	2	4	2	6	
334	PEC	PE-1	23ASS3102A	AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE	A	AICAFT	4	0	4	4	7	12	
335	PEC	PE-1	23ASS3102E	AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE	E	AICAFT	4	0	4	4	7	12	
336	PEC	PE-1	23ASS3102R	AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE	R	AICAFT	3	0	2	4	5	9	
337	PEC	PE-1	23EGD3101A	MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS	A	MADRS	4	0	4	4	7	12	EM(1) Rule:1
338	PEC	PE-1	23EGD3101E	MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS	E	MADRS	4	0	4	4	7	12	EM(1) Rule:1
339	PEC	PE-1	23EGD3101R	MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS	R	MADRS	3	0	2	4	5	9	EM(1) Rule:1
340	PEC	PE-1	23ECF3101A	AUTOMOBILE ENGINEERING	A	AE	4	0	4	4	7	12	
341	PEC	PE-1	23ECF3101E	AUTOMOBILE ENGINEERING	E	AE	4	0	4	4	7	12	
342	PEC	PE-1	23ECF3101R	AUTOMOBILE ENGINEERING	R	AE	3	0	2	4	5	9	
343	PEC	PE-1	23IOT3305A	DEEP LEARNING	A	DL	4	0	4	4	7	12	
344	PEC	PE-1	23IOT3305E	DEEP LEARNING	E	DL	4	0	4	4	7	12	
345	PEC	PE-1	23IOT3101A	INDUSTRIAL INTERNET OF THINGS	A	IIOT	4	0	4	4	7	12	
346	PEC	PE-1	23IOT3101E	INDUSTRIAL INTERNET OF THINGS	E	IIOT	4	0	4	4	7	12	
347	PEC	PE-1	23IOT3101R	INDUSTRIAL INTERNET OF THINGS	R	IIOT	3	0	2	4	5	9	
348	PEC	PE-1	23EDS3101A	ADVANCED EMBEDDED SYSTEMS	A	AES	4	0	4	4	7	12	
349	PEC	PE-1	23EDS3101E	ADVANCED EMBEDDED SYSTEMS	E	AES	4	0	4	4	7	12	
350	PEC	PE-1	23EDS3101R	ADVANCED EMBEDDED SYSTEMS	R	AES	3	0	2	4	5	9	
351	PEC	PE-1	23CPS3101A	IOT SENSING AND ACTUATING DEVICES	A	ISAD	4	0	4	4	7	12	
352	PEC	PE-1	23CPS3101E	IOT SENSING AND ACTUATING DEVICES	E	ISAD	4	0	4	4	7	12	
353	PEC	PE-1	23CPS3101R	IOT SENSING AND ACTUATING DEVICES	R	ISAD	3	0	2	4	5	9	

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354	PEC	PE-1	23ILA3101A	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	A	IIIoT	4	0	4	4	7	12	
355	PEC	PE-1	23ILA3101E	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	E	IIIoT	4	0	4	4	7	12	
356	PEC	PE-1	23ILA3101R	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	R	IIIoT	3	0	2	4	5	9	
357	PEC	PE-1	23DCS3101A	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	A	4GW	4	0	4	4	7	12	
358	PEC	PE-1	23DCS3101E	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	E	4GW	4	0	4	4	7	12	
359	PEC	PE-1	23DCS3101R	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	R	4GW	3	0	2	4	5	9	
360	PEC	PE-1	23DLA3101A	SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS	A	SNTSA	4	0	4	4	7	12	
361	PEC	PE-1	23DLA3101E	SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS	E	SNTSA	4	0	4	4	7	12	
362	PEC	PE-1	23DLA3101R	SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS	R	SNTSA	3	0	2	4	5	9	
363	PEC	PE-1	23CSB3101A	CRYPT ANALYSIS & CYBER DEFENSE	A	CACD	4	0	4	4	7	12	
364	PEC	PE-1	23CSB3101E	CRYPT ANALYSIS & CYBER DEFENSE	E	CACD	4	0	4	4	7	12	
365	PEC	PE-1	23CSB3101R	CRYPT ANALYSIS & CYBER DEFENSE	R	CACD	3	0	2	4	5	9	
366	PEC	PE-1	23CNS3101A	INTRODUCTION TO CLOUD NATIVE COMPUTING	A	ITCNC	4	0	4	4	7	12	
367	PEC	PE-1	23CNS3101E	INTRODUCTION TO CLOUD NATIVE COMPUTING	E	ITCNC	4	0	4	4	7	12	
368	PEC	PE-1	23CNS3101R	INTRODUCTION TO CLOUD NATIVE COMPUTING	R	ITCNC	3	0	2	4	5	9	
369	PEC	PE-1	23SDM3101A	SENTIMENT ANALYSIS	A	SA	4	0	4	4	7	12	
370	PEC	PE-1	23SDM3101E	SENTIMENT ANALYSIS	E	SA	4	0	4	4	7	12	
371	PEC	PE-1	23SDM3101R	SENTIMENT ANALYSIS	R	SA	3	0	2	4	5	9	
372	PEC	PE-1	23HDA3204A	PYTHON FOR GENOMIC DATA SCIENCE	A	PFGDS	5	0	0	0	5	5	
373	PEC	PE-1	23HDA3204E	PYTHON FOR GENOMIC DATA SCIENCE	E	PFGDS	5	0	0	0	5	5	
374	PEC	PE-1	23CCF3101A	TCP/IP & OTHER PROTOCOL SUITE	A	TCP	4	0	4	4	7	12	
375	PEC	PE-1	23CCF3101E	TCP/IP & OTHER PROTOCOL SUITE	E	TCP	4	0	4	4	7	12	
376	PEC	PE-1	23CCF3101R	TCP/IP & OTHER PROTOCOL SUITE	R	TCP	3	0	2	4	5	9	
377	PEC	PE-1	23DSB3101A	DATA ANALYTICS AND VISUALIZATION	A	DAV	4	0	4	4	7	12	
378	PEC	PE-1	23DSB3101E	DATA ANALYTICS AND VISUALIZATION	E	DAV	4	0	4	4	7	12	

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379	PEC	PE-1	23DSB3101R	DATA ANALYTICS AND VISUALIZATION	R	DAV	3	0	2	4	5	9	
380	PEC	PE-1	23ACI3101A	GENERATIVE ADVERSARIAL NETWORKS	A	GANS	4	0	4	4	7	12	
381	PEC	PE-1	23ACI3101E	GENERATIVE ADVERSARIAL NETWORKS	E	GANS	4	0	4	4	7	12	
382	PEC	PE-1	23ACI3101R	GENERATIVE ADVERSARIAL NETWORKS	R	GANS	3	0	2	4	5	9	
383	PEC	PE-1	23ADE3101A	EDGE COMPUTING FUNDAMENTALS	A	ECF	4	0	4	4	7	12	
384	PEC	PE-1	23ADE3101E	EDGE COMPUTING FUNDAMENTALS	E	ECF	4	0	4	4	7	12	
385	PEC	PE-1	23ADE3101R	EDGE COMPUTING FUNDAMENTALS	R	ECF	3	0	2	4	5	9	
386	PEC	PE-1	23ABT3101A	BIOSENSORS AND BIOELECTRONICS	A	BSBE	4	0	4	4	7	12	
387	PEC	PE-1	23ABT3101E	BIOSENSORS AND BIOELECTRONICS	E	BSBE	4	0	4	4	7	12	
388	PEC	PE-1	23ABT3101R	BIOSENSORS AND BIOELECTRONICS	R	BSBE	3	0	2	4	5	9	
389	PEC	PE-1	23IBT3101A	PHARMACEUTICAL BIOTECHNOLOGY	A	PBT	4	0	4	4	7	12	
390	PEC	PE-1	23IBT3101E	PHARMACEUTICAL BIOTECHNOLOGY	E	PBT	4	0	4	4	7	12	
391	PEC	PE-1	23IBT3101R	PHARMACEUTICAL BIOTECHNOLOGY	R	PBT	3	0	2	4	5	9	
392	PEC	PE-1	23HDA3101A	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	A	ISDPDD	4	0	4	4	7	12	
393	PEC	PE-1	23HDA3101E	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	E	ISDPDD	4	0	4	4	7	12	
394	PEC	PE-1	23HDA3101R	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	R	ISDPDD	3	0	2	4	5	9	
395	PEC	PE-1	23HSS3101A	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	A	ITHSCD	4	0	4	4	7	12	
396	PEC	PE-1	23HSS3101E	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	E	ITHSCD	4	0	4	4	7	12	
397	PEC	PE-1	23HSS3101R	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	R	ITHSCD	3	0	2	4	5	9	
398	PEC	PE-1	23ALT3101A	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	A	AMLFTA	4	0	4	4	7	12	
399	PEC	PE-1	23ALT3101E	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	E	AMLFTA	4	0	4	4	7	12	
400	PEC	PE-1	23ALT3101R	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	R	AMLFTA	3	0	2	4	5	9	
401	PEC	PE-1	23AVI3101A	DEEP LEARNING	A	DL	4	0	4	4	7	12	
402	PEC	PE-1	23AVI3101E	DEEP LEARNING	E	DL	4	0	4	4	7	12	
403	PEC	PE-1	23AVI3101R	DEEP LEARNING	R	DL	3	0	2	4	5	9	

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404	PEC	PE-1	23BEW3101A	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	A	ITBTCT	4	0	4	4	7	12	
405	PEC	PE-1	23BEW3101E	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	E	ITBTCT	4	0	4	4	7	12	
406	PEC	PE-1	23BEW3101R	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	R	ITBTCT	3	0	2	4	5	9	
407	PEC	PE-1	23CTM3101A	BUILDING INFORMATION MODELLING	A	BIM	4	0	4	4	7	12	
408	PEC	PE-1	23CTM3101E	BUILDING INFORMATION MODELLING	E	BIM	4	0	4	4	7	12	
409	PEC	PE-1	23CTM3101R	BUILDING INFORMATION MODELLING	R	BIM	3	0	2	4	5	9	
410	PEC	PE-1	23CSC3101A	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	A	FCS	4	0	4	4	7	12	
411	PEC	PE-1	23CSC3101E	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	E	FCS	4	0	4	4	7	12	
412	PEC	PE-1	23CSC3101R	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	R	FCS	3	0	2	4	5	9	
413	PEC	PE-1	23CID3101A	CLOUD INFRASTRUCTURE ENGINEERING	A	CIE	4	0	4	4	7	12	
414	PEC	PE-1	23CID3101E	CLOUD INFRASTRUCTURE ENGINEERING	E	CIE	4	0	4	4	7	12	
415	PEC	PE-1	23CID3101R	CLOUD INFRASTRUCTURE ENGINEERING	R	CIE	3	0	2	4	5	9	
416	PEC	PE-1	23CNE3101A	FOUNDATIONS OF CLOUD NATIVE COMPUTING	A	FCNC	4	0	4	4	7	12	
417	PEC	PE-1	23CNE3101E	FOUNDATIONS OF CLOUD NATIVE COMPUTING	E	FCNC	4	0	4	4	7	12	
418	PEC	PE-1	23CNE3101R	FOUNDATIONS OF CLOUD NATIVE COMPUTING	R	FCNC	3	0	2	4	5	9	
419	PEC	PE-1	23CEC3101A	CLOUD INFRASTRUCTURE AND SERVICES	A	CIS	4	0	4	4	7	12	
420	PEC	PE-1	23CEC3101E	CLOUD INFRASTRUCTURE AND SERVICES	E	CIS	4	0	4	4	7	12	
421	PEC	PE-1	23CEC3101R	CLOUD INFRASTRUCTURE AND SERVICES	R	CIS	3	0	2	4	5	9	
422	PEC	PE-1	23BMI3101A	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	A	BSIP	4	0	4	4	7	12	
423	PEC	PE-1	23BMI3101E	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	E	BSIP	4	0	4	4	7	12	
424	PEC	PE-1	23BMI3101R	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	R	BSIP	3	0	2	4	5	9	

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425	PEC	PE-1	23BIS3101A	MOLECULAR MODELLING AND DRUG DESIGN	A	MMDD	4	0	4	4	7	12	
426	PEC	PE-1	23BIS3101E	MOLECULAR MODELLING AND DRUG DESIGN	E	MMDD	4	0	4	4	7	12	
427	PEC	PE-1	23BIS3101R	MOLECULAR MODELLING AND DRUG DESIGN	R	MMDD	3	0	2	4	5	9	
428	PEC	PE-1	23EME3101A	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	A	PTDEV	4	0	4	4	7	12	
429	PEC	PE-1	23EME3101E	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	E	PTDEV	4	0	4	4	7	12	
430	PEC	PE-1	23EME3101R	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	R	PTDEV	3	0	2	4	5	9	
431	PEC	PE-1	23SMD3101A	SOFTWARE VERIFICATION & VALIDATION	A	SVV	4	0	4	4	7	12	
432	PEC	PE-1	23SMD3101E	SOFTWARE VERIFICATION & VALIDATION	E	SVV	4	0	4	4	7	12	
433	PEC	PE-1	23SMD3101R	SOFTWARE VERIFICATION & VALIDATION	R	SVV	3	0	2	4	5	9	
434	PEC	PE-1	23STE3101A	ADVANCED CONCRETE TECHNOLOGY	A	ACT	4	0	4	4	7	12	
435	PEC	PE-1	23STE3101E	ADVANCED CONCRETE TECHNOLOGY	E	ACT	4	0	4	4	7	12	
436	PEC	PE-1	23STE3101R	ADVANCED CONCRETE TECHNOLOGY	R	ACT	3	0	2	4	5	9	
437	PEC	PE-1	23WRE3101A	RIVER ENGINEERING	A	RE	4	0	4	4	7	12	
438	PEC	PE-1	23WRE3101E	RIVER ENGINEERING	E	RE	4	0	4	4	7	12	
439	PEC	PE-1	23WRE3101R	RIVER ENGINEERING	R	RE	3	0	2	4	5	9	
440	PEC	PE-1	23VLS3101A	ANALOG VLSI DESIGN	A	AVD	4	0	4	4	7	12	
441	PEC	PE-1	23VLS3101E	ANALOG VLSI DESIGN	E	AVD	4	0	4	4	7	12	
442	PEC	PE-1	23VLS3101R	ANALOG VLSI DESIGN	R	AVD	3	0	2	4	5	9	
443	PEC	PE-1	23AIP3101A	DEEP LEARNING	A	DL	4	0	4	4	7	12	
444	PEC	PE-1	23DEA3101A	FUNDAMENTALS OF DATA ENGINEERING	A	FDE	4	0	4	4	7	12	
445	PEC	PE-1	23DEA3101E	FUNDAMENTALS OF DATA ENGINEERING	E	FDE	4	0	4	4	7	12	
446	PEC	PE-1	23DEA3101R	FUNDAMENTALS OF DATA ENGINEERING	R	FDE	3	0	2	4	5	9	
447	PEC	PE-1	23SGT3101A	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	A	DERSG	4	0	4	4	7	12	
448	PEC	PE-1	23SGT3101E	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	E	DERSG	4	0	4	4	7	12	

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449	PEC	PE-1	23SGT3101R	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	R	DERSG	3	0	2	4	5	9	
450	PEC	PE-1	23SMF3101A	REVERSE ENGINEERING & RAPID PROTOTYPING	A	MMC	4	0	4	4	7	12	
451	PEC	PE-1	23SMF3101E	REVERSE ENGINEERING & RAPID PROTOTYPING	E	MMC	4	0	4	4	7	12	
452	PEC	PE-1	23SMF3101R	REVERSE ENGINEERING & RAPID PROTOTYPING	R	MMC	3	0	2	4	5	9	
453	PEC	PE-1	23AEA3101A	AUTOMOTIVE SENSOR AND APPLICATIONS	A	ASA	4	0	4	4	7	12	
454	PEC	PE-1	23AEA3101E	AUTOMOTIVE SENSOR AND APPLICATIONS	E	ASA	4	0	4	4	7	12	
455	PEC	PE-1	23AEA3101R	AUTOMOTIVE SENSOR AND APPLICATIONS	R	ASA	3	0	2	4	5	9	
456	PEC	PE-1	23ASS3101A	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	A	ADAS	4	0	4	4	7	12	
457	PEC	PE-1	23ASS3101E	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	E	ADAS	4	0	4	4	7	12	
458	PEC	PE-1	23ASS3101R	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	R	ADAS	3	0	2	4	5	9	
459	PEC	PE-1	23RFM3101A	MICROWAVE ENGINEERING	A	ME	4	0	4	4	7	12	
460	PEC	PE-1	23RFM3101E	MICROWAVE ENGINEERING	E	ME	4	0	4	4	7	12	
461	PEC	PE-1	23RFM3101R	MICROWAVE ENGINEERING	R	ME	3	0	2	4	5	9	
462	PEC	PE-1	23RAN3101A	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	A	RMPDC	4	0	4	4	7	12	
463	PEC	PE-1	23RAN3101E	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	E	RMPDC	4	0	4	4	7	12	
464	PEC	PE-1	23RAN3101R	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	R	RMPDC	3	0	2	4	5	9	
465	PEC	PE-1	23RAN3102A	AUTONOMOUS MOBILE ROBOT SYSTEMS	A	AMRS	4	0	4	4	7	12	
466	PEC	PE-1	23RAN3102E	AUTONOMOUS MOBILE ROBOT SYSTEMS	E	AMRS	4	0	4	4	7	12	
467	PEC	PE-1	23RAN3102R	AUTONOMOUS MOBILE ROBOT SYSTEMS	R	AMRS	3	0	2	4	5	9	
468	PEC	PE-1	23SCI3101A	SPATIAL DATA VISUALIZATION	A	SDV	4	0	4	4	7	12	
469	PEC	PE-1	23SCI3101E	SPATIAL DATA VISUALIZATION	E	SDV	4	0	4	4	7	12	
470	PEC	PE-1	23SCI3101R	SPATIAL DATA VISUALIZATION	R	SDV	3	0	2	4	5	9	
471	PEC	PE-1	23GET3101A	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	A	SPMET	4	0	4	4	7	12	
472	PEC	PE-1	23GET3101E	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	E	SPMET	4	0	4	4	7	12	

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473	PEC	PE-1	23GET3101R	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	R	SPMET	3	0	2	4	5	9	
474	PEC	PE-1	23GEG3101A	MOLECULAR GENETICS	A	MG	4	0	4	4	7	12	
475	PEC	PE-1	23GEG3101E	MOLECULAR GENETICS	E	MG	4	0	4	4	7	12	
476	PEC	PE-1	23GEG3101R	MOLECULAR GENETICS	R	MG	3	0	2	4	5	9	
477	PEC	PE-1	23MBT3101A	STEM CELL TECHNOLOGY	A	SCT	4	0	4	4	7	12	
478	PEC	PE-1	23MBT3101E	STEM CELL TECHNOLOGY	E	SCT	4	0	4	4	7	12	
479	PEC	PE-1	23MBT3101R	STEM CELL TECHNOLOGY	R	SCT	3	0	2	4	5	9	
480	PEC	PE-1	23GDU3101A	PROGRAMMING FOR GAME DEVELOPMENT	A	PGD	4	0	4	4	7	12	
481	PEC	PE-1	23GDU3101E	PROGRAMMING FOR GAME DEVELOPMENT	E	PGD	4	0	4	4	7	12	
482	PEC	PE-1	23GDU3101R	PROGRAMMING FOR GAME DEVELOPMENT	R	PGD	3	0	2	4	5	9	
483	PEC	PE-1	23GTE3101A	ADVANCED FOUNDATION ENGINEERING	A	AFE	4	0	4	4	7	12	
484	PEC	PE-1	23GTE3101E	ADVANCED FOUNDATION ENGINEERING	E	AFE	4	0	4	4	7	12	
485	PEC	PE-1	23GTE3101R	ADVANCED FOUNDATION ENGINEERING	R	AFE	3	0	2	4	5	9	
486	PEC	PE-1	23CPD3101A	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	A	FMAD	4	0	4	4	7	12	
487	PEC	PE-1	23CPD3101E	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	E	FMAD	4	0	4	4	7	12	
488	PEC	PE-1	23CPD3101R	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	R	FMAD	3	0	2	4	5	9	
489	PEC	PE-1	23CPD3304A	SECURE MOBILE APPLICATION DEVELOPMENT	A	SMAD	4	0	4	4	7	12	
490	PEC	PE-1	23CPD3304E	SECURE MOBILE APPLICATION DEVELOPMENT	E	SMAD	4	0	4	4	7	12	
491	PEC	PE-1	23IMP3101A	NATURAL LANGUAGE PROCESSING & APPLICATIONS	A	NLPA	4	0	4	4	7	12	
492	PEC	PE-1	23IMP3101E	NATURAL LANGUAGE PROCESSING & APPLICATIONS	E	NLPA	4	0	4	4	7	12	
493	PEC	PE-2	23CPD3202A	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	A	RNA	5	0	0	0	5	5	
494	PEC	PE-2	23CPD3202E	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	E	RNA	5	0	0	0	5	5	
495	PEC	PE-2	23CPD3202R	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	R	RNA	3	0	0	0	3	3	
496	PEC	PE-2	23CPD3203A	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	A	FBCPD	5	0	0	0	5	5	

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497	PEC	PE-2	23CPD3203E	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	E	FBCPD	5	0	0	0	5	5	
498	PEC	PE-2	23CPD3203R	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	R	FBCPD	3	0	0	0	3	3	
499	PEC	PE-2	23GTE3202A	INTELLIGENT TRANSPORTATION SYSTEMS	A	ITS	5	0	0	0	5	5	
500	PEC	PE-2	23GTE3202E	INTELLIGENT TRANSPORTATION SYSTEMS	E	ITS	5	0	0	0	5	5	
501	PEC	PE-2	23GTE3202R	INTELLIGENT TRANSPORTATION SYSTEMS	R	ITS	3	0	0	0	3	3	
502	PEC	PE-2	23GTE3203A	GROUND IMPROVEMENT TECHNIQUES	A	GIT	5	0	0	0	5	5	
503	PEC	PE-2	23GTE3203E	GROUND IMPROVEMENT TECHNIQUES	E	GIT	5	0	0	0	5	5	
504	PEC	PE-2	23GTE3203R	GROUND IMPROVEMENT TECHNIQUES	R	GIT	3	0	0	0	3	3	
505	PEC	PE-2	23GDU3202A	UX DESIGN	A	UD	5	0	0	0	5	5	
506	PEC	PE-2	23GDU3202E	UX DESIGN	E	UD	5	0	0	0	5	5	
507	PEC	PE-2	23GDU3202R	UX DESIGN	R	UD	3	0	0	0	3	3	
508	PEC	PE-2	23MBT3202A	VIROLOGY	A	VR	5	0	0	0	5	5	
509	PEC	PE-2	23MBT3202E	VIROLOGY	E	VR	5	0	0	0	5	5	
510	PEC	PE-2	23MBT3202R	VIROLOGY	R	VR	3	0	0	0	3	3	
511	PEC	PE-2	23MBT3203A	NANOBIOTECHNOLOGY	A	NBT	5	0	0	0	5	5	
512	PEC	PE-2	23MBT3203E	NANOBIOTECHNOLOGY	E	NBT	5	0	0	0	5	5	
513	PEC	PE-2	23MBT3203R	NANOBIOTECHNOLOGY	R	NBT	3	0	0	0	3	3	
514	PEC	PE-2	23GEG3202A	MOLECULAR EXPRESSION TECHNOLOGY	A	MET	5	0	0	0	5	5	
515	PEC	PE-2	23GEG3202E	MOLECULAR EXPRESSION TECHNOLOGY	E	MET	5	0	0	0	5	5	
516	PEC	PE-2	23GEG3202R	MOLECULAR EXPRESSION TECHNOLOGY	R	MET	3	0	0	0	3	3	
517	PEC	PE-2	23GEG3203A	TRANSGENIC TECHNOLOGY	A	TT	5	0	0	0	5	5	
518	PEC	PE-2	23GEG3203E	TRANSGENIC TECHNOLOGY	E	TT	5	0	0	0	5	5	
519	PEC	PE-2	23GEG3203R	TRANSGENIC TECHNOLOGY	R	TT	3	0	0	0	3	3	
520	PEC	PE-2	23GET3202A	WIND AND ENERGY STORAGE TECHNOLOGIES	A	WEST	5	0	0	0	5	5	
521	PEC	PE-2	23GET3202E	WIND AND ENERGY STORAGE TECHNOLOGIES	E	WEST	5	0	0	0	5	5	

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522	PEC	PE-2	23GET3202R	WIND AND ENERGY STORAGE TECHNOLOGIES	R	WEST	3	0	0	0	3	3	
523	PEC	PE-2	23GET3203A	ENERGY ECONOMICS AND POLICY	A	EEP	5	0	0	0	5	5	
524	PEC	PE-2	23GET3203E	ENERGY ECONOMICS AND POLICY	E	EEP	5	0	0	0	5	5	
525	PEC	PE-2	23GET3203R	ENERGY ECONOMICS AND POLICY	R	EEP	3	0	0	0	3	3	
526	PEC	PE-2	23SCI3202A	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	A	SCMG	5	0	0	0	5	5	
527	PEC	PE-2	23SCI3202E	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	E	SCMG	5	0	0	0	5	5	
528	PEC	PE-2	23SCI3202R	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	R	SCMG	3	0	0	0	3	3	
529	PEC	PE-2	23IOT3203A	PRECISION AGRICULTURE	A	PA	5	0	0	0	5	5	
530	PEC	PE-2	23IOT3203E	PRECISION AGRICULTURE	E	PA	5	0	0	0	5	5	
531	PEC	PE-2	23IOT3203R	PRECISION AGRICULTURE	R	PA	3	0	0	0	3	3	
532	PEC	PE-2	23IOT3204A	SMART FARMING	A	SF	5	0	0	0	5	5	
533	PEC	PE-2	23IOT3204E	SMART FARMING	E	SF	5	0	0	0	5	5	
534	PEC	PE-2	23IOT3204R	SMART FARMING	R	SF	3	0	0	0	3	3	
535	PEC	PE-2	23RAN3202E	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	E	AVAE	5	0	0	0	5	5	
536	PEC	PE-2	23RAN3202R	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	R	AVAE	3	0	0	0	3	3	
537	PEC	PE-2	23RAN3203A	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	A	RMWR	5	0	0	0	5	5	
538	PEC	PE-2	23RAN3203E	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	E	RMWR	5	0	0	0	5	5	
539	PEC	PE-2	23RAN3203R	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	R	RMWR	3	0	0	0	3	3	
540	PEC	PE-2	23RFM3202A	ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS	A	AADWA	5	0	0	0	5	5	
541	PEC	PE-2	23RFM3202E	ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS	E	AADWA	5	0	0	0	5	5	
542	PEC	PE-2	23RFM3202R	ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS	R	AADWA	3	0	0	0	3	3	
543	PEC	PE-2	23ASS3202A	INTRODUCTION TO INTELLIGENT DRONES	A	IID	5	0	0	0	5	5	
544	PEC	PE-2	23ASS3202E	INTRODUCTION TO INTELLIGENT DRONES	E	IID	5	0	0	0	5	5	
545	PEC	PE-2	23ASS3202R	INTRODUCTION TO INTELLIGENT DRONES	R	IID	3	0	0	0	3	3	
546	PEC	PE-2	23ASS3203R	AI AND IOT FOR AUTONOMOUS VEHICLE	R	AIAV	3	0	0	0	3	3	

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547	PEC	PE-2	23AEA3202A	AUTOTRONICS	A	AT	5	0	0	0	5	5	
548	PEC	PE-2	23AEA3202E	AUTOTRONICS	E	AT	5	0	0	0	5	5	
549	PEC	PE-2	23AEA3202R	AUTOTRONICS	R	AT	3	0	0	0	3	3	
550	PEC	PE-2	23AEA3203A	AUTOMOTIVE POLLUTION AND ITS CONTROL	A	APC	5	0	0	0	5	5	
551	PEC	PE-2	23AEA3203E	AUTOMOTIVE POLLUTION AND ITS CONTROL	E	APC	5	0	0	0	5	5	
552	PEC	PE-2	23AEA3203R	AUTOMOTIVE POLLUTION AND ITS CONTROL	R	APC	3	0	0	0	3	3	
553	PEC	PE-2	23SMF3202A	ADVANCED MATERIALS MANUFACTURING & TESTING	A	AMMT	5	0	0	0	5	5	
554	PEC	PE-2	23SMF3202E	ADVANCED MATERIALS MANUFACTURING & TESTING	E	AMMT	5	0	0	0	5	5	
555	PEC	PE-2	23SMF3202R	ADVANCED MATERIALS MANUFACTURING & TESTING	R	AMMT	3	0	0	0	3	3	
556	PEC	PE-2	23SMF3203A	MODERN MANUFACTURING PROCESSES	A	MMP	5	0	0	0	5	5	
557	PEC	PE-2	23SMF3203E	MODERN MANUFACTURING PROCESSES	E	MMP	5	0	0	0	5	5	
558	PEC	PE-2	23SMF3203R	MODERN MANUFACTURING PROCESSES	R	MMP	3	0	0	0	3	3	
559	PEC	PE-2	23SGT3202A	DISTRIBUTION SYSTEM PRACTICES	A	DSP	5	0	0	0	5	5	
560	PEC	PE-2	23SGT3202E	DISTRIBUTION SYSTEM PRACTICES	E	DSP	5	0	0	0	5	5	
561	PEC	PE-2	23SGT3202R	DISTRIBUTION SYSTEM PRACTICES	R	DSP	3	0	0	0	3	3	
562	PEC	PE-2	23SGT3203A	MICROGRID DYNAMICS AND CONTROL	A	MDC	5	0	0	0	5	5	
563	PEC	PE-2	23SGT3203E	MICROGRID DYNAMICS AND CONTROL	E	MDC	5	0	0	0	5	5	
564	PEC	PE-2	23SGT3203R	MICROGRID DYNAMICS AND CONTROL	R	MDC	3	0	0	0	3	3	
565	PEC	PE-2	23DEA3202A	DATA EXPLORATION AND PREPARATION	A	DEP	5	0	0	0	5	5	
566	PEC	PE-2	23DEA3202E	DATA EXPLORATION AND PREPARATION	E	DEP	5	0	0	0	5	5	
567	PEC	PE-2	23DEA3202R	DATA EXPLORATION AND PREPARATION	R	DEP	3	0	0	0	3	3	
568	PEC	PE-2	23CSC3203A	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	A	DSCC	5	0	0	0	5	5	
569	PEC	PE-2	23CSC3203E	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	E	DSCC	5	0	0	0	5	5	
570	PEC	PE-2	23CSC3203R	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	R	DSCC	3	0	0	0	3	3	

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571	PEC	PE-2	23CNE3203A	CLOUD NATIVE DESIGN PROCESS	A	CNDP	5	0	0	0	5	5	
572	PEC	PE-2	23CNE3203E	CLOUD NATIVE DESIGN PROCESS	E	CNDP	5	0	0	0	5	5	
573	PEC	PE-2	23CNE3203R	CLOUD NATIVE DESIGN PROCESS	R	CNDP	3	0	0	0	3	3	
574	PEC	PE-2	23VLS3202A	TESTING AND VERIFICATION OF VLSI CIRCUITS	A	TVVC	5	0	0	0	5	5	
575	PEC	PE-2	23VLS3202E	TESTING AND VERIFICATION OF VLSI CIRCUITS	E	TVVC	5	0	0	0	5	5	
576	PEC	PE-2	23VLS3202R	TESTING AND VERIFICATION OF VLSI CIRCUITS	R	TVVC	3	0	0	0	3	3	
577	PEC	PE-2	23WRE3202A	SOLID WASTE MANAGEMENT AND LANDFILLS	A	SWML	5	0	0	0	5	5	
578	PEC	PE-2	23WRE3202E	SOLID WASTE MANAGEMENT AND LANDFILLS	E	SWML	5	0	0	0	5	5	
579	PEC	PE-2	23WRE3202R	SOLID WASTE MANAGEMENT AND LANDFILLS	R	SWML	3	0	0	0	3	3	
580	PEC	PE-2	23WRE3203A	DESIGN OF HYDRAULIC STRUCTURES	A	DHS	5	0	0	0	5	5	
581	PEC	PE-2	23WRE3203E	DESIGN OF HYDRAULIC STRUCTURES	E	DHS	5	0	0	0	5	5	
582	PEC	PE-2	23WRE3203R	DESIGN OF HYDRAULIC STRUCTURES	R	DHS	3	0	0	0	3	3	
583	PEC	PE-2	23STE3202A	ADVANCED STRUCTURAL ANALYSIS	A	ASA	5	0	0	0	5	5	
584	PEC	PE-2	23STE3202E	ADVANCED STRUCTURAL ANALYSIS	E	ASA	5	0	0	0	5	5	
585	PEC	PE-2	23STE3202R	ADVANCED STRUCTURAL ANALYSIS	R	ASA	3	0	0	0	3	3	
586	PEC	PE-2	23STE3203A	ADVANCED DESIGN OF STEEL STRUCTURE	A	ADSS	5	0	0	0	5	5	
587	PEC	PE-2	23STE3203E	ADVANCED DESIGN OF STEEL STRUCTURE	E	ADSS	5	0	0	0	5	5	
588	PEC	PE-2	23STE3203R	ADVANCED DESIGN OF STEEL STRUCTURE	R	ADSS	3	0	0	0	3	3	
589	PEC	PE-2	23SMD3202A	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	A	DPCT	5	0	0	0	5	5	
590	PEC	PE-2	23SMD3202E	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	E	DPCT	5	0	0	0	5	5	
591	PEC	PE-2	23SMD3202R	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	R	DPCT	3	0	0	0	3	3	
592	PEC	PE-2	23EME3202A	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	A	CPTEV	5	0	0	0	5	5	
593	PEC	PE-2	23EME3202E	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	E	CPTEV	5	0	0	0	5	5	
594	PEC	PE-2	23EME3202R	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	R	CPTEV	3	0	0	0	3	3	

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595	PEC	PE-2	23EME3203A	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	A	AVAE	5	0	0	0	5	5	
596	PEC	PE-2	23EME3203E	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	E	AVAE	5	0	0	0	5	5	
597	PEC	PE-2	23EME3203R	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	R	AVAE	3	0	0	0	3	3	
598	PEC	PE-2	23BIS3202A	BIOMEDICAL INFORMATICS	A	BMI	5	0	0	0	5	5	
599	PEC	PE-2	23BIS3202E	BIOMEDICAL INFORMATICS	E	BMI	5	0	0	0	5	5	
600	PEC	PE-2	23BIS3202R	BIOMEDICAL INFORMATICS	R	BMI	3	0	0	0	3	3	
601	PEC	PE-2	23BIS3203A	PYTHON AND R PROGRAMMING	A	P&RP	5	0	0	0	5	5	
602	PEC	PE-2	23BIS3203E	PYTHON AND R PROGRAMMING	E	P&RP	5	0	0	0	5	5	
603	PEC	PE-2	23BIS3203R	PYTHON AND R PROGRAMMING	R	P&RP	3	0	0	0	3	3	
604	PEC	PE-2	23BMI3202A	ADVANCED BIOMEDICAL SIGNAL PROCESSING	A	ABSP	5	0	0	0	5	5	
605	PEC	PE-2	23BMI3202E	ADVANCED BIOMEDICAL SIGNAL PROCESSING	E	ABSP	5	0	0	0	5	5	
606	PEC	PE-2	23BMI3202R	ADVANCED BIOMEDICAL SIGNAL PROCESSING	R	ABSP	3	0	0	0	3	3	
607	PEC	PE-2	23CEC3202A	ADVANCED OPERATING SYSTEMS	A	AOS	5	0	0	0	5	5	
608	PEC	PE-2	23CEC3202E	ADVANCED OPERATING SYSTEMS	E	AOS	5	0	0	0	5	5	
609	PEC	PE-2	23CEC3202R	ADVANCED OPERATING SYSTEMS	R	AOS	3	0	0	0	3	3	
610	PEC	PE-2	23CEC3203A	FUNCTIONAL & CONCURRENT PROGRAMMING	A	FCP	5	0	0	0	5	5	
611	PEC	PE-2	23CEC3203E	FUNCTIONAL & CONCURRENT PROGRAMMING	E	FCP	5	0	0	0	5	5	
612	PEC	PE-2	23CEC3203R	FUNCTIONAL & CONCURRENT PROGRAMMING	R	FCP	3	0	0	0	3	3	
613	PEC	PE-2	23CEC3204A	CLOUD DEVOPS	A	CD	5	0	0	0	5	5	
614	PEC	PE-2	23CEC3204E	CLOUD DEVOPS	E	CD	5	0	0	0	5	5	
615	PEC	PE-2	23CEC3204R	CLOUD DEVOPS	R	CD	3	0	0	0	3	3	
616	PEC	PE-2	23HDA3203R	GENETIC PROGRAMMING	R	GP	3	0	0	0	3	3	
617	PEC	PE-2	23HDA3202A	BIO MEDICAL INFORMATICS	A	BMI	5	0	0	0	5	5	
618	PEC	PE-2	23HDA3202E	BIO MEDICAL INFORMATICS	E	BMI	5	0	0	0	5	5	
619	PEC	PE-2	23HDA3202R	BIO MEDICAL INFORMATICS	R	BMI	3	0	0	0	3	3	
620	PEC	PE-2	23CNE3202A	CLOUD NATIVE APPLICATION DEVELOPMENT	A	CNAD	5	0	0	0	5	5	

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621	PEC	PE-2	23CNE3202E	CLOUD NATIVE APPLICATION DEVELOPMENT	E	CNAD	5	0	0	0	5	5	
622	PEC	PE-2	23CNE3202R	CLOUD NATIVE APPLICATION DEVELOPMENT	R	CNAD	3	0	0	0	3	3	
623	PEC	PE-2	23CID3202A	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	A	ECT	5	0	0	0	5	5	
624	PEC	PE-2	23CID3202E	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	E	ECT	5	0	0	0	5	5	
625	PEC	PE-2	23CID3202R	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	R	ECT	3	0	0	0	3	3	
626	PEC	PE-2	23CSC3202A	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	A	DSA	5	0	0	0	5	5	
627	PEC	PE-2	23CSC3202E	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	E	DSA	5	0	0	0	5	5	
628	PEC	PE-2	23CSC3202R	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	R	DSA	3	0	0	0	3	3	
629	PEC	PE-2	23CTM3202A	ADVANCED CONSTRUCTION TECHNOLOGY	A	ACT	5	0	0	0	5	5	
630	PEC	PE-2	23CTM3202E	ADVANCED CONSTRUCTION TECHNOLOGY	E	ACT	5	0	0	0	5	5	
631	PEC	PE-2	23CTM3202R	ADVANCED CONSTRUCTION TECHNOLOGY	R	ACT	3	0	0	0	3	3	
632	PEC	PE-2	23CTM3203A	SUSTAINABLE CONSTRUCTION TECHNOLOGY	A	SCT	5	0	0	0	5	5	
633	PEC	PE-2	23CTM3203E	SUSTAINABLE CONSTRUCTION TECHNOLOGY	E	SCT	5	0	0	0	5	5	
634	PEC	PE-2	23CTM3203R	SUSTAINABLE CONSTRUCTION TECHNOLOGY	R	SCT	3	0	0	0	3	3	
635	PEC	PE-2	23BEW3202A	SMART CONTRACTS	A	SCR	5	0	0	0	5	5	
636	PEC	PE-2	23BEW3202E	SMART CONTRACTS	E	SCR	5	0	0	0	5	5	
637	PEC	PE-2	23BEW3202R	SMART CONTRACTS	R	SCR	3	0	0	0	3	3	
638	PEC	PE-2	23AVI3202A	COMPUTER VISION	A	CV	5	0	0	0	5	5	
639	PEC	PE-2	23AVI3202E	COMPUTER VISION	E	CV	5	0	0	0	5	5	
640	PEC	PE-2	23AVI3202R	COMPUTER VISION	R	CV	3	0	0	0	3	3	
641	PEC	PE-2	23ALT3202A	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	A	DLFNL	5	0	0	0	5	5	

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642	PEC	PE-2	23ALT3202E	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	E	DLFNLP	5	0	0	0	5	5	
643	PEC	PE-2	23ALT3202R	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	R	DLFNLP	3	0	0	0	3	3	
644	PEC	PE-2	23AIP3202A	SOFT COMPUTING	A	SC	5	0	0	0	5	5	
645	PEC	PE-2	23AIP3202E	SOFT COMPUTING	E	SC	5	0	0	0	5	5	
646	PEC	PE-2	23AIP3202R	SOFT COMPUTING	R	SC	3	0	0	0	3	3	
647	PEC	PE-2	23AIP3204A	ARTIFICIAL NEURAL NETWORKS	A	ANN	5	0	0	0	5	5	
648	PEC	PE-2	23AIP3204E	ARTIFICIAL NEURAL NETWORKS	E	ANN	5	0	0	0	5	5	
649	PEC	PE-2	23AIP3204R	ARTIFICIAL NEURAL NETWORKS	R	ANN	3	0	0	0	3	3	
650	PEC	PE-2	23HSS3202A	FUNDAMENTALS OF COMPUTER SECURITY	A	FOCS	5	0	0	0	5	5	
651	PEC	PE-2	23HSS3202E	FUNDAMENTALS OF COMPUTER SECURITY	E	FOCS	5	0	0	0	5	5	
652	PEC	PE-2	23HSS3202R	FUNDAMENTALS OF COMPUTER SECURITY	R	FOCS	3	0	0	0	3	3	
653	PEC	PE-2	23IBT3202A	PHARMACOVIGILANCE AND SAFETY	A	PCS	5	0	0	0	5	5	
654	PEC	PE-2	23IBT3202E	PHARMACOVIGILANCE AND SAFETY	E	PCS	5	0	0	0	5	5	
655	PEC	PE-2	23IBT3202R	PHARMACOVIGILANCE AND SAFETY	R	PCS	3	0	0	0	3	3	
656	PEC	PE-2	23IBT3203A	BIOPROCESS ECONOMICS AND PLANT DESIGN	A	BEPD	5	0	0	0	5	5	
657	PEC	PE-2	23IBT3203E	BIOPROCESS ECONOMICS AND PLANT DESIGN	E	BEPD	5	0	0	0	5	5	
658	PEC	PE-2	23IBT3203R	BIOPROCESS ECONOMICS AND PLANT DESIGN	R	BEPD	3	0	0	0	3	3	
659	PEC	PE-2	23ABT3202A	IOT APPLICATIONS IN PRECISION AGRICULTURE	A	IOTAPA	5	0	0	0	5	5	
660	PEC	PE-2	23ABT3202E	IOT APPLICATIONS IN PRECISION AGRICULTURE	E	IOTAPA	5	0	0	0	5	5	
661	PEC	PE-2	23ABT3202R	IOT APPLICATIONS IN PRECISION AGRICULTURE	R	IOTAPA	3	0	0	0	3	3	
662	PEC	PE-2	23ADE3202A	AI AT THE EDGE	A	AIAE	5	0	0	0	5	5	
663	PEC	PE-2	23ADE3202E	AI AT THE EDGE	E	AIAE	5	0	0	0	5	5	
664	PEC	PE-2	23ADE3202R	AI AT THE EDGE	R	AIAE	3	0	0	0	3	3	
665	PEC	PE-2	23ACI3202A	EXPLAINABLE AI AND COMMUNICATIONS	A	EAIC	5	0	0	0	5	5	
666	PEC	PE-2	23ACI3202E	EXPLAINABLE AI AND COMMUNICATIONS	E	EAIC	5	0	0	0	5	5	

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667	PEC	PE-2	23ACI3202R	EXPLAINABLE AI AND COMMUNICATIONS	R	EAIC	3	0	0	0	3	3	
668	PEC	PE-2	23DSB3202A	DATA WAREHOUSING AND MINING	A	DWHM	5	0	0	0	5	5	
669	PEC	PE-2	23DSB3202E	DATA WAREHOUSING AND MINING	E	DWHM	5	0	0	0	5	5	
670	PEC	PE-2	23DSB3202R	DATA WAREHOUSING AND MINING	R	DWHM	3	0	0	0	3	3	
671	PEC	PE-2	23CCF3202A	CLOUD COMPUTING AND NETWORKS SECURITY	A	CCNS	5	0	0	0	5	5	
672	PEC	PE-2	23CCF3202E	CLOUD COMPUTING AND NETWORKS SECURITY	E	CCNS	5	0	0	0	5	5	
673	PEC	PE-2	23CCF3202R	CLOUD COMPUTING AND NETWORKS SECURITY	R	CCNS	3	0	0	0	3	3	
674	PEC	PE-2	23IMP3202A	DATA ENGINEERING	A	DE	5	0	0	0	5	5	
675	PEC	PE-2	23IMP3202E	DATA ENGINEERING	E	DE	5	0	0	0	5	5	
676	PEC	PE-2	23IMP3202R	DATA ENGINEERING	R	DE	3	0	0	0	3	3	
677	PEC	PE-2	23SDM3202A	OPINION MINING & RECOMMENDER SYSTEMS	A	OMRS	5	0	0	0	5	5	
678	PEC	PE-2	23SDM3202E	OPINION MINING & RECOMMENDER SYSTEMS	E	OMRS	5	0	0	0	5	5	
679	PEC	PE-2	23SDM3202R	OPINION MINING & RECOMMENDER SYSTEMS	R	OMRS	3	0	0	0	3	3	
680	PEC	PE-2	23SDM3203A	META SOCIAL MEDIA ANALYTICS	A	MSMA	5	0	0	0	5	5	
681	PEC	PE-2	23SDM3203E	META SOCIAL MEDIA ANALYTICS	E	MSMA	5	0	0	0	5	5	
682	PEC	PE-2	23SDM3203R	META SOCIAL MEDIA ANALYTICS	R	MSMA	3	0	0	0	3	3	
683	PEC	PE-2	23CNS3202A	FUNDAMENTALS OF CLOUD SECURITY	A	FOCS	5	0	0	0	5	5	
684	PEC	PE-2	23CNS3202E	FUNDAMENTALS OF CLOUD SECURITY	E	FOCS	5	0	0	0	5	5	
685	PEC	PE-2	23CNS3202R	FUNDAMENTALS OF CLOUD SECURITY	R	FOCS	3	0	0	0	3	3	
686	PEC	PE-2	23CSB3202A	NETWORK AND INFRASTRUCTURE SECURITY	A	NIS	5	0	0	0	5	5	
687	PEC	PE-2	23CSB3202E	NETWORK AND INFRASTRUCTURE SECURITY	E	NIS	5	0	0	0	5	5	
688	PEC	PE-2	23CSB3202R	NETWORK AND INFRASTRUCTURE SECURITY	R	NIS	3	0	0	0	3	3	
689	PEC	PE-2	23CSB3203A	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	A	IBCC	3	0	4	0	5	7	
690	PEC	PE-2	23CSB3203E	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	E	IBCC	3	0	4	0	5	7	
691	PEC	PE-2	23CSB3203R	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	R	IBCC	2	0	2	0	3	4	

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692	PEC	PE-2	23DLA3202A	AUTOMATED NETWORK ANALYSIS	A	ANA	5	0	0	0	5	5	
693	PEC	PE-2	23DLA3202E	AUTOMATED NETWORK ANALYSIS	E	ANA	5	0	0	0	5	5	
694	PEC	PE-2	23DLA3202R	AUTOMATED NETWORK ANALYSIS	R	ANA	3	0	0	0	3	3	
695	PEC	PE-2	23DLA3203A	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	A	BTDt	5	0	0	0	5	5	
696	PEC	PE-2	23DLA3203E	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	E	BTDt	5	0	0	0	5	5	
697	PEC	PE-2	23DLA3203R	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	R	BTDt	3	0	0	0	3	3	
698	PEC	PE-2	23DCS3202A	MODERN SATELLITE COMMUNICATION SYSTEMS	A	MSCS	5	0	0	0	5	5	
699	PEC	PE-2	23DCS3202E	MODERN SATELLITE COMMUNICATION SYSTEMS	E	MSCS	5	0	0	0	5	5	
700	PEC	PE-2	23DCS3202R	MODERN SATELLITE COMMUNICATION SYSTEMS	R	MSCS	3	0	0	0	3	3	
701	PEC	PE-2	23ILA3202A	INDUSTRIAL AUTOMATION AND ROBOTICS	A	IAR	5	0	0	0	5	5	
702	PEC	PE-2	23ILA3202E	INDUSTRIAL AUTOMATION AND ROBOTICS	E	IAR	5	0	0	0	5	5	
703	PEC	PE-2	23ILA3202R	INDUSTRIAL AUTOMATION AND ROBOTICS	R	IAR	3	0	0	0	3	3	
704	PEC	PE-2	23ILA3203A	EDGE COMPUTING FOR INDUSTRY 4.0	A	ECI	5	0	0	0	5	5	
705	PEC	PE-2	23ILA3203E	EDGE COMPUTING FOR INDUSTRY 4.0	E	ECI	5	0	0	0	5	5	
706	PEC	PE-2	23ILA3203R	EDGE COMPUTING FOR INDUSTRY 4.0	R	ECI	3	0	0	0	3	3	
707	PEC	PE-2	23CPS3202A	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	A	IOTAP	5	0	0	0	5	5	
708	PEC	PE-2	23CPS3202E	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	E	IOTAP	5	0	0	0	5	5	
709	PEC	PE-2	23CPS3202R	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	R	IOTAP	3	0	0	0	3	3	
710	PEC	PE-2	23EDS3202A	EMBEDDED SYSTEMS FOR IOT	A	ESIOT	5	0	0	0	5	5	
711	PEC	PE-2	23EDS3202E	EMBEDDED SYSTEMS FOR IOT	E	ESIOT	5	0	0	0	5	5	
712	PEC	PE-2	23EDS3202R	EMBEDDED SYSTEMS FOR IOT	R	ESIOT	3	0	0	0	3	3	
713	PEC	PE-2	23IOT3202A	EDGE COMPUTING	A	EC	5	0	0	0	5	5	
714	PEC	PE-2	23IOT3202E	EDGE COMPUTING	E	EC	5	0	0	0	5	5	
715	PEC	PE-2	23IOT3202R	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
716	PEC	PE-2	23ECF3202A	AUTOTRONICS & SAFETY	A	ATS	5	0	0	0	5	5	

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717	PEC	PE-2	23ECF3202E	AUTOTRONICS & SAFETY	E	ATS	5	0	0	0	5	5	
718	PEC	PE-2	23ECF3202R	AUTOTRONICS & SAFETY	R	ATS	3	0	0	0	3	3	
719	PEC	PE-2	23ECF3203A	AUTONOMOUS VEHICLES	A	AV	5	0	0	0	5	5	
720	PEC	PE-2	23ECF3203E	AUTONOMOUS VEHICLES	E	AV	5	0	0	0	5	5	
721	PEC	PE-2	23ECF3203R	AUTONOMOUS VEHICLES	R	AV	3	0	0	0	3	3	
722	PEC	PE-2	23EGD3202A	CREEP, FATIGUE AND FRACTURE MECHANICS	A	CFFM	5	0	0	0	5	5	EM(1) Rule:1
723	PEC	PE-2	23EGD3202E	CREEP, FATIGUE AND FRACTURE MECHANICS	E	CFFM	5	0	0	0	5	5	EM(1) Rule:1
724	PEC	PE-2	23EGD3202R	CREEP, FATIGUE AND FRACTURE MECHANICS	R	CFFM	3	0	0	0	3	3	EM(1) Rule:1
725	PEC	PE-2	23EGD3203A	THEORY OF ELASTICITY AND PLASTICITY	A	TEP	5	0	0	0	5	5	EM(1) Rule:1
726	PEC	PE-2	23EGD3203E	THEORY OF ELASTICITY AND PLASTICITY	E	TEP	5	0	0	0	5	5	EM(1) Rule:1
727	PEC	PE-2	23EGD3203R	THEORY OF ELASTICITY AND PLASTICITY	R	TEP	3	0	0	0	3	3	EM(1) Rule:1
728	PEC	PE-2	23ASS3205A	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	A	AVECUDA	3	0	4	0	5	7	
729	PEC	PE-2	23ASS3205E	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	E	AVECUDA	3	0	4	0	5	7	
730	PEC	PE-2	23ASS3205R	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	R	AVECUDA	2	0	2	0	3	4	
731	PEC	PE-3	23ASS3309A	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	A	AAAV	4	0	4	4	7	12	
732	PEC	PE-3	23ASS3309E	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	E	AAAV	4	0	4	4	7	12	
733	PEC	PE-3	23ASS3309R	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	R	AAAV	3	0	2	4	5	9	
734	PEC	PE-3	23EGD3304A	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN	A	SDSIED	4	0	4	4	7	12	EM(1) Rule:1
735	PEC	PE-3	23EGD3304E	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN	E	SDSIED	4	0	4	4	7	12	EM(1) Rule:1
736	PEC	PE-3	23EGD3304R	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN	R	SDSIED	3	0	2	4	5	9	EM(1) Rule:1
737	PEC	PE-3	23ECF3304A	HYBRID AND ELECTRIC VEHICLE DESIGN	A	HEVD	4	0	4	4	7	12	
738	PEC	PE-3	23ECF3304E	HYBRID AND ELECTRIC VEHICLE DESIGN	E	HEVD	4	0	4	4	7	12	

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739	PEC	PE-3	23ECF3304R	HYBRID AND ELECTRIC VEHICLE DESIGN	R	HEVD	3	0	2	4	5	9	
740	PEC	PE-3	23IOT3305R	DEEP LEARNING	R	DL	3	0	2	4	5	9	
741	PEC	PE-3	23IMP3303A	BIO MEDICAL SIGNAL AND IMAGE ANALYSIS	A	AMSIA	4	0	4	4	7	12	
742	PEC	PE-3	23IMP3303E	BIO MEDICAL SIGNAL AND IMAGE ANALYSIS	E	AMSIA	4	0	4	4	7	12	
743	PEC	PE-3	23IMP3303R	BIO MEDICAL SIGNAL AND IMAGE ANALYSIS	R	AMSIA	3	0	2	4	5	9	
744	PEC	PE-3	23EDS3303A	EMBEDDED AND REAL-TIME SYSTEMS	A	ERTS	4	0	4	4	7	12	
745	PEC	PE-3	23EDS3303E	EMBEDDED AND REAL-TIME SYSTEMS	E	ERTS	4	0	4	4	7	12	
746	PEC	PE-3	23EDS3303R	EMBEDDED AND REAL-TIME SYSTEMS	R	ERTS	3	0	2	4	5	9	
747	PEC	PE-3	23CPS3303A	CYBER PHYSICAL SYSTEMS	A	CPS	4	0	4	4	7	12	
748	PEC	PE-3	23CPS3303E	CYBER PHYSICAL SYSTEMS	E	CPS	4	0	4	4	7	12	
749	PEC	PE-3	23CPS3303R	CYBER PHYSICAL SYSTEMS	R	CPS	3	0	2	4	5	9	
750	PEC	PE-3	23DCS3303A	5G WIRELESS TECHNOLOGIES	A	5GWT	4	0	4	4	7	12	
751	PEC	PE-3	23DCS3303E	5G WIRELESS TECHNOLOGIES	E	5GWT	4	0	4	4	7	12	
752	PEC	PE-3	23DCS3303R	5G WIRELESS TECHNOLOGIES	R	5GWT	3	0	2	4	5	9	
753	PEC	PE-3	23DLA3304A	MULTI AGENT SYSTEMS	A	MAS	4	0	4	4	7	12	
754	PEC	PE-3	23DLA3304E	MULTI AGENT SYSTEMS	E	MAS	4	0	4	4	7	12	
755	PEC	PE-3	23DLA3304R	MULTI AGENT SYSTEMS	R	MAS	3	0	2	4	5	9	
756	PEC	PE-3	23CSB3304A	DIGITAL FORENSICS	A	DF	4	0	4	4	7	12	
757	PEC	PE-3	23CSB3304E	DIGITAL FORENSICS	E	DF	4	0	4	4	7	12	
758	PEC	PE-3	23CSB3304R	DIGITAL FORENSICS	R	DF	3	0	2	4	5	9	
759	PEC	PE-3	23CNS3303A	CONTAINER SECURITY	A	CTSY	4	0	4	4	7	12	
760	PEC	PE-3	23CNS3303E	CONTAINER SECURITY	E	CTSY	4	0	4	4	7	12	
761	PEC	PE-3	23CNS3303R	CONTAINER SECURITY	R	CTSY	3	0	2	4	5	9	
762	PEC	PE-3	23SDM3304A	SOCIAL MEDIA MARKETING ANALYTICS	A	SMMA	4	0	4	4	7	12	
763	PEC	PE-3	23SDM3304E	SOCIAL MEDIA MARKETING ANALYTICS	E	SMMA	4	0	4	4	7	12	
764	PEC	PE-3	23SDM3304R	SOCIAL MEDIA MARKETING ANALYTICS	R	SMMA	3	0	2	4	5	9	

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765	PEC	PE-3	23CNE3304R	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	R	SEC	3	0	2	4	5	9	
766	PEC	PE-3	23CCF3303A	VOIP AND BROADBAND NETWORKS	A	VBN	4	0	4	4	7	12	
767	PEC	PE-3	23CCF3303E	VOIP AND BROADBAND NETWORKS	E	VBN	4	0	4	4	7	12	
768	PEC	PE-3	23CCF3303R	VOIP AND BROADBAND NETWORKS	R	VBN	3	0	2	4	5	9	
769	PEC	PE-3	23DSB3303A	BIG DATA ANALYTICS	A	BDA	4	0	4	4	7	12	
770	PEC	PE-3	23DSB3303E	BIG DATA ANALYTICS	E	BDA	4	0	4	4	7	12	
771	PEC	PE-3	23DSB3303R	BIG DATA ANALYTICS	R	BDA	3	0	2	4	5	9	
772	PEC	PE-3	23ACI3303A	FUZZY LOGIC WITH SET THEORY	A	FLST	4	0	4	4	7	12	
773	PEC	PE-3	23ACI3303E	FUZZY LOGIC WITH SET THEORY	E	FLST	4	0	4	4	7	12	
774	PEC	PE-3	23ACI3303R	FUZZY LOGIC WITH SET THEORY	R	FLST	3	0	2	4	5	9	
775	PEC	PE-3	23ADE3303A	EDGE AI ARCHITECTURES AND APPLICATIONS	A	EAIAA	4	0	4	4	7	12	
776	PEC	PE-3	23ADE3303E	EDGE AI ARCHITECTURES AND APPLICATIONS	E	EAIAA	4	0	4	4	7	12	
777	PEC	PE-3	23ADE3303R	EDGE AI ARCHITECTURES AND APPLICATIONS	R	EAIAA	3	0	2	4	5	9	
778	PEC	PE-3	23ABT3203A	MACHINE LEARNING FOR PRECISION AGRICULTURE	A	MLPA	5	0	0	0	5	5	
779	PEC	PE-3	23ABT3203E	MACHINE LEARNING FOR PRECISION AGRICULTURE	E	MLPA	5	0	0	0	5	5	
780	PEC	PE-3	23ABT3203R	MACHINE LEARNING FOR PRECISION AGRICULTURE	R	MLPA	3	0	0	0	3	3	
781	PEC	PE-3	23ABT3304A	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	A	IPAA	4	0	4	4	7	12	
782	PEC	PE-3	23ABT3304E	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	E	IPAA	4	0	4	4	7	12	
783	PEC	PE-3	23ABT3304R	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	R	IPAA	3	0	2	4	5	9	
784	PEC	PE-3	23ABT3405M	BIOINSTRUMENTATION	M	BIM	4	0	0	0	4	4	
785	PEC	PE-3	23IBT3304A	ENZYME ENGINEERING	A	EE	4	0	4	4	7	12	
786	PEC	PE-3	23IBT3304E	ENZYME ENGINEERING	E	EE	4	0	4	4	7	12	
787	PEC	PE-3	23IBT3304R	ENZYME ENGINEERING	R	EE	3	0	2	4	5	9	
788	PEC	PE-3	23HSS3303A	HARDWARE SECURITY MECHANISMS	A	HSM	4	0	4	4	7	12	
789	PEC	PE-3	23HSS3303E	HARDWARE SECURITY MECHANISMS	E	HSM	4	0	4	4	7	12	
790	PEC	PE-3	23HSS3303R	HARDWARE SECURITY MECHANISMS	R	HSM	3	0	2	4	5	9	
791	PEC	PE-3	23HDA3305A	COMPUTATIONAL NEUROSCIENCE	A	CNSE	4	0	4	4	7	12	

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792	PEC	PE-3	23HDA3305E	COMPUTATIONAL NEUROSCIENCE	E	CNSE	4	0	4	4	7	12	
793	PEC	PE-3	23HDA3305R	COMPUTATIONAL NEUROSCIENCE	R	CNSE	3	0	2	4	5	9	
794	PEC	PE-3	23AIP3305A	GENERATIVE DEEP LEARNING	A	GDL	4	0	4	4	7	12	
795	PEC	PE-3	23AIP3305E	GENERATIVE DEEP LEARNING	E	GDL	4	0	4	4	7	12	
796	PEC	PE-3	23AIP3305R	GENERATIVE DEEP LEARNING	R	GDL	3	0	2	4	5	9	
797	PEC	PE-3	23AIP3203A	MULTI MODAL INFORMATION PROCESSING	A	MMIP	3	0	4	0	5	7	
798	PEC	PE-3	23AIP3203E	MULTI MODAL INFORMATION PROCESSING	E	MMIP	3	0	4	0	5	7	
799	PEC	PE-3	23AIP3203R	MULTI MODAL INFORMATION PROCESSING	R	MMIP	2	0	2	0	3	4	
800	PEC	PE-3	23ALT3303A	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	A	CAICBD	4	0	4	4	7	12	
801	PEC	PE-3	23ALT3303E	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	E	CAICBD	4	0	4	4	7	12	
802	PEC	PE-3	23ALT3303R	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	R	CAICBD	3	0	2	4	5	9	
803	PEC	PE-3	23AVI3303A	OBJECT DETECTION	A	OD	4	0	4	4	7	12	
804	PEC	PE-3	23AVI3303E	OBJECT DETECTION	E	OD	4	0	4	4	7	12	
805	PEC	PE-3	23AVI3303R	OBJECT DETECTION	R	OD	3	0	2	4	5	9	
806	PEC	PE-3	23BEW3303A	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	A	DADW	4	0	4	4	7	12	
807	PEC	PE-3	23BEW3303E	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	E	DADW	4	0	4	4	7	12	
808	PEC	PE-3	23BEW3303R	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	R	DADW	3	0	2	4	5	9	
809	PEC	PE-3	23CTM3304A	CONSTRUCTION PLANNING & SCHEDULING	A	CPS	4	0	4	4	7	12	
810	PEC	PE-3	23CTM3304E	CONSTRUCTION PLANNING & SCHEDULING	E	CPS	4	0	4	4	7	12	
811	PEC	PE-3	23CTM3304R	CONSTRUCTION PLANNING & SCHEDULING	R	CPS	3	0	2	4	5	9	
812	PEC	PE-3	23CSC3304A	CLOUD BASED HIGH PERFORMANCE COMPUTING	A	CHC	4	0	4	4	7	12	
813	PEC	PE-3	23CSC3304E	CLOUD BASED HIGH PERFORMANCE COMPUTING	E	CHC	4	0	4	4	7	12	
814	PEC	PE-3	23CSC3304R	CLOUD BASED HIGH PERFORMANCE COMPUTING	R	CHC	3	0	2	4	5	9	
815	PEC	PE-3	23CID3304A	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	A	CIA	4	0	4	4	7	12	

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816	PEC	PE-3	23CID3304E	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	E	CIA	4	0	4	4	7	12	
817	PEC	PE-3	23CID3304R	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	R	CIA	3	0	2	4	5	9	
818	PEC	PE-3	23HDA3203A	GENETIC PROGRAMMING	A	GP	5	0	0	0	5	5	
819	PEC	PE-3	23HDA3203E	GENETIC PROGRAMMING	E	GP	5	0	0	0	5	5	
820	PEC	PE-3	23CEC3305A	CLOUD & SERVERLESS COMPUTING	A	CSC	4	0	4	4	7	12	
821	PEC	PE-3	23CEC3305E	CLOUD & SERVERLESS COMPUTING	E	CSC	4	0	4	4	7	12	
822	PEC	PE-3	23CEC3305R	CLOUD & SERVERLESS COMPUTING	R	CSC	3	0	2	4	5	9	
823	PEC	PE-3	23BMI3303A	MATERIALS FOR BIO-MEDICAL APPLICATIONS	A	MBMA	4	0	4	4	7	12	
824	PEC	PE-3	23BMI3303E	MATERIALS FOR BIO-MEDICAL APPLICATIONS	E	MBMA	4	0	4	4	7	12	
825	PEC	PE-3	23BMI3303R	MATERIALS FOR BIO-MEDICAL APPLICATIONS	R	MBMA	3	0	2	4	5	9	
826	PEC	PE-3	23BIS3304A	STRUCTURAL BIOLOGY	A	SB	4	0	4	4	7	12	
827	PEC	PE-3	23BIS3304E	STRUCTURAL BIOLOGY	E	SB	4	0	4	4	7	12	
828	PEC	PE-3	23BIS3304R	STRUCTURAL BIOLOGY	R	SB	3	0	2	4	5	9	
829	PEC	PE-3	23EME3304A	CHARGING STATIONS FOR ELECTRIC VEHICLES	A	CSEV	4	0	4	4	7	12	
830	PEC	PE-3	23EME3304E	CHARGING STATIONS FOR ELECTRIC VEHICLES	E	CSEV	4	0	4	4	7	12	
831	PEC	PE-3	23EME3304R	CHARGING STATIONS FOR ELECTRIC VEHICLES	R	CSEV	3	0	2	4	5	9	
832	PEC	PE-3	23ILA3304A	INDUSTRIAL DRIVES AND CONTROL	A	ID&C	4	0	4	4	7	12	
833	PEC	PE-3	23ILA3304E	INDUSTRIAL DRIVES AND CONTROL	E	ID&C	4	0	4	4	7	12	
834	PEC	PE-3	23ILA3304R	INDUSTRIAL DRIVES AND CONTROL	R	ID&C	3	0	2	4	5	9	
835	PEC	PE-3	23SMD3303A	CONTINUOUS DELIVERY & DEVOPS	A	CDD	4	0	4	4	7	12	
836	PEC	PE-3	23SMD3303E	CONTINUOUS DELIVERY & DEVOPS	E	CDD	4	0	4	4	7	12	
837	PEC	PE-3	23SMD3303R	CONTINUOUS DELIVERY & DEVOPS	R	CDD	3	0	2	4	5	9	
838	PEC	PE-3	23STE3304A	BRIDGE ENGINEERING	A	BE	4	0	4	4	7	12	
839	PEC	PE-3	23STE3304E	BRIDGE ENGINEERING	E	BE	4	0	4	4	7	12	
840	PEC	PE-3	23STE3304R	BRIDGE ENGINEERING	R	BE	3	0	2	4	5	9	
841	PEC	PE-3	23WRE3304A	WATER RESOURCES FIELD METHODS	A	WRFM	4	0	4	4	7	12	
842	PEC	PE-3	23WRE3304E	WATER RESOURCES FIELD METHODS	E	WRFM	4	0	4	4	7	12	

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843	PEC	PE-3	23WRE3304R	WATER RESOURCES FIELD METHODS	R	WRFM	3	0	2	4	5	9	
844	PEC	PE-3	23VLS3303A	VLSI PHYSICAL DESIGN AUTOMATION	A	VPDA	4	0	4	4	7	12	
845	PEC	PE-3	23VLS3303E	VLSI PHYSICAL DESIGN AUTOMATION	E	VPDA	4	0	4	4	7	12	
846	PEC	PE-3	23VLS3303R	VLSI PHYSICAL DESIGN AUTOMATION	R	VPDA	3	0	2	4	5	9	
847	PEC	PE-3	23CID3203A	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	A	AHASCE	5	0	0	0	5	5	
848	PEC	PE-3	23CID3203E	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	E	AHASCE	5	0	0	0	5	5	
849	PEC	PE-3	23CID3203R	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	R	AHASCE	3	0	0	0	3	3	
850	PEC	PE-3	23AIP3101E	DEEP LEARNING	E	DL	4	0	4	4	7	12	
851	PEC	PE-3	23AIP3101R	DEEP LEARNING	R	DL	3	0	2	4	5	9	
852	PEC	PE-3	23DEA3303A	BIG DATA TECHNOLOGIES	A	BDT	4	0	4	4	7	12	
853	PEC	PE-3	23DEA3303E	BIG DATA TECHNOLOGIES	E	BDT	4	0	4	4	7	12	
854	PEC	PE-3	23DEA3303R	BIG DATA TECHNOLOGIES	R	BDT	3	0	2	4	5	9	
855	PEC	PE-3	23SGT3304A	ENERGY MANAGEMENT SYSTEMS AND SCADA	A	EMS&SCADA	4	0	4	4	7	12	
856	PEC	PE-3	23SGT3304E	ENERGY MANAGEMENT SYSTEMS AND SCADA	E	EMS&SCADA	4	0	4	4	7	12	
857	PEC	PE-3	23SGT3304R	ENERGY MANAGEMENT SYSTEMS AND SCADA	R	EMS&SCADA	3	0	2	4	5	9	
858	PEC	PE-3	23SMF3304A	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING	A	SDSISM	4	0	4	4	7	12	
859	PEC	PE-3	23SMF3304E	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING	E	SDSISM	4	0	4	4	7	12	
860	PEC	PE-3	23SMF3304R	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING	R	SDSISM	3	0	2	4	5	9	
861	PEC	PE-3	23AEA3304A	ALTERNATE DRIVES, TRACTION AND CONTROLS	A	ADTC	4	0	4	4	7	12	
862	PEC	PE-3	23AEA3304E	ALTERNATE DRIVES, TRACTION AND CONTROLS	E	ADTC	4	0	4	4	7	12	
863	PEC	PE-3	23AEA3304R	ALTERNATE DRIVES, TRACTION AND CONTROLS	R	ADTC	3	0	2	4	5	9	

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864	PEC	PE-3	23ASS3304A	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	A	ADLAS	4	0	4	4	7	12	
865	PEC	PE-3	23ASS3304E	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	E	ADLAS	4	0	4	4	7	12	
866	PEC	PE-3	23ASS3304R	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	R	ADLAS	3	0	2	4	5	9	
867	PEC	PE-3	23ASS3203A	AI AND IOT FOR AUTONOMOUS VEHICLE	A	AIAV	5	0	0	0	5	5	
868	PEC	PE-3	23ASS3203E	AI AND IOT FOR AUTONOMOUS VEHICLE	E	AIAV	5	0	0	0	5	5	
869	PEC	PE-3	23RFM3303A	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	A	MRSNA	4	0	4	4	7	12	
870	PEC	PE-3	23RFM3303E	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	E	MRSNA	4	0	4	4	7	12	
871	PEC	PE-3	23RFM3303R	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	R	MRSNA	3	0	2	4	5	9	
872	PEC	PE-3	23RAN3304A	ADVANCED ROBOTICS	A	AR	4	0	4	4	7	12	
873	PEC	PE-3	23RAN3304E	ADVANCED ROBOTICS	E	AR	4	0	4	4	7	12	
874	PEC	PE-3	23RAN3304R	ADVANCED ROBOTICS	R	AR	3	0	2	4	5	9	
875	PEC	PE-3	23SCI3303A	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	A	SCPD	4	0	4	4	7	12	
876	PEC	PE-3	23SCI3303E	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	E	SCPD	4	0	4	4	7	12	
877	PEC	PE-3	23SCI3303R	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	R	SCPD	3	0	2	4	5	9	
878	PEC	PE-3	23GET3304A	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	A	GIRES	4	0	4	4	7	12	
879	PEC	PE-3	23GET3304E	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	E	GIRES	4	0	4	4	7	12	
880	PEC	PE-3	23GET3304R	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	R	GIRES	3	0	2	4	5	9	
881	PEC	PE-3	23GEG3304A	MOLECULAR MARKERS AND DIAGNOSTICS	A	MMD	4	0	4	4	7	12	
882	PEC	PE-3	23GEG3304E	MOLECULAR MARKERS AND DIAGNOSTICS	E	MMD	4	0	4	4	7	12	
883	PEC	PE-3	23GEG3304R	MOLECULAR MARKERS AND DIAGNOSTICS	R	MMD	3	0	2	4	5	9	
884	PEC	PE-3	23MBT3304A	HEALTHCARE BIOTECHNOLOGY	A	HBT	4	0	4	4	7	12	
885	PEC	PE-3	23MBT3304E	HEALTHCARE BIOTECHNOLOGY	E	HBT	4	0	4	4	7	12	
886	PEC	PE-3	23MBT3304R	HEALTHCARE BIOTECHNOLOGY	R	HBT	3	0	2	4	5	9	
887	PEC	PE-3	23GDU3303A	AR & VR APPLICATION DEVELOPMENT	A	AR&VR	4	0	4	4	7	12	

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888	PEC	PE-3	23GDU3303E	AR & VR APPLICATION DEVELOPMENT	E	AR&VR	4	0	4	4	7	12	
889	PEC	PE-3	23GDU3303R	AR & VR APPLICATION DEVELOPMENT	R	AR&VR	3	0	2	4	5	9	
890	PEC	PE-3	23GTE3304A	PAVEMENT MATERIALS &DESIGN	A	PMD	4	0	4	4	7	12	
891	PEC	PE-3	23GTE3304E	PAVEMENT MATERIALS &DESIGN	E	PMD	4	0	4	4	7	12	
892	PEC	PE-3	23GTE3304R	PAVEMENT MATERIALS &DESIGN	R	PMD	3	0	2	4	5	9	
893	PEC	PE-3	23CPD3304R	SECURE MOBILE APPLICATION DEVELOPMENT	R	SMAD	3	0	2	4	5	9	
894	PEC	PE-4	23CPD3406M	META REACT NATIVE SPECIALIZATION	M	MRNS	3	0	0	0	3	3	
895	PEC	PE-4	23GTE3405M	URBAN TRANSPORTATION SYSTEMS PLANNING	M	UTSP	3	0	0	0	3	3	
896	PEC	PE-4	23GTE3406M	GEOTECHNICAL EARTHQUAKE ENGINEERING	M	BIE	3	0	0	0	3	3	
897	PEC	PE-4	23GDU3404M	COMPUTER GRAPHICS	M	CG	3	0	0	0	3	3	
898	PEC	PE-4	23GDU3405M	3D MODELLING & ANIMATION	M	3DMA	3	0	0	0	3	3	
899	PEC	PE-4	23CPD3405M	UX DESIGN	M	UXD	3	0	0	0	3	3	
900	PEC	PE-4	23MBT3405M	CANCER BIOLOGY	M	CB	3	0	0	0	3	3	
901	PEC	PE-4	23MBT3406M	NEUROBIOLOGY	M	NB	3	0	0	0	3	3	
902	PEC	PE-4	23GEG3405M	GENOMICS AND PROTEOMICS	M	GP	3	0	0	0	3	3	
903	PEC	PE-4	23GEG3406M	DNA FORENSICS	M	DNF	3	0	0	0	3	3	
904	PEC	PE-4	23GET3405M	ENERGY MANAGEMENT AND GREEN BUILDING	M	EMGB	3	0	0	0	3	3	
905	PEC	PE-4	23GET3406M	HYDROGEN FUEL CELL TECHNOLOGY	M	HFCT	3	0	0	0	3	3	
906	PEC	PE-4	23SCI3404M	SPATIAL AND SOCIAL IMPLICATIONS OF IMMERSIVE TECHNOLOGIES	M	SSIIT	3	0	0	0	3	3	
907	PEC	PE-4	23SCI3405M	SPATIAL AUDIO DESIGN FOR GAMES	M	SADG	3	0	0	0	3	3	
908	PEC	PE-4	23RAN3405M	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	M	AIR	3	0	0	0	3	3	
909	PEC	PE-4	23RAN3406M	HUMAN MACHINE INTERFACE & BRAIN MACHINE INTERFACE	M	HMIBMI	3	0	0	0	3	3	
910	PEC	PE-4	23IOT3407M	APPLIED MACHINE LEARNING FOR AGRICULTURE	M	AMLA	3	0	0	0	3	3	
911	PEC	PE-4	23RFM3404M	RF AND MILLIMETER-WAVE CIRCUIT DESIGN	M	RFMECD	3	0	0	0	3	3	
912	PEC	PE-4	23ASS3405M	EXPERT SYSTEMS	M	ES	3	0	0	0	3	3	
913	PEC	PE-4	23ASS3406M	SELF-DRIVING CARS	M	SDC	3	0	0	0	3	3	

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914	PEC	PE-4	23AEA3405M	VEHICLE CONTROL SYSTEMS	M	VCS	3	0	0	0	3	3	
915	PEC	PE-4	23AEA3406M	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	M	AEES	3	0	0	0	3	3	
916	PEC	PE-4	23SMF3405M	ROBOTICS & INDUSTRIAL AUTOMATION	M	RIA	3	0	0	0	3	3	
917	PEC	PE-4	23SMF3406M	MECHANICAL MEASUREMENTS AND METROLOGY	M	MMM	3	0	0	0	3	3	
918	PEC	PE-4	23SGT3405M	SMART GRID COMMUNICATION AND CYBERSECURITY	M	SGCCS	3	0	0	0	3	3	
919	PEC	PE-4	23SGT3406M	SMART METERS AND SMART CITIES	M	SMSC	3	0	0	0	3	3	
920	PEC	PE-4	23DEA3404M	DATA WAREHOUSING AND BUSINESS INTELLIGENCE	M	DWBI	3	0	0	0	3	3	
921	PEC	PE-4	23CSC3406M	CLOUD COMPUTING FOR SCIENTIFIC DISCOVERY	M	CCFSD	3	0	0	0	3	3	
922	PEC	PE-4	23CID3406M	HYBRID CLOUD INTEGRATION AND MANAGEMENT	M	HCIM	3	0	0	0	3	3	
923	PEC	PE-4	23CNE3406M	CLOUD NATIVE SOFTWARE ARCHITECTURES	M	CNSA	3	0	0	0	3	3	
924	PEC	PE-4	23VLS3404M	SYSTEM-ON-CHIP	M	SOC	3	0	0	0	3	3	
925	PEC	PE-4	23WRE3405M	URBAN WATER HYDROLOGY AND HYDRAULICS	M	UWHH	3	0	0	0	3	3	
926	PEC	PE-4	23WRE3406M	ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSES	M	EIALCA	3	0	0	0	3	3	
927	PEC	PE-4	23STE3405M	PRESTRESSED CONCRETE	M	PC	3	0	0	0	3	3	
928	PEC	PE-4	23STE3406M	PRECAST AND PREFABRICATED STRUCTURES	M	PPS	3	0	0	0	3	3	
929	PEC	PE-4	23SMD3404M	SOFTWARE PROJECT MANAGEMENT	M	SPM	3	0	0	0	3	3	
930	PEC	PE-4	23SMD3405M	SOFTWARE ARCHITECTURE & DESIGN	M	SAD	3	0	0	0	3	3	
931	PEC	PE-4	23ILA3406M	DIGITAL MANUFACTURING AND DESIGN	M	DMD	3	0	0	0	3	3	
932	PEC	PE-4	23ILA3405M	INDUSTRIAL COMMUNICATION PROTOCOLS AND CYBER SECURITY	M	ICPCS	3	0	0	0	3	3	
933	PEC	PE-4	23EME3405M	INTRODUCTION TO BATTERY-MANAGEMENT SYSTEMS	M	IBMS	3	0	0	0	3	3	
934	PEC	PE-4	23EME3406M	BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE	M	BSAEV	3	0	0	0	3	3	
935	PEC	PE-4	23BIS3405M	APPLIED BIOINFORMATICS	M	ABI	3	0	0	0	3	3	
936	PEC	PE-4	23BIS3406M	NGS SEQUENCING AND DATA ANALYSIS	M	NGSDA	3	0	0	0	3	3	

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937	PEC	PE-4	23BMI3404M	NANOTECHNOLOGY AND NANOSENSORS	M	NTNS	3	0	0	0	3	3	
938	PEC	PE-4	23CEC3406M	ADVANCED COMPUTER ARCHITECTURE	M	ACA	3	0	0	0	3	3	
939	PEC	PE-4	23CEC3407M	PARALLEL ALGORITHMS	M	PA	3	0	0	0	3	3	
940	PEC	PE-4	23CEC3408M	CLOUD SECURITY	M	CS	3	0	0	0	3	3	
941	PEC	PE-4	23CEC3409M	ARCHITECTING CLOUD SOLUTIONS*	M	ACS	3	0	0	0	3	3	
942	PEC	PE-4	23HDA3406M	NGS SEQUENCING AND DATA ANALYSIS	M	NGSDA	3	0	0	0	3	3	
943	PEC	PE-4	23CID3405M	RELIABLE CLOUD INFRASTRUCTURE: DESIGN & PROCESS	M	RID	3	0	0	0	3	3	
944	PEC	PE-4	23CNE3304A	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	A	SEC	4	0	4	4	7	12	
945	PEC	PE-4	23CNE3304E	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	E	SEC	4	0	4	4	7	12	
946	PEC	PE-4	23CSC3405M	CLOUD-BASED GRID COMPUTING	M	CGC	3	0	0	0	3	3	
947	PEC	PE-4	23CTM3405M	CONSTRUCTION CONTRACTS	M	CC	3	0	0	0	3	3	
948	PEC	PE-4	23CTM3406M	CONSTRUCTION FORMULATION APPRAISAL	M	CFA	3	0	0	0	3	3	
949	PEC	PE-4	23BEW3404M	BLOCKCHAIN PLATFORMS AND PROTOCOLS	M	BCPAP	3	0	0	0	3	3	
950	PEC	PE-4	23BEW3405M	BLOCKCHAIN SECURITY	M	BCS	3	0	0	0	3	3	
951	PEC	PE-4	23BEW3406M	ORACLES AND DATA FEEDS	M	ODF	3	0	0	0	3	3	
952	PEC	PE-4	23AVI3404M	VISUAL RECOGNITION AND SCENE UNDERSTANDING	M	VRASU	3	0	0	0	3	3	
953	PEC	PE-4	23AVI3405M	DEEP REINFORCEMENT LEARNING FOR VISION	M	DRLV	3	0	0	0	3	3	
954	PEC	PE-4	23ALT3404M	TEXT UNDERSTANDING	M	TUS	3	0	0	0	3	3	
955	PEC	PE-4	23ALT3405M	NATURAL LANGUAGE PROCESSING	M	NLP	3	0	0	0	3	3	
956	PEC	PE-4	23AIP3406M	COGNITIVE COMPUTING	M	CC	3	0	0	0	3	3	
957	PEC	PE-4	23AIP3407M	PERCEPTION AND COMPUTER VISION	M	PCV	3	0	0	0	3	3	
958	PEC	PE-4	23AIP3408M	MACHINE LEARNING ON CLOUD	M	MLC	3	0	0	0	3	3	
959	PEC	PE-4	23HDA3407M	INTRODUCTION TO GENOMIC TECHNOLOGIES	M	IGT	3	0	0	0	3	3	
960	PEC	PE-4	23HSS3404M	SOFTWARE SECURITY PRINCIPLES	M	SSP	3	0	0	0	3	3	
961	PEC	PE-4	23HSS3405M	SECURE CO-DESIGN METHODOLOGIES	M	SCDM	3	0	0	0	3	3	

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962	PEC	PE-4	23HSS3406M	HARDWARE TROJAN DETECTION AND PREVENTION	M	HTDAP	3	0	0	0	3	3	
963	PEC	PE-4	23IBT3405M	BIOPROCESS VALIDATION AND CGMP	M	BVcGMP	3	0	0	0	3	3	
964	PEC	PE-4	23IBT3406M	FOOD TECHNOLOGY	M	FT	3	0	0	0	3	3	
965	PEC	PE-4	23ABT3406M	DATA ACQUISITION AND COMMUNICATION SYSTEMS FOR AGRICULTURE	M	DACSA	3	0	0	0	3	3	
966	PEC	PE-4	23ADE3404M	EDGE AI AND 5G	M	EAI5G	3	0	0	0	3	3	
967	PEC	PE-4	23ADE3405M	EDGE AI SECURITY AND PROTECTION	M	EAISP	3	0	0	0	3	3	
968	PEC	PE-4	23ACI3404M	HEURISTIC ALGORITHMS	M	HAG	3	0	0	0	3	3	
969	PEC	PE-4	23ACI3405M	SWARM INTELLIGENCE APPROACHES	M	SIA	3	0	0	0	3	3	
970	PEC	PE-4	23DSB3404M	BIG DATA OPTIMIZATION	M	BDO	3	0	0	0	3	3	
971	PEC	PE-4	23DSB3407M	DATA ANALYTICS ON CLOUD	M	DAC	3	0	0	0	3	3	
972	PEC	PE-4	23DSB3408M	DIGITAL MEDIA ANALYTICS	M	DMA	3	0	0	0	3	3	
973	PEC	PE-4	23CCF3404M	5G MOBILE AND IEEE STANDARDS	M	5GMI	3	0	0	0	3	3	
974	PEC	PE-4	23CNE3405M	SERVERLESS COMPUTING AND EVENT-DRIVEN ARCHITECTURES	M	SCEDA	3	0	0	0	3	3	
975	PEC	PE-4	23SDM3405M	DIGITAL MEDIA ANALYTICS	M	DMA	3	0	0	0	3	3	
976	PEC	PE-4	23SDM3406M	ETHICAL SOCIAL MEDIA	M	ESM	3	0	0	0	3	3	
977	PEC	PE-4	23CNS3404M	MICROSERVICES SECURITY	M	MSS	3	0	0	0	3	3	
978	PEC	PE-4	23CNS3405M	INFRASTRUCTURE AS CODE SECURITY	M	ISACS	3	0	0	0	3	3	
979	PEC	PE-4	23CNS3406M	IDENTITY AND ACCESS MANAGEMENT IN CLOUD NATIVE ENVIRONMENTS	M	IAMCNE	3	0	0	0	3	3	
980	PEC	PE-4	23CNS3407M	NETWORK SECURITY IN CLOUD NATIVE ARCHITECTURES	M	NSCNA	3	0	0	0	3	3	
981	PEC	PE-4	23CSB3405M	DATABASE SYSTEM AND SECURITY	M	DSS	3	0	0	0	3	3	
982	PEC	PE-4	23CSB3406M	PROGRAMMING FOR SMART CONTRACTS	M	PSC	3	0	0	0	3	3	
983	PEC	PE-4	23CSB3407M	CLOUD SECURITY	M	CS	3	0	0	0	3	3	
984	PEC	PE-4	23DLA3405M	BLOCKCHAIN ANALYTICS	M	BCA	3	0	0	0	3	3	
985	PEC	PE-4	23DLA3406M	CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGY	M	CBT	3	0	0	0	3	3	
986	PEC	PE-4	23DCS3404M	OPTICAL WIRELESS COMMUNICATIONS	M	PWC	3	0	0	0	3	3	

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987	PEC	PE-4	23CPS3404M	FOUNDATIONS OF HYBRID AND EMBEDDED SYSTEMS	M	DVP	3	0	0	0	3	3	
988	PEC	PE-4	23EDS3404M	CLOUD ARCHITECTURE IN IOT	M	CAIOT	3	0	0	0	3	3	
989	PEC	PE-4	23IMP3404M	DATA VISUALIZATION	M	DV	3	0	0	0	3	3	
990	PEC	PE-4	23IOT3406M	DATA VISUALIZATION TECHNIQUES	M	DVT	3	0	0	0	3	3	
991	PEC	PE-4	23DSB3406M	DIGITAL VIDEO PROCESSING	M	DVP	3	0	0	0	3	3	
992	PEC	PE-4	23ECF3405M	SPECIAL PURPOSE VEHICLES	M	SPV	3	0	0	0	3	3	
993	PEC	PE-4	23ECF3406M	VEHICLE DYNAMICS	M	VD	3	0	0	0	3	3	
994	PEC	PE-4	23EGD3405M	ADVANCED VIBRATIONS	M	AV	3	0	0	0	3	3	EM(1) Rule:1
995	PEC	PE-4	23EGD3406M	MECHANICS OF COMPOSITE MATERIALS	M	MOCM	3	0	0	0	3	3	EM(1) Rule:1
996	PEC	PE-4	23ASS3410M	CYBERSECURITY IN AUTONOMOUS VEHICLE	M	CAV	3	0	0	0	3	3	
997	PEC	PE-5	23ASS3511	AI DRIVEN ECU DESIGN FOR AUTONOMOUS VEHICLES	R	AEDATT	2	0	2	0	3	4	
998	PEC	PE-5	23EGD3507	ADVANCED STRENGTH OF MATERIALS	R	ASM	3	0	0	0	3	3	EM(1) Rule:1
999	PEC	PE-5	23EGD3508	HYBRID AND ELECTRIC VEHICLE DESIGN	R	HEVD	3	0	0	0	3	3	EM(1) Rule:1
1000	PEC	PE-5	23ECF3507	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	R	TMEES	3	0	0	0	3	3	
1001	PEC	PE-5	23ECF3508	ALTERNATE ENERGY SOURCES FOR AUTOMOBILES	R	AESFA	3	0	0	0	3	3	
1002	PEC	PE-5	23IOT3508	BIG DATA ANALYTICS	R	BDA	3	0	0	0	3	3	
1003	PEC	PE-5	23IMP3505	MULTI MEDIA PROCESSING	R	MMP	3	0	0	0	3	3	
1004	PEC	PE-5	23IMP3506	INTRODUCTION TO QUANTUM COMPUTING	R	MMP	3	0	0	0	3	3	
1005	PEC	PE-5	23EDS3505	EDGE COMPUTING & DATA ANALYTICS IN IOT	R	ECDAI	3	0	0	0	3	3	
1006	PEC	PE-5	23CPS3505	CLOUD COMPUTING FOR IOT ENGINEERS	R	CCIOTE	3	0	0	0	3	3	
1007	PEC	PE-5	23CPS3506	WIRELESS SENSOR NETWORKS	R	WSN	3	0	0	0	3	3	
1008	PEC	PE-5	23CPS3507	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
1009	PEC	PE-5	23ILA3508	PLC PROGRAMMING & CONTROL	R	PLCPC	3	0	0	0	3	3	
1010	PEC	PE-5	23DCS3505	MACHINE LEARNING FOR WIRELESS COMMUNICATION	R	MLWC	3	0	0	0	3	3	
1011	PEC	PE-5	23DLA3507	DISTRIBUTED LEDGER ARCHITECTURE FOR AUTOMATION	R	DLAA	3	0	0	0	3	3	

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1012	PEC	PE-5	23DLA3508	PERMISSIONED DISTRIBUTED LEDGER	R	PDL	3	0	0	0	3	3	
1013	PEC	PE-5	23CSB3508	SECURE SOFTWARE ENGINEERING	R	SSE	3	0	0	0	3	3	
1014	PEC	PE-5	23CSB3509	WEB SECURITY	R	WS	3	0	0	0	3	3	
1015	PEC	PE-5	23CSB3510	SECURITY GOVERNANCE & MANAGEMENT	R	SGM	3	0	0	0	3	3	
1016	PEC	PE-5	23CNS3508	MONITORING AND LOGGING FOR CLOUD NATIVE SECURITY	R	MLCNS	3	0	0	0	3	3	
1017	PEC	PE-5	23CNS3509	COMPLIANCE AND GOVERNANCE IN CLOUD NATIVE ENVIRONMENTS	R	CGCNE	3	0	0	0	3	3	
1018	PEC	PE-5	23CNS3510	SERVERLESS SECURITY	R	SLSY	3	0	0	0	3	3	
1019	PEC	PE-5	23CNS3511	CLOUD NATIVE SECURITY TOOLS AND SOLUTIONS	R	CNSTAS	3	0	0	0	3	3	
1020	PEC	PE-5	23CNS3512	FUTURE TRENDS IN CLOUD NATIVE SECURITY	R	FTCNS	3	0	0	0	3	3	
1021	PEC	PE-5	23SDM3507	INTELLIGENT SOCIAL MEDIA MONITORING SYSTEMS	R	ISMMS	3	0	0	0	3	3	
1022	PEC	PE-5	23CNE3507	CLOUD NATIVE NETWORKING AND STORAGE SYSTEMS	R	CNNSS	3	0	0	0	3	3	
1023	PEC	PE-5	23HDA3204R	PYTHON FOR GENOMIC DATA SCIENCE	R	PFGDS	3	0	0	0	3	3	
1024	PEC	PE-5	23HDA3510	GENOMIC DATA SCIENCE & CLUSTERING	R	GDSC	3	0	0	0	3	3	
1025	PEC	PE-5	23CCF3505	IP MULTIMEDIA SUB-SYSTEM & EMERGING TECHNOLOGIES	R	IMSET	3	0	0	0	3	3	
1026	PEC	PE-5	23CCF3506	IT SECURITY: DEFENCE AGAINST THE DIGITAL DARK ARTS	R	IMSET	3	0	0	0	3	3	
1027	PEC	PE-5	23DSB3509	ADVANCED DATABASES	R	AD	3	0	0	0	3	3	
1028	PEC	PE-5	23DSB3510	BUSINESS ANALYTICS	R	BA	3	0	0	0	3	3	
1029	PEC	PE-5	23DSB3511	GRAPH & WEB ANALYTICS	R	GWA	3	0	0	0	3	3	
1030	PEC	PE-5	23DSB3512	DATA GOVERNANCE ON CLOUD	R	DGC	3	0	0	0	3	3	
1031	PEC	PE-5	23ACI3506	DATA MANIPULATION	R	DMP	3	0	0	0	3	3	
1032	PEC	PE-5	23ACI3507	REINFORCEMENT LEARNING	R	RLG	3	0	0	0	3	3	
1033	PEC	PE-5	23ACI3508	EVOLUTIONARY COMPUTATION	R	ECP	3	0	0	0	3	3	
1034	PEC	PE-5	23ADE3506	EDGE AI DEVELOPMENT FRAMEWORKS AND TOOLS	R	EAIDFT	3	0	0	0	3	3	
1035	PEC	PE-5	23ADE3507	EDGE AI ANALYTICS AND DATA MANAGEMENT	R	EAIADM	3	0	0	0	3	3	
1036	PEC	PE-5	23ADE3508	EDGE AI AND SUSTAINABILITY	R	EAIAS	3	0	0	0	3	3	

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1037	PEC	PE-5	23ABT3507	MICROFLUIDICS FOR AGRICULTURAL APPLICATIONS	R	MAP	3	0	0	0	3	3	
1038	PEC	PE-5	23ABT3508	BIOINFORMATICS FOR AGRICULTURE	R	BIA	3	0	0	0	3	3	
1039	PEC	PE-5	23IBT3507	MICROBIAL TECHNOLOGY	R	MBT	3	0	0	0	3	3	
1040	PEC	PE-5	23IBT3508	METABOLIC ENGINEERING	R	MBE	3	0	0	0	3	3	
1041	PEC	PE-5	23HSS3507	SIDE-CHANNEL ATTACKS AND COUNTERMEASURES	R	SCACM	3	0	0	0	3	3	
1042	PEC	PE-5	23HSS3508	FORMAL METHODS FOR HARDWARE-SOFTWARE SECURITY	R	FMHSS	3	0	0	0	3	3	
1043	PEC	PE-5	23HSS3509	TRUSTED PLATFORM MODULES AND SECURE ELEMENTS	R	TPMASE	3	0	0	0	3	3	
1044	PEC	PE-5	23HSS3510	SECURE COMMUNICATION PROTOCOLS AND APIS	R	SCPA	3	0	0	0	3	3	
1045	PEC	PE-5	23HSS3511	HARDWARE-SOFTWARE CO-DESIGN	R	HSCCS	3	0	0	0	3	3	
1046	PEC	PE-5	23HSS3512	FUTURE TRENDS IN HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY	R	FTHSCS	3	0	0	0	3	3	
1047	PEC	PE-5	23HDA3511	EPI GENETIC CONTROL OF GENE EXPRESSION	R	ECBI	3	0	0	0	3	3	
1048	PEC	PE-5	23SDM3508	SEARCH ENGINE OPTIMIZATION	R	SEO	3	0	0	0	3	3	
1049	PEC	PE-5	23AIP3509	COMPUTATIONAL EPIDEMIOLOGY	R	CE	3	0	0	0	3	3	
1050	PEC	PE-5	23AIP3510	NATURAL LANGUAGE PROCESSING	R	NLP	3	0	0	0	3	3	
1051	PEC	PE-5	23AIP3511	SPEECH PROCESSING	R	SP	2	0	2	0	3	4	
1052	PEC	PE-5	23AIP3512	DESIGN & MANAGEMENT OF DISTRIBUTED APPLICATIONS FOR AI ON CLOUD	R	DMDAAC	3	0	0	0	3	3	
1053	PEC	PE-5	23AIP3513	ARCHITECTING DEEP LEARNING WORKLOADS ON CLOUD	R	ADLWC	3	0	0	0	3	3	
1054	PEC	PE-5	23ALT3506	LANGUAGE UNDERSTANDING WITH PRE-TRAINED MODELS	R	LUWPTM	3	0	0	0	3	3	
1055	PEC	PE-5	23ALT3507	LARGE LANGUAGE MODEL FOR SPEECH PROCESSING	R	LLMFSP	3	0	0	0	3	3	
1056	PEC	PE-5	23AVI3506	HUMAN COMPUTER INTERACTION	R	HCI	3	0	0	0	3	3	
1057	PEC	PE-5	23AVI3507	OBJECT LOCALIZATION	R	OL	3	0	0	0	3	3	
1058	PEC	PE-5	23AVI3508	ADVANCED IMAGE PROCESSING AND ANALYSIS	R	AIPA	3	0	0	0	3	3	
1059	PEC	PE-5	23BEW3507	BLOCKCHAIN SCALABILITY AND LAYER 2 SOLUTIONS	R	BCSALS	3	0	0	0	3	3	
1060	PEC	PE-5	23BEW3508	REGULATORY LANDSCAPE AND COMPLIANCE	R	RLAC	3	0	0	0	3	3	

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1061	PEC	PE-5	23BEW3509	FUTURE TRENDS IN BLOCKCHAIN AND WEB3	R	FTBCAW	3	0	0	0	3	3	
1062	PEC	PE-5	23CTM3507	QUALITY AND SAFETY IN CONSTRUCTION	R	QSC	3	0	0	0	3	3	
1063	PEC	PE-5	23CTM3508	GREEN BUILDING	R	GB	3	0	0	0	3	3	
1064	PEC	PE-5	23CID3507	CLOUD ENGINEERING	R	CE	3	0	0	0	3	3	
1065	PEC	PE-5	23HDA3509	MOLECULAR MODELING AND DRUG DESIGN	R	MMDD	3	0	0	0	3	3	
1066	PEC	PE-5	23CEC3510	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
1067	PEC	PE-5	23CEC3511	HIGH PERFORMANCE COMPUTING	R	HPC	3	0	0	0	3	3	
1068	PEC	PE-5	23CEC3512	DESIGN OF DISTRIBUTED APPLICATIONS ON CLOUD (DDA)	R	DDAC	3	0	0	0	3	3	
1069	PEC	PE-5	23CEC3513	CLOUD NETWORKING	R	CN	3	0	0	0	3	3	
1070	PEC	PE-5	23BMI3505	BIOSENSING AND BIOELECTRONICS	R	BSBE	3	0	0	0	3	3	
1071	PEC	PE-5	23BIS3507	SYSTEMS BIOLOGY	R	SSB	3	0	0	0	3	3	
1072	PEC	PE-5	23BIS3508	DATABASE MANAGEMENT SYSTEM FOR BIOLOGIST	R	DBMS	3	0	0	0	3	3	
1073	PEC	PE-5	23EME3507	AI AND IOT FOR ELECTRIC VEHICLE	R	AIEV	3	0	0	0	3	3	
1074	PEC	PE-5	23EME3508	EV SYSTEM AND WIRING DESIGN	R	ESWS	3	0	0	0	3	3	
1075	PEC	PE-5	23ILA3507	SMART SENSORS AND SENSOR NETWORKING	R	SSSN	3	0	0	0	3	3	
1076	PEC	PE-5	23SMD3506	SOFTWARE RELIABILITY	R	SR	3	0	0	0	3	3	
1077	PEC	PE-5	23SMD3507	CROSS-PLATFORM USER INTERFACE DESIGN	R	CPUIF	3	0	0	0	3	3	
1078	PEC	PE-5	23STE3507	PRE ENGINEERING STRUCTURES	R	PES	3	0	0	0	3	3	
1079	PEC	PE-5	23STE3508	ADVANCED DESIGN OF REINFORCED CONCRETE STRUCTURES	R	ADRCs	3	0	0	0	3	3	
1080	PEC	PE-5	23WRE3507	PHYSICO-CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT	R	PCPWWT	3	0	0	0	3	3	
1081	PEC	PE-5	23WRE3508	SUSTAINABLE ENGINEERING AND TECHNOLOGY	R	SET	3	0	0	0	3	3	
1082	PEC	PE-5	23VLS3505	MIXED SIGNAL IC DESIGN	R	MSID	3	0	0	0	3	3	
1083	PEC	PE-5	23CNE3508	CLOUD INFRASTRUCTURE AND VIRTUALIZATION	R	CIIV	3	0	0	0	3	3	
1084	PEC	PE-5	23CID3508	CLOUD DATA MANAGEMENT AND STORAGE SOLUTIONS	R	CDMSS	3	0	0	0	3	3	
1085	PEC	PE-5	23CSC3508	PARALLEL COMPUTING FOR SCIENTISTS USING CLOUD PLATFORMS	R	PCSCP	3	0	0	0	3	3	

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1086	PEC	PE-5	23CSC3507	CLOUD-BASED SCALABLE COMPUTING AND BIG DATA ANALYTICS	R	CSCBD	3	0	0	0	3	3	
1087	PEC	PE-5	23DEA3505R	MACHINE LEARNING ENGINEERING FOR BIG DATA	R	MLEBD	3	0	0	0	3	3	
1088	PEC	PE-5	23SGT3507	INTERNET OF THINGS AND SMART GRID ANALYTICS	R	IOT&SGA	3	0	0	0	3	3	
1089	PEC	PE-5	23SGT3508	SMART GRID PROTECTION	R	SGP	3	0	0	0	3	3	
1090	PEC	PE-5	23SMF3507	MACHINE TO MACHINE COMMUNICATION	R	MMC	3	0	0	0	3	3	
1091	PEC	PE-5	23SMF3508	FLEXIBLE MANUFACTURING SYSTEMS	R	FMS	3	0	0	0	3	3	
1092	PEC	PE-5	23AEA3507	SOFT COMPUTING TECHNIQUES FOR AUTOMOTIVE APPLICATIONS	R	SCTAA	3	0	0	0	3	3	
1093	PEC	PE-5	23AEA3508	AUTOMOTIVE NETWORKING AND PROTOCOLS	R	ANP	3	0	0	0	3	3	
1094	PEC	PE-5	23ASS3507	LOCALIZATION & PROGRAMMING REAL-TIME AUTONOMOUS SYSTEMS	R	LPRAS	3	0	0	0	3	3	
1095	PEC	PE-5	23ASS3508	REINFORCEMENT LEARNING FOR AUTONOMOUS SYSTEM	R	RLA	3	0	0	0	3	3	
1096	PEC	PE-5	23RFM3505	SATELLITE DESIGN	R	SD	3	0	0	0	3	3	
1097	PEC	PE-5	23RAN3202A	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	A	AVAE	5	0	0	0	5	5	
1098	PEC	PE-5	23RAN3507	COMPUTER VISION & APPLICATIONS	R	CVA	3	0	0	0	3	3	
1099	PEC	PE-5	23SCI3506	SPATIAL USER INTERFACE DESIGN	R	SUID	3	0	0	0	3	3	
1100	PEC	PE-5	23SCI3507	INTRODUCTION TO SPATIAL COMPUTING	R	ITSC	3	0	0	0	3	3	
1101	PEC	PE-5	23GET3507	AI AND IOT FOR GREEN ENERGY INTEGRATION	R	AIGEI	3	0	0	0	3	3	
1102	PEC	PE-5	23GET3508	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	R	PERES	3	0	0	0	3	3	
1103	PEC	PE-5	23GEG3507	MICROBIAL GENETICS	R	MBG	3	0	0	0	3	3	
1104	PEC	PE-5	23GEG3508	GENE AND ENVIRONMENT	R	BI	3	0	0	0	3	3	
1105	PEC	PE-5	23MBT3507	BIOELECTRONICS & BIOSENSORS	R	BB	3	0	0	0	3	3	
1106	PEC	PE-5	23MBT3508	TISSUE ENGINEERING	R	NBT	3	0	0	0	3	3	
1107	PEC	PE-5	23GDU3506	PRINCIPLES OF GAME DESIGN	R	PRGD	3	0	0	0	3	3	
1108	PEC	PE-5	23GDU3507	BUSINESS OF GAMES & ENTREPRENEURSHIP	R	BGE	3	0	0	0	3	3	
1109	PEC	PE-5	23GTE3507	TRAFFIC ENGINEERING AND MANAGEMENT	R	TEM	3	0	0	0	3	3	

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1110	PEC	PE-5	23GTE3508	DESIGN OF EARTH RETAINING STRUCTURES	R	DERS	3	0	0	0	3	3	
1111	PEC	PE-5	23CPD3507	ADVANCED MOBILE APPLICATION DEVELOPMENT	R	AMAD	3	0	0	0	3	3	
1112	PEC	PE-5	23CPD3508	CROSS PLATFORM USER INTERFACE DESIGN	R	CPED	3	0	0	0	3	3	
1113	PEC	PE-5	23IMP3101R	NATURAL LANGUAGE PROCESSING & APPLICATIONS	R	NLPA	3	0	2	4	5	9	
1114	PRI		23IE4053 R	CAPSTONE PROJECT - 1	R	CP-1	0	0	8	16	8	24	
1115	PRI		23IE4053R	CAPSTONE PROJECT - 1	R	CP-1	0	0	8	16	8	24	
1116	PRI	PRI-CORE	23IE4054A	CAPSTONE PROJECT - 2	A	CP-2	0	0	10	20	10	30	
1117	PRI	PRI-CORE	23IE4054R	CAPSTONE PROJECT - 2	R	CP-2	0	0	8	16	8	24	
1118	PRI	PRI-CORE	23IE2040	SOCIAL INTERNSHIP	R	SIP	0	0	0	4	0	4	
1119	PRI	PRI-CORE	23IE3041	TECHNICAL INTERNSHIP	R	TIP	0	0	0	4	0	4	
1120	PRI	PRI-CORE	23IE4053A	CAPSTONE PROJECT - 1	A	CP-1	0	0	10	20	10	30	
1121	PRI	PRI-CORE	23IE4048	ENGINEERING PROJECT	R	EPJ	0	0	8	16	8	24	
1122	OEC		23OECE06M	EXPLORING OUR RESPONSES TO CLIMATE CHANGE	M	EORCC	4	0	0	0	4	4	
1123	OEC		23OECE05M	SELF-DRIVING CARS	M	SDC	4	0	0	0	4	4	
1124	OEC	OE-1	23OEME01M	ROBOTICS	M	RBT	4	0	0	0	4	4	
1125	OEC	OE-1	23OEME01	ROBOTICS	R	RBT	4	0	0	0	4	4	
1126	OEC	OE-1	23ME2106R	MECHANICS OF SOLIDS	R	MOS	3	0	2	0	4	5	
1127	OEC	OE-1	23OECE03	ELECTRICAL POWER ENGINEERING	R	EPE	4	0	0	0	4	4	
1128	OEC	OE-1	23CE2208R	GEOTECHNICAL ENGINEERING	R	GTE	3	0	2	0	4	5	
1129	OEC	OE-1	23ACCBT	BUSINESS TECHNOLOGY	R	BT	4	0	0	0	4	4	
1130	OEC	OE-1	22FT2212R	PROCESSING OF AQUATIC FOODS	R	PAF	3	0	2	0	4	5	
1131	OEC	OE-1	23OEBT01	IPR AND PATENT LAWS	R	IPR	4	0	0	0	4	4	
1132	OEC	OE-1	23BT2209R	BIOCHEMICAL REACTION ENGINEERING	R	BCRE	3	0	2	0	4	5	
1133	OEC	OE-1	23AD2204R	DATA MANAGEMENT AND WAREHOUSING	R	DMW	3	0	2	0	4	5	
1134	OEC	OE-1	23EC2105R	SIGNALS & COMMUNICATION SYSTEMS	R	SCS	3	0	2	0	4	5	
1135	OEC	OE-1	23OEDT01	INNOVATIVE PRODUCT DEVELOPMENT FOR ENTREPRENEURS	R	IPDFE	4	0	0	0	4	4	

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1136	OEC	OE-2	23OEDT02	STRATEGIC FINANCIAL AND MARKETING PLANNING FOR ENTREPRENEURS	R	SFMPE	4	0	0	0	4	4	
1137	OEC	OE-2	23EC2208R	DIGITAL COMMUNICATION	R	DC	3	0	2	0	4	5	
1138	OEC	OE-2	23AD3106R	BIG DATA ENGINEERING	R	BDE	3	0	2	0	4	5	
1139	OEC	OE-2	23ACCAFA	FINANCIAL ACCOUNTING	R	FA	3	2	0	0	5	5	
1140	OEC	OE-2	22FT22C1R	FOOD ANALYSIS AND QUALITY ASSURANCE	R	FAQA	3	0	2	0	4	5	
1141	OEC	OE-2	23BT3212	PLANT AND ANIMAL BIOTECHNOLOGY	R	PABT	3	0	2	0	4	5	
1142	OEC	OE-2	23EE2207R	CONTROL SYSTEMS	R	CS	3	0	2	0	4	5	
1143	OEC	OE-2	23CI2001	ADAPTIVE SOFTWARE ENGINEERING	R	ASE	3	1	0	0	4	4	
1144	OEC	OE-2	23CE2209R	TRANSPORTATION ENGINEERING	R	TPE	3	0	2	0	4	5	
1145	OEC	OE-2	23ME2116	FLUID MECHANICS & HYDRAULIC MACHINES	R	FMHM	3	0	2	0	4	5	
1146	OEC	OE-3	23CS2104R	OPERATING SYSTEMS	R	OS	3	0	2	0	4	5	
1147	OEC	OE-3	23EE2205R	POWER ELECTRONICS	R	PES	3	0	2	0	4	5	
1148	OEC	OE-3	23OEME03M	OPERATIONS RESEARCH	M	ORS	4	0	0	0	4	4	
1149	OEC	OE-3	23ME2208	MANUFACTURING PROCESSES	R	MP	3	0	2	0	4	5	
1150	OEC	OE-3	23CE3109	ENVIRONMENTAL ENGINEERING	R	EVE	3	0	2	0	4	5	
1151	OEC	OE-3	22FT3215R	TECHNOLOGY OF MEAT AND POULTRY	R	TMP	3	0	2	0	4	5	
1152	OEC	OE-3	23ACCAMA	MANAGEMENT ACCOUNTING	R	MA	3	2	0	0	5	5	
1153	OEC	OE-3	23EC3112R	DISCRETE TIME SIGNAL PROCESSING	R	DTSP	3	0	2	0	4	5	
1154	OEC	OE-3	23BT3213R	DOWNSTREAM PROCESSING	R	DSP	2	0	4	0	4	6	
1155	OEC	OE-3	23AD3207R	NATURAL LANGUAGE PROCESSING	R	NLP	3	0	2	0	4	5	
1156	OEC	OE-3	23OEDT03	LEADERSHIP IN ENTREPRENEURIAL VENTURES	R	LEV	4	0	0	0	4	4	
1157	VAC	VAC-	23SP2101	ATHLETICS	R	ATH	0	0	0	2	0	2	
1158	VAC	VAC-	23SP2103	BADMINTON	R	BMT	0	0	0	2	0	2	
1159	VAC	VAC-	23SP2102	BASKETBALL	R	BKB	0	0	0	2	0	2	
1160	VAC	VAC-	23SP2105	CHESS	R	CHS	0	0	0	2	0	2	
1161	VAC	VAC-	23SP2104	CRICKET	R	CRKT	0	0	0	2	0	2	
1162	VAC	VAC-	23SP2108	KABADDI	R	KBD	0	0	0	2	0	2	

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1163	VAC	VAC-	23SP2109	KHO-KHO	R	KHO	0	0	0	2	0	2	
1164	VAC	VAC-	23SP2111	TABLE TENNIS	R	TTS	0	0	0	2	0	2	
1165	VAC	VAC-	23SP2110	TENNIS	R	TNS	0	0	0	2	0	2	
1166	VAC	VAC-	23SP2113	THROW BALL	R	THB	0	0	0	2	0	2	
1167	VAC	VAC-	23SP2114	VOLLEYBALL	R	VOB	0	0	0	2	0	2	
1168	VAC	VAC-	23SP2116	YOGA	R	YOG	0	0	0	2	0	2	
1169	VAC	VAC-CERT	23CC3005	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING USING PYTHON [INDUSTRIAL AUTOMATION]-L1 (TESSOLVE)	R	AIML1	0	0	0	8	0	8	
1170	VAC	VAC-CERT	23CC3006	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING USING PYTHON [INDUSTRIAL AUTOMATION]-L2 (TESSOLVE)	R	AIML2	0	0	0	8	0	8	
1171	VAC	VAC-CERT	23CC3010	AWS CERTIFIED CLOUD PRACTITIONER	R	AWS-CCP	0	0	0	8	0	0	
1172	VAC	VAC-CERT	23CC3011	AWS CERTIFIED DEVELOPER - ASSOCIATE	R	AWS-CDA	0	0	0	8	0	0	
1173	VAC	VAC-CERT	23CC3012	AWS CERTIFIED DEVOPS ENGINEER - PROFESSIONAL	R	AWS-CDEP	0	0	0	8	0	0	
1174	VAC	VAC-CERT	23CC3013	AWS CERTIFIED MACHINE LEARNING - SPECIALTY	R	AWS-CML	0	0	0	8	2	8	
1175	VAC	VAC-CERT	23CC3014	AWS CERTIFIED SOLUTIONS ARCHITECT - ASSOCIATE	R	AWS-CSA	0	0	0	8	0	0	
1176	VAC	VAC-CERT	23CC3015	AWS CERTIFIED SYSOPS ADMINISTRATOR - ASSOCIATE	R	AWS-CSYA	0	0	0	8	0	0	
1177	VAC	VAC-CERT	23CC3017	CERTIFIED ETHICAL HACKER	R	CEH	0	0	0	8	0	0	
1178	VAC	VAC-CERT	23CC3018	CERTIFIED HYPERLEDGER FABRIC DEVELOPER	R	CHFD	0	0	0	8	0	0	
1179	VAC	VAC-CERT	23CC3019	CERTIFIED KUBERNETES APPLICATION DEVELOPER	R	CKAD	0	0	0	8	0	0	
1180	VAC	VAC-CERT	23CC3020	CISCO CERTIFIED NETWORK ADMINITRATOR	R	CISCO-CNA	0	0	0	8	0	0	
1181	VAC	VAC-CERT	23CC3026	EMBEDDED SYSTEM APPLICATION & IOT PROGRAMMING (TESSOLVE-L1)	R	ESAIP	0	0	0	8	0	8	
1182	VAC	VAC-CERT	23CC3027	EPAM COE CERTIFICATION ON FRONTEND TECHNOLOGIES	R	EPAM-FT	0	0	0	8	0	0	
1183	VAC	VAC-CERT	23CC3028	EPAM COE CERTIFICATION ON .NET	R	EPAM-	0	0	0	8	0	0	
1184	VAC	VAC-CERT	23CC3030	EPAM COE CERTIFICATION ON JAVA	R	EPAM-J	0	0	0	8	0	0	
1185	VAC	VAC-CERT	23CC3033	GOOGLE : ASSOCIATE CLOUD ENGINEER	R	GACE	0	0	0	8	0	0	

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1186	VAC	VAC-CERT	23CC3034	GOOGLE PROFESSIONAL CLOUD ARCHITECT	R	GPCA	0	0	0	8	0	0	
1187	VAC	VAC-CERT	23CC3035	GOOGLE TENSORFLOW DEVELOPER CERTIFICATE	R	GTFDC	0	0	0	8	0	0	
1188	VAC	VAC-CERT	23CC3038	HANDS-ON: 5G END-TO-END	R	5GEEC	0	0	0	8	0	8	
1189	VAC	VAC-CERT	23CC3039	IIOT PROGRAMMING & AUTOMATION (TESSOLVE-L2)	R	IIPA-L2	0	0	0	8	0	8	
1190	VAC	VAC-CERT	23CC3040	JUNIPER NETWORKS CERTIFIED ASSOCIATE, JUNOS	R	JNCA	0	0	0	8	0	0	
1191	VAC	VAC-CERT	23CC3041	LINUX FOUNDATION CERTIFIED IT ASSOCIATE	R	LFCA	0	0	0	8	0	0	
1192	VAC	VAC-CERT	23CC3042	LINUX PROFESSIONAL INSTITUTE: LINUX ESSENTIALS	R	LPI-LE	0	0	0	8	0	0	
1193	VAC	VAC-CERT	23CC3045	MICROSOFT CERTIFIED : AZURE DEVELOPER ASSOCIATE	R	MC-ADA	0	0	0	8	0	0	
1194	VAC	VAC-CERT	23CC3046	MICROSOFT CERTIFIED: AZURE ADMINISTRATOR ASSOCIATE	R	MC-AAA	0	0	0	8	0	0	
1195	VAC	VAC-CERT	23CC3047	MICROSOFT CERTIFIED: AZURE AI ENGINEER ASSOCIATE	R	MC-AAEA	0	0	0	8	0	0	
1196	VAC	VAC-CERT	23CC3050	MICROSOFT CERTIFIED: AZURE FUNDAMENTALS	R	MC-AF	0	0	0	8	0	0	
1197	VAC	VAC-CERT	23CC3051	MICROSOFT CERTIFIED: AZURE IOT	R	MC-	0	0	0	8	0	0	
1198	VAC	VAC-CERT	23CC3059	NI CLAD	R	NI-CL	0	0	0	8	0	8	
1199	VAC	VAC-CERT	23CC3060	PCAP - CERTIFIED ASSOCIATE IN PYTHON PROGRAMMING	R	PCAP	0	0	0	8	0	0	
1200	VAC	VAC-CERT	23CC3061	PCCET: PALO ALTO NETWORKS CERTIFIED CYBERSECURITY ENTRY-LEVEL TECHNICIAN	R	PCCET	0	0	0	8	0	0	
1201	VAC	VAC-CERT	23CC3071	PROGRAMMING USING PYTHON	R	PUP	0	0	0	8	0	8	
1202	VAC	VAC-CERT	23CC3080	SALESFORCE CERTIFIED ADMINISTRATOR	R	SFCA	0	0	0	8	0	0	
1203	VAC	VAC-CERT	23CC3082	SERVICENOW CERTIFIED APPLICATION DEVELOPER	R	SNCAD	0	0	0	8	0	0	
1204	VAC	VAC-CERT	23CC3083	SERVICENOW CERTIFIED SYSTEM ADMINISTRATOR	R	SNCSA	0	0	0	8	0	0	
1205	VAC	VAC-CERT	23CC3091	UNITY CERTIFIED ASSOCIATE: GAME DEVELOPER	R	UCA-GD	0	0	0	8	0	0	
1206	VAC	VAC-CERT	23CC3096	WIPRO TALENT NEXT JAVA FULL STACK CERTIFICATION	R	WTNJFSC	0	0	0	8	0	0	
1207	VAC	VAC-CERT	23CC3097	WIPRO TALENT NEXT J2EE CERTIFICATION	R	WTNJ2EEC	0	0	0	8	0	0	
1208	AUC	AUC-CORE	23UC0008	INDIAN CONSTITUTION	R	IC	2	0	0	0	0	2	
1209	AUC	AUC-CORE	22UC0009	ECOLOGY AND ENVIRONMENT	R	E&E	2	0	0	0	0	2	

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1210	AUC	AUC-CORE	23UC0018	FUNDAMENTALS OF MATHEMATICS	R	FOM	3	0	0	0	0	3	
1211	AUC	AUC-CORE	23UC0017	INDIAN KNOWLEDGE SYSTEMS: VEDIC MATHEMATICS	R	IKSVM	0	0	0	2	0	2	
1212	AUC	AUC-CORE	23UC0013	GLOBAL LOGIC BUILDING CONTEST PRACTICUM	R	GLBCP	0	0	0	2	0	2	
1213	AUC	AUC-CORE	23UC0014	GLOBAL LOGIC BUILDING CONTEST PRACTICUM	R	GLBCP	0	0	0	2	0	2	
1214	AUC	AUC-CAREER	CRTCODL2V2	CAMPUS RECRUITMENT: CODING SKILLS TRAINING - DATA STRUCTURES	R	CRT: CST-DS	0	0	0	8	0	8	
1215	AUC	AUC-CAREER	CRTCODL3V3	CAMPUS RECRUITMENT: CODING SKILLS TRAINING - ALGORITHMS	R	CRT: CST-	0	0	0	8	0	8	
1216	AUC	AUC-CAREER	CRTVQRL1V1	CAMPUS RECRUITMENT: VERBAL APTITUDE TRAINING	R	CRT: VAT	0	0	0	8	0	8	
1217	AUC	AUC-CAREER	CRTVQRL2V2	CAMPUS RECRUITMENT: QUANTITATIVE APTITUDE TRAINING	R	CRT: QAT	0	0	0	8	0	8	
1218	AUC	AUC-CAREER	CRTVQRL3V3	CAMPUS RECRUITMENT: REASONING APTITUDE TRAINING	R	CRT: RAT	0	0	0	8	0	8	
1219	AUC	AUC-CAREER	CRTCSSL1V1	CAMPUS RECRUITMENT: COMMUNICATION SKILLS TRAINING	R	CRT: CST	0	0	0	8	0	8	
1220	AUC	AUC-CAREER	CRTCSSL2V2	CAMPUS RECRUITMENT: SOFT SKILLS TRAINING	R	CRT: SST	0	0	0	8	0	8	
1221	AUC	AUC-CAREER	CRTTOLL1V1	CAMPUS RECRUITMENT: TOOL BASED TRAINING	R	CRT: TBT	0	0	0	8	0	8	
1222	AUC	AUC-CAREER	CRTTOLL2V2	CAMPUS RECRUITMENT: TOOL BASED TRAINING	R	CRT: TBT	0	0	0	8	0	8	
1223	AUC	AUC-CAREER	CRTINDL1V1	CAMPUS RECRUITMENT: INDUSTRY-SPECIFIC TRAINING	R	CRT: IST	0	0	0	8	0	8	
1224	AUC	AUC-CAREER	CRTINDL2V2	CAMPUS RECRUITMENT: INDUSTRY-SPECIFIC TRAINING	R	CRT: IST	0	0	0	8	0	8	
1225	AUC	AUC-CAREER	CADCORL1V1	CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN	R	CAD: TICD	0	0	0	8	0	8	
1226	AUC	AUC-CAREER	CADCORL2V2	CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN	R	CAD: TICD	0	0	0	8	0	8	
1227	AUC	AUC-CAREER	CADUPSL1V1	CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING	R	CAD: UPSC	0	0	0	8	0	8	
1228	AUC	AUC-CAREER	CADUPSL2V2	CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING	R	CAD: UPSC	0	0	0	8	0	8	
1229	AUC	AUC-CAREER	CADGATL1V1	CAREER ADVANCEMENT: GATE TRAINING	R	CAD: GATE	0	0	0	8	0	8	
1230	AUC	AUC-CAREER	CADGREL1V1	CAREER ADVANCEMENT: GRE, TOEFL & IELTS TRAINING	R	CAD: GRE-	0	0	0	8	0	8	
1231	AUC	AUC-CAREER	CADCATL1V1	CAREER ADVANCEMENT: CAT, GMAT TRAINING	R	CAD: CAT-	0	0	0	8	0	8	

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1232	AUC	AUC-CAREER	CADENTL1V1	CAREER ADVANCEMENT: ENTREPRENEURIAL CAREER PATHWAY TRAINING	R	CAD: ECPT	0	0	0	8	0	8	
1233	AUC	AUC-CAREER	CRTCODL1V1	CAMPUS RECRUITMENT: LOGIC BUILDING SKILLS TRAINING	R	CRT: LBST	0	0	0	8	0	8	
1234	SIL	SIL-CORE	22UC0021	SOCIAL IMMERSIVE LEARNING	R	SIL-1	0	0	0	4	1	4	
1235	SIL	SIL-CORE	22UC0022	SOCIAL IMMERSIVE LEARNING	R	SIL-2	0	0	0	4	1	4	
1236	SIL	SIL-CORE	22UC0023	SOCIAL IMMERSIVE LEARNING	R	SIL-3	0	0	0	4	1	4	
1237	MIN	MIN-CORE	23MRPA01	FUNDAMENTALS OF AGRONOMY	R	FOA	3	0	2	0	4	5	
1238	MIN	MIN-CORE	23MRPA02	INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE	R	IACC	3	0	2	0	4	5	
1239	MIN	MIN-CORE	23MRPA03	GEOINFORMATICS AND NANOTECHNOLOGY FOR PRECISION FARMING	R	GNPF	3	0	2	0	4	5	
1240	MIN	MIN-CORE	23MRPA04	PROTECTED CULTIVATION AND POST-HARVEST TECHNOLOGIES	R	PCPHT	3	0	2	0	4	5	
1241	MIN	MIN-CORE	23MRWS02	SOIL AND WATER CONSERVATION ENGINEERING	R	SWCE	3	0	2	0	4	5	
1242	MIN	MIN-CORE	23MRWS03	IRRIGATION WATER MANAGEMENT	R	IWM	3	0	2	0	4	5	
1243	MIN	MIN-CORE	23MRWS04	RAINFED AGRICULTURE AND WATERSHED MANAGEMENT	R	RAWM	3	0	2	0	4	5	
1244	MIN	MIN-CORE	23MRID01	INTRODUCTION TO INTERIOR DESIGN	R	IID	3	0	2	0	4	5	
1245	MIN	MIN-CORE	23MRID02	SPACE PLANNING AND LAYOUT	R	SPL	3	0	2	0	4	5	
1246	MIN	MIN-CORE	23MRID03	INTERIOR MATERIAL AND FINISHES	R	IMF	3	0	2	0	4	5	
1247	MIN	MIN-CORE	23MRID04	FURNITURE AND ACCESSORIES DESIGN	R	FAD	3	0	2	0	4	5	
1248	MIN	MIN-CORE	23MRAP01M	INTRODUCTION TO ANTHROPOLOGY	M	ITA	4	0	0	0	4	4	
1249	MIN	MIN-CORE	23MRAP02M	CULTURAL EVOLUTION	M	CET	4	0	0	0	4	4	
1250	MIN	MIN-CORE	23MRAP03M	HUMAN ECOLOGY AND ECOLOGICAL ANTHROPOLOGY	M	HEEA	4	0	0	0	4	4	
1251	MIN	MIN-CORE	23MRAP04M	FUNDAMENTALS IN ARCHEOLOGICAL ANTHROPOLOGY CHRONOLOGY	M	FAAC	4	0	0	0	4	4	
1252	MIN	MIN-CORE	23MRAR01	FUNDAMENTALS OF MACRO-ECONOMICS	R	FME	4	0	0	0	4	4	
1253	MIN	MIN-CORE	23MRAR02	BASICS OF ECONOMETRICS	R	BOE	4	0	0	0	4	4	
1254	MIN	MIN-CORE	23MRAR03	INTERNATIONAL RELATIONS: THEORIES AND CONCEPTS	R	IRTC	4	0	0	0	4	4	

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1255	MIN	MIN-CORE	23MRAR04	BEHAVIOURAL ECONOMICS AND POLICY	R	BEP	4	0	0	0	4	4	
1256	MIN	MIN-CORE	23MRBA01M	ORGANIZATIONAL BEHAVIOUR	M	OBR	4	0	0	0	4	4	
1257	MIN	MIN-CORE	23MRBA02M	MARKETING MANAGEMENT	M	MMG	4	0	0	0	4	4	
1258	MIN	MIN-CORE	23MRBA03M	FINANCIAL MANAGEMENT	M	FMG	4	0	0	0	4	4	
1259	MIN	MIN-CORE	23MRBA04M	HUMAN RESOURCE MANAGEMENT	M	HRM	4	0	0	0	4	4	
1260	MIN	MIN-CORE	23MRAC01M	AI FOR BUSINESS STRATEGY	M	ABS	4	0	0	0	4	4	
1261	MIN	MIN-CORE	23MRAC02M	AI STRATEGY AND GOVERNANCE	M	ASG	4	0	0	0	4	4	
1262	MIN	MIN-CORE	23MRAC03M	SUCCESSFUL AI STRATEGIES : A CEO'S PERSPECTIVES	M	SAI	4	0	0	0	4	4	
1263	MIN	MIN-CORE	23MRAC04M	CRAFTING A COMPETITIVE ADVANTAGE	M	CCA	4	0	0	0	4	4	
1264	MIN	MIN-CORE	23MRFT01	INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY	R	IFST	3	0	2	0	4	5	
1265	MIN	MIN-CORE	23MRFT02	FOOD ANALYSIS AND QUALITY ASSURANCE	R	FAQA	3	0	2	0	4	5	
1266	MIN	MIN-CORE	23MRFT03	FOOD SAFETY AND REGULATIONS	R	FSR	3	1	0	0	4	4	
1267	MIN	MIN-CORE	23MRFT04	FOOD ENGINEERING	R	FEG	3	0	2	0	4	5	
1268	MIN	MIN-CORE	23MRDM01M	FUNDAMENTALS OF DIGITAL MARKETING	M	FDM	4	0	0	0	4	4	
1269	MIN	MIN-CORE	23MRDM02M	SOCIAL MEDIA MARKETING	M	SMM	4	0	0	0	4	4	
1270	MIN	MIN-CORE	23MRDM03M	SEARCH ENGINE OPTIMIZATION	M	SEO	4	0	0	0	4	4	
1271	MIN	MIN-CORE	23MRDM04M	ARTIFICIAL INTELLIGENCE IN MARKETING	M	AIM	4	0	0	0	4	4	
1272	MIN	MIN-CORE	23MRFA01M	FOUNDATIONS AND APPLICATIONS OF FINANCIAL TECHNOLOGY	M	AFT	4	0	0	0	4	4	
1273	MIN	MIN-CORE	23MRFA02M	DECENTRALISED FINANCE: THE FUTURE OF FINANCE	M	DFFF	4	0	0	0	4	4	
1274	MIN	MIN-CORE	23MRFA03M	FINTECH INNOVATIONS	M	FIV	4	0	0	0	4	4	
1275	MIN	MIN-CORE	23MRFA04M	USING MACHINE LEARNING IN TRADING AND FINANCE	M	ML	4	0	0	0	4	4	
1276	MIN	MIN-CORE	23MRIB01M	INTERNATIONAL BUSINESS ESSENTIALS	M	IBET	4	0	0	0	4	4	
1277	MIN	MIN-CORE	23MRIB02M	INTERNATIONAL BUSINESS ENVIRONMENT	M	IBEV	4	0	0	0	4	4	
1278	MIN	MIN-CORE	23MRIB03M	INTERNATIONAL BUSINESS OPERATIONS	M	IBO	4	0	0	0	4	4	
1279	MIN	MIN-CORE	23MRIB04M	INTERNATIONAL BUSINESS MODELS	M	IBM	4	0	0	0	4	4	
1280	MIN	MIN-CORE	23MRCA01	INTRODUCTION TO CREATIVE ARTS	R	ICA	0	0	6	4	4	10	

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1281	MIN	MIN-CORE	23MRCA02	DRAWING AND SKETCHING	R	DAS	0	0	6	4	4	10	
1282	MIN	MIN-CORE	23MRCA03	PAINTING	R	PNT	0	0	6	4	4	10	
1283	MIN	MIN-CORE	23MRCA04	CREATIVE WRITING	R	CWT	0	0	6	4	4	10	
1284	MIN	MIN-CORE	23MRFM01	FILM AESTHETICS	R	FAS	0	0	6	4	4	10	
1285	MIN	MIN-CORE	23MRFM02	SCREEN WRITING	R	SWT	0	0	6	4	4	10	
1286	MIN	MIN-CORE	23MRFM04	SOUND DESIGN	R	SDS	0	0	6	4	4	10	
1287	MIN	MIN-CORE	23MRGD01	INTRODUCTION TO GRAPHIC DESIGN	R	IGD	0	0	6	4	4	10	
1288	MIN	MIN-CORE	23MRGD02	TYPOGRAPHY	R	TPY	0	0	6	4	4	10	
1289	MIN	MIN-CORE	23MRGD03	VISUAL IDENTITY AND BRANDING	R	VIB	0	0	6	4	4	10	
1290	MIN	MIN-CORE	23MRGD04	PRINT DESIGN	R	PRDG	0	0	6	4	4	10	
1291	MIN	MIN-CORE	23MRAG01	INTRODUCTION TO GAME MATH	R	IGM	0	0	6	4	4	10	
1292	MIN	MIN-CORE	23MRAG02	DRAWING BASICS	R	DBS	0	0	6	4	4	10	
1293	MIN	MIN-CORE	23MRAG03	GRAPHIC DESIGN	R	GDS	0	0	6	4	4	10	
1294	MIN	MIN-CORE	23MRAG04	CONCEPTS OF 3D	R	C3D	0	0	6	4	4	10	
1295	MIN	MIN-CORE	23MROB01M	ORGANIZATIONAL BEHAVIOUR	M	POM	4	0	0	0	4	4	
1296	MIN	MIN-CORE	23MROB02M	ORGANIZATIONAL BEHAVIOUR MODELS	M	OBM	4	0	0	0	4	4	
1297	MIN	MIN-CORE	23MROB03M	ORGANIZATIONAL CHANGE AND DEVELOPMENT	M	OCD	4	0	0	0	4	4	
1298	MIN	MIN-CORE	23MROB04M	LEADERSHIP IN ORGANIZATION	M	LIO	4	0	0	0	4	4	
1299	MIN	MIN-CORE	23MRIM01	APPLIED DESIGN THINKING	R	ADT	3	0	2	0	4	5	
1300	MIN	MIN-CORE	23MRIM02	BUSINESS MODEL INNOVATION	R	BMI	3	0	2	0	4	5	
1301	MIN	MIN-CORE	23MRIM03	VENTURE MANAGEMENT	R	VMT	3	0	2	0	4	5	
1302	MIN	MIN-CORE	23MRIM04	BUSINESS AND LEADERSHIP	R	BL	3	0	2	0	4	5	
1303	MIN	MIN-CORE	23MRTP01	INTRODUCTION TO TECHNOLOGICAL ENTREPRENEURSHIP	R	ITEP	3	0	2	0	4	5	
1304	MIN	MIN-CORE	23MRTP02	LEAN STARTUP LAUNCHPAD	R	LSLP	3	0	2	0	4	5	
1305	MIN	MIN-CORE	23MRTP03	ENTREPRENEURSHIP AND VENTURE CAPITAL	R	EVC	3	0	2	0	4	5	
1306	MIN	MIN-CORE	23MRTP04	BUILDING AND SUSTAINING A SUCCESSFUL ENTERPRISE	R	BSSE	3	0	2	0	4	5	
1307	MIN	MIN-CORE	23MRCL01	PRINCIPLES OF COMPANIES ACT AND CORPORATE GOVERNANCE	R	PCACG	3	0	2	0	4	5	

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1308	MIN	MIN-CORE	23MRCL02	MERGERS, ACQUISITIONS AND PRIVATE EQUITY	R	MAPE	3	0	2	0	4	5	
1309	MIN	MIN-CORE	23MRCL03	INSOLVENCY AND BANKRUPTCY LAW	R	IBL	3	0	2	0	4	5	
1310	MIN	MIN-CORE	23MRCL04	COMPETITION LAW AND PRACTICE	R	CLP	3	0	2	0	4	5	
1311	MIN	MIN-CORE	23MRCM01	LINEAR ALGEBRA	R	LAG	2	2	0	0	4	4	
1312	MIN	MIN-CORE	23MRCM02	ADVANCED NUMERICAL ANALYSIS	R	ANA	2	2	0	0	4	4	
1313	MIN	MIN-CORE	23MRCM03	MATHEMATICAL MODELLING	R	MML	3	0	2	0	4	5	
1314	MIN	MIN-CORE	23MRCM04	STOCHASTIC PROCESSES & OPTIMIZATION	R	SPO	2	2	0	0	4	4	
1315	MIN	MIN-CORE	23MRCM05	FUZZY MATHEMATICS AND ITS APPLICATIONS	R	FMAA	2	2	0	0	4	4	
1316	MIN	MIN-CORE	23MRIP01	EMERGENCE AND DEVELOPMENT OF IPR	R	EDIPR	3	0	2	0	4	5	
1317	MIN	MIN-CORE	23MRIP02	LAW OF COPYRIGHT	R	LOCR	3	0	2	0	4	5	
1318	MIN	MIN-CORE	23MRIP03	LAW OF PATENTS	R	LOPS	3	0	2	0	4	5	
1319	MIN	MIN-CORE	23MRIP04	LAW OF TRADEMARK	R	LOTM	3	0	2	0	4	5	
1320	MIN	MIN-CORE	23MRPY01	BASICS OF PHARMACOLOGY	R	BOP	3	0	2	0	4	5	
1321	MIN	MIN-CORE	23MRPY02	ADVANCED PHARMACOLOGY - I	R	AP-I	3	0	2	0	4	5	
1322	MIN	MIN-CORE	23MRPY03	EXPERIMENTAL PHARMACOLOGY	R	EPC	3	0	2	0	4	5	
1323	MIN	MIN-CORE	23MRPY04	ADVANCED PHARMACOLOGY - II	R	AP-II	3	0	2	0	4	5	
1324	MSDC	MIN-SDP	23MRPY05	PRACTICAL PHARMACOLOGY	R	PRI	0	0	6	4	4	10	
1325	MSDC	MIN-SDP	23MRIP05	LAW OF DESIGNS, GEOGRAPHICAL INDICATIONS AND PLANT VARIETIES	R	LODGP	0	0	6	4	4	10	
1326	MSDC	MIN-SDP	23MRCM06	TRANSFORM TECHNIQUES FOR ENGINEERING	R	TTE	2	0	2	4	4	8	
1327	MSDC	MIN-SDP	23MRCM07	STATISTICS WITH R PROGRAMMING	R	SWRP	2	0	2	4	4	8	
1328	MSDC	MIN-SDP	23MRCM08	MATRIX COMPUTATION	R	MCT	2	0	2	4	4	8	
1329	MSDC	MIN-SDP	23MRCL05	COMMERCIAL CONTRACT DRAFTING	R	CCD	0	0	6	4	4	10	
1330	MSDC	MIN-SDP	23MRTP05	TECH INNOVATION PROJECT FOR ENTREPRENEURS	R	TIPFE	0	0	6	4	4	10	
1331	MSDC	MIN-SDP	23MRIM05	PROJECT INNOVATE: STRATEGIES FOR ENTREPRENEURIAL GROWTH	R	PISEG	0	0	6	4	4	10	
1332	MSDC	MIN-SDP	23MROB05	TEAM BUILDING AND COLLABORATION SKILLS FOR MANAGERS	M	TBCM	0	0	6	4	4	10	
1333	MSDC	MIN-SDP	23MRAG05	DIGITAL ART	R	DTA	0	0	6	4	4	10	

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1334	MSDC	MIN-SDP	23MRBA05M	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	M	LSCM	0	0	6	4	4	10	
1335	MSDC	MIN-SDP	23MRGD05	PUBLICATION DESIGN	R	PUDG	0	0	6	4	4	10	
1336	MSDC	MIN-SDP	23MRFM05	DIGITAL PHOTOGRAPHY	R	DPG	0	0	6	4	4	10	
1337	MSDC	MIN-SDP	23MRCA05	SCULPTURE	R	SCP	0	0	6	4	4	10	
1338	MSDC	MIN-SDP	23MRIB05	PROFESSIONAL SKILLS FOR INTERNATIONAL BUSINESS	M	PIB	0	0	6	4	4	10	
1339	MSDC	MIN-SDP	23MRFA05	TRADING ALGORITHMNS	M	TA	0	0	6	4	4	10	
1340	MSDC	MIN-SDP	23MRDM05	CONTENT MARKETING	M	CM	0	0	6	4	4	10	
1341	MSDC	MIN-SDP	23MRFT05	FOOD PACKAGING TECHNOLOGY	R	FPT	2	0	2	4	4	8	
1342	MSDC	MIN-SDP	23MRAC05	AI APPLICATIONS FOR BUSINESS SUCCESS	M	AIA	0	0	6	4	4	10	
1343	MSDC	MIN-SDP	23MRAR05	SOCIAL GEOGRAPHY AND CARTOGRAPHY	R	SGC	0	0	6	4	4	10	
1344	MSDC	MIN-SDP	23MRAP05	SOCIAL CULTURE ANTHROPOLOGY	M	SCA	0	0	6	4	4	10	
1345	MSDC	MIN-SDP	23MRID05	DESIGN PRESENTATION AND COMMUNICATION	R	DPC	0	0	6	4	4	10	
1346	MSDC	MIN-SDP	23MRPA05	MODERN FARMING TECHNIQUES AND INNOVATIONS	R	AELP	0	0	6	4	4	10	
1347	SMFC	SMFC-	23CS06EF	MERN STACK WEB DEVELOPMENT	E	MSWD	0	0	6	4	4	10	
1348	SMFC	SMFC-	23ACCAPM	PERFORMANCE MANAGEMENT	R	PM	3	2	0	0	5	5	
1349	SMFC	SMFC-	22CM1206	ADVANCED COST ACCOUNTING	R	ACA	3	2	0	0	5	5	
1350	SMFC	SMFC-CORE	22CM31B5	ACCOUNTING & REPORTING STANDARDS	R	ARS	3	2	0	0	5	5	
1351	SMFC	SMFC-	23ACCATX	TAXATION	R	TXT	3	2	0	0	5	5	
1352	SMFC	SMFC-	22CM21B2	INCOME TAX LAW & PRACTICE	R	ITLP	3	2	0	0	5	5	
1353	SMFC	SMFC-CORE	22FT12C1	PRINCIPLES OF FOOD PRESERVATION	R	PFP	1	0	0	4	2	5	
1354	SMFC	SMFC-	22FT32C2R	FOOD PACKAGING TECHNOLOGY	R	FPT	1	0	0	4	2	5	
1355	SMFC	SMFC-	22FT1207R	FOOD MICROBIOLOGY	R	FMB	3	0	2	0	4	5	
1356	SMFC	SMFC-CORE	22FT2213R	BAKERY, CONFECTIONERY AND SNACKS TECHNOLOGY	R	BCST	2	0	4	0	4	6	
1357	SMFC	SMFC-CORE	22FT1104	INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY	R	IFST	3	0	2	0	4	5	
1358	SMFC	SMFC-	22FT1102	FOOD CHEMISTRY	R	FC	3	0	2	0	4	5	
1359	SMFC	SMFC-	22FT1105	FOOD BIOCHEMISTRY	R	FBC	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1360	SMFC	SMFC-CORE	22FT2109R	PROCESSING OF HORTICULTURAL PRODUCE	R	PHP	3	0	2	0	4	5	
1361	SMFC	SMFC-	23EC2211R	VLSI DESIGN	R	VLSID	3	0	2	2	4.5	7	
1362	SMFC	SMFC-	22CE1201	ENGINEERING GEOLOGY	R	EGY	3	0	2	0	4	5	
1363	SMFC	SMFC-	23CE2102R	FLUID MECHANICS & HYDRAULICS	R	FMH	3	0	2	0	4	5	
1364	SMFC	SMFC-	23ME3113R	MANUFACTURING TECHNOLOGY	R	MT	2	0	2	0	3	4	
1365	SMFC	SMFC-CORE	23CI2203	MANAGEMENT INFORMATION SYSTEM - ERP	R	MIS	2	0	0	0	2	2	
1366	SMFC	SMFC-CORE	23EC01HF	VLSI PHYSICAL DESIGN AUTOMATION	R	VPDA	3	0	2	0	4	5	
1367	SMFC	SMFC-	23CE2103R	SURVEYING	R	SVY	3	0	2	4	5	9	
1368	SMFC	SMFC-	23CE2206	STRUCTURAL ANALYSIS	R	STA	3	1	0	0	4	4	
1369	SMFC	SMFC-	23CE2207	CONCRETE TECHNOLOGY	R	CT	3	0	2	4	5	9	
1370	SMFC	SMFC-CORE	23ME1004	WORKSHOP PRACTICES FOR ENGINEERS	R	WPE	0	0	4	0	2	4	
1371	SMFC	SMFC-	23EE01HF	RESTRUCTURED POWER SYSTEMS	R	RPS	3	0	2	0	4	5	
1372	SMFC	SMFC-	23EE2101	ELECTRICAL CIRCUITS	R	ELC	2	0	2	0	3	4	
1373	SMFC	SMFC-	23BT1101	CELL BIOLOGY	R	CB	3	0	0	0	3	3	
1374	SMFC	SMFC-	23BT2103R	BIOCHEMISTRY	R	BCM	3	0	2	0	4	5	
1375	SMFC	SMFC-	23BT2105R	IMMUNOLOGY	R	IMM	3	0	2	0	4	5	
1376	SMFC	SMFC-	23BT2206	MOLECULAR BIOLOGY	R	MBY	3	0	0	0	3	3	
1377	SMFC	SMFC-CORE	23EE3106R	POWER SYSTEM ANALYSIS & STABILITY	R	PSAS	2	1	0	0	3	3	
1378	SMFC	SMFC-CORE	23EE3208R	POWER SYSTEM PROTECTION & CONTROL	R	PSPC	2	0	2	2	3.5	6	
1379	SMFC	SMFC-	23ME1002	ENGINEERING GRAPHICS	R	EG	0	0	4	0	2	4	
1380	SMFC	SMFC-CORE	23EC2209R	ELECTROMAGNETIC WAVES & TRANSMISSION LINES	R	EMWTL	3	0	0	0	3	3	
1381	SMFC	SMFC-	23ME3110R	HEAT TRANSFER	R	HT	3	0	2	0	4	5	
1382	SMFC	SMFC-CORE	23ME2209R	KINEMATICS & DYNAMICS OF MACHINES	R	KDOM	3	1	2	0	5	6	
1383	SMFC	SMFC-	23ME3111R	MECHANICAL ENGINEERING DESIGN	R	MED	3	0	0	0	3	3	
1384	SMFC	SMFC-CORE	23CS05EF	PYTHON FULL STACK DEVELOPMENT WITH DJANGO	E	PFSO	0	0	6	4	4	10	
1385	SMFC	SMFC-	23EE2102R	ELECTRICAL MACHINES	R	ELM	3	0	2	0	4	5	
1386	SMFC	SMFC-CORE	23EE2204R	ELECTRICAL POWER GENERATION, TRANSMISSION & DISTRIBUTION	R	EPGTD	2	1	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1387	SMFC	SMFC-CORE	23AD4108	ETHICS FOR ARTIFICIAL INTELLIGENCE	R	EAI	1	0	0	0	1	1	
1388	SMFC	SMFC-CORE	23AD2103R	SYSTEM DESIGN & INTRODUCTION TO CLOUD	R	SDC	3	0	2	0	4	5	
1389	SMFC	SMFC-	23BT3214	BIOINFORMATICS	R	BI	2	0	2	0	3	4	
1390	SMFC	SMFC-	23EC02HF	SENSORS AND TRANSDUCERS	R	SAT	3	0	2	0	4	5	
1391	SMFC	SMFC-CORE	23CS03HF	ADVANCED ALGORITHMS & DATA STRUCTURES	R	AADS	3	0	2	0	4	5	
1392	SMFC	SMFC-CORE	23CS2103R	ADVANCED OBJECT ORIENTED PROGRAMMING	R	AOOP	3	0	2	4	5	9	
1393	SMFC	SMFC-CORE	23CS2205R	DESIGN AND ANALYSIS OF ALGORITHMS	R	DAA	3	0	2	4	5	9	
1394	SMFC	SMFC-	23AD2205R	DEEP LEARNING	R	DL	3	0	2	4	5	9	
1395	SMFC	SMFC-	23BT2215	PROCESS ENGINEERING PRINCIPLES	R	PEP	2	0	2	0	3	4	
1396	SMFC	SMFC-CORE	23AD01HF	MACHINE LEARNING FOR HEALTHCARE	R	MLH	3	0	2	0	4	5	
1397	SMFC	SMFC-	23AD03HF	REINFORCEMENT LEARNING	R	RIL	3	0	2	0	4	5	
1398	SMFC	SMFC-	23AD04HF	EXPLAINABLE AI	R	EAI	3	0	2	0	4	5	
1399	SMFC	SMFC-	23BT2104	MICROBIOLOGY	R	MBG	3	0	2	0	4	5	
1400	SMFC	SMFC-	23ME2107R	THERMODYNAMICS	R	TD	3	0	0	0	3	3	
1401	SMFC	SMFC-	23CS04HF	HIGH PERFORMANCE COMPUTING	R	HPC	3	0	2	0	4	5	
1402	SMFC	SMFC-CORE	23AD02HF	DATA ENGINEERING AND ARCHITECTURE	R	DEA	3	0	2	0	4	5	
1403	SMFC	SMFC-	22CM1203	DATA ANALYSIS WITH EXCEL	R	DAWE	0	0	0	4	1	4	

Category & Grouping

S#	Category	Group Name
1	MINOR	AI AND COMPETITIVE ADVANTAGE
2	MINOR	ANIMATION AND GAMING
3	MINOR	ANTHROPOLOGY
4	MINOR	ARTS
5	MINOR	BUSINESS ADMINISTRATION
6	MINOR	COMPUTATIONAL MATHEMATICS
7	MINOR	CORPORATE LAW
8	MINOR	CREATIVE ARTS
9	MINOR	DIGITAL MARKETING AND AUTOMATION
10	MINOR	FILM MAKING
11	MINOR	FINTECH AND ALGORITHMIC TRADING
12	MINOR	FOOD TECHNOLOGY
13	MINOR	GRAPHIC DESIGN
14	MINOR	INNOVATION MANAGEMENT AND ENTREPRENEURSHIP
15	MINOR	INTELLECTUAL PROPERTY LAW
16	MINOR	INTERIOR DESIGN
17	MINOR	INTERNATIONAL BUSINESS
18	MINOR	ORGANIZATIONAL BEHAVIOUR
19	MINOR	PHARMACOLOGY
20	MINOR	PRECISION AGRICULTURE
21	MINOR	TECHNOPRENEURSHIP
22	MINOR	WATER SCIENCE AND MANAGEMENT
23	DOUBLE MAJOR	SECOND MAJOR CSE FOR FIRST MAJOR ECE / IOT
24	DOUBLE MAJOR	SECOND MAJOR CSIT FOR FIRST MAJOR ECE / IOT
25	DOUBLE MAJOR	SECOND MAJOR EEE FOR FIRST MAJOR ECE / IOT
26	DOUBLE MAJOR	SECOND MAJOR ECE FOR FIRST MAJOR EEE / IOT
27	DOUBLE MAJOR	SECOND MAJOR AIDS FOR FIRST MAJOR ECE / IOT / CSE / CSIT
28	DOUBLE MAJOR	SECOND MAJOR ANIMATION AND GAMING FOR FIRST MAJOR B.TECH / BBA / B.COM /
29	DOUBLE MAJOR	SECOND MAJOR BUSINESS ADMINISTRATION FOR FIRST MAJOR B.TECH / B.COM / BSC

S#	Category	Group Name
30	DOUBLE MAJOR	SECOND MAJOR COMPUTER APPLICATIONS FOR FIRST MAJOR B.COM / BBA / BSC / BA
31	DOUBLE MAJOR	SECOND MAJOR ECONOMICS AND PUBLIC POLICY FOR FIRST MAJOR B.TECH / B.COM /
32	DOUBLE MAJOR	SECOND MAJOR FOOD TECHNOLOGY FOR FIRST MAJOR B.TECH / B.COM / BBA / BSC
33	DOUBLE MAJOR	SECOND MAJOR COMMERCE FOR FIRST MAJOR B.TECH / BBA / BSC / BCA / BA
34	SPECIALIZATION	AGRI-BIOTECHNOLOGY
35	SPECIALIZATION	AI AND AUTONOMOUS SYSTEMS
36	SPECIALIZATION	AI FOR COMPUTATIONAL INTELLIGENCE
37	SPECIALIZATION	AI SYSTEMS FOR VISUAL INTELLIGENCE
38	SPECIALIZATION	AI-DRIVEN EDGE ARCHITECTURES AND APPLICATIONS
39	SPECIALIZATION	AI-DRIVEN LANGUAGE TECHNOLOGIES
40	SPECIALIZATION	AUTOMOTIVE ELECTRONICS AND AUTOSAR
41	SPECIALIZATION	AUTOMOTIVE ENERGY ENGINEERING
42	SPECIALIZATION	BIOINFORMATICS
43	SPECIALIZATION	BLOCKCHAIN ENGINEERING FOR WEB3
44	SPECIALIZATION	CLOUD AND EDGE COMPUTING
45	SPECIALIZATION	CLOUD INFRASTRUCTURE DESIGN AND ENGINEERING?
46	SPECIALIZATION	CLOUD NATIVE SECURITY
47	SPECIALIZATION	CLOUD NATIVE SOFTWARE ENGINEERING
48	SPECIALIZATION	CLOUD-BASED SCIENTIFIC COMPUTING
49	SPECIALIZATION	COMPUTER COMMUNICATION AND 5G TECHNOLOGY
50	SPECIALIZATION	CONSTRUCTION TECHNOLOGY AND MANAGEMENT
51	SPECIALIZATION	CROSS PLATFORM DEVELOPMENT FRAMEWORKS
52	SPECIALIZATION	CYBER PHYSICAL SYSTEMS AND IOT
53	SPECIALIZATION	CYBER SECURITY AND BLOCKCHAIN TECHNOLOGY
54	SPECIALIZATION	DATA COMMUNICATIONS
55	SPECIALIZATION	DATA ENGINEERING FOR AI
56	SPECIALIZATION	DATA SCIENCE AND BIG DATA ANALYTICS
57	SPECIALIZATION	DISTRIBUTED LEDGER ANALYTICS
58	SPECIALIZATION	EMBEDDED SYSTEMS
59	SPECIALIZATION	E-MOBILITY ENGINEERING

S#	Category	Group Name
60	SPECIALIZATION	ENGINEERING DESIGN
61	SPECIALIZATION	GAME DEVELOPMENT AND UX DESIGN
62	SPECIALIZATION	GEOTECHNICAL AND TRANSPORTATION ENGINEERING
63	SPECIALIZATION	GREEN ENERGY TECHNOLOGIES
64	SPECIALIZATION	HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY
65	SPECIALIZATION	HEALTHCARE DATA ANALYTICS
66	SPECIALIZATION	INDUSTRIAL AUTOMATION
67	SPECIALIZATION	INDUSTRIAL BIOTECHNOLOGY
68	SPECIALIZATION	INTELLIGENT MULTIMEDIA PROCESSING
69	SPECIALIZATION	IOT ANALYTICS
70	SPECIALIZATION	MEDICAL BIOTECHNOLOGY
71	SPECIALIZATION	ROBOTICS AND AUTOMATION
72	SPECIALIZATION	SMART GRID TECHNOLOGIES
73	SPECIALIZATION	SMART MANUFACTURING
74	SPECIALIZATION	SOCIAL AND DIGITAL MEDIA ANALYTICS
75	SPECIALIZATION	SOFTWARE MODELLING AND DEVOPS
76	SPECIALIZATION	SPATIAL COMPUTING AND IMMERSIVE TECHNOLOGIES
77	SPECIALIZATION	STRUCTURAL ENGINEERING
78	SPECIALIZATION	VERY LARGE-SCALE INTEGRATION
79	SPECIALIZATION	WATER RESOURCE AND ENVIRONMENTAL ENGINEERING
80	PROJECT	RESEARCH PROJECT
81	PROJECT	INNOVATION PROJECT
82	PROJECT	CAPSTONE PROJECT

Category & Grouping Courses

1. MINOR: AI AND COMPETITIVE ADVANTAGE

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRAC01M	AI FOR BUSINESS STRATEGY	M	ABS	4	0	0	0	4	4	
2	MIN	MIN-CORE	23MRAC02M	AI STRATEGY AND GOVERNANCE	M	ASG	4	0	0	0	4	4	
3	MIN	MIN-CORE	23MRAC03M	SUCCESSFUL AI STRATEGIES : A CEO'S PERSPECTIVES	M	SAI	4	0	0	0	4	4	
4	MIN	MIN-CORE	23MRAC04M	CRAFTING A COMPETITIVE ADVANTAGE	M	CCA	4	0	0	0	4	4	
5	MSDC	MIN-SDP	23MRAC05	AI APPLICATIONS FOR BUSINESS SUCCESS	M	AIA	0	0	6	4	4	10	

2. MINOR: ANIMATION AND GAMING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRAG01	INTRODUCTION TO GAME MATH	R	IGM	0	0	6	4	4	10	
2	MIN	MIN-CORE	23MRAG02	DRAWING BASICS	R	DBS	0	0	6	4	4	10	
3	MIN	MIN-CORE	23MRAG03	GRAPHIC DESIGN	R	GDS	0	0	6	4	4	10	
4	MIN	MIN-CORE	23MRAG04	CONCEPTS OF 3D	R	C3D	0	0	6	4	4	10	
5	MSDC	MIN-SDP	23MRAG05	DIGITAL ART	R	DTA	0	0	6	4	4	10	

3. MINOR: ANTHROPOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRAP01M	INTRODUCTION TO ANTHROPOLOGY	M	ITA	4	0	0	0	4	4	
2	MIN	MIN-CORE	23MRAP02M	CULTURAL EVOLUTION	M	CET	4	0	0	0	4	4	
3	MIN	MIN-CORE	23MRAP03M	HUMAN ECOLOGY AND ECOLOGICAL ANTHROPOLOGY	M	HEEA	4	0	0	0	4	4	
4	MIN	MIN-CORE	23MRAP04M	FUNDAMENTALS IN ARCHEOLOGICAL ANTHROPOLOGY CHRONOLOGY	M	FAAC	4	0	0	0	4	4	
5	MSDC	MIN-SDP	23MRAP05	SOCIAL CULTURE ANTHROPOLOGY	M	SCA	0	0	6	4	4	10	

4. MINOR: ARTS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRAR01	FUNDAMENTALS OF MACRO-ECONOMICS	R	FME	4	0	0	0	4	4	
2	MIN	MIN-CORE	23MRAR02	BASICS OF ECONOMETRICS	R	BOE	4	0	0	0	4	4	
3	MIN	MIN-CORE	23MRAR03	INTERNATIONAL RELATIONS: THEORIES AND CONCEPTS	R	IRTC	4	0	0	0	4	4	
4	MIN	MIN-CORE	23MRAR04	BEHAVIOURAL ECONOMICS AND POLICY	R	BEP	4	0	0	0	4	4	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	MSDC	MIN-SDP	23MRAR05	SOCIAL GEOGRAPHY AND CARTOGRAPHY	R	SGC	0	0	6	4	4	10	

5. MINOR: BUSINESS ADMINISTRATION

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRBA01M	ORGANIZATIONAL BEHAVIOUR	M	OBR	4	0	0	0	4	4	
2	MIN	MIN-CORE	23MRBA02M	MARKETING MANAGEMENT	M	MMG	4	0	0	0	4	4	
3	MIN	MIN-CORE	23MRBA03M	FINANCIAL MANAGEMENT	M	FMG	4	0	0	0	4	4	
4	MIN	MIN-CORE	23MRBA04M	HUMAN RESOURCE MANAGEMENT	M	HRM	4	0	0	0	4	4	
5	MSDC	MIN-SDP	23MRBA05M	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	M	LSCM	0	0	6	4	4	10	

6. MINOR: COMPUTATIONAL MATHEMATICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRCM01	LINEAR ALGEBRA	R	LAG	2	2	0	0	4	4	
2	MIN	MIN-CORE	23MRCM02	ADVANCED NUMERICAL ANALYSIS	R	ANA	2	2	0	0	4	4	
3	MIN	MIN-CORE	23MRCM03	MATHEMATICAL MODELLING	R	MML	3	0	2	0	4	5	
4	MIN	MIN-CORE	23MRCM04	STOCHASTIC PROCESSES & OPTIMIZATION	R	SPO	2	2	0	0	4	4	
5	MIN	MIN-CORE	23MRCM05	FUZZY MATHEMATICS AND ITS APPLICATIONS	R	FMAA	2	2	0	0	4	4	
6	MSDC	MIN-SDP	23MRCM06	TRANSFORM TECHNIQUES FOR ENGINEERING	R	TTE	2	0	2	4	4	8	
7	MSDC	MIN-SDP	23MRCM07	STATISTICS WITH R PROGRAMMING	R	SWRP	2	0	2	4	4	8	
8	MSDC	MIN-SDP	23MRCM08	MATRIX COMPUTATION	R	MCT	2	0	2	4	4	8	

7. MINOR: CORPORATE LAW

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRCL01	PRINCIPLES OF COMPANIES ACT AND CORPORATE GOVERNANCE	R	PCACG	3	0	2	0	4	5	
2	MIN	MIN-CORE	23MRCL02	MERGERS, ACQUISITIONS AND PRIVATE EQUITY	R	MAPE	3	0	2	0	4	5	
3	MIN	MIN-CORE	23MRCL03	INSOLVENCY AND BANKRUPTCY LAW	R	IBL	3	0	2	0	4	5	
4	MIN	MIN-CORE	23MRCL04	COMPETITION LAW AND PRACTICE	R	CLP	3	0	2	0	4	5	
5	MSDC	MIN-SDP	23MRCL05	COMMERCIAL CONTRACT DRAFTING	R	CCD	0	0	6	4	4	10	

8. MINOR: CREATIVE ARTS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRCA01	INTRODUCTION TO CREATIVE ARTS	R	ICA	0	0	6	4	4	10	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
2	MIN	MIN-CORE	23MRCA02	DRAWING AND SKETCHING	R	DAS	0	0	6	4	4	10	
3	MIN	MIN-CORE	23MRCA03	PAINTING	R	PNT	0	0	6	4	4	10	
4	MIN	MIN-CORE	23MRCA04	CREATIVE WRITING	R	CWT	0	0	6	4	4	10	
5	MSDC	MIN-SDP	23MRCA05	SCULPTURE	R	SCP	0	0	6	4	4	10	

9. MINOR: DIGITAL MARKETING AND AUTOMATION

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRDM01M	FUNDAMENTALS OF DIGITAL MARKETING	M	FDM	4	0	0	0	4	4	
2	MIN	MIN-CORE	23MRDM02M	SOCIAL MEDIA MARKETING	M	SMM	4	0	0	0	4	4	
3	MIN	MIN-CORE	23MRDM03M	SEARCH ENGINE OPTIMIZATION	M	SEO	4	0	0	0	4	4	
4	MIN	MIN-CORE	23MRDM04M	ARTIFICIAL INTELLIGENCE IN MARKETING	M	AIM	4	0	0	0	4	4	
5	MSDC	MIN-SDP	23MRDM05	CONTENT MARKETING	M	CM	0	0	6	4	4	10	

10. MINOR: FILM MAKING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRFM01	FILM AESTHETICS	R	FAS	0	0	6	4	4	10	
2	MIN	MIN-CORE	23MRFM02	SCREEN WRITING	R	SWT	0	0	6	4	4	10	
3	MIN	MIN-CORE	23MRFM04	SOUND DESIGN	R	SDS	0	0	6	4	4	10	
4	MSDC	MIN-SDP	23MRFM05	DIGITAL PHOTOGRAPHY	R	DPG	0	0	6	4	4	10	

11. MINOR: FINTECH AND ALGORITHMIC TRADING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRFA01M	FOUNDATIONS AND APPLICATIONS OF FINANCIAL TECHNOLOGY	M	AFT	4	0	0	0	4	4	
2	MIN	MIN-CORE	23MRFA02M	DECENTRALISED FINANCE: THE FUTURE OF FINANCE	M	DFFF	4	0	0	0	4	4	
3	MIN	MIN-CORE	23MRFA03M	FINTECH INNOVATIONS	M	FIV	4	0	0	0	4	4	
4	MIN	MIN-CORE	23MRFA04M	USING MACHINE LEARNING IN TRADING AND FINANCE	M	ML	4	0	0	0	4	4	
5	MSDC	MIN-SDP	23MRFA05	TRADING ALGORITHMS	M	TA	0	0	6	4	4	10	

12. MINOR: FOOD TECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRFT01	INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY	R	IFST	3	0	2	0	4	5	
2	MIN	MIN-CORE	23MRFT02	FOOD ANALYSIS AND QUALITY ASSURANCE	R	FAQA	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
3	MIN	MIN-CORE	23MRFT03	FOOD SAFETY AND REGULATIONS	R	FSR	3	1	0	0	4	4	
4	MIN	MIN-CORE	23MRFT04	FOOD ENGINEERING	R	FEG	3	0	2	0	4	5	
5	MSDC	MIN-SDP	23MRFT05	FOOD PACKAGING TECHNOLOGY	R	FPT	2	0	2	4	4	8	

13. MINOR: GRAPHIC DESIGN

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRGD01	INTRODUCTION TO GRAPHIC DESIGN	R	IGD	0	0	6	4	4	10	
2	MIN	MIN-CORE	23MRGD02	TYPOGRAPHY	R	TPY	0	0	6	4	4	10	
3	MIN	MIN-CORE	23MRGD03	VISUAL IDENTITY AND BRANDING	R	VIB	0	0	6	4	4	10	
4	MIN	MIN-CORE	23MRGD04	PRINT DESIGN	R	PRDG	0	0	6	4	4	10	
5	MSDC	MIN-SDP	23MRGD05	PUBLICATION DESIGN	R	PUDG	0	0	6	4	4	10	

14. MINOR: INNOVATION MANAGEMENT AND ENTREPRENEURSHIP

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRIM01	APPLIED DESIGN THINKING	R	ADT	3	0	2	0	4	5	
2	MIN	MIN-CORE	23MRIM02	BUSINESS MODEL INNOVATION	R	BMI	3	0	2	0	4	5	
3	MIN	MIN-CORE	23MRIM03	VENTURE MANAGEMENT	R	VMT	3	0	2	0	4	5	
4	MIN	MIN-CORE	23MRIM04	BUSINESS AND LEADERSHIP	R	BL	3	0	2	0	4	5	
5	MSDC	MIN-SDP	23MRIM05	PROJECT INNOVATE: STRATEGIES FOR ENTREPRENEURIAL GROWTH	R	PISEG	0	0	6	4	4	10	

15. MINOR: INTELLECTUAL PROPERTY LAW

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRIP01	EMERGENCE AND DEVELOPMENT OF IPR	R	EDIPR	3	0	2	0	4	5	
2	MIN	MIN-CORE	23MRIP02	LAW OF COPYRIGHT	R	LOCR	3	0	2	0	4	5	
3	MIN	MIN-CORE	23MRIP03	LAW OF PATENTS	R	LOPS	3	0	2	0	4	5	
4	MIN	MIN-CORE	23MRIP04	LAW OF TRADEMARK	R	LOTM	3	0	2	0	4	5	
5	MSDC	MIN-SDP	23MRIP05	LAW OF DESIGNS, GEOGRAPHICAL INDICATIONS AND PLANT VARIETIES	R	LODGP	0	0	6	4	4	10	

16. MINOR: INTERIOR DESIGN

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRID01	INTRODUCTION TO INTERIOR DESIGN	R	IID	3	0	2	0	4	5	
2	MIN	MIN-CORE	23MRID02	SPACE PLANNING AND LAYOUT	R	SPL	3	0	2	0	4	5	
3	MIN	MIN-CORE	23MRID03	INTERIOR MATERIAL AND FINISHES	R	IMF	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
4	MIN	MIN-CORE	23MRID04	FURNITURE AND ACCESSORIES DESIGN	R	FAD	3	0	2	0	4	5	
5	MSDC	MIN-SDP	23MRID05	DESIGN PRESENTATION AND COMMUNICATION	R	DPC	0	0	6	4	4	10	

17. MINOR: INTERNATIONAL BUSINESS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRIB01M	INTERNATIONAL BUSINESS ESSENTIALS	M	IBET	4	0	0	0	4	4	
2	MIN	MIN-CORE	23MRIB02M	INTERNATIONAL BUSINESS ENVIRONMENT	M	IBEV	4	0	0	0	4	4	
3	MIN	MIN-CORE	23MRIB03M	INTERNATIONAL BUSINESS OPERATIONS	M	IBO	4	0	0	0	4	4	
4	MIN	MIN-CORE	23MRIB04M	INTERNATIONAL BUSINESS MODELS	M	IBM	4	0	0	0	4	4	
5	MSDC	MIN-SDP	23MRIB05	PROFESSIONAL SKILLS FOR INTERNATIONAL BUSINESS	M	PIB	0	0	6	4	4	10	

18. MINOR: ORGANIZATIONAL BEHAVIOUR

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MROB01M	ORGANIZATIONAL BEHAVIOUR	M	POM	4	0	0	0	4	4	
2	MIN	MIN-CORE	23MROB02M	ORGANIZATIONAL BEHAVIOUR MODELS	M	OBM	4	0	0	0	4	4	
3	MIN	MIN-CORE	23MROB03M	ORGANIZATIONAL CHANGE AND DEVELOPMENT	M	OCD	4	0	0	0	4	4	
4	MIN	MIN-CORE	23MROB04M	LEADERSHIP IN ORGANIZATION	M	LIO	4	0	0	0	4	4	
5	MSDC	MIN-SDP	23MROB05	TEAM BUILDING AND COLLABORATION SKILLS FOR MANAGERS	M	TBCM	0	0	6	4	4	10	

19. MINOR: PHARMACOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRPY01	BASICS OF PHARMACOLOGY	R	BOP	3	0	2	0	4	5	
2	MIN	MIN-CORE	23MRPY02	ADVANCED PHARMACOLOGY - I	R	AP-I	3	0	2	0	4	5	
3	MIN	MIN-CORE	23MRPY03	EXPERIMENTAL PHARMACOLOGY	R	EPC	3	0	2	0	4	5	
4	MIN	MIN-CORE	23MRPY04	ADVANCED PHARMACOLOGY - II	R	AP-II	3	0	2	0	4	5	
5	MSDC	MIN-SDP	23MRPY05	PRACTICAL PHARMACOLOGY	R	PRI	0	0	6	4	4	10	

20. MINOR: PRECISION AGRICULTURE

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRPA01	FUNDAMENTALS OF AGRONOMY	R	FOA	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
2	MIN	MIN-CORE	23MRPA02	INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE	R	IACC	3	0	2	0	4	5	
3	MIN	MIN-CORE	23MRPA03	GEOINFORMATICS AND NANOTECHNOLOGY FOR PRECISION FARMING	R	GNPF	3	0	2	0	4	5	
4	MIN	MIN-CORE	23MRPA04	PROTECTED CULTIVATION AND POST-HARVEST TECHNOLOGIES	R	PCPHT	3	0	2	0	4	5	
5	MSDC	MIN-SDP	23MRPA05	MODERN FARMING TECHNIQUES AND INNOVATIONS	R	AELP	0	0	6	4	4	10	

21. MINOR: TECHNOPRENEURSHIP

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRTP01	INTRODUCTION TO TECHNOLOGICAL ENTREPRENEURSHIP	R	ITEP	3	0	2	0	4	5	
2	MIN	MIN-CORE	23MRTP02	LEAN STARTUP LAUNCHPAD	R	LSLP	3	0	2	0	4	5	
3	MIN	MIN-CORE	23MRTP03	ENTREPRENEURSHIP AND VENTURE CAPITAL	R	EVC	3	0	2	0	4	5	
4	MIN	MIN-CORE	23MRTP04	BUILDING AND SUSTAINING A SUCCESSFUL ENTERPRISE	R	BSSE	3	0	2	0	4	5	
5	MSDC	MIN-SDP	23MRTP05	TECH INNOVATION PROJECT FOR ENTREPRENEURS	R	TIPFE	0	0	6	4	4	10	

22. MINOR: WATER SCIENCE AND MANAGEMENT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	23MRPA01	FUNDAMENTALS OF AGRONOMY	R	FOA	3	0	2	0	4	5	
2	MIN	MIN-CORE	23MRPA02	INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE	R	IACC	3	0	2	0	4	5	
3	MIN	MIN-CORE	23MRPA03	GEOINFORMATICS AND NANOTECHNOLOGY FOR PRECISION FARMING	R	GNPF	3	0	2	0	4	5	
4	MIN	MIN-CORE	23MRPA04	PROTECTED CULTIVATION AND POST-HARVEST TECHNOLOGIES	R	PCPHT	3	0	2	0	4	5	
5	MSDC	MIN-SDP	23MRPA05	MODERN FARMING TECHNIQUES AND INNOVATIONS	R	AELP	0	0	6	4	4	10	

23. DOUBLE MAJOR: SECOND MAJOR CSE FOR FIRST MAJOR ECE / IOT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PCC	PCC-CORE	23AD2102A	DATABASE MANAGEMENT SYSTEMS	A	DBMS	4	0	4	0	6	8	CTSD(1)
2	PCC	PCC-CORE	23AD2102E	DATABASE MANAGEMENT SYSTEMS	E	DBMS	4	0	4	0	6	8	CTSD(1)
3	PCC	PCC-CORE	23AD2102R	DATABASE MANAGEMENT SYSTEMS	R	DBMS	3	0	2	0	4	5	CTSD(1)
4	FCC	FC-1	23CS3203F	QUANTUM COMPUTING	F	QCP	2	0	2	0	3	4	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	OE	OE-2	23CI2001	ADAPTIVE SOFTWARE ENGINEERING	R	ASE	3	1	0	0	4	4	
6	OE	OE-3	23CS2104R	OPERATING SYSTEMS	R	OS	3	0	2	0	4	5	
7	SMFC	SMFC-	23CS04HF	HIGH PERFORMANCE COMPUTING	R	HPC	3	0	2	0	4	5	
8	SMFC	SMFC-CORE	23CS03HF	ADVANCED ALGORITHMS & DATA STRUCTURES	R	AADS	3	0	2	0	4	5	
9	SMFC	SMFC-CORE	23CS2103R	ADVANCED OBJECT ORIENTED PROGRAMMING	R	AOOP	3	0	2	4	5	9	
10	SMFC	SMFC-CORE	23CS2205R	DESIGN AND ANALYSIS OF ALGORITHMS	R	DAA	3	0	2	4	5	9	
11	SMFC	SMFC-CORE	23CS05EF	PYTHON FULL STACK DEVELOPMENT WITH DJANGO	E	PFSD	0	0	6	4	4	10	
12	SMFC	SMFC-	23CS06EF	MERN STACK WEB DEVELOPMENT	E	MSWD	0	0	6	4	4	10	

24. DOUBLE MAJOR: SECOND MAJOR CSIT FOR FIRST MAJOR ECE / IOT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PCC	PCC-CORE	23AD2102A	DATABASE MANAGEMENT SYSTEMS	A	DBMS	4	0	4	0	6	8	CTSD(1)
2	PCC	PCC-CORE	23AD2102E	DATABASE MANAGEMENT SYSTEMS	E	DBMS	4	0	4	0	6	8	CTSD(1)
3	PCC	PCC-CORE	23AD2102R	DATABASE MANAGEMENT SYSTEMS	R	DBMS	3	0	2	0	4	5	CTSD(1)
4	FCC	FC-1	23CS3203F	QUANTUM COMPUTING	F	QCP	2	0	2	0	3	4	
5	OE	OE-2	23CI2001	ADAPTIVE SOFTWARE ENGINEERING	R	ASE	3	1	0	0	4	4	
6	OE	OE-3	23CS2104R	OPERATING SYSTEMS	R	OS	3	0	2	0	4	5	
7	SMFC	SMFC-	23CS04HF	HIGH PERFORMANCE COMPUTING	R	HPC	3	0	2	0	4	5	
8	SMFC	SMFC-CORE	23CS03HF	ADVANCED ALGORITHMS & DATA STRUCTURES	R	AADS	3	0	2	0	4	5	
9	SMFC	SMFC-CORE	23CS2103R	ADVANCED OBJECT ORIENTED PROGRAMMING	R	AOOP	3	0	2	4	5	9	
10	SMFC	SMFC-CORE	23CS2205R	DESIGN AND ANALYSIS OF ALGORITHMS	R	DAA	3	0	2	4	5	9	
11	SMFC	SMFC-CORE	23CS05EF	PYTHON FULL STACK DEVELOPMENT WITH DJANGO	E	PFSD	0	0	6	4	4	10	
12	SMFC	SMFC-CORE	23CI2203	MANAGEMENT INFORMATION SYSTEM - ERP	R	MIS	2	0	0	0	2	2	
13	SMFC	SMFC-	23CS06EF	MERN STACK WEB DEVELOPMENT	E	MSWD	0	0	6	4	4	10	

25. DOUBLE MAJOR: SECOND MAJOR EEE FOR FIRST MAJOR ECE / IOT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	FCC	FC-1	23EE2225F	POWER QUALITY	F	PQ	3	0	0	0	3	3	
2	OE	OE-1	23OEEE03	ELECTRICAL POWER ENGINEERING	R	EPE	4	0	0	0	4	4	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
3	OEC	OE-2	23EE2207R	CONTROL SYSTEMS	R	CS	3	0	2	0	4	5	
4	OEC	OE-3	23EE2205R	POWER ELECTRONICS	R	PES	3	0	2	0	4	5	
5	SMFC	SMFC-	23EE2102R	ELECTRICAL MACHINES	R	ELM	3	0	2	0	4	5	
6	SMFC	SMFC-CORE	23EE2204R	ELECTRICAL POWER GENERATION, TRANSMISSION & DISTRIBUTION	R	EPGTD	2	1	0	0	3	3	
7	SMFC	SMFC-CORE	23EE3106R	POWER SYSTEM ANALYSIS & STABILITY	R	PSAS	2	1	0	0	3	3	
8	SMFC	SMFC-CORE	23EE3208R	POWER SYSTEM PROTECTION & CONTROL	R	PSPC	2	0	2	2	3.5	6	
9	SMFC	SMFC-	23EE01HF	RESTRUCTURED POWER SYSTEMS	R	RPS	3	0	2	0	4	5	
10	SMFC	SMFC-	23EE2101	ELECTRICAL CIRCUITS	R	ELC	2	0	2	0	3	4	

26. DOUBLE MAJOR: SECOND MAJOR ECE FOR FIRST MAJOR EEE / IOT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	FCC	FC-1	23EC2229F	WIRELESS SENSOR NETWORKS	F	WSN	2	0	2	0	3	4	
2	FCC	FC-1	23EC2224F	DEEP NETWORK ARCHITECTURES	F	DNA	2	0	2	0	3	4	
3	OEC	OE-1	23EC2105R	SIGNALS & COMMUNICATION SYSTEMS	R	SCS	3	0	2	0	4	5	
4	OEC	OE-2	23EC2208R	DIGITAL COMMUNICATION	R	DC	3	0	2	0	4	5	
5	OEC	OE-3	23EC3112R	DISCRETE TIME SIGNAL PROCESSING	R	DTSP	3	0	2	0	4	5	
6	SMFC	SMFC-	23EC02HF	SENSORS AND TRANSDUCERS	R	SAT	3	0	2	0	4	5	
7	SMFC	SMFC-CORE	23EC2209R	ELECTROMAGNETIC WAVES & TRANSMISSION LINES	R	EMWTL	3	0	0	0	3	3	
8	SMFC	SMFC-CORE	23EC01HF	VLSI PHYSICAL DESIGN AUTOMATION	R	VPDA	3	0	2	0	4	5	
9	SMFC	SMFC-	23EC2211R	VLSI DESIGN	R	VLSID	3	0	2	2	4.5	7	

27. DOUBLE MAJOR: SECOND MAJOR AIDS FOR FIRST MAJOR ECE / IOT / CSE / CSIT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	FCC	FC-1	23AD2224F	CLOUD COMPUTING	F	CC	2	1	0	0	3	3	
2	OEC	OE-1	23AD2204R	DATA MANAGEMENT AND WAREHOUSING	R	DMW	3	0	2	0	4	5	
3	OEC	OE-2	23AD3106R	BIG DATA ENGINEERING	R	BDE	3	0	2	0	4	5	
4	OEC	OE-3	23AD3207R	NATURAL LANGUAGE PROCESSING	R	NLP	3	0	2	0	4	5	
5	SMFC	SMFC-CORE	23AD01HF	MACHINE LEARNING FOR HEALTHCARE	R	MLH	3	0	2	0	4	5	
6	SMFC	SMFC-	23AD03HF	REINFORCEMENT LEARNING	R	RIL	3	0	2	0	4	5	
7	SMFC	SMFC-	23AD04HF	EXPLAINABLE AI	R	EAI	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
8	SMFC	SMFC-	23AD2205R	DEEP LEARNING	R	DL	3	0	2	4	5	9	
9	SMFC	SMFC-CORE	23AD4108	ETHICS FOR ARTIFICIAL INTELLIGENCE	R	EAI	1	0	0	0	1	1	
10	SMFC	SMFC-CORE	23AD2103R	SYSTEM DESIGN & INTRODUCTION TO CLOUD	R	SDC	3	0	2	0	4	5	
11	SMFC	SMFC-CORE	23AD02HF	DATA ENGINEERING AND ARCHITECTURE	R	DEA	3	0	2	0	4	5	

32. DOUBLE MAJOR: SECOND MAJOR FOOD TECHNOLOGY FOR FIRST MAJOR B.TECH / B.COM / BBA / BSC / BCA / BA

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	OEC	OE-1	22FT2212R	PROCESSING OF AQUATIC FOODS	R	PAF	3	0	2	0	4	5	
2	OEC	OE-2	22FT22C1R	FOOD ANALYSIS AND QUALITY ASSURANCE	R	FAQA	3	0	2	0	4	5	
3	OEC	OE-3	22FT3215R	TECHNOLOGY OF MEAT AND POULTRY	R	TMP	3	0	2	0	4	5	
4	SMFC	SMFC-	22FT1102	FOOD CHEMISTRY	R	FC	3	0	2	0	4	5	
5	SMFC	SMFC-	22FT1105	FOOD BIOCHEMISTRY	R	FBC	3	0	2	0	4	5	
6	SMFC	SMFC-CORE	22FT2109R	PROCESSING OF HORTICULTURAL PRODUCE	R	PHP	3	0	2	0	4	5	
7	SMFC	SMFC-CORE	22FT12C1	PRINCIPLES OF FOOD PRESERVATION	R	PFP	1	0	0	4	2	5	
8	SMFC	SMFC-	22FT32C2R	FOOD PACKAGING TECHNOLOGY	R	FPT	1	0	0	4	2	5	
9	SMFC	SMFC-	22FT1207R	FOOD MICROBIOLOGY	R	FMB	3	0	2	0	4	5	
10	SMFC	SMFC-CORE	22FT2213R	BAKERY, CONFECTIONERY AND SNACKS TECHNOLOGY	R	BCST	2	0	4	0	4	6	
11	SMFC	SMFC-CORE	22FT1104	INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY	R	IFST	3	0	2	0	4	5	

33. DOUBLE MAJOR: SECOND MAJOR COMMERCE FOR FIRST MAJOR B.TECH / BBA / BSC / BCA / BA

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	OEC	OE-1	23ACCABT	BUSINESS TECHNOLOGY	R	BT	4	0	0	0	4	4	
2	OEC	OE-2	23ACCAFA	FINANCIAL ACCOUNTING	R	FA	3	2	0	0	5	5	
3	OEC	OE-3	23ACCAMA	MANAGEMENT ACCOUNTING	R	MA	3	2	0	0	5	5	
4	SMFC	SMFC-	23ACCAPM	PERFORMANCE MANAGEMENT	R	PM	3	2	0	0	5	5	
5	SMFC	SMFC-	22CM1206	ADVANCED COST ACCOUNTING	R	ACA	3	2	0	0	5	5	
6	SMFC	SMFC-CORE	22CM31B5	ACCOUNTING & REPORTING STANDARDS	R	ARS	3	2	0	0	5	5	
7	SMFC	SMFC-	23ACCATX	TAXATION	R	TXT	3	2	0	0	5	5	
8	SMFC	SMFC-	22CM21B2	INCOME TAX LAW & PRACTICE	R	ITLP	3	2	0	0	5	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
9	SMFC	SMFC-	22CM1203	DATA ANALYSIS WITH EXCEL	R	DAWE	0	0	0	4	1	4	

34. SPECIALIZATION: AGRI-BIOTECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDBT10A	MASS SPECTROMETRY BASED PROTEOMICS	A	MSBP	0	0	6	4	4	10	
2	SDC	SDP-4	23SDBT10E	MASS SPECTROMETRY BASED PROTEOMICS	E	MSBP	0	0	6	4	4	10	
3	SDC	SDP-4	23SDBT10R	MASS SPECTROMETRY BASED PROTEOMICS	R	MSBP	0	0	2	4	2	6	
4	PEC	PE-1	23ABT3101A	BIOSENSORS AND BIOELECTRONICS	A	BSBE	4	0	4	4	7	12	
5	PEC	PE-1	23ABT3101E	BIOSENSORS AND BIOELECTRONICS	E	BSBE	4	0	4	4	7	12	
6	PEC	PE-1	23ABT3101R	BIOSENSORS AND BIOELECTRONICS	R	BSBE	3	0	2	4	5	9	
7	PEC	PE-2	23ABT3202A	IOT APPLICATIONS IN PRECISION AGRICULTURE	A	IOTAPA	5	0	0	0	5	5	
8	PEC	PE-2	23ABT3202E	IOT APPLICATIONS IN PRECISION AGRICULTURE	E	IOTAPA	5	0	0	0	5	5	
9	PEC	PE-2	23ABT3202R	IOT APPLICATIONS IN PRECISION AGRICULTURE	R	IOTAPA	3	0	0	0	3	3	
10	PEC	PE-3	23ABT3203A	MACHINE LEARNING FOR PRECISION AGRICULTURE	A	MLPA	5	0	0	0	5	5	
11	PEC	PE-3	23ABT3203E	MACHINE LEARNING FOR PRECISION AGRICULTURE	E	MLPA	5	0	0	0	5	5	
12	PEC	PE-3	23ABT3203R	MACHINE LEARNING FOR PRECISION AGRICULTURE	R	MLPA	3	0	0	0	3	3	
13	PEC	PE-3	23ABT3304A	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	A	IPAA	4	0	4	4	7	12	
14	PEC	PE-3	23ABT3304E	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	E	IPAA	4	0	4	4	7	12	
15	PEC	PE-3	23ABT3304R	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	R	IPAA	3	0	2	4	5	9	
16	PEC	PE-3	23ABT3405M	BIOINSTRUMENTATION	M	BIM	4	0	0	0	4	4	
17	PEC	PE-4	23ABT3406M	DATA ACQUISITION AND COMMUNICATION SYSTEMS FOR AGRICULTURE	M	DACSA	3	0	0	0	3	3	
18	PEC	PE-5	23ABT3507	MICROFLUIDICS FOR AGRICULTURAL APPLICATIONS	R	MAP	3	0	0	0	3	3	
19	PEC	PE-5	23ABT3508	BIOINFORMATICS FOR AGRICULTURE	R	BIA	3	0	0	0	3	3	

35. SPECIALIZATION: AI AND AUTONOMOUS SYSTEMS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDAD09A	AUTONOMOUS VEHICLE SYSTEMS	A	AVS	0	0	6	4	4	10	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
2	SDC	SDP-4	23SDAD09E	AUTONOMOUS VEHICLE SYSTEMS	E	AVS	0	0	6	4	4	10	
3	SDC	SDP-4	23SDAD09R	AUTONOMOUS VEHICLE SYSTEMS	R	AVS	0	0	2	4	2	6	
4	PEC	PE-1	23ASS3101A	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	A	ADAS	4	0	4	4	7	12	
5	PEC	PE-1	23ASS3101E	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	E	ADAS	4	0	4	4	7	12	
6	PEC	PE-1	23ASS3101R	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	R	ADAS	3	0	2	4	5	9	
7	PEC	PE-1	23ASS3102A	AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE	A	AICAFT	4	0	4	4	7	12	
8	PEC	PE-1	23ASS3102E	AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE	E	AICAFT	4	0	4	4	7	12	
9	PEC	PE-1	23ASS3102R	AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE	R	AICAFT	3	0	2	4	5	9	
10	PEC	PE-2	23ASS3202A	INTRODUCTION TO INTELLIGENT DRONES	A	IID	5	0	0	0	5	5	
11	PEC	PE-2	23ASS3202E	INTRODUCTION TO INTELLIGENT DRONES	E	IID	5	0	0	0	5	5	
12	PEC	PE-2	23ASS3202R	INTRODUCTION TO INTELLIGENT DRONES	R	IID	3	0	0	0	3	3	
13	PEC	PE-2	23ASS3203R	AI AND IOT FOR AUTONOMOUS VEHICLE	R	AIAV	3	0	0	0	3	3	
14	PEC	PE-2	23ASS3205A	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	A	AVECUDA	3	0	4	0	5	7	
15	PEC	PE-2	23ASS3205E	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	E	AVECUDA	3	0	4	0	5	7	
16	PEC	PE-2	23ASS3205R	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	R	AVECUDA	2	0	2	0	3	4	
17	PEC	PE-3	23ASS3203A	AI AND IOT FOR AUTONOMOUS VEHICLE	A	AIAV	5	0	0	0	5	5	
18	PEC	PE-3	23ASS3203E	AI AND IOT FOR AUTONOMOUS VEHICLE	E	AIAV	5	0	0	0	5	5	
19	PEC	PE-3	23ASS3304A	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	A	ADLAS	4	0	4	4	7	12	
20	PEC	PE-3	23ASS3304E	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	E	ADLAS	4	0	4	4	7	12	
21	PEC	PE-3	23ASS3304R	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	R	ADLAS	3	0	2	4	5	9	
22	PEC	PE-3	23ASS3309A	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	A	AAAV	4	0	4	4	7	12	
23	PEC	PE-3	23ASS3309E	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	E	AAAV	4	0	4	4	7	12	
24	PEC	PE-3	23ASS3309R	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	R	AAAV	3	0	2	4	5	9	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
25	PEC	PE-4	23ASS3405M	EXPERT SYSTEMS	M	ES	3	0	0	0	3	3	
26	PEC	PE-4	23ASS3406M	SELF-DRIVING CARS	M	SDC	3	0	0	0	3	3	
27	PEC	PE-4	23ASS3410M	CYBERSECURITY IN AUTONOMUS VEHICLE	M	CAV	3	0	0	0	3	3	
28	PEC	PE-5	23ASS3507	LOCALIZATION & PROGRAMMING REAL-TIME AUTONOMOUS SYSTEMS	R	LPRAS	3	0	0	0	3	3	
29	PEC	PE-5	23ASS3508	REINFORCEMENT LEARNING FOR AUTONOMOUS SYSTEM	R	RLA	3	0	0	0	3	3	
30	PEC	PE-5	23ASS3511	AI DRIVEN ECU DESIGN FOR AUTONOMOUS VEHICLES	R	AEDATT	2	0	2	0	3	4	

36. SPECIALIZATION: AI FOR COMPUTATIONAL INTELLIGENCE

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS17A	GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES	A	GANI	0	0	6	4	4	10	
2	SDC	SDP-3	23SDCS17E	GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES	E	GANI	0	0	6	4	4	10	
3	SDC	SDP-3	23SDCS17R	GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES	R	GANI	0	0	2	4	2	6	
4	PEC	PE-1	23ACI3101A	GENERATIVE ADVERSARIAL NETWORKS	A	GANS	4	0	4	4	7	12	
5	PEC	PE-1	23ACI3101E	GENERATIVE ADVERSARIAL NETWORKS	E	GANS	4	0	4	4	7	12	
6	PEC	PE-1	23ACI3101R	GENERATIVE ADVERSARIAL NETWORKS	R	GANS	3	0	2	4	5	9	
7	PEC	PE-2	23ACI3202A	EXPLAINABLE AI AND COMMUNICATIONS	A	EAIC	5	0	0	0	5	5	
8	PEC	PE-2	23ACI3202E	EXPLAINABLE AI AND COMMUNICATIONS	E	EAIC	5	0	0	0	5	5	
9	PEC	PE-2	23ACI3202R	EXPLAINABLE AI AND COMMUNICATIONS	R	EAIC	3	0	0	0	3	3	
10	PEC	PE-3	23ACI3303A	FUZZY LOGIC WITH SET THEORY	A	FLST	4	0	4	4	7	12	
11	PEC	PE-3	23ACI3303E	FUZZY LOGIC WITH SET THEORY	E	FLST	4	0	4	4	7	12	
12	PEC	PE-3	23ACI3303R	FUZZY LOGIC WITH SET THEORY	R	FLST	3	0	2	4	5	9	
13	PEC	PE-4	23ACI3404M	HEURISTIC ALGORITHMS	M	HAG	3	0	0	0	3	3	
14	PEC	PE-4	23ACI3405M	SWARM INTELLIGENCE APPROCAHES	M	SIA	3	0	0	0	3	3	
15	PEC	PE-5	23ACI3506	DATA MANIPULATION	R	DMP	3	0	0	0	3	3	
16	PEC	PE-5	23ACI3507	REINFORCEMENT LEARNING	R	RLG	3	0	0	0	3	3	
17	PEC	PE-5	23ACI3508	EVOLUTIONARY COMPUTATION	R	ECP	3	0	0	0	3	3	

37. SPECIALIZATION: AI SYSTEMS FOR VISUAL INTELLIGENCE

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS19A	VISUAL RECOGNITION AND SCENE UNDERSTANDING	A	VRSU	0	0	6	4	4	10	
2	SDC	SDP-3	23SDCS19E	VISUAL RECOGNITION AND SCENE UNDERSTANDING	E	VRSU	0	0	6	4	4	10	
3	SDC	SDP-3	23SDCS19R	VISUAL RECOGNITION AND SCENE UNDERSTANDING	R	VRSU	0	0	2	4	2	6	
4	PEC	PE-1	23AVI3101A	DEEP LEARNING	A	DL	4	0	4	4	7	12	
5	PEC	PE-1	23AVI3101E	DEEP LEARNING	E	DL	4	0	4	4	7	12	
6	PEC	PE-1	23AVI3101R	DEEP LEARNING	R	DL	3	0	2	4	5	9	
7	PEC	PE-2	23AVI3202A	COMPUTER VISION	A	CV	5	0	0	0	5	5	
8	PEC	PE-2	23AVI3202E	COMPUTER VISION	E	CV	5	0	0	0	5	5	
9	PEC	PE-2	23AVI3202R	COMPUTER VISION	R	CV	3	0	0	0	3	3	
10	PEC	PE-3	23AVI3303A	OBJECT DETECTION	A	OD	4	0	4	4	7	12	
11	PEC	PE-3	23AVI3303E	OBJECT DETECTION	E	OD	4	0	4	4	7	12	
12	PEC	PE-3	23AVI3303R	OBJECT DETECTION	R	OD	3	0	2	4	5	9	
13	PEC	PE-4	23AVI3404M	VISUAL RECOGNITION AND SCENE UNDERSTANDING	M	VRASU	3	0	0	0	3	3	
14	PEC	PE-4	23AVI3405M	DEEP REINFORCEMENT LEARNING FOR VISION	M	DRLV	3	0	0	0	3	3	
15	PEC	PE-5	23AVI3506	HUMAN COMPUTER INTERACTION	R	HCI	3	0	0	0	3	3	
16	PEC	PE-5	23AVI3507	OBJECT LOCALIZATION	R	OL	3	0	0	0	3	3	
17	PEC	PE-5	23AVI3508	ADVANCED IMAGE PROCESSING AND ANALYSIS	R	AIPA	3	0	0	0	3	3	

38. SPECIALIZATION: AI-DRIVEN EDGE ARCHITECTURES AND APPLICATIONS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS20A	SMART IOT AND SENSOR NETWORKS	A	SISN	0	0	6	4	4	10	
2	SDC	SDP-3	23SDCS20E	SMART IOT AND SENSOR NETWORKS	E	SISN	0	0	6	4	4	10	
3	SDC	SDP-3	23SDCS20R	SMART IOT AND SENSOR NETWORKS	R	SISN	0	0	2	4	2	6	
4	PEC	PE-1	23ADE3101A	EDGE COMPUTING FUNDAMENTALS	A	ECF	4	0	4	4	7	12	
5	PEC	PE-1	23ADE3101E	EDGE COMPUTING FUNDAMENTALS	E	ECF	4	0	4	4	7	12	
6	PEC	PE-1	23ADE3101R	EDGE COMPUTING FUNDAMENTALS	R	ECF	3	0	2	4	5	9	
7	PEC	PE-2	23ADE3202A	AI AT THE EDGE	A	AIAE	5	0	0	0	5	5	
8	PEC	PE-2	23ADE3202E	AI AT THE EDGE	E	AIAE	5	0	0	0	5	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
9	PEC	PE-2	23ADE3202R	AI AT THE EDGE	R	AIAE	3	0	0	0	3	3	
10	PEC	PE-3	23ADE3303A	EDGE AI ARCHITECTURES AND APPLICATIONS	A	EAIAA	4	0	4	4	7	12	
11	PEC	PE-3	23ADE3303E	EDGE AI ARCHITECTURES AND APPLICATIONS	E	EAIAA	4	0	4	4	7	12	
12	PEC	PE-3	23ADE3303R	EDGE AI ARCHITECTURES AND APPLICATIONS	R	EAIAA	3	0	2	4	5	9	
13	PEC	PE-4	23ADE3404M	EDGE AI AND 5G	M	EAI5G	3	0	0	0	3	3	
14	PEC	PE-4	23ADE3405M	EDGE AI SECURITY AND PROTECTION	M	EAI5P	3	0	0	0	3	3	
15	PEC	PE-5	23ADE3506	EDGE AI DEVELOPMENT FRAMEWORKS AND TOOLS	R	EAI5FT	3	0	0	0	3	3	
16	PEC	PE-5	23ADE3507	EDGE AI ANALYTICS AND DATA MANAGEMENT	R	EAI5ADM	3	0	0	0	3	3	
17	PEC	PE-5	23ADE3508	EDGE AI AND SUSTAINABILITY	R	EAI5AS	3	0	0	0	3	3	

39. SPECIALIZATION: AI-DRIVEN LANGUAGE TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS18A	TEXT ANALYTICS	A	TAT	0	0	6	4	4	10	
2	SDC	SDP-3	23SDCS18E	TEXT ANALYTICS	E	TAT	0	0	6	4	4	10	
3	SDC	SDP-3	23SDCS18R	TEXT ANALYTICS	R	TAT	0	0	2	4	2	6	
4	PEC	PE-1	23ALT3101A	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	A	AMLFTA	4	0	4	4	7	12	
5	PEC	PE-1	23ALT3101E	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	E	AMLFTA	4	0	4	4	7	12	
6	PEC	PE-1	23ALT3101R	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	R	AMLFTA	3	0	2	4	5	9	
7	PEC	PE-2	23ALT3202A	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	A	DLFNLP	5	0	0	0	5	5	
8	PEC	PE-2	23ALT3202E	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	E	DLFNLP	5	0	0	0	5	5	
9	PEC	PE-2	23ALT3202R	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	R	DLFNLP	3	0	0	0	3	3	
10	PEC	PE-3	23ALT3303A	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	A	CAICBD	4	0	4	4	7	12	
11	PEC	PE-3	23ALT3303E	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	E	CAICBD	4	0	4	4	7	12	
12	PEC	PE-3	23ALT3303R	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	R	CAICBD	3	0	2	4	5	9	
13	PEC	PE-4	23ALT3404M	TEXT UNDERSTANDING	M	TUS	3	0	0	0	3	3	
14	PEC	PE-4	23ALT3405M	NATURAL LANGUAGE PROCESSING	M	NLP	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
15	PEC	PE-5	23ALT3506	LANGUAGE UNDERSTANDING WITH PRE-TRAINED MODELS	R	LUWPTM	3	0	0	0	3	3	
16	PEC	PE-5	23ALT3507	LARGE LANGUAGE MODEL FOR SPEECH PROCESSING	R	LLMFSP	3	0	0	0	3	3	

40. SPECIALIZATION: AUTOMOTIVE ELECTRONICS AND AUTOSAR

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	23AEA3101A	AUTOMOTIVE SENSOR AND APPLICATIONS	A	ASA	4	0	4	4	7	12	
2	PEC	PE-1	23AEA3101E	AUTOMOTIVE SENSOR AND APPLICATIONS	E	ASA	4	0	4	4	7	12	
3	PEC	PE-1	23AEA3101R	AUTOMOTIVE SENSOR AND APPLICATIONS	R	ASA	3	0	2	4	5	9	
4	PEC	PE-2	23AEA3202A	AUTOTRONICS	A	AT	5	0	0	0	5	5	
5	PEC	PE-2	23AEA3202E	AUTOTRONICS	E	AT	5	0	0	0	5	5	
6	PEC	PE-2	23AEA3202R	AUTOTRONICS	R	AT	3	0	0	0	3	3	
7	PEC	PE-2	23AEA3203A	AUTOMOTIVE POLLUTION AND ITS CONTROL	A	APC	5	0	0	0	5	5	
8	PEC	PE-2	23AEA3203E	AUTOMOTIVE POLLUTION AND ITS CONTROL	E	APC	5	0	0	0	5	5	
9	PEC	PE-2	23AEA3203R	AUTOMOTIVE POLLUTION AND ITS CONTROL	R	APC	3	0	0	0	3	3	
10	PEC	PE-3	23AEA3304A	ALTERNATE DRIVES, TRACTION AND CONTROLS	A	ADTC	4	0	4	4	7	12	
11	PEC	PE-3	23AEA3304E	ALTERNATE DRIVES, TRACTION AND CONTROLS	E	ADTC	4	0	4	4	7	12	
12	PEC	PE-3	23AEA3304R	ALTERNATE DRIVES, TRACTION AND CONTROLS	R	ADTC	3	0	2	4	5	9	
13	PEC	PE-4	23AEA3405M	VEHICLE CONTROL SYSTEMS	M	VCS	3	0	0	0	3	3	
14	PEC	PE-4	23AEA3406M	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	M	AEES	3	0	0	0	3	3	
15	PEC	PE-5	23AEA3507	SOFT COMPUTING TECHNIQUES FOR AUTOMOTIVE APPLICATIONS	R	SCTAA	3	0	0	0	3	3	
16	PEC	PE-5	23AEA3508	AUTOMOTIVE NETWORKING AND PROTOCOLS	R	ANP	3	0	0	0	3	3	

41. SPECIALIZATION: AUTOMOTIVE ENERGY ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDME04A	ANALYSIS OF ENERGY SYSTEMS	A	AES	0	0	6	4	4	10	
2	SDC	SDP-4	23SDME04E	ANALYSIS OF ENERGY SYSTEMS	E	AES	0	0	6	4	4	10	
3	SDC	SDP-4	23SDME04R	ANALYSIS OF ENERGY SYSTEMS	R	AES	0	0	2	4	2	6	
4	PEC	PE-1	23ECF3101A	AUTOMOBILE ENGINEERING	A	AE	4	0	4	4	7	12	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	PEC	PE-1	23ECF3101E	AUTOMOBILE ENGINEERING	E	AE	4	0	4	4	7	12	
6	PEC	PE-1	23ECF3101R	AUTOMOBILE ENGINEERING	R	AE	3	0	2	4	5	9	
7	PEC	PE-2	23ECF3202A	AUTOTRONICS & SAFETY	A	ATS	5	0	0	0	5	5	
8	PEC	PE-2	23ECF3202E	AUTOTRONICS & SAFETY	E	ATS	5	0	0	0	5	5	
9	PEC	PE-2	23ECF3202R	AUTOTRONICS & SAFETY	R	ATS	3	0	0	0	3	3	
10	PEC	PE-2	23ECF3203A	AUTONOMOUS VEHICLES	A	AV	5	0	0	0	5	5	
11	PEC	PE-2	23ECF3203E	AUTONOMOUS VEHICLES	E	AV	5	0	0	0	5	5	
12	PEC	PE-2	23ECF3203R	AUTONOMOUS VEHICLES	R	AV	3	0	0	0	3	3	
13	PEC	PE-3	23ECF3304A	HYBRID AND ELECTRIC VEHICLE DESIGN	A	HEVD	4	0	4	4	7	12	
14	PEC	PE-3	23ECF3304E	HYBRID AND ELECTRIC VEHICLE DESIGN	E	HEVD	4	0	4	4	7	12	
15	PEC	PE-3	23ECF3304R	HYBRID AND ELECTRIC VEHICLE DESIGN	R	HEVD	3	0	2	4	5	9	
16	PEC	PE-4	23ECF3405M	SPECIAL PURPOSE VEHICLES	M	SPV	3	0	0	0	3	3	
17	PEC	PE-4	23ECF3406M	VEHICLE DYNAMICS	M	VD	3	0	0	0	3	3	
18	PEC	PE-5	23ECF3507	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	R	TMEES	3	0	0	0	3	3	
19	PEC	PE-5	23ECF3508	ALTERNATE ENERGY SOURCES FOR AUTOMOBILES	R	AESFA	3	0	0	0	3	3	

42. SPECIALIZATION: BIOINFORMATICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDBT08A	DRUG DESIGN: PRINCIPLES AND ENGINEERING	A	DDPE	0	0	6	4	4	10	BI(1)
2	SDC	SDP-3	23SDBT08E	DRUG DESIGN: PRINCIPLES AND ENGINEERING	E	DDPE	0	0	6	4	4	10	BI(1)
3	SDC	SDP-3	23SDBT08R	DRUG DESIGN: PRINCIPLES AND ENGINEERING	R	DDPE	0	0	2	4	2	6	BI(1)
4	PEC	PE-1	23BIS3101A	MOLECULAR MODELLING AND DRUG DESIGN	A	MMDD	4	0	4	4	7	12	
5	PEC	PE-1	23BIS3101E	MOLECULAR MODELLING AND DRUG DESIGN	E	MMDD	4	0	4	4	7	12	
6	PEC	PE-1	23BIS3101R	MOLECULAR MODELLING AND DRUG DESIGN	R	MMDD	3	0	2	4	5	9	
7	PEC	PE-2	23BIS3202A	BIOMEDICAL INFORMATICS	A	BMI	5	0	0	0	5	5	
8	PEC	PE-2	23BIS3202E	BIOMEDICAL INFORMATICS	E	BMI	5	0	0	0	5	5	
9	PEC	PE-2	23BIS3202R	BIOMEDICAL INFORMATICS	R	BMI	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
10	PEC	PE-2	23BIS3203A	PYTHON AND R PROGRAMMING	A	P&RP	5	0	0	0	5	5	
11	PEC	PE-2	23BIS3203E	PYTHON AND R PROGRAMMING	E	P&RP	5	0	0	0	5	5	
12	PEC	PE-2	23BIS3203R	PYTHON AND R PROGRAMMING	R	P&RP	3	0	0	0	3	3	
13	PEC	PE-3	23BIS3304A	STRUCTURAL BIOLOGY	A	SB	4	0	4	4	7	12	
14	PEC	PE-3	23BIS3304E	STRUCTURAL BIOLOGY	E	SB	4	0	4	4	7	12	
15	PEC	PE-3	23BIS3304R	STRUCTURAL BIOLOGY	R	SB	3	0	2	4	5	9	
16	PEC	PE-4	23BIS3405M	APPLIED BIOINFORMATICS	M	ABI	3	0	0	0	3	3	
17	PEC	PE-4	23BIS3406M	NGS SEQUENCING AND DATA ANALYSIS	M	NGSDA	3	0	0	0	3	3	
18	PEC	PE-5	23BIS3507	SYSTEMS BIOLOGY	R	SSB	3	0	0	0	3	3	
19	PEC	PE-5	23BIS3508	DATABASE MANAGEMENT SYSTEM FOR BIOLOGIST	R	DBMS	3	0	0	0	3	3	

43. SPECIALIZATION: BLOCKCHAIN ENGINEERING FOR WEB3

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDAD08A	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	A	EBCMDC	0	0	6	4	4	10	DWHM(1)
2	SDC	SDP-3	23SDAD08E	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	E	EBCMDC	0	0	6	4	4	10	DWHM(1)
3	SDC	SDP-3	23SDAD08R	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	R	EBCMDC	0	0	2	4	2	6	DWHM(1)
4	PEC	PE-1	23BEW3101A	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	A	ITBTCT	4	0	4	4	7	12	
5	PEC	PE-1	23BEW3101E	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	E	ITBTCT	4	0	4	4	7	12	
6	PEC	PE-1	23BEW3101R	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	R	ITBTCT	3	0	2	4	5	9	
7	PEC	PE-2	23BEW3202A	SMART CONTRACTS	A	SCR	5	0	0	0	5	5	
8	PEC	PE-2	23BEW3202E	SMART CONTRACTS	E	SCR	5	0	0	0	5	5	
9	PEC	PE-2	23BEW3202R	SMART CONTRACTS	R	SCR	3	0	0	0	3	3	
10	PEC	PE-3	23BEW3303A	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	A	DADW	4	0	4	4	7	12	
11	PEC	PE-3	23BEW3303E	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	E	DADW	4	0	4	4	7	12	
12	PEC	PE-3	23BEW3303R	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	R	DADW	3	0	2	4	5	9	
13	PEC	PE-4	23BEW3404M	BLOCKCHAIN PLATFORMS AND PROTOCOLS	M	BCPAP	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
14	PEC	PE-4	23BEW3405M	BLOCKCHAIN SECURITY	M	BCS	3	0	0	0	3	3	
15	PEC	PE-4	23BEW3406M	ORACLES AND DATA FEEDS	M	ODF	3	0	0	0	3	3	
16	PEC	PE-5	23BEW3507	BLOCKCHAIN SCALABILITY AND LAYER 2 SOLUTIONS	R	BCSALS	3	0	0	0	3	3	
17	PEC	PE-5	23BEW3508	REGULATORY LANDSCAPE AND COMPLIANCE	R	RLAC	3	0	0	0	3	3	
18	PEC	PE-5	23BEW3509	FUTURE TRENDS IN BLOCKCHAIN AND WEB3	R	FTBCAW	3	0	0	0	3	3	

44. SPECIALIZATION: CLOUD AND EDGE COMPUTING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS04A	CLOUD BASED SOLUTIONS ARCHITECT	A	CBSA	0	0	6	4	4	10	RTOS(1)
2	SDC	SDP-3	23SDCS04E	CLOUD BASED SOLUTIONS ARCHITECT	E	CBSA	0	0	6	4	4	10	RTOS(1)
3	SDC	SDP-3	23SDCS04R	CLOUD BASED SOLUTIONS ARCHITECT	R	CBSA	0	0	2	4	2	6	RTOS(1)
4	PEC	PE-1	23CEC3101A	CLOUD INFRASTRUCTURE AND SERVICES	A	CIS	4	0	4	4	7	12	
5	PEC	PE-1	23CEC3101E	CLOUD INFRASTRUCTURE AND SERVICES	E	CIS	4	0	4	4	7	12	
6	PEC	PE-1	23CEC3101R	CLOUD INFRASTRUCTURE AND SERVICES	R	CIS	3	0	2	4	5	9	
7	PEC	PE-2	23CEC3202A	ADVANCED OPERATING SYSTEMS	A	AOS	5	0	0	0	5	5	
8	PEC	PE-2	23CEC3202E	ADVANCED OPERATING SYSTEMS	E	AOS	5	0	0	0	5	5	
9	PEC	PE-2	23CEC3202R	ADVANCED OPERATING SYSTEMS	R	AOS	3	0	0	0	3	3	
10	PEC	PE-2	23CEC3203A	FUNCTIONAL & CONCURRENT PROGRAMMING	A	FCP	5	0	0	0	5	5	
11	PEC	PE-2	23CEC3203E	FUNCTIONAL & CONCURRENT PROGRAMMING	E	FCP	5	0	0	0	5	5	
12	PEC	PE-2	23CEC3203R	FUNCTIONAL & CONCURRENT PROGRAMMING	R	FCP	3	0	0	0	3	3	
13	PEC	PE-2	23CEC3204A	CLOUD DEVOPS	A	CD	5	0	0	0	5	5	
14	PEC	PE-2	23CEC3204E	CLOUD DEVOPS	E	CD	5	0	0	0	5	5	
15	PEC	PE-2	23CEC3204R	CLOUD DEVOPS	R	CD	3	0	0	0	3	3	
16	PEC	PE-3	23CEC3305A	CLOUD & SERVERLESS COMPUTING	A	CSC	4	0	4	4	7	12	
17	PEC	PE-3	23CEC3305E	CLOUD & SERVERLESS COMPUTING	E	CSC	4	0	4	4	7	12	
18	PEC	PE-3	23CEC3305R	CLOUD & SERVERLESS COMPUTING	R	CSC	3	0	2	4	5	9	
19	PEC	PE-4	23CEC3406M	ADVANCED COMPUTER ARCHITECTURE	M	ACA	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
20	PEC	PE-4	23CEC3407M	PARALLEL ALGORITHMS	M	PA	3	0	0	0	3	3	
21	PEC	PE-4	23CEC3408M	CLOUD SECURITY	M	CS	3	0	0	0	3	3	
22	PEC	PE-4	23CEC3409M	ARCHITECTING CLOUD SOLUTIONS*	M	ACS	3	0	0	0	3	3	
23	PEC	PE-5	23CEC3510	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
24	PEC	PE-5	23CEC3511	HIGH PERFORMANCE COMPUTING	R	HPC	3	0	0	0	3	3	
25	PEC	PE-5	23CEC3512	DESIGN OF DISTRIBUTED APPLICATIONS ON CLOUD (DDA)	R	DDAC	3	0	0	0	3	3	
26	PEC	PE-5	23CEC3513	CLOUD NETWORKING	R	CN	3	0	0	0	3	3	

45. SPECIALIZATION: CLOUD INFRASTRUCTURE DESIGN AND ENGINEERING?

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS16A	CLOUD INFRASTRUCTURE DESIGN	A	CISD	0	0	6	4	4	10	
2	SDC	SDP-3	23SDCS16E	CLOUD INFRASTRUCTURE DESIGN	E	CISD	0	0	6	4	4	10	
3	SDC	SDP-3	23SDCS16R	CLOUD INFRASTRUCTURE DESIGN	R	CISD	0	0	2	4	2	6	
4	PEC	PE-1	23CID3101A	CLOUD INFRASTRUCTURE ENGINEERING	A	CIE	4	0	4	4	7	12	
5	PEC	PE-1	23CID3101E	CLOUD INFRASTRUCTURE ENGINEERING	E	CIE	4	0	4	4	7	12	
6	PEC	PE-1	23CID3101R	CLOUD INFRASTRUCTURE ENGINEERING	R	CIE	3	0	2	4	5	9	
7	PEC	PE-2	23CID3202A	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	A	ECT	5	0	0	0	5	5	
8	PEC	PE-2	23CID3202E	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	E	ECT	5	0	0	0	5	5	
9	PEC	PE-2	23CID3202R	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	R	ECT	3	0	0	0	3	3	
10	PEC	PE-3	23CID3304A	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	A	CIA	4	0	4	4	7	12	
11	PEC	PE-3	23CID3304E	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	E	CIA	4	0	4	4	7	12	
12	PEC	PE-3	23CID3304R	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	R	CIA	3	0	2	4	5	9	
13	PEC	PE-3	23CID3203A	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	A	AHASCE	5	0	0	0	5	5	
14	PEC	PE-3	23CID3203E	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	E	AHASCE	5	0	0	0	5	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
15	PEC	PE-3	23CID3203R	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	R	AHASCE	3	0	0	0	3	3	
16	PEC	PE-4	23CID3405M	RELIABLE CLOUD INFRASTRUCTURE: DESIGN & PROCESS	M	RID	3	0	0	0	3	3	
17	PEC	PE-4	23CID3406M	HYBRID CLOUD INTEGRATION AND MANAGEMENT	M	HCIM	3	0	0	0	3	3	
18	PEC	PE-5	23CID3507	CLOUD ENGINEERING	R	CE	3	0	0	0	3	3	
19	PEC	PE-5	23CID3508	CLOUD DATA MANAGEMENT AND STORAGE SOLUTIONS	R	CDMSS	3	0	0	0	3	3	

46. SPECIALIZATION: CLOUD NATIVE SECURITY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS05A	CLOUD BASED SECURITY SPECIALITY	A	CBSS	0	0	6	4	4	10	NPS(1)
2	SDC	SDP-3	23SDCS05E	CLOUD BASED SECURITY SPECIALITY	E	CBSS	0	0	6	4	4	10	NPS(1)
3	SDC	SDP-3	23SDCS05R	CLOUD BASED SECURITY SPECIALITY	R	CBSS	0	0	2	4	2	6	NPS(1)
4	PEC	PE-1	23CNS3101A	INTRODUCTION TO CLOUD NATIVE COMPUTING	A	ITCNC	4	0	4	4	7	12	
5	PEC	PE-1	23CNS3101E	INTRODUCTION TO CLOUD NATIVE COMPUTING	E	ITCNC	4	0	4	4	7	12	
6	PEC	PE-1	23CNS3101R	INTRODUCTION TO CLOUD NATIVE COMPUTING	R	ITCNC	3	0	2	4	5	9	
7	PEC	PE-2	23CNS3202A	FUNDAMENTALS OF CLOUD SECURITY	A	FOCS	5	0	0	0	5	5	
8	PEC	PE-2	23CNS3202E	FUNDAMENTALS OF CLOUD SECURITY	E	FOCS	5	0	0	0	5	5	
9	PEC	PE-2	23CNS3202R	FUNDAMENTALS OF CLOUD SECURITY	R	FOCS	3	0	0	0	3	3	
10	PEC	PE-3	23CNS3303A	CONTAINER SECURITY	A	CTSY	4	0	4	4	7	12	
11	PEC	PE-3	23CNS3303E	CONTAINER SECURITY	E	CTSY	4	0	4	4	7	12	
12	PEC	PE-3	23CNS3303R	CONTAINER SECURITY	R	CTSY	3	0	2	4	5	9	
13	PEC	PE-4	23CNS3404M	MICROSERVICES SECURITY	M	MSS	3	0	0	0	3	3	
14	PEC	PE-4	23CNS3405M	INFRASTRUCTURE AS CODE SECURITY	M	ISACS	3	0	0	0	3	3	
15	PEC	PE-4	23CNS3406M	IDENTITY AND ACCESS MANAGEMENT IN CLOUD NATIVE ENVIRONMENTS	M	IAMCNE	3	0	0	0	3	3	
16	PEC	PE-4	23CNS3407M	NETWORK SECURITY IN CLOUD NATIVE ARCHITECTURES	M	NSCNA	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
17	PEC	PE-5	23CNS3508	MONITORING AND LOGGING FOR CLOUD NATIVE SECURITY	R	MLCNS	3	0	0	0	3	3	
18	PEC	PE-5	23CNS3509	COMPLIANCE AND GOVERNANCE IN CLOUD NATIVE ENVIRONMENTS	R	CGCNE	3	0	0	0	3	3	
19	PEC	PE-5	23CNS3510	SERVERLESS SECURITY	R	SLSY	3	0	0	0	3	3	
20	PEC	PE-5	23CNS3511	CLOUD NATIVE SECURITY TOOLS AND SOLUTIONS	R	CNSTAS	3	0	0	0	3	3	
21	PEC	PE-5	23CNS3512	FUTURE TRENDS IN CLOUD NATIVE SECURITY	R	FTCNS	3	0	0	0	3	3	

47. SPECIALIZATION: CLOUD NATIVE SOFTWARE ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS15A	SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING	A	SDCNC	0	0	6	4	4	10	
2	SDC	SDP-3	23SDCS15E	SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING	E	SDCNC	0	0	6	4	4	10	
3	SDC	SDP-3	23SDCS15R	SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING	R	SDCNC	0	0	2	4	2	6	
4	PEC	PE-1	23CNE3101A	FOUNDATIONS OF CLOUD NATIVE COMPUTING	A	FCNC	4	0	4	4	7	12	
5	PEC	PE-1	23CNE3101E	FOUNDATIONS OF CLOUD NATIVE COMPUTING	E	FCNC	4	0	4	4	7	12	
6	PEC	PE-1	23CNE3101R	FOUNDATIONS OF CLOUD NATIVE COMPUTING	R	FCNC	3	0	2	4	5	9	
7	PEC	PE-2	23CNE3202A	CLOUD NATIVE APPLICATION DEVELOPMENT	A	CNAD	5	0	0	0	5	5	
8	PEC	PE-2	23CNE3202E	CLOUD NATIVE APPLICATION DEVELOPMENT	E	CNAD	5	0	0	0	5	5	
9	PEC	PE-2	23CNE3202R	CLOUD NATIVE APPLICATION DEVELOPMENT	R	CNAD	3	0	0	0	3	3	
10	PEC	PE-2	23CNE3203A	CLOUD NATIVE DESIGN PROCESS	A	CNDP	5	0	0	0	5	5	
11	PEC	PE-2	23CNE3203E	CLOUD NATIVE DESIGN PROCESS	E	CNDP	5	0	0	0	5	5	
12	PEC	PE-2	23CNE3203R	CLOUD NATIVE DESIGN PROCESS	R	CNDP	3	0	0	0	3	3	
13	PEC	PE-3	23CNE3304R	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	R	SEC	3	0	2	4	5	9	
14	PEC	PE-4	23CNE3304A	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	A	SEC	4	0	4	4	7	12	
15	PEC	PE-4	23CNE3304E	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	E	SEC	4	0	4	4	7	12	
16	PEC	PE-4	23CNE3405M	SERVERLESS COMPUTING AND EVENT-DRIVEN ARCHITECTURES	M	SCEDA	3	0	0	0	3	3	
17	PEC	PE-4	23CNE3406M	CLOUD NATIVE SOFTWARE ARCHITECTURES	M	CNSA	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
18	PEC	PE-5	23CNE3507	CLOUD NATIVE NETWORKING AND STORAGE SYSTEMS	R	CNNSS	3	0	0	0	3	3	
19	PEC	PE-5	23CNE3508	CLOUD INFRASTRUCTURE AND VIRTUALIZATION	R	CIIV	3	0	0	0	3	3	

48. SPECIALIZATION: CLOUD-BASED SCIENTIFIC COMPUTING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS14A	CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS	A	CASW	0	0	6	4	4	10	
2	SDC	SDP-3	23SDCS14E	CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS	E	CASW	0	0	6	4	4	10	
3	SDC	SDP-3	23SDCS14R	CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS	R	CASW	0	0	2	4	2	6	
4	PEC	PE-1	23CSC3101A	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	A	FCS	4	0	4	4	7	12	
5	PEC	PE-1	23CSC3101E	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	E	FCS	4	0	4	4	7	12	
6	PEC	PE-1	23CSC3101R	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	R	FCS	3	0	2	4	5	9	
7	PEC	PE-2	23CSC3202A	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	A	DSA	5	0	0	0	5	5	
8	PEC	PE-2	23CSC3202E	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	E	DSA	5	0	0	0	5	5	
9	PEC	PE-2	23CSC3202R	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	R	DSA	3	0	0	0	3	3	
10	PEC	PE-2	23CSC3203A	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	A	DSCC	5	0	0	0	5	5	
11	PEC	PE-2	23CSC3203E	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	E	DSCC	5	0	0	0	5	5	
12	PEC	PE-2	23CSC3203R	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	R	DSCC	3	0	0	0	3	3	
13	PEC	PE-3	23CSC3304A	CLOUD BASED HIGH PERFORMANCE COMPUTING	A	CHC	4	0	4	4	7	12	
14	PEC	PE-3	23CSC3304E	CLOUD BASED HIGH PERFORMANCE COMPUTING	E	CHC	4	0	4	4	7	12	
15	PEC	PE-3	23CSC3304R	CLOUD BASED HIGH PERFORMANCE COMPUTING	R	CHC	3	0	2	4	5	9	
16	PEC	PE-4	23CSC3405M	CLOUD-BASED GRID COMPUTING	M	CGC	3	0	0	0	3	3	
17	PEC	PE-4	23CSC3406M	CLOUD COMPUTING FOR SCIENTIFIC DISCOVERY	M	CCFSD	3	0	0	0	3	3	
18	PEC	PE-5	23CSC3508	PARALLEL COMPUTING FOR SCIENTISTS USING CLOUD PLATFORMS	R	PCSCP	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
19	PEC	PE-5	23CSC3507	CLOUD-BASED SCALABLE COMPUTING AND BIG DATA ANALYTICS	R	CSCBD	3	0	0	0	3	3	

49. SPECIALIZATION: COMPUTER COMMUNICATION AND 5G TECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDEC12A	NETWORK PROGRAMMABILITY AND AUTOMATION	A	NPA	0	0	6	4	4	10	ESD(1)
2	SDC	SDP-3	23SDEC12E	NETWORK PROGRAMMABILITY AND AUTOMATION	E	NPA	0	0	6	4	4	10	ESD(1)
3	SDC	SDP-3	23SDEC12R	NETWORK PROGRAMMABILITY AND AUTOMATION	R	NPA	0	0	2	4	2	6	ESD(1)
4	PEC	PE-1	23CCF3101A	TCP/IP & OTHER PROTOCOL SUITE	A	TCP	4	0	4	4	7	12	
5	PEC	PE-1	23CCF3101E	TCP/IP & OTHER PROTOCOL SUITE	E	TCP	4	0	4	4	7	12	
6	PEC	PE-1	23CCF3101R	TCP/IP & OTHER PROTOCOL SUITE	R	TCP	3	0	2	4	5	9	
7	PEC	PE-2	23CCF3202A	CLOUD COMPUTING AND NETWORKS SECURITY	A	CCNS	5	0	0	0	5	5	
8	PEC	PE-2	23CCF3202E	CLOUD COMPUTING AND NETWORKS SECURITY	E	CCNS	5	0	0	0	5	5	
9	PEC	PE-2	23CCF3202R	CLOUD COMPUTING AND NETWORKS SECURITY	R	CCNS	3	0	0	0	3	3	
10	PEC	PE-3	23CCF3303A	VOIP AND BROADBAND NETWORKS	A	VBN	4	0	4	4	7	12	
11	PEC	PE-3	23CCF3303E	VOIP AND BROADBAND NETWORKS	E	VBN	4	0	4	4	7	12	
12	PEC	PE-3	23CCF3303R	VOIP AND BROADBAND NETWORKS	R	VBN	3	0	2	4	5	9	
13	PEC	PE-4	23CCF3404M	5G MOBILE AND IEEE STANDARDS	M	5GMI	3	0	0	0	3	3	
14	PEC	PE-5	23CCF3505	IP MULTIMEDIA SUB-SYSTEM & EMERGING TECHNOLOGIES	R	IMSET	3	0	0	0	3	3	
15	PEC	PE-5	23CCF3506	IT SECURITY: DEFENCE AGAINST THE DIGITAL DARK ARTS	R	IMSET	3	0	0	0	3	3	

50. SPECIALIZATION: CONSTRUCTION TECHNOLOGY AND MANAGEMENT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCE04A	PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE	A	PSRBPS	0	0	6	4	4	10	CPM(1)
2	SDC	SDP-3	23SDCE04E	PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE	E	PSRBPS	0	0	6	4	4	10	CPM(1)
3	SDC	SDP-3	23SDCE04R	PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE	R	PSRBPS	0	0	2	4	2	6	CPM(1)
4	PEC	PE-1	23CTM3101A	BUILDING INFORMATION MODELLING	A	BIM	4	0	4	4	7	12	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	PEC	PE-1	23CTM3101E	BUILDING INFORMATION MODELLING	E	BIM	4	0	4	4	7	12	
6	PEC	PE-1	23CTM3101R	BUILDING INFORMATION MODELLING	R	BIM	3	0	2	4	5	9	
7	PEC	PE-2	23CTM3202A	ADVANCED CONSTRUCTION TECHNOLOGY	A	ACT	5	0	0	0	5	5	
8	PEC	PE-2	23CTM3202E	ADVANCED CONSTRUCTION TECHNOLOGY	E	ACT	5	0	0	0	5	5	
9	PEC	PE-2	23CTM3202R	ADVANCED CONSTRUCTION TECHNOLOGY	R	ACT	3	0	0	0	3	3	
10	PEC	PE-2	23CTM3203A	SUSTAINABLE CONSTRUCTION TECHNOLOGY	A	SCT	5	0	0	0	5	5	
11	PEC	PE-2	23CTM3203E	SUSTAINABLE CONSTRUCTION TECHNOLOGY	E	SCT	5	0	0	0	5	5	
12	PEC	PE-2	23CTM3203R	SUSTAINABLE CONSTRUCTION TECHNOLOGY	R	SCT	3	0	0	0	3	3	
13	PEC	PE-3	23CTM3304A	CONSTRUCTION PLANNING & SCHEDULING	A	CPS	4	0	4	4	7	12	
14	PEC	PE-3	23CTM3304E	CONSTRUCTION PLANNING & SCHEDULING	E	CPS	4	0	4	4	7	12	
15	PEC	PE-3	23CTM3304R	CONSTRUCTION PLANNING & SCHEDULING	R	CPS	3	0	2	4	5	9	
16	PEC	PE-4	23CTM3405M	CONSTRUCTION CONTRACTS	M	CC	3	0	0	0	3	3	
17	PEC	PE-4	23CTM3406M	CONSTRUCTION FORMULATION APPRAISAL	M	CFA	3	0	0	0	3	3	
18	PEC	PE-5	23CTM3507	QUALITY AND SAFETY IN CONSTRUCTION	R	QSC	3	0	0	0	3	3	
19	PEC	PE-5	23CTM3508	GREEN BUILDING	R	GB	3	0	0	0	3	3	

51. SPECIALIZATION: CROSS PLATFORM DEVELOPMENT FRAMEWORKS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDCI04A	ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES	A	AAMA	0	0	6	4	4	10	
2	SDC	SDP-4	23SDCI04E	ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES	E	AAMA	0	0	6	4	4	10	
3	SDC	SDP-4	23SDCI04R	ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES	R	AAMA	0	0	2	4	2	6	
4	PEC	PE-1	23CPD3101A	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	A	FMAD	4	0	4	4	7	12	
5	PEC	PE-1	23CPD3101E	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	E	FMAD	4	0	4	4	7	12	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
6	PEC	PE-1	23CPD3101R	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	R	FMAD	3	0	2	4	5	9	
7	PEC	PE-1	23CPD3304A	SECURE MOBILE APPLICATION DEVELOPMENT	A	SMAD	4	0	4	4	7	12	
8	PEC	PE-1	23CPD3304E	SECURE MOBILE APPLICATION DEVELOPMENT	E	SMAD	4	0	4	4	7	12	
9	PEC	PE-2	23CPD3202A	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	A	RNA	5	0	0	0	5	5	
10	PEC	PE-2	23CPD3202E	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	E	RNA	5	0	0	0	5	5	
11	PEC	PE-2	23CPD3202R	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	R	RNA	3	0	0	0	3	3	
12	PEC	PE-2	23CPD3203A	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	A	FBCPD	5	0	0	0	5	5	
13	PEC	PE-2	23CPD3203E	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	E	FBCPD	5	0	0	0	5	5	
14	PEC	PE-2	23CPD3203R	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	R	FBCPD	3	0	0	0	3	3	
15	PEC	PE-3	23CPD3304R	SECURE MOBILE APPLICATION DEVELOPMENT	R	SMAD	3	0	2	4	5	9	
16	PEC	PE-4	23CPD3406M	META REACT NATIVE SPECIALIZATION	M	MRNS	3	0	0	0	3	3	
17	PEC	PE-4	23CPD3405M	UX DESIGN	M	UXD	3	0	0	0	3	3	
18	PEC	PE-5	23CPD3507	ADVANCED MOBILE APPLICATION DEVELOPMENT	R	AMAD	3	0	0	0	3	3	
19	PEC	PE-5	23CPD3508	CROSS PLATFORM USER INTERFACE DESIGN	R	CPED	3	0	0	0	3	3	

52. SPECIALIZATION: CYBER PHYSICAL SYSTEMS AND IOT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDIN06A	EMBEDDED AND IOT ROGRAMMING	A	IOTHP	0	0	6	4	4	10	FITS(1)
2	SDC	SDP-3	23SDIN06E	EMBEDDED AND IOT ROGRAMMING	E	IOTHP	0	0	6	4	4	10	FITS(1)
3	SDC	SDP-3	23SDIN06R	EMBEDDED AND IOT ROGRAMMING	R	IOTHP	0	0	2	4	2	6	FITS(1)
4	PEC	PE-1	23CPS3101A	IOT SENSING AND ACTUATING DEVICES	A	ISAD	4	0	4	4	7	12	
5	PEC	PE-1	23CPS3101E	IOT SENSING AND ACTUATING DEVICES	E	ISAD	4	0	4	4	7	12	
6	PEC	PE-1	23CPS3101R	IOT SENSING AND ACTUATING DEVICES	R	ISAD	3	0	2	4	5	9	
7	PEC	PE-2	23CPS3202A	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	A	IOTAP	5	0	0	0	5	5	
8	PEC	PE-2	23CPS3202E	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	E	IOTAP	5	0	0	0	5	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
9	PEC	PE-2	23CPS3202R	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	R	IOTAP	3	0	0	0	3	3	
10	PEC	PE-3	23CPS3303A	CYBER PHYSICAL SYSTEMS	A	CPS	4	0	4	4	7	12	
11	PEC	PE-3	23CPS3303E	CYBER PHYSICAL SYSTEMS	E	CPS	4	0	4	4	7	12	
12	PEC	PE-3	23CPS3303R	CYBER PHYSICAL SYSTEMS	R	CPS	3	0	2	4	5	9	
13	PEC	PE-4	23CPS3404M	FOUNDATIONS OF HYBRID AND EMBEDDED SYSTEMS	M	DVP	3	0	0	0	3	3	
14	PEC	PE-5	23CPS3505	CLOUD COMPUTING FOR IOT ENGINEERS	R	CCIOTE	3	0	0	0	3	3	
15	PEC	PE-5	23CPS3506	WIRELESS SENSOR NETWORKS	R	WSN	3	0	0	0	3	3	
16	PEC	PE-5	23CPS3507	EDGE COMPUTING	R	EC	3	0	0	0	3	3	

53. SPECIALIZATION: CYBER SECURITY AND BLOCKCHAIN TECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS05A	CLOUD BASED SECURITY SPECIALITY	A	CBSS	0	0	6	4	4	10	NPS(1)
2	SDC	SDP-3	23SDCS05E	CLOUD BASED SECURITY SPECIALITY	E	CBSS	0	0	6	4	4	10	NPS(1)
3	SDC	SDP-3	23SDCS05R	CLOUD BASED SECURITY SPECIALITY	R	CBSS	0	0	2	4	2	6	NPS(1)
4	PEC	PE-1	23CSB3101A	CRYPT ANALYSIS & CYBER DEFENSE	A	CACD	4	0	4	4	7	12	
5	PEC	PE-1	23CSB3101E	CRYPT ANALYSIS & CYBER DEFENSE	E	CACD	4	0	4	4	7	12	
6	PEC	PE-1	23CSB3101R	CRYPT ANALYSIS & CYBER DEFENSE	R	CACD	3	0	2	4	5	9	
7	PEC	PE-2	23CSB3202A	NETWORK AND INFRASTRUCTURE SECURITY	A	NIS	5	0	0	0	5	5	
8	PEC	PE-2	23CSB3202E	NETWORK AND INFRASTRUCTURE SECURITY	E	NIS	5	0	0	0	5	5	
9	PEC	PE-2	23CSB3202R	NETWORK AND INFRASTRUCTURE SECURITY	R	NIS	3	0	0	0	3	3	
10	PEC	PE-2	23CSB3203A	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	A	IBCC	3	0	4	0	5	7	
11	PEC	PE-2	23CSB3203E	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	E	IBCC	3	0	4	0	5	7	
12	PEC	PE-2	23CSB3203R	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	R	IBCC	2	0	2	0	3	4	
13	PEC	PE-3	23CSB3304A	DIGITAL FORENSICS	A	DF	4	0	4	4	7	12	
14	PEC	PE-3	23CSB3304E	DIGITAL FORENSICS	E	DF	4	0	4	4	7	12	
15	PEC	PE-3	23CSB3304R	DIGITAL FORENSICS	R	DF	3	0	2	4	5	9	
16	PEC	PE-4	23CSB3405M	DATABASE SYSTEM AND SECURITY	M	DSS	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
17	PEC	PE-4	23CSB3406M	PROGRAMMING FOR SMART CONTRACTS	M	PSC	3	0	0	0	3	3	
18	PEC	PE-4	23CSB3407M	CLOUD SECURITY	M	CS	3	0	0	0	3	3	
19	PEC	PE-5	23CSB3508	SECURE SOFTWARE ENGINEERING	R	SSE	3	0	0	0	3	3	
20	PEC	PE-5	23CSB3509	WEB SECURITY	R	WS	3	0	0	0	3	3	
21	PEC	PE-5	23CSB3510	SECURITY GOVERNANCE & MANAGEMENT	R	SGM	3	0	0	0	3	3	

54. SPECIALIZATION: DATA COMMUNICATIONS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDEC13A	5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS	A	5PIA	0	0	6	4	4	10	ESD(1)
2	SDC	SDP-3	23SDEC13E	5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS	E	5PIA	0	0	6	4	4	10	ESD(1)
3	SDC	SDP-3	23SDEC13R	5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS	R	5PIA	0	0	2	4	2	6	ESD(1)
4	PEC	PE-1	23DCS3101A	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	A	4GW	4	0	4	4	7	12	
5	PEC	PE-1	23DCS3101E	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	E	4GW	4	0	4	4	7	12	
6	PEC	PE-1	23DCS3101R	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	R	4GW	3	0	2	4	5	9	
7	PEC	PE-2	23DCS3202A	MODERN SATELLITE COMMUNICATION SYSTEMS	A	MSCS	5	0	0	0	5	5	
8	PEC	PE-2	23DCS3202E	MODERN SATELLITE COMMUNICATION SYSTEMS	E	MSCS	5	0	0	0	5	5	
9	PEC	PE-2	23DCS3202R	MODERN SATELLITE COMMUNICATION SYSTEMS	R	MSCS	3	0	0	0	3	3	
10	PEC	PE-3	23DCS3303A	5G WIRELESS TECHNOLOGIES	A	5GWT	4	0	4	4	7	12	
11	PEC	PE-3	23DCS3303E	5G WIRELESS TECHNOLOGIES	E	5GWT	4	0	4	4	7	12	
12	PEC	PE-3	23DCS3303R	5G WIRELESS TECHNOLOGIES	R	5GWT	3	0	2	4	5	9	
13	PEC	PE-4	23DCS3404M	OPTICAL WIRELESS COMMUNICATIONS	M	PWC	3	0	0	0	3	3	
14	PEC	PE-5	23DCS3505	MACHINE LEARNING FOR WIRELESS COMMUNICATION	R	MLWC	3	0	0	0	3	3	

55. SPECIALIZATION: DATA ENGINEERING FOR AI

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	23DEA3101A	FUNDAMENTALS OF DATA ENGINEERING	A	FDE	4	0	4	4	7	12	
2	PEC	PE-1	23DEA3101E	FUNDAMENTALS OF DATA ENGINEERING	E	FDE	4	0	4	4	7	12	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
3	PEC	PE-1	23DEA3101R	FUNDAMENTALS OF DATA ENGINEERING	R	FDE	3	0	2	4	5	9	
4	PEC	PE-2	23DEA3202A	DATA EXPLORATION AND PREPARATION	A	DEP	5	0	0	0	5	5	
5	PEC	PE-2	23DEA3202E	DATA EXPLORATION AND PREPARATION	E	DEP	5	0	0	0	5	5	
6	PEC	PE-2	23DEA3202R	DATA EXPLORATION AND PREPARATION	R	DEP	3	0	0	0	3	3	
7	PEC	PE-3	23DEA3303A	BIG DATA TECHNOLOGIES	A	BDT	4	0	4	4	7	12	
8	PEC	PE-3	23DEA3303E	BIG DATA TECHNOLOGIES	E	BDT	4	0	4	4	7	12	
9	PEC	PE-3	23DEA3303R	BIG DATA TECHNOLOGIES	R	BDT	3	0	2	4	5	9	
10	PEC	PE-4	23DEA3404M	DATA WAREHOUSING AND BUSINESS INTELLIGENCE	M	DWBI	3	0	0	0	3	3	
11	PEC	PE-5	23DEA3505R	MACHINE LEARNING ENGINEERING FOR BIG DATA	R	MLEBD	3	0	0	0	3	3	

56. SPECIALIZATION: DATA SCIENCE AND BIG DATA ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDCS08A	CLOUD BASED DATA ANALYTICS SPECIALITY	A	CBDAS	0	0	6	4	4	10	DSS(1)
2	SDC	SDP-3	23SDCS08E	CLOUD BASED DATA ANALYTICS SPECIALITY	E	CBDAS	0	0	6	4	4	10	DSS(1)
3	SDC	SDP-3	23SDCS08R	CLOUD BASED DATA ANALYTICS SPECIALITY	R	CBDAS	0	0	2	4	2	6	DSS(1)
4	PEC	PE-1	23DSB3101A	DATA ANALYTICS AND VISUALIZATION	A	DAV	4	0	4	4	7	12	
5	PEC	PE-1	23DSB3101E	DATA ANALYTICS AND VISUALIZATION	E	DAV	4	0	4	4	7	12	
6	PEC	PE-1	23DSB3101R	DATA ANALYTICS AND VISUALIZATION	R	DAV	3	0	2	4	5	9	
7	PEC	PE-2	23DSB3202A	DATA WAREHOUSING AND MINING	A	DWHM	5	0	0	0	5	5	
8	PEC	PE-2	23DSB3202E	DATA WAREHOUSING AND MINING	E	DWHM	5	0	0	0	5	5	
9	PEC	PE-2	23DSB3202R	DATA WAREHOUSING AND MINING	R	DWHM	3	0	0	0	3	3	
10	PEC	PE-3	23DSB3303A	BIG DATA ANALYTICS	A	BDA	4	0	4	4	7	12	
11	PEC	PE-3	23DSB3303E	BIG DATA ANALYTICS	E	BDA	4	0	4	4	7	12	
12	PEC	PE-3	23DSB3303R	BIG DATA ANALYTICS	R	BDA	3	0	2	4	5	9	
13	PEC	PE-4	23DSB3404M	BIG DATA OPTIMIZATION	M	BDO	3	0	0	0	3	3	
14	PEC	PE-4	23DSB3407M	DATA ANALYTICS ON CLOUD	M	DAC	3	0	0	0	3	3	
15	PEC	PE-4	23DSB3408M	DIGITAL MEDIA ANALYTICS	M	DMA	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
16	PEC	PE-4	23DSB3406M	DIGITAL VIDEO PROCESSING	M	DVP	3	0	0	0	3	3	
17	PEC	PE-5	23DSB3509	ADVANCED DATABASES	R	AD	3	0	0	0	3	3	
18	PEC	PE-5	23DSB3510	BUSINESS ANALYTICS	R	BA	3	0	0	0	3	3	
19	PEC	PE-5	23DSB3511	GRAPH & WEB ANALYTICS	R	GWA	3	0	0	0	3	3	
20	PEC	PE-5	23DSB3512	DATA GOVERNANCE ON CLOUD	R	DGC	3	0	0	0	3	3	

57. SPECIALIZATION: DISTRIBUTED LEDGER ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDAD08A	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	A	EBCMDC	0	0	6	4	4	10	DWHM(1)
2	SDC	SDP-3	23SDAD08E	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	E	EBCMDC	0	0	6	4	4	10	DWHM(1)
3	SDC	SDP-3	23SDAD08R	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	R	EBCMDC	0	0	2	4	2	6	DWHM(1)
4	PEC	PE-1	23DLA3101A	SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS	A	SNTSA	4	0	4	4	7	12	
5	PEC	PE-1	23DLA3101E	SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS	E	SNTSA	4	0	4	4	7	12	
6	PEC	PE-1	23DLA3101R	SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS	R	SNTSA	3	0	2	4	5	9	
7	PEC	PE-2	23DLA3202A	AUTOMATED NETWORK ANALYSIS	A	ANA	5	0	0	0	5	5	
8	PEC	PE-2	23DLA3202E	AUTOMATED NETWORK ANALYSIS	E	ANA	5	0	0	0	5	5	
9	PEC	PE-2	23DLA3202R	AUTOMATED NETWORK ANALYSIS	R	ANA	3	0	0	0	3	3	
10	PEC	PE-2	23DLA3203A	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	A	BTDT	5	0	0	0	5	5	
11	PEC	PE-2	23DLA3203E	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	E	BTDT	5	0	0	0	5	5	
12	PEC	PE-2	23DLA3203R	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	R	BTDT	3	0	0	0	3	3	
13	PEC	PE-3	23DLA3304A	MULTI AGENT SYSTEMS	A	MAS	4	0	4	4	7	12	
14	PEC	PE-3	23DLA3304E	MULTI AGENT SYSTEMS	E	MAS	4	0	4	4	7	12	
15	PEC	PE-3	23DLA3304R	MULTI AGENT SYSTEMS	R	MAS	3	0	2	4	5	9	
16	PEC	PE-4	23DLA3405M	BLOCKCHAIN ANALYTICS	M	BCA	3	0	0	0	3	3	
17	PEC	PE-4	23DLA3406M	CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGY	M	CBT	3	0	0	0	3	3	
18	PEC	PE-5	23DLA3507	DISTRIBUTED LEDGER ARCHITECTURE FOR AUTOMATION	R	DLAA	3	0	0	0	3	3	
19	PEC	PE-5	23DLA3508	PERMISSIONED DISTRIBUTED LEDGER	R	PDL	3	0	0	0	3	3	

58. SPECIALIZATION: EMBEDDED SYSTEMS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDEC14A	EMBEDDED PROTOTYPE	A	EPT	0	0	6	4	4	10	ESD(1)
2	SDC	SDP-3	23SDEC14E	EMBEDDED PROTOTYPE	E	EPT	0	0	6	4	4	10	ESD(1)
3	SDC	SDP-3	23SDEC14R	EMBEDDED PROTOTYPE	R	EPT	0	0	2	4	2	6	ESD(1)
4	PEC	PE-1	23EDS3101A	ADVANCED EMBEDDED SYSTEMS	A	AES	4	0	4	4	7	12	
5	PEC	PE-1	23EDS3101E	ADVANCED EMBEDDED SYSTEMS	E	AES	4	0	4	4	7	12	
6	PEC	PE-1	23EDS3101R	ADVANCED EMBEDDED SYSTEMS	R	AES	3	0	2	4	5	9	
7	PEC	PE-2	23EDS3202A	EMBEDDED SYSTEMS FOR IOT	A	ESIOT	5	0	0	0	5	5	
8	PEC	PE-2	23EDS3202E	EMBEDDED SYSTEMS FOR IOT	E	ESIOT	5	0	0	0	5	5	
9	PEC	PE-2	23EDS3202R	EMBEDDED SYSTEMS FOR IOT	R	ESIOT	3	0	0	0	3	3	
10	PEC	PE-3	23EDS3303A	EMBEDDED AND REAL-TIME SYSTEMS	A	ERTS	4	0	4	4	7	12	
11	PEC	PE-3	23EDS3303E	EMBEDDED AND REAL-TIME SYSTEMS	E	ERTS	4	0	4	4	7	12	
12	PEC	PE-3	23EDS3303R	EMBEDDED AND REAL-TIME SYSTEMS	R	ERTS	3	0	2	4	5	9	
13	PEC	PE-4	23EDS3404M	CLOUD ARCHITECTURE IN IOT	M	CAIOT	3	0	0	0	3	3	
14	PEC	PE-5	23EDS3505	EDGE COMPUTING & DATA ANALYTICS IN IOT	R	ECDAI	3	0	0	0	3	3	

59. SPECIALIZATION: E-MOBILITY ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDEE06A	EVT HARDWARE PROTOTYPING	A	EVTHP	0	0	6	4	4	10	
2	SDC	SDP-4	23SDEE06E	EVT HARDWARE PROTOTYPING	E	EVTHP	0	0	6	4	4	10	
3	SDC	SDP-4	23SDEE06R	EVT HARDWARE PROTOTYPING	R	EVTHP	0	0	2	4	2	6	
4	PEC	PE-1	23EME3101A	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	A	PTDEV	4	0	4	4	7	12	
5	PEC	PE-1	23EME3101E	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	E	PTDEV	4	0	4	4	7	12	
6	PEC	PE-1	23EME3101R	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	R	PTDEV	3	0	2	4	5	9	
7	PEC	PE-2	23EME3202A	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	A	CPTEV	5	0	0	0	5	5	
8	PEC	PE-2	23EME3202E	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	E	CPTEV	5	0	0	0	5	5	
9	PEC	PE-2	23EME3202R	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	R	CPTEV	3	0	0	0	3	3	
10	PEC	PE-2	23EME3203A	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	A	AVAE	5	0	0	0	5	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
11	PEC	PE-2	23EME3203E	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	E	AVAE	5	0	0	0	5	5	
12	PEC	PE-2	23EME3203R	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	R	AVAE	3	0	0	0	3	3	
13	PEC	PE-3	23EME3304A	CHARGING STATIONS FOR ELECTRIC VEHICLES	A	CSEV	4	0	4	4	7	12	
14	PEC	PE-3	23EME3304E	CHARGING STATIONS FOR ELECTRIC VEHICLES	E	CSEV	4	0	4	4	7	12	
15	PEC	PE-3	23EME3304R	CHARGING STATIONS FOR ELECTRIC VEHICLES	R	CSEV	3	0	2	4	5	9	
16	PEC	PE-4	23EME3405M	INTRODUCTION TO BATTERY-MANAGEMENT SYSTEMS	M	IBMS	3	0	0	0	3	3	
17	PEC	PE-4	23EME3406M	BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE	M	BSAEV	3	0	0	0	3	3	
18	PEC	PE-5	23EME3507	AI AND IOT FOR ELECTRIC VEHICLE	R	AIEV	3	0	0	0	3	3	
19	PEC	PE-5	23EME3508	EV SYSTEM AND WIRING DESIGN	R	ESWS	3	0	0	0	3	3	

60. SPECIALIZATION: ENGINEERING DESIGN

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDME05A	3D MODELLING AND DIGITAL PROTOTYPING	A	3DMDP	0	0	6	4	4	10	
2	SDC	SDP-4	23SDME05E	3D MODELLING AND DIGITAL PROTOTYPING	E	3DMDP	0	0	6	4	4	10	
3	SDC	SDP-4	23SDME05R	3D MODELLING AND DIGITAL PROTOTYPING	R	3DMDP	0	0	2	4	2	6	
4	PEC	PE-1	23EGD3101A	MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS	A	MADRS	4	0	4	4	7	12	EM(1) Rule:1
5	PEC	PE-1	23EGD3101E	MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS	E	MADRS	4	0	4	4	7	12	EM(1) Rule:1
6	PEC	PE-1	23EGD3101R	MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS	R	MADRS	3	0	2	4	5	9	EM(1) Rule:1
7	PEC	PE-2	23EGD3202A	CREEP, FATIGUE AND FRACTURE MECHANICS	A	CFFM	5	0	0	0	5	5	EM(1) Rule:1
8	PEC	PE-2	23EGD3202E	CREEP, FATIGUE AND FRACTURE MECHANICS	E	CFFM	5	0	0	0	5	5	EM(1) Rule:1
9	PEC	PE-2	23EGD3202R	CREEP, FATIGUE AND FRACTURE MECHANICS	R	CFFM	3	0	0	0	3	3	EM(1) Rule:1
10	PEC	PE-2	23EGD3203A	THEORY OF ELASTICITY AND PLASTICITY	A	TEP	5	0	0	0	5	5	EM(1) Rule:1
11	PEC	PE-2	23EGD3203E	THEORY OF ELASTICITY AND PLASTICITY	E	TEP	5	0	0	0	5	5	EM(1) Rule:1
12	PEC	PE-2	23EGD3203R	THEORY OF ELASTICITY AND PLASTICITY	R	TEP	3	0	0	0	3	3	EM(1) Rule:1

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
13	PEC	PE-3	23EGD3304A	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN	A	SDSIED	4	0	4	4	7	12	EM(1) Rule:1
14	PEC	PE-3	23EGD3304E	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN	E	SDSIED	4	0	4	4	7	12	EM(1) Rule:1
15	PEC	PE-3	23EGD3304R	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN	R	SDSIED	3	0	2	4	5	9	EM(1) Rule:1
16	PEC	PE-4	23EGD3405M	ADVANCED VIBRATIONS	M	AV	3	0	0	0	3	3	EM(1) Rule:1
17	PEC	PE-4	23EGD3406M	MECHANICS OF COMPOSITE MATERIALS	M	MOCM	3	0	0	0	3	3	EM(1) Rule:1
18	PEC	PE-5	23EGD3507	ADVANCED STRENGTH OF MATERIALS	R	ASM	3	0	0	0	3	3	EM(1) Rule:1
19	PEC	PE-5	23EGD3508	HYBRID AND ELECTRIC VEHICLE DESIGN	R	HEVD	3	0	0	0	3	3	EM(1) Rule:1

61. SPECIALIZATION: GAME DEVELOPMENT AND UX DESIGN

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDCS06A	CERTIFIED GAME DEVELOPER	A	CGD	0	0	6	4	4	10	
2	SDC	SDP-4	23SDCS06E	CERTIFIED GAME DEVELOPER	E	CGD	0	0	6	4	4	10	
3	SDC	SDP-4	23SDCS06R	CERTIFIED GAME DEVELOPER	R	CGD	0	0	2	4	2	6	
4	PEC	PE-1	23GDU3101A	PROGRAMMING FOR GAME DEVELOPMENT	A	PGD	4	0	4	4	7	12	
5	PEC	PE-1	23GDU3101E	PROGRAMMING FOR GAME DEVELOPMENT	E	PGD	4	0	4	4	7	12	
6	PEC	PE-1	23GDU3101R	PROGRAMMING FOR GAME DEVELOPMENT	R	PGD	3	0	2	4	5	9	
7	PEC	PE-2	23GDU3202A	UX DESIGN	A	UD	5	0	0	0	5	5	
8	PEC	PE-2	23GDU3202E	UX DESIGN	E	UD	5	0	0	0	5	5	
9	PEC	PE-2	23GDU3202R	UX DESIGN	R	UD	3	0	0	0	3	3	
10	PEC	PE-3	23GDU3303A	AR & VR APPLICATION DEVELOPMENT	A	AR&VR	4	0	4	4	7	12	
11	PEC	PE-3	23GDU3303E	AR & VR APPLICATION DEVELOPMENT	E	AR&VR	4	0	4	4	7	12	
12	PEC	PE-3	23GDU3303R	AR & VR APPLICATION DEVELOPMENT	R	AR&VR	3	0	2	4	5	9	
13	PEC	PE-4	23GDU3404M	COMPUTER GRAPHICS	M	CG	3	0	0	0	3	3	
14	PEC	PE-4	23GDU3405M	3D MODELLING & ANIMATION	M	3DMA	3	0	0	0	3	3	
15	PEC	PE-5	23GDU3506	PRINCIPLES OF GAME DESIGN	R	PRGD	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
16	PEC	PE-5	23GDU3507	BUSINESS OF GAMES & ENTREPRENEURSHIP	R	BGE	3	0	0	0	3	3	

62. SPECIALIZATION: GEOTECHNICAL AND TRANSPORTATION ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDCE05A	DESIGN OF THE PAVEMENT BY USING MX ROADS	A	DPMX	0	0	6	4	4	10	
2	SDC	SDP-4	23SDCE05E	DESIGN OF THE PAVEMENT BY USING MX ROADS	E	DPMX	0	0	6	4	4	10	
3	SDC	SDP-4	23SDCE05R	DESIGN OF THE PAVEMENT BY USING MX ROADS	R	DPMX	0	0	2	4	2	6	
4	PEC	PE-1	23GTE3101A	ADVANCED FOUNDATION ENGINEERING	A	AFE	4	0	4	4	7	12	
5	PEC	PE-1	23GTE3101E	ADVANCED FOUNDATION ENGINEERING	E	AFE	4	0	4	4	7	12	
6	PEC	PE-1	23GTE3101R	ADVANCED FOUNDATION ENGINEERING	R	AFE	3	0	2	4	5	9	
7	PEC	PE-2	23GTE3202A	INTELLIGENT TRANSPORTATION SYSTEMS	A	ITS	5	0	0	0	5	5	
8	PEC	PE-2	23GTE3202E	INTELLIGENT TRANSPORTATION SYSTEMS	E	ITS	5	0	0	0	5	5	
9	PEC	PE-2	23GTE3202R	INTELLIGENT TRANSPORTATION SYSTEMS	R	ITS	3	0	0	0	3	3	
10	PEC	PE-2	23GTE3203A	GROUND IMPROVEMENT TECHNIQUES	A	GIT	5	0	0	0	5	5	
11	PEC	PE-2	23GTE3203E	GROUND IMPROVEMENT TECHNIQUES	E	GIT	5	0	0	0	5	5	
12	PEC	PE-2	23GTE3203R	GROUND IMPROVEMENT TECHNIQUES	R	GIT	3	0	0	0	3	3	
13	PEC	PE-3	23GTE3304A	PAVEMENT MATERIALS & DESIGN	A	PMD	4	0	4	4	7	12	
14	PEC	PE-3	23GTE3304E	PAVEMENT MATERIALS & DESIGN	E	PMD	4	0	4	4	7	12	
15	PEC	PE-3	23GTE3304R	PAVEMENT MATERIALS & DESIGN	R	PMD	3	0	2	4	5	9	
16	PEC	PE-4	23GTE3405M	URBAN TRANSPORTATION SYSTEMS PLANNING	M	UTSP	3	0	0	0	3	3	
17	PEC	PE-4	23GTE3406M	GEOTECHNICAL EARTHQUAKE ENGINEERING	M	BIE	3	0	0	0	3	3	
18	PEC	PE-5	23GTE3507	TRAFFIC ENGINEERING AND MANAGEMENT	R	TEM	3	0	0	0	3	3	
19	PEC	PE-5	23GTE3508	DESIGN OF EARTH RETAINING STRUCTURES	R	DERS	3	0	0	0	3	3	

63. SPECIALIZATION: GREEN ENERGY TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDEE05A	MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS	A	GML	0	0	6	4	4	10	
2	SDC	SDP-4	23SDEE05E	MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS	E	GML	0	0	6	4	4	10	
3	SDC	SDP-4	23SDEE05R	MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS	R	GML	0	0	2	4	2	6	
4	PEC	PE-1	23GET3101A	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	A	SPMET	4	0	4	4	7	12	
5	PEC	PE-1	23GET3101E	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	E	SPMET	4	0	4	4	7	12	
6	PEC	PE-1	23GET3101R	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	R	SPMET	3	0	2	4	5	9	
7	PEC	PE-2	23GET3202A	WIND AND ENERGY STORAGE TECHNOLOGIES	A	WEST	5	0	0	0	5	5	
8	PEC	PE-2	23GET3202E	WIND AND ENERGY STORAGE TECHNOLOGIES	E	WEST	5	0	0	0	5	5	
9	PEC	PE-2	23GET3202R	WIND AND ENERGY STORAGE TECHNOLOGIES	R	WEST	3	0	0	0	3	3	
10	PEC	PE-2	23GET3203A	ENERGY ECONOMICS AND POLICY	A	EEP	5	0	0	0	5	5	
11	PEC	PE-2	23GET3203E	ENERGY ECONOMICS AND POLICY	E	EEP	5	0	0	0	5	5	
12	PEC	PE-2	23GET3203R	ENERGY ECONOMICS AND POLICY	R	EEP	3	0	0	0	3	3	
13	PEC	PE-3	23GET3304A	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	A	GIRES	4	0	4	4	7	12	
14	PEC	PE-3	23GET3304E	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	E	GIRES	4	0	4	4	7	12	
15	PEC	PE-3	23GET3304R	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	R	GIRES	3	0	2	4	5	9	
16	PEC	PE-4	23GET3405M	ENERGY MANAGEMENT AND GREEN BUILDING	M	EMGB	3	0	0	0	3	3	
17	PEC	PE-4	23GET3406M	HYDROGEN FUEL CELL TECHNOLOGY	M	HFCT	3	0	0	0	3	3	
18	PEC	PE-5	23GET3507	AI AND IOT FOR GREEN ENERGY INTEGRATION	R	AIGEI	3	0	0	0	3	3	
19	PEC	PE-5	23GET3508	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	R	PERES	3	0	0	0	3	3	

64. SPECIALIZATION: HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDCS21A	HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY	A	HSCISS	0	0	6	4	4	10	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
2	SDC	SDP-4	23SDCS21E	HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY	E	HSCISS	0	0	6	4	4	10	
3	SDC	SDP-4	23SDCS21R	HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY	R	HSCISS	0	0	2	4	2	6	
4	PEC	PE-1	23HSS3101A	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	A	ITHSCD	4	0	4	4	7	12	
5	PEC	PE-1	23HSS3101E	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	E	ITHSCD	4	0	4	4	7	12	
6	PEC	PE-1	23HSS3101R	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	R	ITHSCD	3	0	2	4	5	9	
7	PEC	PE-2	23HSS3202A	FUNDAMENTALS OF COMPUTER SECURITY	A	FOCS	5	0	0	0	5	5	
8	PEC	PE-2	23HSS3202E	FUNDAMENTALS OF COMPUTER SECURITY	E	FOCS	5	0	0	0	5	5	
9	PEC	PE-2	23HSS3202R	FUNDAMENTALS OF COMPUTER SECURITY	R	FOCS	3	0	0	0	3	3	
10	PEC	PE-3	23HSS3303A	HARDWARE SECURITY MECHANISMS	A	HSM	4	0	4	4	7	12	
11	PEC	PE-3	23HSS3303E	HARDWARE SECURITY MECHANISMS	E	HSM	4	0	4	4	7	12	
12	PEC	PE-3	23HSS3303R	HARDWARE SECURITY MECHANISMS	R	HSM	3	0	2	4	5	9	
13	PEC	PE-4	23HSS3404M	SOFTWARE SECURITY PRINCIPLES	M	SSP	3	0	0	0	3	3	
14	PEC	PE-4	23HSS3405M	SECURE CO-DESIGN METHODOLOGIES	M	SCDM	3	0	0	0	3	3	
15	PEC	PE-4	23HSS3406M	HARDWARE TROJAN DETECTION AND PREVENTION	M	HTDAP	3	0	0	0	3	3	
16	PEC	PE-5	23HSS3507	SIDE-CHANNEL ATTACKS AND COUNTERMEASURES	R	SCACM	3	0	0	0	3	3	
17	PEC	PE-5	23HSS3508	FORMAL METHODS FOR HARDWARE-SOFTWARE SECURITY	R	FMHSS	3	0	0	0	3	3	
18	PEC	PE-5	23HSS3509	TRUSTED PLATFORM MODULES AND SECURE ELEMENTS	R	TPMASE	3	0	0	0	3	3	
19	PEC	PE-5	23HSS3510	SECURE COMMUNICATION PROTOCOLS AND APIS	R	SCPA	3	0	0	0	3	3	
20	PEC	PE-5	23HSS3511	HARDWARE-SOFTWARE CO-DESIGN	R	HSCCS	3	0	0	0	3	3	
21	PEC	PE-5	23HSS3512	FUTURE TRENDS IN HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY	R	FTHSCS	3	0	0	0	3	3	

65. SPECIALIZATION: HEALTHCARE DATA ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDBT08A	DRUG DESIGN: PRINCIPLES AND ENGINEERING	A	DDPE	0	0	6	4	4	10	BI(1)

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
2	SDC	SDP-3	23SDBT08E	DRUG DESIGN: PRINCIPLES AND ENGINEERING	E	DDPE	0	0	6	4	4	10	BI(1)
3	SDC	SDP-3	23SDBT08R	DRUG DESIGN: PRINCIPLES AND ENGINEERING	R	DDPE	0	0	2	4	2	6	BI(1)
4	PEC	PE-1	23HDA3101A	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	A	ISDPDD	4	0	4	4	7	12	
5	PEC	PE-1	23HDA3101E	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	E	ISDPDD	4	0	4	4	7	12	
6	PEC	PE-1	23HDA3101R	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	R	ISDPDD	3	0	2	4	5	9	
7	PEC	PE-1	23HDA3204A	PYTHON FOR GENOMIC DATA SCIENCE	A	PFGDS	5	0	0	0	5	5	
8	PEC	PE-1	23HDA3204E	PYTHON FOR GENOMIC DATA SCIENCE	E	PFGDS	5	0	0	0	5	5	
9	PEC	PE-2	23HDA3202A	BIO MEDICAL INFORMATICS	A	BMI	5	0	0	0	5	5	
10	PEC	PE-2	23HDA3202E	BIO MEDICAL INFORMATICS	E	BMI	5	0	0	0	5	5	
11	PEC	PE-2	23HDA3202R	BIO MEDICAL INFORMATICS	R	BMI	3	0	0	0	3	3	
12	PEC	PE-2	23HDA3203R	GENETIC PROGRAMMING	R	GP	3	0	0	0	3	3	
13	PEC	PE-3	23HDA3305A	COMPUTATIONAL NEUROSCIENCE	A	CNSE	4	0	4	4	7	12	
14	PEC	PE-3	23HDA3305E	COMPUTATIONAL NEUROSCIENCE	E	CNSE	4	0	4	4	7	12	
15	PEC	PE-3	23HDA3305R	COMPUTATIONAL NEUROSCIENCE	R	CNSE	3	0	2	4	5	9	
16	PEC	PE-3	23HDA3203A	GENETIC PROGRAMMING	A	GP	5	0	0	0	5	5	
17	PEC	PE-3	23HDA3203E	GENETIC PROGRAMMING	E	GP	5	0	0	0	5	5	
18	PEC	PE-4	23HDA3407M	INTRODUCTION TO GENOMIC TECHNOLOGIES	M	IGT	3	0	0	0	3	3	
19	PEC	PE-4	23HDA3406M	NGS SEQUENCING AND DATA ANALYSIS	M	NGSDA	3	0	0	0	3	3	
20	PEC	PE-5	23HDA3511	EPI GENETIC CONTROL OF GENE EXPRESSION	R	ECBI	3	0	0	0	3	3	
21	PEC	PE-5	23HDA3509	MOLECULAR MODELING AND DRUG DESIGN	R	MMDD	3	0	0	0	3	3	
22	PEC	PE-5	23HDA3204R	PYTHON FOR GENOMIC DATA SCIENCE	R	PFGDS	3	0	0	0	3	3	
23	PEC	PE-5	23HDA3510	GENOMIC DATA SCIENCE & CLUSTERING	R	GDSC	3	0	0	0	3	3	

66. SPECIALIZATION: INDUSTRIAL AUTOMATION

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDEE07A	IA HARDWARE PROTOTYPING	A	IAHP	0	0	6	4	4	10	FITS(1)
2	SDC	SDP-3	23SDEE07E	IA HARDWARE PROTOTYPING	E	IAHP	0	0	6	4	4	10	FITS(1)

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
3	SDC	SDP-3	23SDEE07R	IA HARDWARE PROTOTYPING	R	IAHP	0	0	2	4	2	6	FITS(1)
4	PEC	PE-1	23ILA3101A	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	A	IIIoT	4	0	4	4	7	12	
5	PEC	PE-1	23ILA3101E	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	E	IIIoT	4	0	4	4	7	12	
6	PEC	PE-1	23ILA3101R	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	R	IIIoT	3	0	2	4	5	9	
7	PEC	PE-2	23ILA3202A	INDUSTRIAL AUTOMATION AND ROBOTICS	A	IAR	5	0	0	0	5	5	
8	PEC	PE-2	23ILA3202E	INDUSTRIAL AUTOMATION AND ROBOTICS	E	IAR	5	0	0	0	5	5	
9	PEC	PE-2	23ILA3202R	INDUSTRIAL AUTOMATION AND ROBOTICS	R	IAR	3	0	0	0	3	3	
10	PEC	PE-2	23ILA3203A	EDGE COMPUTING FOR INDUSTRY 4.0	A	ECI	5	0	0	0	5	5	
11	PEC	PE-2	23ILA3203E	EDGE COMPUTING FOR INDUSTRY 4.0	E	ECI	5	0	0	0	5	5	
12	PEC	PE-2	23ILA3203R	EDGE COMPUTING FOR INDUSTRY 4.0	R	ECI	3	0	0	0	3	3	
13	PEC	PE-3	23ILA3304A	INDUSTRIAL DRIVES AND CONTROL	A	ID&C	4	0	4	4	7	12	
14	PEC	PE-3	23ILA3304E	INDUSTRIAL DRIVES AND CONTROL	E	ID&C	4	0	4	4	7	12	
15	PEC	PE-3	23ILA3304R	INDUSTRIAL DRIVES AND CONTROL	R	ID&C	3	0	2	4	5	9	
16	PEC	PE-4	23ILA3405M	INDUSTRIAL COMMUNICATION PROTOCOLS AND CYBER SECURITY	M	ICPCS	3	0	0	0	3	3	
17	PEC	PE-4	23ILA3406M	DIGITAL MANUFACTURING AND DESIGN	M	DMD	3	0	0	0	3	3	
18	PEC	PE-5	23ILA3508	PLC PROGRAMMING & CONTROL	R	PLCPC	3	0	0	0	3	3	
19	PEC	PE-5	23ILA3507	SMART SENSORS AND SENSOR NETWORKING	R	SSSN	3	0	0	0	3	3	

67. SPECIALIZATION: INDUSTRIAL BIOTECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDBT07A	ASPECTS OF BIOCHEMICAL ENGINEERING	A	ABCE	0	0	6	4	4	10	
2	SDC	SDP-4	23SDBT07E	ASPECTS OF BIOCHEMICAL ENGINEERING	E	ABCE	0	0	6	4	4	10	
3	SDC	SDP-4	23SDBT07R	ASPECTS OF BIOCHEMICAL ENGINEERING	R	ABCE	0	0	2	4	2	6	
4	PEC	PE-1	23IBT3101A	PHARMACEUTICAL BIOTECHNOLOGY	A	PBT	4	0	4	4	7	12	
5	PEC	PE-1	23IBT3101E	PHARMACEUTICAL BIOTECHNOLOGY	E	PBT	4	0	4	4	7	12	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
6	PEC	PE-1	23IBT3101R	PHARMACEUTICAL BIOTECHNOLOGY	R	PBT	3	0	2	4	5	9	
7	PEC	PE-2	23IBT3202A	PHARMACOVIGILANCE AND SAFETY	A	PCS	5	0	0	0	5	5	
8	PEC	PE-2	23IBT3202E	PHARMACOVIGILANCE AND SAFETY	E	PCS	5	0	0	0	5	5	
9	PEC	PE-2	23IBT3202R	PHARMACOVIGILANCE AND SAFETY	R	PCS	3	0	0	0	3	3	
10	PEC	PE-2	23IBT3203A	BIOPROCESS ECONOMICS AND PLANT DESIGN	A	BEPD	5	0	0	0	5	5	
11	PEC	PE-2	23IBT3203E	BIOPROCESS ECONOMICS AND PLANT DESIGN	E	BEPD	5	0	0	0	5	5	
12	PEC	PE-2	23IBT3203R	BIOPROCESS ECONOMICS AND PLANT DESIGN	R	BEPD	3	0	0	0	3	3	
13	PEC	PE-3	23IBT3304A	ENZYME ENGINEERING	A	EE	4	0	4	4	7	12	
14	PEC	PE-3	23IBT3304E	ENZYME ENGINEERING	E	EE	4	0	4	4	7	12	
15	PEC	PE-3	23IBT3304R	ENZYME ENGINEERING	R	EE	3	0	2	4	5	9	
16	PEC	PE-4	23IBT3405M	BIOPROCESS VALIDATION AND CGMP	M	BVcGMP	3	0	0	0	3	3	
17	PEC	PE-4	23IBT3406M	FOOD TECHNOLOGY	M	FT	3	0	0	0	3	3	
18	PEC	PE-5	23IBT3507	MICROBIAL TECHNOLOGY	R	MBT	3	0	0	0	3	3	
19	PEC	PE-5	23IBT3508	METABOLIC ENGINEERING	R	MBE	3	0	0	0	3	3	

68. SPECIALIZATION: INTELLIGENT MULTIMEDIA PROCESSING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDEC15A	NATURAL LANGUAGE PROCESSING USING TENSOR FLOW	A	NLPTF	0	0	6	4	4	10	ESDA(1)
2	SDC	SDP-3	23SDEC15E	NATURAL LANGUAGE PROCESSING USING TENSOR FLOW	E	NLPTF	0	0	6	4	4	10	ESDA(1)
3	SDC	SDP-3	23SDEC15R	NATURAL LANGUAGE PROCESSING USING TENSOR FLOW	R	NLPTF	0	0	2	4	2	6	ESDA(1)
4	PEC	PE-1	23IMP3101A	NATURAL LANGUAGE PROCESSING & APPLICATIONS	A	NLPA	4	0	4	4	7	12	
5	PEC	PE-1	23IMP3101E	NATURAL LANGUAGE PROCESSING & APPLICATIONS	E	NLPA	4	0	4	4	7	12	
6	PEC	PE-2	23IMP3202A	DATA ENGINEERING	A	DE	5	0	0	0	5	5	
7	PEC	PE-2	23IMP3202E	DATA ENGINEERING	E	DE	5	0	0	0	5	5	
8	PEC	PE-2	23IMP3202R	DATA ENGINEERING	R	DE	3	0	0	0	3	3	
9	PEC	PE-3	23IMP3303A	BIO MEDICAL SIGNAL AND IMAGE ANALYSIS	A	AMSIA	4	0	4	4	7	12	
10	PEC	PE-3	23IMP3303E	BIO MEDICAL SIGNAL AND IMAGE ANALYSIS	E	AMSIA	4	0	4	4	7	12	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
11	PEC	PE-3	23IMP3303R	BIO MEDICAL SIGNAL AND IMAGE ANALYSIS	R	AMSIA	3	0	2	4	5	9	
12	PEC	PE-4	23IMP3404M	DATA VISUALIZATION	M	DV	3	0	0	0	3	3	
13	PEC	PE-5	23IMP3101R	NATURAL LANGUAGE PROCESSING & APPLICATIONS	R	NLPA	3	0	2	4	5	9	
14	PEC	PE-5	23IMP3505	MULTI MEDIA PROCESSING	R	MMP	3	0	0	0	3	3	
15	PEC	PE-5	23IMP3506	INTRODUCTION TO QUANTUM COMPUTING	R	MMP	3	0	0	0	3	3	

69. SPECIALIZATION: IOT ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDIN05A	IOT ANALYTICS FOR THE CLOUD	A	IOTAC	0	0	6	4	4	10	CCIoT(1)
2	SDC	SDP-3	23SDIN05E	IOT ANALYTICS FOR THE CLOUD	E	IOTAC	0	0	6	4	4	10	CCIoT(1)
3	SDC	SDP-3	23SDIN05R	IOT ANALYTICS FOR THE CLOUD	R	IOTAC	0	0	2	4	2	6	CCIoT(1)
4	PEC	PE-1	23IOT3101A	INDUSTRIAL INTERNET OF THINGS	A	IIoT	4	0	4	4	7	12	
5	PEC	PE-1	23IOT3101E	INDUSTRIAL INTERNET OF THINGS	E	IIoT	4	0	4	4	7	12	
6	PEC	PE-1	23IOT3101R	INDUSTRIAL INTERNET OF THINGS	R	IIoT	3	0	2	4	5	9	
7	PEC	PE-1	23IOT3305A	DEEP LEARNING	A	DL	4	0	4	4	7	12	
8	PEC	PE-1	23IOT3305E	DEEP LEARNING	E	DL	4	0	4	4	7	12	
9	PEC	PE-2	23IOT3202A	EDGE COMPUTING	A	EC	5	0	0	0	5	5	
10	PEC	PE-2	23IOT3202E	EDGE COMPUTING	E	EC	5	0	0	0	5	5	
11	PEC	PE-2	23IOT3202R	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
12	PEC	PE-2	23IOT3203A	PRECISION AGRICULTURE	A	PA	5	0	0	0	5	5	
13	PEC	PE-2	23IOT3203E	PRECISION AGRICULTURE	E	PA	5	0	0	0	5	5	
14	PEC	PE-2	23IOT3203R	PRECISION AGRICULTURE	R	PA	3	0	0	0	3	3	
15	PEC	PE-2	23IOT3204A	SMART FARMING	A	SF	5	0	0	0	5	5	
16	PEC	PE-2	23IOT3204E	SMART FARMING	E	SF	5	0	0	0	5	5	
17	PEC	PE-2	23IOT3204R	SMART FARMING	R	SF	3	0	0	0	3	3	
18	PEC	PE-3	23IOT3305R	DEEP LEARNING	R	DL	3	0	2	4	5	9	
19	PEC	PE-4	23IOT3406M	DATA VISUALIZATION TECHNIQUES	M	DVT	3	0	0	0	3	3	
20	PEC	PE-4	23IOT3407M	APPLIED MACHINE LEARNING FOR AGRICULTURE	M	AMLA	3	0	0	0	3	3	
21	PEC	PE-5	23IOT3508	BIG DATA ANALYTICS	R	BDA	3	0	0	0	3	3	

70. SPECIALIZATION: MEDICAL BIOTECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDBT09A	CELL CULTURE TECHNOLOGIES	A	CCT	0	0	6	4	4	10	
2	SDC	SDP-4	23SDBT09E	CELL CULTURE TECHNOLOGIES	E	CCT	0	0	6	4	4	10	
3	SDC	SDP-4	23SDBT09R	CELL CULTURE TECHNOLOGIES	R	CCT	0	0	2	4	2	6	
4	PEC	PE-1	23MBT3101A	STEM CELL TECHNOLOGY	A	SCT	4	0	4	4	7	12	
5	PEC	PE-1	23MBT3101E	STEM CELL TECHNOLOGY	E	SCT	4	0	4	4	7	12	
6	PEC	PE-1	23MBT3101R	STEM CELL TECHNOLOGY	R	SCT	3	0	2	4	5	9	
7	PEC	PE-2	23MBT3202A	VIROLOGY	A	VR	5	0	0	0	5	5	
8	PEC	PE-2	23MBT3202E	VIROLOGY	E	VR	5	0	0	0	5	5	
9	PEC	PE-2	23MBT3202R	VIROLOGY	R	VR	3	0	0	0	3	3	
10	PEC	PE-2	23MBT3203A	NANOBIOTECHNOLOGY	A	NBT	5	0	0	0	5	5	
11	PEC	PE-2	23MBT3203E	NANOBIOTECHNOLOGY	E	NBT	5	0	0	0	5	5	
12	PEC	PE-2	23MBT3203R	NANOBIOTECHNOLOGY	R	NBT	3	0	0	0	3	3	
13	PEC	PE-3	23MBT3304A	HEALTHCARE BIOTECHNOLOGY	A	HBT	4	0	4	4	7	12	
14	PEC	PE-3	23MBT3304E	HEALTHCARE BIOTECHNOLOGY	E	HBT	4	0	4	4	7	12	
15	PEC	PE-3	23MBT3304R	HEALTHCARE BIOTECHNOLOGY	R	HBT	3	0	2	4	5	9	
16	PEC	PE-4	23MBT3405M	CANCER BIOLOGY	M	CB	3	0	0	0	3	3	
17	PEC	PE-4	23MBT3406M	NEUROBIOLOGY	M	NB	3	0	0	0	3	3	
18	PEC	PE-5	23MBT3507	BIOELECTRONICS & BIOSENSORS	R	BB	3	0	0	0	3	3	
19	PEC	PE-5	23MBT3508	TISSUE ENGINEERING	R	NBT	3	0	0	0	3	3	

71. SPECIALIZATION: ROBOTICS AND AUTOMATION

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDEC17A	ROBOT DESIGN AND ANALYSIS	A	RDA	0	0	6	4	4	10	
2	SDC	SDP-4	23SDEC17E	ROBOT DESIGN AND ANALYSIS	E	RDA	0	0	6	4	4	10	
3	SDC	SDP-4	23SDEC17R	ROBOT DESIGN AND ANALYSIS	R	RDA	0	0	2	4	2	6	
4	PEC	PE-1	23RAN3101A	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	A	RMPDC	4	0	4	4	7	12	
5	PEC	PE-1	23RAN3101E	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	E	RMPDC	4	0	4	4	7	12	
6	PEC	PE-1	23RAN3101R	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	R	RMPDC	3	0	2	4	5	9	
7	PEC	PE-1	23RAN3102A	AUTONOMOUS MOBILE ROBOT SYSTEMS	A	AMRS	4	0	4	4	7	12	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
8	PEC	PE-1	23RAN3102E	AUTONOMOUS MOBILE ROBOT SYSTEMS	E	AMRS	4	0	4	4	7	12	
9	PEC	PE-1	23RAN3102R	AUTONOMOUS MOBILE ROBOT SYSTEMS	R	AMRS	3	0	2	4	5	9	
10	PEC	PE-2	23RAN3202E	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	E	AVAE	5	0	0	0	5	5	
11	PEC	PE-2	23RAN3202R	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	R	AVAE	3	0	0	0	3	3	
12	PEC	PE-2	23RAN3203A	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	A	RMWR	5	0	0	0	5	5	
13	PEC	PE-2	23RAN3203E	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	E	RMWR	5	0	0	0	5	5	
14	PEC	PE-2	23RAN3203R	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	R	RMWR	3	0	0	0	3	3	
15	PEC	PE-3	23RAN3304A	ADVANCED ROBOTICS	A	AR	4	0	4	4	7	12	
16	PEC	PE-3	23RAN3304E	ADVANCED ROBOTICS	E	AR	4	0	4	4	7	12	
17	PEC	PE-3	23RAN3304R	ADVANCED ROBOTICS	R	AR	3	0	2	4	5	9	
18	PEC	PE-4	23RAN3405M	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	M	AIR	3	0	0	0	3	3	
19	PEC	PE-4	23RAN3406M	HUMAN MACHINE INTERFACE & BRAIN MACHINE INTERFACE	M	HMIBMI	3	0	0	0	3	3	
20	PEC	PE-5	23RAN3202A	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	A	AVAE	5	0	0	0	5	5	
21	PEC	PE-5	23RAN3507	COMPUTER VISION & APPLICATIONS	R	CVA	3	0	0	0	3	3	

72. SPECIALIZATION: SMART GRID TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDEE04A	AI & ML FOR SMART GRIDS	A	AIMLSG	0	0	6	4	4	10	
2	SDC	SDP-4	23SDEE04E	AI & ML FOR SMART GRIDS	E	AIMLSG	0	0	6	4	4	10	
3	SDC	SDP-4	23SDEE04R	AI & ML FOR SMART GRIDS	R	AIMLSG	0	0	2	4	2	6	
4	PEC	PE-1	23SGT3101A	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	A	DERSG	4	0	4	4	7	12	
5	PEC	PE-1	23SGT3101E	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	E	DERSG	4	0	4	4	7	12	
6	PEC	PE-1	23SGT3101R	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	R	DERSG	3	0	2	4	5	9	
7	PEC	PE-2	23SGT3202A	DISTRIBUTION SYSTEM PRACTICES	A	DSP	5	0	0	0	5	5	
8	PEC	PE-2	23SGT3202E	DISTRIBUTION SYSTEM PRACTICES	E	DSP	5	0	0	0	5	5	
9	PEC	PE-2	23SGT3202R	DISTRIBUTION SYSTEM PRACTICES	R	DSP	3	0	0	0	3	3	
10	PEC	PE-2	23SGT3203A	MICROGRID DYNAMICS AND CONTROL	A	MDC	5	0	0	0	5	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
11	PEC	PE-2	23SGT3203E	MICROGRID DYNAMICS AND CONTROL	E	MDC	5	0	0	0	5	5	
12	PEC	PE-2	23SGT3203R	MICROGRID DYNAMICS AND CONTROL	R	MDC	3	0	0	0	3	3	
13	PEC	PE-3	23SGT3304A	ENERGY MANAGEMENT SYSTEMS AND SCADA	A	EMS&SCADA	4	0	4	4	7	12	
14	PEC	PE-3	23SGT3304E	ENERGY MANAGEMENT SYSTEMS AND SCADA	E	EMS&SCADA	4	0	4	4	7	12	
15	PEC	PE-3	23SGT3304R	ENERGY MANAGEMENT SYSTEMS AND SCADA	R	EMS&SCADA	3	0	2	4	5	9	
16	PEC	PE-4	23SGT3405M	SMART GRID COMMUNICATION AND CYBERSECURITY	M	SGCCS	3	0	0	0	3	3	
17	PEC	PE-4	23SGT3406M	SMART METERS AND SMART CITIES	M	SMSC	3	0	0	0	3	3	
18	PEC	PE-5	23SGT3507	INTERNET OF THINGS AND SMART GRID ANALYTICS	R	IOT&SGA	3	0	0	0	3	3	
19	PEC	PE-5	23SGT3508	SMART GRID PROTECTION	R	SGP	3	0	0	0	3	3	

73. SPECIALIZATION: SMART MANUFACTURING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDME06A	GEOMETRIC DIMENSIONING AND TOLERANCING	A	GDAT	0	0	6	4	4	10	
2	SDC	SDP-4	23SDME06E	GEOMETRIC DIMENSIONING AND TOLERANCING	E	GDAT	0	0	6	4	4	10	
3	SDC	SDP-4	23SDME06R	GEOMETRIC DIMENSIONING AND TOLERANCING	R	GDAT	0	0	2	4	2	6	
4	PEC	PE-1	23SMF3101A	REVERSE ENGINEERING & RAPID PROTOTYPING	A	MMC	4	0	4	4	7	12	
5	PEC	PE-1	23SMF3101E	REVERSE ENGINEERING & RAPID PROTOTYPING	E	MMC	4	0	4	4	7	12	
6	PEC	PE-1	23SMF3101R	REVERSE ENGINEERING & RAPID PROTOTYPING	R	MMC	3	0	2	4	5	9	
7	PEC	PE-2	23SMF3202A	ADVANCED MATERIALS MANUFACTURING & TESTING	A	AMMT	5	0	0	0	5	5	
8	PEC	PE-2	23SMF3202E	ADVANCED MATERIALS MANUFACTURING & TESTING	E	AMMT	5	0	0	0	5	5	
9	PEC	PE-2	23SMF3202R	ADVANCED MATERIALS MANUFACTURING & TESTING	R	AMMT	3	0	0	0	3	3	
10	PEC	PE-2	23SMF3203A	MODERN MANUFACTURING PROCESSES	A	MMP	5	0	0	0	5	5	
11	PEC	PE-2	23SMF3203E	MODERN MANUFACTURING PROCESSES	E	MMP	5	0	0	0	5	5	
12	PEC	PE-2	23SMF3203R	MODERN MANUFACTURING PROCESSES	R	MMP	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
13	PEC	PE-3	23SMF3304A	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING	A	SDSISM	4	0	4	4	7	12	
14	PEC	PE-3	23SMF3304E	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING	E	SDSISM	4	0	4	4	7	12	
15	PEC	PE-3	23SMF3304R	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING	R	SDSISM	3	0	2	4	5	9	
16	PEC	PE-4	23SMF3405M	ROBOTICS & INDUSTRIAL AUTOMATION	M	RIA	3	0	0	0	3	3	
17	PEC	PE-4	23SMF3406M	MECHANICAL MEASUREMENTS AND METROLOGY	M	MMM	3	0	0	0	3	3	
18	PEC	PE-5	23SMF3507	MACHINE TO MACHINE COMMUNICATION	R	MMC	3	0	0	0	3	3	
19	PEC	PE-5	23SMF3508	FLEXIBLE MANUFACTURING SYSTEMS	R	FMS	3	0	0	0	3	3	

74. SPECIALIZATION: SOCIAL AND DIGITAL MEDIA ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-3	23SDAD06A	ANALYSIS OF DIGITAL MARKETING	A	ADM	0	0	6	4	4	10	ML(1)
2	SDC	SDP-3	23SDAD06E	ANALYSIS OF DIGITAL MARKETING	E	ADM	0	0	6	4	4	10	ML(1)
3	SDC	SDP-3	23SDAD06R	ANALYSIS OF DIGITAL MARKETING	R	ADM	0	0	2	4	2	6	ML(1)
4	PEC	PE-1	23SDM3101A	SENTIMENT ANALYSIS	A	SA	4	0	4	4	7	12	
5	PEC	PE-1	23SDM3101E	SENTIMENT ANALYSIS	E	SA	4	0	4	4	7	12	
6	PEC	PE-1	23SDM3101R	SENTIMENT ANALYSIS	R	SA	3	0	2	4	5	9	
7	PEC	PE-2	23SDM3202A	OPINION MINING & RECOMMENDER SYSTEMS	A	OMRS	5	0	0	0	5	5	
8	PEC	PE-2	23SDM3202E	OPINION MINING & RECOMMENDER SYSTEMS	E	OMRS	5	0	0	0	5	5	
9	PEC	PE-2	23SDM3202R	OPINION MINING & RECOMMENDER SYSTEMS	R	OMRS	3	0	0	0	3	3	
10	PEC	PE-2	23SDM3203A	META SOCIAL MEDIA ANALYTICS	A	MSMA	5	0	0	0	5	5	
11	PEC	PE-2	23SDM3203E	META SOCIAL MEDIA ANALYTICS	E	MSMA	5	0	0	0	5	5	
12	PEC	PE-2	23SDM3203R	META SOCIAL MEDIA ANALYTICS	R	MSMA	3	0	0	0	3	3	
13	PEC	PE-3	23SDM3304A	SOCIAL MEDIA MARKETING ANALYTICS	A	SMMA	4	0	4	4	7	12	
14	PEC	PE-3	23SDM3304E	SOCIAL MEDIA MARKETING ANALYTICS	E	SMMA	4	0	4	4	7	12	
15	PEC	PE-3	23SDM3304R	SOCIAL MEDIA MARKETING ANALYTICS	R	SMMA	3	0	2	4	5	9	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
16	PEC	PE-4	23SDM3405M	DIGITAL MEDIA ANALYTICS	M	DMA	3	0	0	0	3	3	
17	PEC	PE-4	23SDM3406M	ETHICAL SOCIAL MEDIA	M	ESM	3	0	0	0	3	3	
18	PEC	PE-5	23SDM3508	SEARCH ENGINE OPTIMIZATION	R	SEO	3	0	0	0	3	3	
19	PEC	PE-5	23SDM3507	INTELLIGENT SOCIAL MEDIA MONITORING SYSTEMS	R	ISMMS	3	0	0	0	3	3	

75. SPECIALIZATION: SOFTWARE MODELLING AND DEVOPS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDCI05A	CLOUD DEVOPS	A	CDP	0	0	6	4	4	10	
2	SDC	SDP-4	23SDCI05E	CLOUD DEVOPS	E	CDP	0	0	6	4	4	10	
3	SDC	SDP-4	23SDCI05R	CLOUD DEVOPS	R	CDP	0	0	2	4	2	6	
4	PEC	PE-1	23SMD3101A	SOFTWARE VERIFICATION & VALIDATION	A	SVV	4	0	4	4	7	12	
5	PEC	PE-1	23SMD3101E	SOFTWARE VERIFICATION & VALIDATION	E	SVV	4	0	4	4	7	12	
6	PEC	PE-1	23SMD3101R	SOFTWARE VERIFICATION & VALIDATION	R	SVV	3	0	2	4	5	9	
7	PEC	PE-2	23SMD3202A	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	A	DPCT	5	0	0	0	5	5	
8	PEC	PE-2	23SMD3202E	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	E	DPCT	5	0	0	0	5	5	
9	PEC	PE-2	23SMD3202R	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	R	DPCT	3	0	0	0	3	3	
10	PEC	PE-3	23SMD3303A	CONTINUOUS DELIVERY & DEVOPS	A	CDD	4	0	4	4	7	12	
11	PEC	PE-3	23SMD3303E	CONTINUOUS DELIVERY & DEVOPS	E	CDD	4	0	4	4	7	12	
12	PEC	PE-3	23SMD3303R	CONTINUOUS DELIVERY & DEVOPS	R	CDD	3	0	2	4	5	9	
13	PEC	PE-4	23SMD3404M	SOFTWARE PROJECT MANAGEMENT	M	SPM	3	0	0	0	3	3	
14	PEC	PE-4	23SMD3405M	SOFTWARE ARCHITECTURE & DESIGN	M	SAD	3	0	0	0	3	3	
15	PEC	PE-5	23SMD3506	SOFTWARE RELIABILITY	R	SR	3	0	0	0	3	3	
16	PEC	PE-5	23SMD3507	CROSS-PLATFORM USER INTERFACE DESIGN	R	CPUIF	3	0	0	0	3	3	

76. SPECIALIZATION: SPATIAL COMPUTING AND IMMERSIVE TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDCS06A	CERTIFIED GAME DEVELOPER	A	CGD	0	0	6	4	4	10	
2	SDC	SDP-4	23SDCS06E	CERTIFIED GAME DEVELOPER	E	CGD	0	0	6	4	4	10	
3	SDC	SDP-4	23SDCS06R	CERTIFIED GAME DEVELOPER	R	CGD	0	0	2	4	2	6	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
4	PEC	PE-1	23SCI3101A	SPATIAL DATA VISUALIZATION	A	SDV	4	0	4	4	7	12	
5	PEC	PE-1	23SCI3101E	SPATIAL DATA VISUALIZATION	E	SDV	4	0	4	4	7	12	
6	PEC	PE-1	23SCI3101R	SPATIAL DATA VISUALIZATION	R	SDV	3	0	2	4	5	9	
7	PEC	PE-2	23SCI3202A	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	A	SCMG	5	0	0	0	5	5	
8	PEC	PE-2	23SCI3202E	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	E	SCMG	5	0	0	0	5	5	
9	PEC	PE-2	23SCI3202R	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	R	SCMG	3	0	0	0	3	3	
10	PEC	PE-3	23SCI3303A	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	A	SCPD	4	0	4	4	7	12	
11	PEC	PE-3	23SCI3303E	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	E	SCPD	4	0	4	4	7	12	
12	PEC	PE-3	23SCI3303R	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	R	SCPD	3	0	2	4	5	9	
13	PEC	PE-4	23SCI3404M	SPATIAL AND SOCIAL IMPLICATIONS OF IMMERSIVE TECHNOLOGIES	M	SSIIT	3	0	0	0	3	3	
14	PEC	PE-4	23SCI3405M	SPATIAL AUDIO DESIGN FOR GAMES	M	SADG	3	0	0	0	3	3	
15	PEC	PE-5	23SCI3506	SPATIAL USER INTERFACE DESIGN	R	SUID	3	0	0	0	3	3	
16	PEC	PE-5	23SCI3507	INTRODUCTION TO SPATIAL COMPUTING	R	ITSC	3	0	0	0	3	3	

77. SPECIALIZATION: STRUCTURAL ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDCE06A	DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE	A	SAFE	0	0	6	4	4	10	
2	SDC	SDP-4	23SDCE06E	DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE	E	SAFE	0	0	6	4	4	10	
3	SDC	SDP-4	23SDCE06R	DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE	R	SAFE	0	0	2	4	2	6	
4	PEC	PE-1	23STE3101A	ADVANCED CONCRETE TECHNOLOGY	A	ACT	4	0	4	4	7	12	
5	PEC	PE-1	23STE3101E	ADVANCED CONCRETE TECHNOLOGY	E	ACT	4	0	4	4	7	12	
6	PEC	PE-1	23STE3101R	ADVANCED CONCRETE TECHNOLOGY	R	ACT	3	0	2	4	5	9	
7	PEC	PE-2	23STE3202A	ADVANCED STRUCTURAL ANALYSIS	A	ASA	5	0	0	0	5	5	
8	PEC	PE-2	23STE3202E	ADVANCED STRUCTURAL ANALYSIS	E	ASA	5	0	0	0	5	5	
9	PEC	PE-2	23STE3202R	ADVANCED STRUCTURAL ANALYSIS	R	ASA	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
10	PEC	PE-2	23STE3203A	ADVANCED DESIGN OF STEEL STRUCTURE	A	ADSS	5	0	0	0	5	5	
11	PEC	PE-2	23STE3203E	ADVANCED DESIGN OF STEEL STRUCTURE	E	ADSS	5	0	0	0	5	5	
12	PEC	PE-2	23STE3203R	ADVANCED DESIGN OF STEEL STRUCTURE	R	ADSS	3	0	0	0	3	3	
13	PEC	PE-3	23STE3304A	BRIDGE ENGINEERING	A	BE	4	0	4	4	7	12	
14	PEC	PE-3	23STE3304E	BRIDGE ENGINEERING	E	BE	4	0	4	4	7	12	
15	PEC	PE-3	23STE3304R	BRIDGE ENGINEERING	R	BE	3	0	2	4	5	9	
16	PEC	PE-4	23STE3405M	PRESTRESSED CONCRETE	M	PC	3	0	0	0	3	3	
17	PEC	PE-4	23STE3406M	PRECAST AND PREFABRICATED STRUCTURES	M	PPS	3	0	0	0	3	3	
18	PEC	PE-5	23STE3507	PRE ENGINEERING STRUCTURES	R	PES	3	0	0	0	3	3	
19	PEC	PE-5	23STE3508	ADVANCED DESIGN OF REINFORCED CONCRETE STRUCTURES	R	ADRCs	3	0	0	0	3	3	

78. SPECIALIZATION: VERY LARGE-SCALE INTEGRATION

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDEC18A	VLSI SUBMICRON DESIGN AND VERIFICATION	A	VSDV	0	0	6	4	4	10	
2	SDC	SDP-4	23SDEC18E	VLSI SUBMICRON DESIGN AND VERIFICATION	E	VSDV	0	0	6	4	4	10	
3	SDC	SDP-4	23SDEC18R	VLSI SUBMICRON DESIGN AND VERIFICATION	R	VSDV	0	0	2	4	2	6	
4	PEC	PE-1	23VLS3101A	ANALOG VLSI DESIGN	A	AVD	4	0	4	4	7	12	
5	PEC	PE-1	23VLS3101E	ANALOG VLSI DESIGN	E	AVD	4	0	4	4	7	12	
6	PEC	PE-1	23VLS3101R	ANALOG VLSI DESIGN	R	AVD	3	0	2	4	5	9	
7	PEC	PE-2	23VLS3202A	TESTING AND VERIFICATION OF VLSI CIRCUITS	A	TVVC	5	0	0	0	5	5	
8	PEC	PE-2	23VLS3202E	TESTING AND VERIFICATION OF VLSI CIRCUITS	E	TVVC	5	0	0	0	5	5	
9	PEC	PE-2	23VLS3202R	TESTING AND VERIFICATION OF VLSI CIRCUITS	R	TVVC	3	0	0	0	3	3	
10	PEC	PE-3	23VLS3303A	VLSI PHYSICAL DESIGN AUTOMATION	A	VPDA	4	0	4	4	7	12	
11	PEC	PE-3	23VLS3303E	VLSI PHYSICAL DESIGN AUTOMATION	E	VPDA	4	0	4	4	7	12	
12	PEC	PE-3	23VLS3303R	VLSI PHYSICAL DESIGN AUTOMATION	R	VPDA	3	0	2	4	5	9	
13	PEC	PE-4	23VLS3404M	SYSTEM-ON-CHIP	M	SOC	3	0	0	0	3	3	
14	PEC	PE-5	23VLS3505	MIXED SIGNAL IC DESIGN	R	MSID	3	0	0	0	3	3	

79. SPECIALIZATION: WATER RESOURCE AND ENVIRONMENTAL ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	SDC	SDP-4	23SDCE07A	ARC-GIS (PRO)	A	ARC	0	0	6	4	4	10	
2	SDC	SDP-4	23SDCE07E	ARC-GIS (PRO)	E	ARC	0	0	6	4	4	10	
3	SDC	SDP-4	23SDCE07R	ARC-GIS (PRO)	R	ARC	0	0	2	4	2	6	
4	PEC	PE-1	23WRE3101A	RIVER ENGINEERING	A	RE	4	0	4	4	7	12	
5	PEC	PE-1	23WRE3101E	RIVER ENGINEERING	E	RE	4	0	4	4	7	12	
6	PEC	PE-1	23WRE3101R	RIVER ENGINEERING	R	RE	3	0	2	4	5	9	
7	PEC	PE-2	23WRE3202A	SOLID WASTE MANAGEMENT AND LANDFILLS	A	SWML	5	0	0	0	5	5	
8	PEC	PE-2	23WRE3202E	SOLID WASTE MANAGEMENT AND LANDFILLS	E	SWML	5	0	0	0	5	5	
9	PEC	PE-2	23WRE3202R	SOLID WASTE MANAGEMENT AND LANDFILLS	R	SWML	3	0	0	0	3	3	
10	PEC	PE-2	23WRE3203A	DESIGN OF HYDRAULIC STRUCTURES	A	DHS	5	0	0	0	5	5	
11	PEC	PE-2	23WRE3203E	DESIGN OF HYDRAULIC STRUCTURES	E	DHS	5	0	0	0	5	5	
12	PEC	PE-2	23WRE3203R	DESIGN OF HYDRAULIC STRUCTURES	R	DHS	3	0	0	0	3	3	
13	PEC	PE-3	23WRE3304A	WATER RESOURCES FIELD METHODS	A	WRFM	4	0	4	4	7	12	
14	PEC	PE-3	23WRE3304E	WATER RESOURCES FIELD METHODS	E	WRFM	4	0	4	4	7	12	
15	PEC	PE-3	23WRE3304R	WATER RESOURCES FIELD METHODS	R	WRFM	3	0	2	4	5	9	
16	PEC	PE-4	23WRE3405M	URBAN WATER HYDROLOGY AND HYDRAULICS	M	UWHH	3	0	0	0	3	3	
17	PEC	PE-4	23WRE3406M	ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSES	M	EIALCA	3	0	0	0	3	3	
18	PEC	PE-5	23WRE3507	PHYSICO-CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT	R	PCPWWT	3	0	0	0	3	3	
19	PEC	PE-5	23WRE3508	SUSTAINABLE ENGINEERING AND TECHNOLOGY	R	SET	3	0	0	0	3	3	

82. PROJECT: CAPSTONE PROJECT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PRI		23IE4053 R	CAPSTONE PROJECT - 1	R	CP-1	0	0	8	16	8	24	
2	PRI		23IE4053R	CAPSTONE PROJECT - 1	R	CP-1	0	0	8	16	8	24	
3	PRI	PRI-CORE	23IE4053A	CAPSTONE PROJECT - 1	A	CP-1	0	0	10	20	10	30	
4	PRI	PRI-CORE	23IE4054A	CAPSTONE PROJECT - 2	A	CP-2	0	0	10	20	10	30	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	PRI	PRI-CORE	23IE4054R	CAPSTONE PROJECT - 2	R	CP-2	0	0	8	16	8	24	

Program Articulation Matrix

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	HAS	23FL3054 - FLG	CO1	Acquire a working knowledge of the basic elements of the French language viz. letters, vowels, accents, articles, useful expressions, etc.					2			2						
2	HAS	23FL3054 - FLG	CO2	Classify questions and respond in the affirmative or negative with ?tre and avoir and form plurals						2				3				
3	HAS	23FL3054 - FLG	CO3	Utilize and apply the adjectives and essential verbs.								2		2				
4	HAS	23FL3054 - FLG	CO4	Construct and use in speech, vocabulary, reading, questions and answers								2				3		
5	HAS	23FL3055 - GLG	CO1	classify their understanding of greeting wishes, alphabets and numbers learning. to understand the greetings in formal and informal way					2			2						
6	HAS	23FL3055 - GLG	CO2	Apply their knowledge of essential daily expressions, present, past and future tense. Conjugating the verbs in the Singular and Plural groups, Past participle tense and the futertense and relations with the verbs										3				
7	HAS	23FL3055 - GLG	CO3	Utilize their understanding with suitable prepositions, questions, and possessive pronouns, and the importance of four German cases. Prepositions in Akkusativ and Dativ										2				
8	HAS	23FL3055 - GLG	CO4	Develop their knowledge about how to move in public places, such as shopping centres, restaurants, tourist places, etc, and preparation of them for German A1 level examination.								2				3		

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
9	HAS	23FL3058 - JLG	CO1	Classify Hiragana, Katakana, and basic Kanji characters used in greetings and simple scripts					2			2						
10	HAS	23FL3058 - JLG	CO2	Apply their knowledge of essential daily expressions, numbers, months, dates, time, body parts, colors, and common vocabulary to effectively communicate in basic everyday situations										3				
11	HAS	23FL3058 - JLG	CO3	Utilize their understanding of present, past, and future tenses, along with the ability to construct interrogative sentences, to express themselves in various timeframes and ask questions effectively in different conversational contexts. pen_spark								2		2				
12	HAS	23FL3058 - JLG	CO4	Develop their knowledge of verbs, including negative conjugations, and prepositions to discuss hobbies, deliver self-introductions, and navigate basic interview scenarios in Japanese								2				3		
13	HAS	23MB0001 - BME	CO1	Understand the basic concepts of marketing management		2												
14	HAS	23MB0001 - BME	CO2	Understand the concepts of Marketing environment, consumer behaviour and Segmentation, Targeting and Positioning (STP)		2												
15	HAS	23MB0001 - BME	CO3	Apply the marketing mix strategies with special focus on technology products				2										
16	HAS	23MB0001 - BME	CO4	Apply promotion and distribution strategies for marketing of high tech products and services						2								
17	HAS	23MB0002 - PIMT	CO1	Understand the basic management concepts along with an insight into levels of management									2					
18	HAS	23MB0002 - PIMT	CO2	Understand the key contributions of classical approach to Management												2		

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
19	HAS	23MB0002 - PIMT	CO3	Understand and apply Quantitative methods to improve Management performance.									2					
20	HAS	23MB0002 - PIMT	CO4	Understand the key contributions of Behavioural and contemporary approaches to Management.									2					
21	HAS	23MB0003 - FMFE	CO1	Understanding the comprehension of finance functions and diverse business models to facilitate informed decision-making processes within financial management.		2												
22	HAS	23MB0003 - FMFE	CO2	Analyzing the investment decisions through an understanding of capital budgeting techniques, both traditional and modern, emphasizing long-term implications.				2										
23	HAS	23MB0003 - FMFE	CO3	Analyze and make informed decisions regarding working capital management, considering the short-term financial health of organizations through practical case studies.				2										
24	HAS	23MB0003 - FMFE	CO4	Developing proficiency in comprehending and utilizing various sources of finance while discerning the implications of different dividend policies in practical financial scenarios.				2										
25	HAS	23MB0004 - OMG	CO1	Remember and understand the various management theories and management approaches.									2					
26	HAS	23MB0004 - OMG	CO2	Remember and understand organization theories, structures and organization principles												2		

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
27	HAS	23MB0004 - OMG	CO3	Have basic knowledge and understanding of motivation, motivational theories, leadership theories, moral and behavioral sciences and also understand the management concept, administration and management objectives.									2					
28	HAS	23MB0004 - OMG	CO4	Remember and understand the various issues in industrial relations, trade unions and college bargaining and industrial safety									2					
29	HAS	23MB0005 - MPF	CO1	Understanding Personal Finance	2													
30	HAS	23MB0005 - MPF	CO2	Applying and Building a Budget and Tracking Your Money		3												
31	HAS	23MB0005 - MPF	CO3	Applying and Managing Debt and Credit in present context			3											
32	HAS	23MB0005 - MPF	CO4	Applying Saving and Investment to present scenario			3											
33	HAS	23MB4062 - CPM	CO1	Understand construction principles and techniques to effectively plan and execute construction projects.	1										2		1	
34	HAS	23MB4062 - CPM	CO2	Understand about construction project scheduling, cost estimation, and resource allocation for a particular project	1										2		1	
35	HAS	23MB4062 - CPM	CO3	Understand about the Construction Methods and Techniques	1										2		1	
36	HAS	23MB4062 - CPM	CO4	Understand about the Construction Project Cost Estimation and Control.	1										2		1	
37	HAS	23MB4062 - CPM	CO5	Understand about project cost control and monitoring, earned value management in construction.	1										2		1	

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
38	HAS	23MB4063 - RSQM	CO1	Demonstrate an understanding of resource management principles and the importance of resource optimization in construction projects by applying best practices to enhance efficiency.	2			3				2						2
39	HAS	23MB4063 - RSQM	CO2	Interpret and ensure compliance with construction safety regulations and standards set by regulatory bodies, ensuring legal and regulatory adherence in project execution.	2			3				2						2
40	HAS	23MB4063 - RSQM	CO3	Apply hazard identification techniques and conduct comprehensive risk assessments to prioritize and mitigate risks in construction environments, enhancing safety management.	2			3				2						2
41	HAS	23MB4063 - RSQM	CO4	Develop and implement safety management systems and quality assurance strategies, including safety policies, training, and communication, to ensure high safety standards and quality control in construction projects.	2			3				2						2
42	HAS	23MB4064 - SDM	CO1	Understand the concepts of digital marketing and search engine optimization											2			
43	HAS	23MB4064 - SDM	CO2	Apply the search engine optimization technique to website											2			
44	HAS	23MB4064 - SDM	CO3	Apply the key PPC concepts to draw visitors to a business websites											2			
45	HAS	23MB4064 - SDM	CO4	Analyse the search engine optimization technique for marketing strategy											2			
46	HAS	23MB4065 - DET	CO1	Introduction to Digital Economics	2													
47	HAS	23MB4065 - DET	CO2	Digital Business Models		2												
48	HAS	23MB4065 - DET	CO3	Tokenomics Fundamentals			3											

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
49	HAS	23MB4065 - DET	CO4	Economic Implications of Cryptocurrencies			3											
50	HAS	23MB4066 - DFDFS	CO1	Define and explain the key concepts of DeFi, including decentralization, blockchain technology, smart contracts, and decentralized applications (DApps). Differentiate between traditional financial systems and DeFi ecosystems, identifying the advantages and challenges of each.	2												2	
51	HAS	23MB4066 - DFDFS	CO2	Describe the fundamentals of blockchain technology, including consensus mechanisms, cryptographic principles, and transaction processing. Evaluate different blockchain platforms and their suitability for supporting DeFi applications.			2										2	
52	HAS	23MB4066 - DFDFS	CO3	Analyze and evaluate various decentralized financial protocols, such as decentralized exchanges (DEXs), lending platforms, liquidity provision mechanisms, and asset management protocols. Demonstrate the ability to interact with DeFi protocols through hands-on exercises and practical applications.						3								3
53	HAS	23MB4066 - DFDFS	CO4	Explain the concept of stablecoins and synthetic assets, including their design principles, use cases, and implications for the broader financial ecosystem. Assess the role of stablecoins and synthetic assets in mitigating volatility and enabling new financial services in DeFi.						3								3
54	HAS	23MB4067 - IMPP	CO1	Understand the basic management concepts along with an insight into production and control											2			2

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
55	HAS	23MB4067 - IMPP	CO2	Select best forecasting models to predict future demand	2													2
56	HAS	23MB4067 - IMPP	CO3	Solve various production scheduling problems to optimize productivity				2										2
57	HAS	23MB4067 - IMPP	CO4	Understand concept of Inventory control, Method study and time study											2			2
58	HAS	23MB4068 - IMG	CO1	Identify and analyze market needs and gaps, using tools such as SWOT and PESTLE analysis, to pinpoint real-world problems suitable for entrepreneurial solutions.		1									2		2	
59	HAS	23MB4068 - IMG	CO2	Develop innovative solutions through creative thinking and apply lean startup principles to build and iterate a minimum viable product (MVP).		1									1		1	
60	HAS	23MB4068 - IMG	CO3	Create a comprehensive lean business model canvas that outlines customer segments, value propositions, channels, revenue streams, and key metrics.		1									2		1	
61	HAS	23MB4068 - IMG	CO4	Create a compelling business plan and investor pitch, including financial projections and funding strategies, demonstrating effective communication and persuasion skills.		1									2		2	
62	HAS	23UC0026 - HGP	CO1	Understanding the basic concepts of value education								2	1					
63	HAS	23UC0026 - HGP	CO2	Gain basic understanding of the principles in harmony among the human beings								2	1					
64	HAS	23UC0026 - HGP	CO3	Gain knowledge in the concept of Harmony in the family and society								1	3					
65	HAS	23UC0026 - HGP	CO4	Acquire knowledge in the concepts of harmony in the nature								1	3					

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
66	HAS	23UC0027 - LAMS	CO1	Understand basic leadership, skills and perspectives and leadership styles									3					
67	HAS	23UC0027 - LAMS	CO2	Understand different managerial skills and apply them to develop high performance teams											3			
68	HAS	23UC0027 - LAMS	CO3	Analyse effective communicative strategies and apply them in team tasks										3				
69	HAS	23UC0027 - LAMS	CO4	Apply strategic planning fundamentals and decision-making techniques, through exercises and case studies											3			
70	HAS	23UC1101 - IPE	CO1	Language Mechanics and Basic Grammar										2				
71	HAS	23UC1101 - IPE	CO2	Integrated Reading and Techniques of Writing										2				
72	HAS	23UC1202 - EP	CO1	Express the ability in interactive skills of listening, speaking, reading, and writing that are better suited for the corporate environment.									3	3				
73	HAS	23UC1202 - EP	CO2	Apply various strategies for LSRW skills and apply them in interpreting the text									3	3				
74	HAS	23UC1203 - DTI	CO1	Understand the importance of Design thinking mindset for identifying contextualized problems		1												
75	HAS	23UC1203 - DTI	CO2	Analyze the problem statement by empathizing with user							2							
76	HAS	23UC1203 - DTI	CO3	Develop ideation and test the prototypes made			2											
77	HAS	23UC1203 - DTI	CO4	Explore the fundamentals of entrepreneurship skills for transforming the challenge into an opportunity											1			
78	BSC	22PH1008 - PEE	CO1	Applying the concepts of basics of crystal structure to find out for the structure property relation through crystal imperfections.	3													

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
79	BSC	22PH1008 - PEE	CO2	Understand the conducting and semiconducting properties of solids at the microscopic level	2													
80	BSC	22PH1008 - PEE	CO3	Understand the dielectric properties of materials at the microscopic level and their applications.	2													
81	BSC	22PH1008 - PEE	CO4	Apply the spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications	3													
82	BSC	22PH1008 - PEE	CO5	Apply the knowledge on the structure and properties of materials while executing related experiments				3										
83	BSC	23CS3201 - DSS	CO1	Understand the fundamental principles of data science and statistics	2	2												2
84	BSC	23CS3201 - DSS	CO2	Gain basic understanding the role of data science in various scenarios in the real-world problems.		2		3										2
85	BSC	23CS3201 - DSS	CO3	Apply probabilistic predictions and decisions based on data analysis.		2		3										2
86	BSC	23CS3201 - DSS	CO4	Implement and apply proficiency in statistical inference techniques			2											2
87	BSC	23CY1001 - ECY	CO1	Apply the operation of electrochemical systems to produce electric energy and storage devices.	3	2												
88	BSC	23CY1001 - ECY	CO2	Use the fundamental aspects of electrochemistry and materials science relevant to corrosion phenomena.	3	2												
89	BSC	23CY1001 - ECY	CO3	Examine water quality and apply appropriate purification technique for intended problem.	3	2												

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
90	BSC	23CY1001 - ECY	CO4	Employ the fundamental principles and general properties of materials in various engineering applications.	3	2												
91	BSC	23CY1001 - ECY	CO5	Analyze the data, develop skills in chemical analysis and their application in engineering.	3						3							
92	BSC	23MT1001 - LACE	CO1	Apply matrix algebra to the real-world applications in engineering, physical and biological sciences, computer science, finance, economics and solving the system of equations.	3													
93	BSC	23MT1001 - LACE	CO2	Apply multivariate differential calculus to find maxima & minima of functions and understand the concepts of second order differential equations and its applications.	3													
94	BSC	23MT1001 - LACE	CO3	Apply beta and gamma functions to evaluate improper integrals. Evaluate double and triple integrals techniques over a region in two dimensional and three-dimensional geometry.	3													
95	BSC	23MT1001 - LACE	CO4	interpret the physical meaning of different operators such as gradient, curl and compute the line integrals of vector functions and learn their applications.	3													
96	BSC	23MT2003 - MMNM	CO1	Modeling and solution of algebraic and transcendental equations.	3	3											3	
97	BSC	23MT2003 - MMNM	CO2	Applying numerical methods to solve ordinary differential equations.	3	3											3	
98	BSC	23MT2003 - MMNM	CO3	Solving of Linear and non-linear Partial Differential Equations.	3	3											3	
99	BSC	23MT2003 - MMNM	CO4	Applications of Partial Differential Equations.	3	3											3	

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
100	BSC	23MT2004 - MPG	CO1	Apply various methods for finding the optimal solution of Linear Programming Problem.	2	2											2	
101	BSC	23MT2004 - MPG	CO2	Apply Integer and Fractional programming approaches for solving optimization problems.	2	3											2	
102	BSC	23MT2004 - MPG	CO3	Apply quadratic programming and geometric programming techniques for solving non linear programming problems	2		3										3	
103	BSC	23MT2004 - MPG	CO4	Apply evolutionary algorithms, nature-inspired metaheuristics, to solve complex optimization problems in infinite-dimensional spaces.		3	3										3	
104	BSC	23MT2007 - RVASP	CO1	Apply Mathematical models of random phenomena and solve probabilistic problems.	2												2	
105	BSC	23MT2007 - RVASP	CO2	Analyze different types of random variables and compute statistical parameters of the random variables.	3	3											3	
106	BSC	23MT2007 - RVASP	CO3	Apply random processes in the time domain and model time varying linear systems.		3												
107	BSC	23MT2007 - RVASP	CO4	Analyze random processes in frequency domains and model spectral characteristics of LTI systems.			3											
108	ESC	23AD20010 - AIML	CO1	Apply a variety of artificial intelligence algorithms and techniques to effectively solve complex problems in diverse real-world environments		3	3	3									3	
109	ESC	23AD20010 - AIML	CO2	Solve constraint satisfaction problems, employ knowledge engineering principles to perform inferencing, reasoning and probability theory.		3	3	3									3	
110	ESC	23AD20010 - AIML	CO3	Apply various machine learning techniques to analyze and solve real-world problems		3	3	3									3	

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
111	ESC	23AD2001O - AIML	CO4	solve complex real-world problems using advanced supervised and unsupervised learning techniques.		3	3	3									3	
112	ESC	23AD2001O - AIML	CO5	Evaluate solutions for various AI & ML related problems.			3	3	3								3	
113	ESC	23EC1101 - FITS	CO1	Apply the basic concepts of IoT and its implementation using the Development Hardware	2	1											3	
114	ESC	23EC1101 - FITS	CO2	Apply the different sensors interfacing with Development Hardware		1	3										3	
115	ESC	23EC1101 - FITS	CO3	Apply the different actuators interfacing with Development Hardware		1	3										3	
116	ESC	23EC1101 - FITS	CO4	Analyze the IoT concept to solve real time insights		1	3	2									3	
117	ESC	23EC1101 - FITS	CO5	Analyze the concept of IoT by interfacing with sensors and Development Hardware		1	3										3	
118	ESC	23EC1202 - DDCA	CO1	Build the combinational and programmable digital logic circuits using logic gates and optimization methods	2	2											3	
119	ESC	23EC1202 - DDCA	CO2	Construct the sequential and memory circuits using flip-flops	2	2											3	
120	ESC	23EC1202 - DDCA	CO3	Organize computer architecture and instructions sequence	2	2											3	
121	ESC	23EC1202 - DDCA	CO4	Model the Memory Architecture and I/O Organization modules	2	2											3	
122	ESC	23EC1202 - DDCA	CO5	Develop and analyze computer architecture modules using basic combinational, sequential and memory logics	2		2		2								3	

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
123	ESC	23EC1203 - BEEC	CO1	Understand the basic concepts of circuits and its fundamentals	2												3	
124	ESC	23EC1203 - BEEC	CO2	Grasp the principles of AC circuits, including sinusoidal waveforms, impedance, and power factor.	2												3	
125	ESC	23EC1203 - BEEC	CO3	Comprehend the behavior of basic electronic components, such as diodes, and transistors.	2												3	
126	ESC	23EC1203 - BEEC	CO4	Understand the basic functional Principles of analog and digital ICs.	2												3	
127	ESC	23ME1103 - DTW	CO1	Demonstrate proficiency in typing sentence , paragraph , report , presentations along spread sheets using office tools, LaTeX tools and PowerBI					2									2
128	ESC	23ME1103 - DTW	CO2	Build a static website and blog with using html along with Special features of HTML5, CSS and Javascript					3					3				
129	ESC	23ME1103 - DTW	CO3	Develop a virtual environment with cospace and construct a marker based Augmented Reality			3										3	
130	ESC	23ME1103 - DTW	CO4	Utilising the softwares of Autodesk Fusion 360 and the same can be printed in 3D printer as physical prototype			3										3	
131	ESC	23SC1101 - CTSD	CO1	Develop and apply logical building blocks to solve real world problems	3	3	3											
132	ESC	23SC1101 - CTSD	CO2	Apply computational thinking for designing solutions	3	3	3											
133	ESC	23SC1101 - CTSD	CO3	Develop and apply the CRUD operations on arrays	3			3										
134	ESC	23SC1101 - CTSD	CO4	Apply CRUD operations on Linear Data Structures	3	3	3											

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
135	ESC	23SC1101 - CTSD	CO5	Apply the structured programming paradigm with logic building skills on Basic and Linear Data Structures for solving real world problems	3													
136	ESC	23SC1101 - CTSD	CO6	Skill the students in such a way that students will be able to develop logic that help them to create programs as well as applications in C														
137	ESC	23SC1202 - DS	CO1	Understand various sorting algorithms and analyse the efficiency of the algorithms.	3	3												
138	ESC	23SC1202 - DS	CO2	Implement and evaluate Linear Data Structures and Demonstrate their applications.	3	3	3											
139	ESC	23SC1202 - DS	CO3	Implement and evaluate tree data structures and understand hashing techniques	3	3	3						3					
140	ESC	23SC1202 - DS	CO4	Understand graph data structures and apply graphs to solve problems	3	3							3					
141	ESC	23SC1202 - DS	CO5	"Design, Develop and evaluate common practical applications for linear and nonlinear data structures."			3						3					
142	ESC	23SC1202 - DS	CO6	"Skill the students in such a way that students will be able to develop logic that help them to create programs on both linear and non-linear data structures and its applications."			3						3					
143	ESC	23SC1203R - CTOD	CO1	Apply Object oriented paradigm for code reusability			3		3									3
144	ESC	23SC1203R - CTOD	CO2	Design object-oriented solutions to the real-world problems through SOLID design principles			3		3									3
145	ESC	23SC1203R - CTOD	CO3	Build Abstract Data Types by applying generic classes and java API			3		3									3
146	ESC	23SC1203R - CTOD	CO4	Demonstrate Exception handling and String manipulation techniques			3		3									3

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
147	ESC	23SC1203R - CTOD	CO5	Develop solutions for real time problems by using object-oriented programming concepts.	3	3		3										3
148	ESC	23SC1203R - CTOD	CO6	Develop a real time project by using object-oriented programming concepts.	3	3		3										3
149	PCC	23AD2102R - DBMS	CO1	Apply fundamental database design principles, including normalization, to model complex data relationships.			3											
150	PCC	23AD2102R - DBMS	CO2	Develop efficient and secure database applications using Structured Query Language (SQL) and PL/SQL for data manipulation and retrieval.			3											1
151	PCC	23AD2102R - DBMS	CO3	Implement and manage database systems with appropriate indexing techniques, query optimization strategies, and concurrency control mechanisms for efficient and reliable data access.					2				2					2
152	PCC	23AD2102R - DBMS	CO4	Analyze and evaluate the suitability of emerging database technologies like NoSQL and Big Data for modern applications, considering security implications.					2				3					2
153	PCC	23AD2102R - DBMS	CO5	Design and implement practical database solutions to solve real-world problems using appropriate database management system technologies and best practices.			2		2				2					3
154	PCC	23EC2106R - PRC	CO1	Apply the foundational concepts of the 8086 microprocessor, including its architecture, pinout, addressing modes, instruction set, timing diagrams for different modes, ALU programming, and practical examples."		2			3		3						2	

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
155	PCC	23EC2106R - PRC	CO2	Apply the core aspects of the 8051 microcontroller, focusing on its architecture, pin diagram, addressing modes, instruction sets, and programs involving arithmetic and logical operations, as well as the use of timers and counters."		2			3		3						2	
156	PCC	23EC2106R - PRC	CO3	Analyse the 8051 microcontroller applications through assembly-level programming, exploring interrupts, serial port operations, and peripherals like timers, seven-segment displays, LCDs, ADCs, DACs, and stepper motor control, with case studies in keypad interfacing, traffic signals, home automation, and industrial use cases."		2			3		3						2	
157	PCC	23EC2106R - PRC	CO4	Apply the architectures and features of PIC and ARM microcontrollers, examining the ARM series\' evolution, core features, pipeline processing, processor modes and registers, exception handling, and ARM\'s Thumb mode of execution."		2			3		3						2	
158	PCC	23EC2106R - PRC	CO5	Analyse the 8051 microcontroller applications through assembly-level programming, exploring interrupts, serial port operations, and peripherals like timers, seven-segment displays, LCDs."		2			3		3						2	
159	PCC	23EC2210R - NPS	CO1	Apply the knowledge of communication to understand the concepts of physical layer and datalink layer.	2	2	2											2
160	PCC	23EC2210R - NPS	CO2	Analyze various MAC protocols and apply IP addressing concepts to subnet a network.		2	3											2

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
161	PCC	23EC2210R - NPS	CO3	Analyze static and dynamic routing algorithms and transport layer protocols.		2	3											2
162	PCC	23EC2210R - NPS	CO4	Analyze application layer protocols and various cryptographic algorithms.		2	3											2
163	PCC	23EC2210R - NPS	CO5	Analyze the functionality of the network using different protocols and working of various cryptographic algorithms.		2			3									2
164	PCC	23IN2101R - IOTPA	CO1	Apply the concepts of IoT Architecture and technologies	3						3						3	
165	PCC	23IN2101R - IOTPA	CO2	Apply the logical design of IoT system	3						3						3	
166	PCC	23IN2101R - IOTPA	CO3	Apply IoT networking protocols and Authentication Protocols for IoT Application layer.	3	3			3								3	
167	PCC	23IN2101R - IOTPA	CO4	Apply IoT protocols and programming concepts for real-world problems.	3	3			3								3	
168	PCC	23IN2101R - IOTPA	CO5	Develop IoT based applications using IoT Protocols			3		3									3
169	PCC	23IN2102 - EDAIC	CO1	Apply the knowledge of Semiconductor physics and discuss BJT configurations and its applications	2												2	
170	PCC	23IN2102 - EDAIC	CO2	Apply the limitations of BJT and discuss the characteristics and applications of Field Effect Transistors	2												2	
171	PCC	23IN2102 - EDAIC	CO3	Analyze the linear and nonlinear circuits approaches and realize the characteristics of operational Amplifiers	2	2											3	
172	PCC	23IN2102 - EDAIC	CO4	Apply the knowledge of internal structure, operation and applications of different ICs	2												2	

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
173	PCC	23IN2102 - EDAIC	CO5	Design and analyze analog circuits for real-time applications using Passive and Active Components		2	3		3								2	
174	PCC	23IN2203R - WTIOT	CO1	Apply RF spectrum analysis techniques to assess and optimize wireless communication systems	2												2	
175	PCC	23IN2203R - WTIOT	CO2	Apply knowledge of various wireless personal area network technologies, including Bluetooth, UWB, and ZigBee, to implement efficient sensor networks.	2	2											2	
176	PCC	23IN2203R - WTIOT	CO3	Apply the IEEE 802.11 standards to enhance WLAN connectivity and quality of service, including power-saving mechanisms.	2												2	
177	PCC	23IN2203R -	CO4	Illustrate the various cellular standards	2												2	
178	PCC	23IN2203R - WTIOT	CO5	Design and Analyse various analog and digital communication circuits			2										2	
179	PCC	23IN3104R - RTOS	CO1	Understand subsystem components of the Kernel and apply the CPU Scheduling algorithms.	2						3						2	
180	PCC	23IN3104R - RTOS	CO2	Understand memory and process virtualization and Paging, apply Page Replacement Algorithms	2						3						2	
181	PCC	23IN3104R - RTOS	CO3	Understand and Apply the threading issues for RTOS	2	2			2								3	
182	PCC	23IN3104R - RTOS	CO4	Understand and Apply the memory management concepts in RTOS	3	3			2								2	
183	PCC	23IN3104R - RTOS	CO5	Able to perform experimentation Real-Time Operating Systems Other Basic Operating System Functions														
184	PCC	23IN3105R - ESD	CO1	Understand Embedded C programming concepts and apply for embedded system design.			2		2									3

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
185	PCC	23IN3105R - ESD	CO2	Apply GPIO and HAL concepts to interface various input output devices.			2		2									3
186	PCC	23IN3105R - ESD	CO3	Apply UART, I2C communication protocols to interface real time devices.		3			3									3
187	PCC	23IN3105R - ESD	CO4	Analyze state flow models for embedded system applications			3		3									3
188	PCC	23IN3105R - ESD	CO5	Design and develop real world applications using embedded system design principles.		2			3									3
189	PRI	23IE2040 - SIP	CO1	Remember the fundamentals of the science of water cycle along with powerful tools that students can use to diagnose the health of the local water cycle as well as develop targeted action plans to restore the local natural water cycle and bring water prosperity			3										3	
190	PRI	23IE2040 - SIP	CO2	Remember the water sustainability and water resilience of village, city, residential facilities and households using multi-level water scorecards				3									3	
191	PRI	23IE2040 - SIP	CO3	Apply the design thinking positive action plan for a village, campus, residential facility and community neighbourhood.					3								3	
192	PRI	23IE2040 - SIP	CO4	Apply the water positive solutions within an urban watershed, a rural watershed, residential institutional and corporate community						3							3	
193	PRI	23IE3041 - TIP	CO1	Ability to demonstrate the impact of academic skills and logical thinking			3										3	
194	PRI	23IE3041 - TIP	CO2	Ability to integrate existing and new technical knowledge for industrial application				3									3	

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
195	PRI	23IE3041 - TIP	CO3	Ability to demonstrate the impact of the internship on their learning and professional development					3								3	
196	PRI	23IE3041 - TIP	CO4	Demonstrate the ability to harness resources by analyzing challenges						3							3	
197	PRI	23IE4048 - EPJ	CO1	Literature search equips students with the ability to efficiently locate, evaluate, and synthesize academic and scholarly sources relevant to their field of study. Students will develop skills to conduct comprehensive searches, critically assess the credibility of sources, and apply research findings to support their academic or professional work.	2													
198	PRI	23IE4048 - EPJ	CO2	Problem identification enables students to accurately recognize and define complex issues or challenges within a given context. Students will learn to analyze situations critically, identify underlying causes, and articulate clear problem statements that guide effective problem-solving strategies.		2												
199	PRI	23IE4048 - EPJ	CO3	Analysis of research work prepares students to critically evaluate and interpret research studies, assessing the methodology, data, and conclusions. Students will develop the ability to dissect research findings, identify strengths and weaknesses, and draw informed conclusions that contribute to their own academic or professional endeavors.						3							3	

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
200	PRI	23IE4048 - EPJ	CO4	Evaluation of research work trains students to systematically assess the quality and relevance of research studies by examining their design, methodology, and overall contributions to the field. Students will gain the skills to judge the validity, reliability, and impact of research, enabling them to make informed decisions and provide constructive feedback in academic or professional contexts.									2					3
201	PRI	23IE4053 R - CP-1	CO1	Exercise to acquire knowledge within the chosen area of technology for project development.	2													
202	PRI	23IE4053 R - CP-1	CO2	Identify, discuss and justify the technical aspects of the chosen area for problem analysis		2												
203	PRI	23IE4053 R - CP-1	CO3	Reproduce, improve and refine technical aspects for chosen problem						3							2	
204	PRI	23IE4053 R - CP-1	CO4	Communicate and report effectively project related activities and findings.									2					3
205	PRI	23IE4053R - CP-1	CO1	Exercise to acquire knowledge within the chosen area of technology for project development.	2													
206	PRI	23IE4053R - CP-1	CO2	Identify, discuss and justify the technical aspects of the chosen area for problem analysis		2												
207	PRI	23IE4053R - CP-1	CO3	Reproduce, improve and refine technical aspects for chosen problem						3							2	
208	PRI	23IE4053R - CP-1	CO4	Communicate and report effectively project related activities and findings.									2					3

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
209	PRI	23IE4054R - CP-2	CO1	Literature search equips students with the ability to efficiently locate, evaluate, and synthesize academic and scholarly sources relevant to their field of study. Students will develop skills to conduct comprehensive searches, critically assess the credibility of sources, and apply research findings to support their academic or professional work.	2													
210	PRI	23IE4054R - CP-2	CO2	Problem identification enables students to accurately recognize and define complex issues or challenges within a given context. Students will learn to analyze situations critically, identify underlying causes, and articulate clear problem statements that guide effective problem-solving strategies.		2												
211	PRI	23IE4054R - CP-2	CO3	Analysis of research work prepares students to critically evaluate and interpret research studies, assessing the methodology, data, and conclusions. Students will develop the ability to dissect research findings, identify strengths and weaknesses, and draw informed conclusions that contribute to their own academic or professional endeavors.						3								
212	PRI	23IE4054R - CP-2	CO4	Analysis of research work prepares students to critically evaluate and interpret research studies, assessing the methodology, data, and conclusions. Students will develop the ability to dissect research findings, identify strengths and weaknesses, and draw informed conclusions that contribute to their own academic or professional endeavors.									2					

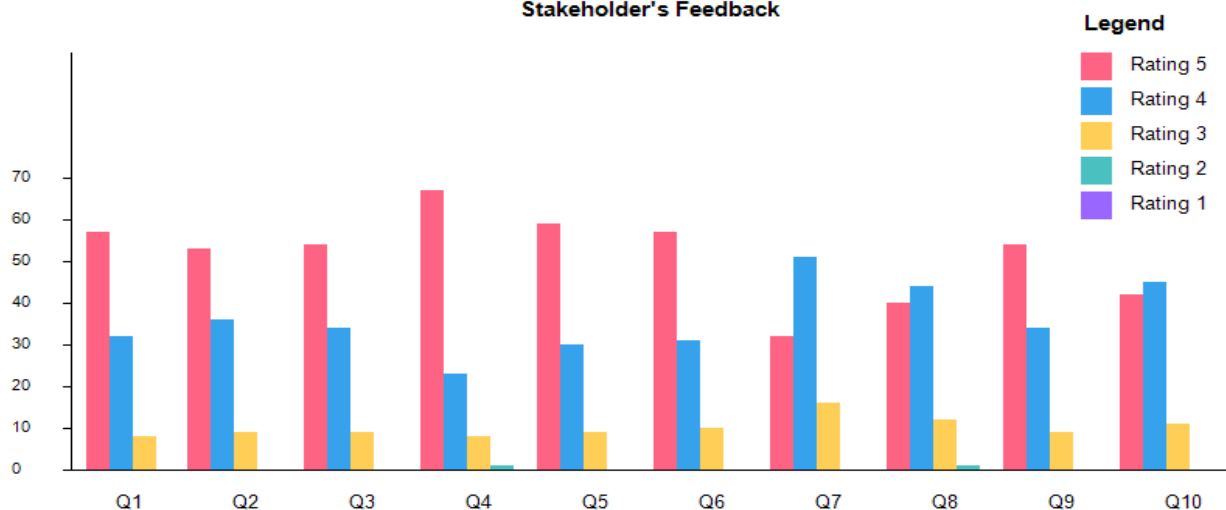
S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
213	SIL	22UC0021 - SIL-1	CO1	Apply effective communication and collaboration skills to work with diverse populations in addressing social issues within the community.								3	3					2
214	SIL	22UC0021 - SIL-1	CO2	Build technological solutions to real-world problems or challenges with peers to achieve common goals.								3	3					2
215	SIL	22UC0021 - SIL-1	CO3	Plan effectively to communicate ideas and collaborate with others to achieve artistic or recreational goals.				3										2
216	SIL	22UC0021 - SIL-1	CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment.				3					3					2
217	SIL	22UC0021 - SIL-1	CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences.						3								2
218	SIL	22UC0022 - SIL-2	CO1	Apply effective communication and collaboration skills to work with diverse populations in addressing social issues within the community.								3	3					
219	SIL	22UC0022 - SIL-2	CO2	Build technological solutions to real-world problems or challenges with peers to achieve common goals.								3	3					
220	SIL	22UC0022 - SIL-2	CO3	Plan effectively to communicate ideas and collaborate with others to achieve artistic or recreational goals.			3					3	3					
221	SIL	22UC0022 - SIL-2	CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment.			3					3	3					3

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
222	SIL	22UC0022 - SIL-2	CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences.			3					3	3					
223	SIL	22UC0023 - SIL-3	CO1	Apply effective communication and collaboration skills to work with diverse populations in addressing social issues within the community.								3	3					
224	SIL	22UC0023 - SIL-3	CO2	Build technological solutions to real-world problems or challenges with peers to achieve common goals.								3	3					
225	SIL	22UC0023 - SIL-3	CO3	Plan effectively to communicate ideas and collaborate with others to achieve artistic or recreational goals.			3						3					3
226	SIL	22UC0023 - SIL-3	CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment.			3						3					3
227	SIL	22UC0023 - SIL-3	CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences.			3			3			3					
					2.3	2.2	2.8	2.8	2.6	2.8	2.9	2.3	2.6	2.6	2	2.6	2.5	2.4

Stakeholder's Feedback

Q#	Question	No. of Stakeholder's						Rating (%)				
		STU	ALU	IE	AP	FAC	TOT	[5]	[4]	[3]	[2]	[1]
Q1	How would you rate the relevance of the current syllabus content in addressing industry needs and trends?	604	256	182	169	678	1889	57.6	32.8	8.8	0.7	0
Q2	How well do the course outcomes align with the skills required in the industry?	604	256	182	169	678	1889	53.7	36.3	9.3	0.7	0
Q3	How would you rate the inclusion of emerging technologies or methodologies in the syllabus?	604	256	182	169	678	1889	54.9	34.5	9.8	0.8	0
Q4	How effectively are the latest tools integrated into the curriculum?	604	256	182	0	0	1042	67.4	23.1	8	1.5	0
Q5	How beneficial are the global certifications included in the curriculum for industry readiness?	604	256	182	0	678	1720	59.5	30.1	9.4	0.9	0.1
Q6	How effectively does the curriculum incorporate practical lab experiments relevant to industry practices?	0	256	182	0	0	438	57.1	31.7	10.5	0.7	0
Q7	How does this curriculum compare with similar curricula at other institutions in terms of content and quality?	0	0	0	169	0	169	32.5	51.5	16	0	0
Q8	How effective is the integration of research opportunities into the curriculum?	0	0	0	169	678	847	40.6	44.7	12.9	1.8	0
Q9	How beneficial were the MOOCs recommended as part of the curriculum?	604	256	0	169	678	1707	54.6	34.7	9.8	0.9	0
Q10	How well does the course content map to skill council recommendations?	0	0	182	169	678	1029	42.7	45.3	11.6	0.5	0

Stakeholder's Feedback





(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Humanities Arts And Social Sciences (HAS)

23FL3054 - FRENCH LANGUAGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23FL3054	FRENCH LANGUAGE	FLG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Acquire a working knowledge of the basic elements of the French language viz. letters, vowels, accents, articles, useful expressions, etc.	2	PO5, PO8
CO2	Classify questions and respond in the affirmative or negative with ?tre and avoir and form plurals	2	PO6, PO10
CO3	Utilize and apply the adjectives and essential verbs.	3	PO8, PO10
CO4	Construct and use in speech, vocabulary, reading, questions and answers	3	PO8, PO12

Syllabus

Les alphabet, les articles ,les articles indefinis,la negation, les chiffres , les joiurs de la semaine, les mois de l\annee,les articles conttactes

les pronoms sujets,faites de la phrases presentez-vous,les auxiliries comme AVOIR,ETRE,ALLER, les mots interrogatifs , la famille ,la contraire,

la conjugation du verbe premiere et ddeuxieme et troisieme les adjectifs interrogatifs , les adjectifs demonstratifs,les adjectifs possessifs

les professions, le pronom ON,les questions generale,le futue sample,la passe recent.le futur proche.nationalities,les animaux,les loisirs,

Reference Books

- 1 Le NouvelEsprit, M?thodedeFran?ais,Tome Un,publi?parLangersInternational, poisson -quinton, 01, goyal.
- 2 Cours deLangue etdeCivilisationFran?aises,TomeUn,publi? parHachette, vergne-sirieys, 04, goyal.
- 3 Bonjour Tristesse", Fran?oise Sagan, Bonjour Tristesse (Folio) (French Edition), Gallimard.
- 4 L'?tranger", Albert Camus, L'?tranger (Folio) (French Edition), Gallimard.

23FL3055 - GERMAN LANGUAGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23FL3055	GERMAN LANGUAGE	GLG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	classify their understanding of greeting wishes, alphabets and numbers learning. to understand the greetings in formal and informal way	2	PO5, PO8
CO2	Apply their knowledge of essential daily expressions, present, past and future tense. Conjugating the verbs in the Singular and Plural groups, Past participle tense and the futertense and relations with the verbs	3	PO10
CO3	Utilize their understanding with suitable prepositions, questions, and possessive pronouns, and the importance of four German cases. Prepositions in Akkusativ and Dativ	3	PO10
CO4	Develop their knowledge about how to move in public places, such as shopping centres, restaurants, tourist places, etc, and preparation of them for German A1 level examination.	3	PO8, PO12

Syllabus

Introduction to multiplication concepts (may be a bit advanced for beginners). Simple multiplication problems with pictures or manipulatives might be introduced. Learn the upper and lowercase letters of the German alphabet (A-Z, a-z). Practice pronunciation of each letter.

Sein Form: Used for statements about existence, location, and becoming (e.g., "Ich bin Student" - I am a student).
Haben Form: Used for statements about possession, action, and completion (e.g., "Ich habe ein Auto" - I have a car).

Building German sentences? Cases (Nominative, Accusative, Dative, Genitive) are key! They show the role of nouns and pronouns (like "ich," "mein Buch"). Prepositions (in, auf) and questions (Wo? Wer?) require specific cases too. Understanding cases unlocks clear and flexible sentence structures!

Understand about how to move in public places such as shopping centres restaurants tourist places etc and preparation of them for German A1 level examination. A1 German for navigating public places: Learn basic greetings ("Guten Tag") and phrases ("Entschuldigung, wo ist...?" - Excuse me, where is...?). Practice ordering ("Ein Kaffee, bitte" - One coffee, please) and asking permission ("Darf ich hier sitzen?" - May I sit here?). Remember key vocabulary for shops ("Gesch?ft"), restaurants ("Restaurant") and tourist spots ("Sehensw?rdigkeit").

Reference Books

- 1 Studio D A1, Deutsch als Fremdsprache , Kursbuch und Arbeitsbuch, Cornelsen, 2000, Goyal Publishers & Distributors Pvt.Ltd. New Delhi.
- 2 Collins, easy learning German Grammar & Practice , Harpercollins Specials, 2004, Goyal Publishers & Distributors Pvt.Ltd..
- 3 Tangram aktuell 1 Kursbuch + Arbeits buch , Huebner , 2007, Goyal publishers and Distributors pvt.Ltd.
- 4 Studio d A1 Deutsch als Fremdsprache A1, Vocabulary , Cornelsen, 2004, Goyal Publishers & Distributors Pvt Ltd.

23FL3058 - JAPANESE LANGUAGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23FL3058	JAPANESE LANGUAGE	JLG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Classify Hiragana, Katakana, and basic Kanji characters used in greetings and simple scripts	2	PO5, PO8
CO2	Apply their knowledge of essential daily expressions, numbers, months, dates, time, body parts, colors, and common vocabulary to effectively communicate in basic everyday situations	3	PO10
CO3	Utilize their understanding of present, past, and future tenses, along with the ability to construct interrogative sentences, to express themselves in various timeframes and ask questions effectively in different conversational contexts. pen_spark	3	PO8, PO10
CO4	Develop their knowledge of verbs, including negative conjugations, and prepositions to discuss hobbies, deliver self-introductions, and navigate basic interview scenarios in Japanese	3	PO8, PO12

Syllabus

Greetings and writing script- Hiragana , katakana and basic Kanji

Daily uses expressions , Numbers , Months, date , time, Body parts and colors name, daily uses vocabularies

Present tense , Past tense, Future tense , Interrogative sentences,

Verbs , Negative verbs , Propositions , Hobbies , self introduction, Interview preparation in Japanese

Reference Books

- 1 Minna no Nihongo - N5 Level, 3A Corporation, 2nd Edition, Goyal Publosher.
- 2 Genki: An Integrated Course in Elementary Japanese", Eri Banno, Yoko Ikeda, Yutaka Ohno, 3rd Edition, The Japan Times.
- 3 Japanese from Zero, George Trombley and Yukari Takenaka, 7th Edition, YesJapan Corporation.
- 4 Remembering the Kanji, James W. Heisig, 2nd Edition, University of Hawaii Press.

23MB0001 - BASICS OF MARKETING FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB0001	BASICS OF MARKETING FOR ENGINEERS	BME	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of marketing management	2	PO2
CO2	Understand the concepts of Marketing environment, consumer behaviour and Segmentation, Targeting and Positioning (STP)	2	PO2
CO3	Apply the marketing mix strategies with special focus on technology products	3	PO4
CO4	Apply promotion and distribution strategies for marketing of high tech products and services	3	PO6

Syllabus

Introduction and Nature of Marketing: Evolution of Marketing Concept - Core concepts of marketing - Scope and Importance of Marketing. -Difference between Selling and Marketing - Marketing Myopia - Consumer Marketing Vs. Industrial Marketing.

Marketing Environment and factors of marketing environment-Understanding Consumer Behaviour-nature, scope and importance of consumer behaviour-Factors influencing Consumer Behaviour-Buying decision making process-Market Segmentation, Targeting and Positioning (STP).

Marketing mix - Product definition, levels of product, product classification, difference between goods and services, Product Life Cycle, New Product Development-Technology and Product Management-Concept of Pricing-Factors influencing the pricing policy-Pricing strategies-Pricing Considerations in High-Tech Markets.

Promotion mix-Marketing Communication Tools for High-Tech Markets-Channels of distribution-Supply Chain Management in High-Tech Markets-Technology Marketing, Green Marketing, and Concept of market study.

Reference Books

- 1 Marketing Management, Kotler and Keller, 15th Edition, 2017, Pearson Education.
- 2 Marketing Management, Rajan Saxena, 6th Edition 2019, McGraw-Hill.
- 3 Marketing Management, V. S. Ramaswamy and S. Namakumari, 6th Edition 2018, Sage Publications India Pvt Ltd.
- 4 Principles of Marketing, Philip Kotler , Gary Armstrong, et al., 19th Edition 2023, Pearson Education.

23MB0002 - PARADIGMS IN MANAGEMENT THOUGHT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB0002	PARADIGMS IN MANAGEMENT THOUGHT	PIMT	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic management concepts along with an insight into levels of management	2	PO9
CO2	Understand the key contributions of classical approach to Management	2	PO12
CO3	Understand and apply Quantitative methods to improve Management performance.	3	PO9
CO4	Understand the key contributions of Behavioural and contemporary approaches to Management.	4	PO9

Syllabus

Management Introduction , Early management thought , Management Concept , Nature - Management as art, science, profession , Scope and functions of Management , Levels of Management , Importance of management, Classical Approach to Management, Scientific Management, The advent of Scientific Management, Frederick W Taylors contributions, Contribution by Henry L Gantt

Contribution by Frank, Lillian Gilberth, General Administrative Approach, Henry Fayols contributions towards general management , Max Webers Bureaucracy Approach, Quantitative Approach, Important contributions , TQM , implications in todays management , Six sigma

Behavioral Approach, Organizational Behaviour , Contributions of Elton Mayos ,Hawthorne studies , contributions of Mary Parker Follett , Chester Bernard

Contemporary Approach: Systems Theory , Contingency Theory , Chaos Theory , Peter F Drucker Contributions , C K Prahlads Contribution ,Porters theory , Worker Management , Employee Engagement , People Capability Maturity Model.

Reference Books

- 1 Management, Stoner, Freeman, Gilbert, 7th edition, PHI.
- 2 Management A Global & Entrepreneurial Perspective, Weihrich, Cannice, Koontz, 13th Edition, Mc Graw Hill.
- 3 The evolution of management thought , Daniel A Wren, Arther G Bedeian, 7th edition , john wiley& sons.
- 4 PRINCIPLES AND PRACTICE OF MANAGEMENT, Prasad L M, 2019, SULTAN CHAND & SONS.

23MB0003 - FINANCIAL MANAGEMENT FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB0003	FINANCIAL MANAGEMENT FOR ENGINEERS	FMFE	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the comprehension of finance functions and diverse business models to facilitate informed decision-making processes within financial management.	2	PO2
CO2	Analyzing the investment decisions through an understanding of capital budgeting techniques, both traditional and modern, emphasizing long-term implications.	3	PO4
CO3	Analyze and make informed decisions regarding working capital management, considering the short-term financial health of organizations through practical case studies.	3	PO4
CO4	Developing proficiency in comprehending and utilizing various sources of finance while discerning the implications of different dividend policies in practical financial scenarios.	3	PO4

Syllabus

Introduction to Finance: Financial Management, Definitions, Investment Decision, Finance Decision, Dividend Decision, Types of Business, Proprietary company, Partnership Company, Company, Features, Merits and Demerits, Private Limited Company Vs. Public Limited Company, Classification of companies, Franchisee, Cooperative Society. How to start a limited company, Public Issue.

Capital Budgeting Meaning, Features, Techniques of Capital Budgeting, Traditional methods- Payback Period, ARR and Modern Methods- NPV, IRR & Profitability Index, Case studies on Capital Budgeting.

Working Capital Management- Gross working capital, Net working Capital, operating cycle, computation of working capital Requirement, determinants of working capital requirements in a company, Cash Management, Receivables Management, and Inventory Management. Case studies on Working Capital.

Sources of Finance and Dividend: Short-term sources - Cash credit limit, Overdraft, Bill Discounting, Short term loans, long-term sources Equity, Preference, Bond/ Debenture, Term loans, Venture capital financing. Dividends, Meaning, Types of Dividends, Dividend Policies in Practice.

Reference Books

- 1 Theory & Problems In Financial Management , Khan, M. Y & Jain, P. K , 10, TMH.
- 2 Financial Management, C Paramasivan, 1, New Age India .
- 3 Financial Management, Bhalla V K, 3, Sultan CHand.
- 4 Financial Management, I M Pandey, 10, Vikas Publishing House.
- 5 Essentials of Financial Management, Pandey IM, 1, Vikas Publishing House.
- 6 Financial Management for Engineers, Peter Flynn, 1, Pearson Custom Publishing.

23MB0004 - ORGANIZATION MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB0004	ORGANIZATION MANAGEMENT	OMG	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Remember and understand the various management theories and management approaches.	2	PO9
CO2	Remember and understand organization theories, structures and organization principles	2	PO12
CO3	Have basic knowledge and understanding of motivation, motivational theories, leadership theories, moral and behavioral sciences and also understand the management concept, administration and management objectives.	2	PO9
CO4	Remember and understand the various issues in industrial relations, trade unions and college bargaining and industrial safety	2	PO9

Syllabus

Development of Management thought , Introduction, Various theories; Functional approach, scientific management approach, human relations approach, latest management thoughts, organisation theory-classical organisation, neo-classical organisation theory, modern organisation theory

Organization Structure, Principles of organisation, organizational theories, departmentalism, authority, power, organizing, organizational effectiveness, structuring the organisation, organizational change, organisation charts; types of organisations, line , functional and line and staff relations, Organisational manuals

Motivation, Morale and behavioral science, Motivation Characteristics, importance, Kinds of motivation. Thoughts of motivational philosophy: Douglass McGregor, X and Y theory; Herzbergs theory. Human needs, Incentive as motivators, Managing dissatisfaction and frustration. Morale, Absenteeism, Behavioral science, Group dynamics, Group behavior. Leadership, Meaning, importance, styles, theories, leaders Vs managers. Management concept, Management, Administration, Organisation, Difference and Relationship between Management, Administration and Organisation, Importance of Management, Characteristics of management, Managerial Skills, Managerial Objectives, Harmonization of Objectives, Hierarchy of Objectives

Industrial Relations, Trade Union And Collective Bargaining, Industrial relations, Industrial Psychology, Industrial disputes, Conflict management, Views about conflict, Labor Policy. Workers grievances, Suggestion system. Trade Unions. Collective Bargaining, Negotiations, Industrial Safety, working conditions, Accidents, Preventive measures, Safety training.

Reference Books

- 1 Organizational behavior, Stephen P. Robins, 11th edition, PHI.
- 2 Essentials of Management, Koontz & Wehrich, 12th edition, Tata Mc Grawhill.
- 3 PRINCIPLES AND PRACTICE OF MANAGEMENT, Prasad L M , 1 January 2019, SULTAN CHAND & SONS-NEW DELHI.
- 4 Principles of Management, GUPTA, MEENAKSHI, 2009, PHI Learning Pvt. Ltd..

23MB0005 - MANAGING PERSONAL FINANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB0005	MANAGING PERSONAL FINANCE	MPF	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Personal Finance	2	PO1
CO2	Applying and Building a Budget and Tracking Your Money	3	PO2
CO3	Applying and Managing Debt and Credit in present context	3	PO3
CO4	Applying Saving and Investment to present scenario	3	PO3

Syllabus

Introduction to personal finance. Importance of financial literacy. Overview of course structure and assessment methods.

Income and Expense Tracking Tracking income and expenses. Tools for tracking (apps, spreadsheets). Activity: Create a personal income and expense tracker. Creating a Budget Components of a budget. Setting budget categories. Activity: Develop a monthly budget.

Emergency Fund Importance of an emergency fund. How to build and maintain an emergency fund. Activity: Calculate required emergency fund. Saving for Goals Short-term vs. long-term savings goals. Setting SMART financial goals. Activity: Set personal financial goals.

Types of Debt Good debt vs. bad debt. Understanding interest rates. Activity: Identify and categorize personal debts. Strategies for Paying Off Debt Debt repayment strategies (e.g., snowball, avalanche). Debt consolidation options. Activity: Create a debt repayment plan.

Reference Books

- 1 Personal Finance, Jeff Madura, 7, TMH.
- 2 Focus on Personal Finance, Jack R. Kapoor, Les R. Dlabay, Robert J. Hughes, and Melissa Hart, 5, McGraw-Hill Education.
- 3 Financial Planning: A Guide to Managing Your Financial Life, Jeff Madura, 6, Pearson Publisher.
- 4 The Total Money Makeover, Dave Ramsey, 3, Thomas Nelson.

23MB4062 - CONSTRUCTION PROJECT MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB4062	CONSTRUCTION PROJECT MANAGEMENT	CPM	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand construction principles and techniques to effectively plan and execute construction projects.	2	PO1, PO11, PSO1
CO2	Understand about construction project scheduling, cost estimation, and resource allocation for a particular project	2	PO1, PO11, PSO1
CO3	Understand about the Construction Methods and Techniques	2	PO1, PO11, PSO1
CO4	Understand about the Construction Project Cost Estimation and Control.	2	PO1, PO11, PSO1
CO5	Understand about project cost control and monitoring, earned value management in construction.	2	PO1, PO11, PSO1

Syllabus

: Introduction to Construction Technology and Management: Overview of construction industry and its role in infrastructure development Introduction to construction technology and its applications : Construction project life cycle and stakeholders, Construction project delivery methods and contracts,

Construction Project Planning and Scheduling: Project feasibility analysis and site selection, Construction project planning and organizing, Construction project scheduling techniques (Gantt charts, critical path method), Resource allocation and optimization in construction projects

Construction Methods and Techniques: Fundamentals of construction methods and techniques, Building systems and construction technologies, Earthwork and foundation construction, Concrete construction techniques, Structural steel and timber construction

Construction Project Cost Estimation and Control: Cost estimation techniques in construction projects, Quantity takeoff and pricing of construction materials, Cost control and monitoring in construction projects, Earned value management in construction

Reference Books

- 1 Construction Project Management, y Frederick Gould, Nancy Joyce, 2019, McGraw-Hill Education.
- 2 Construction Management, Daniel W. Halpin, 2010, Wiley.
- 3 Construction Planning, Equipment, Peurifoy, 2018, McGraw-Hill Education.
- 4 Construction Materials, Methods, and techniques, William P. Spence, 2016, Pearson.

23MB4063 - RESOURCES SAFETY AND QUALITY MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB4063	RESOURCES SAFETY AND QUALITY MANAGEMENT	RSQM	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate an understanding of resource management principles and the importance of resource optimization in construction projects by applying best practices to enhance efficiency.	2	PO1, PO4, PO8, PSO2
CO2	Interpret and ensure compliance with construction safety regulations and standards set by regulatory bodies, ensuring legal and regulatory adherence in project execution.	2	PO1, PO4, PO8, PSO2
CO3	Apply hazard identification techniques and conduct comprehensive risk assessments to prioritize and mitigate risks in construction environments, enhancing safety management.	3	PO1, PO4, PO8, PSO2
CO4	Develop and implement safety management systems and quality assurance strategies, including safety policies, training, and communication, to ensure high safety standards and quality control in construction projects.	3	PO1, PO4, PO8, PSO2

Syllabus

Overview of resource management principles and concepts, Importance of resource optimization in construction projects, Techniques for resource allocation and effective utilization.

Overview of safety regulations and standards in the construction industry, Key regulatory bodies and their roles, Understanding and interpreting safety regulations and standards.

Ensuring compliance with legal and regulatory requirements.

Methods for identifying hazards in construction environments, Hazard mapping and walkthrough inspections, Conducting qualitative and quantitative risk assessments, Prioritizing risks based on severity and likelihood.

Introduction to safety management systems (SMS), Components of an effective safety management system, Implementation of safety policies and procedures, Training and communication strategies for promoting safety culture, Understanding quality assurance (QA) and quality control (QC) in construction, Importance of quality standards and specifications.

Reference Books

- 1 Construction Safety and the OSHA Standards, David L. Goetsch, 2, Pearson.
- 2 Safety Management Systems in Aviation, Alan J. Stolzer, Carl D. Halford, John J. Goglia, 1, Ashgate Publishing.
- 3 Project Management: A Systems Approach to Planning, Scheduling, and Controlling, Harold Kerzner, 4, John Wiley & Sons.
- 4 Quality Management for the Technology Sector, Roger C. Pearson, 3, Elsevier.
- 5 Safety Management Systems in the Workplace, Charles D. Reese, 2, Pearson.

23MB4064 - SEO AND DIGITAL MARKETING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB4064	SEO AND DIGITAL MARKETING	SDM	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of digital marketing and search engine optimization	2	PO11
CO2	Apply the search engine optimization technique to website	3	PO11
CO3	Apply the key PPC concepts to draw visitors to a business websites	3	PO11
CO4	Analyse the search engine optimization technique for marketing strategy	4	PO11

Syllabus

Introduction to Digital Marketing & SEO: Concept, and Scope of Digital Marketing, Comparison of Marketing and Digital Marketing, Benefits of Digital Marketing, Digital Marketing Platforms and Strategies, Digital Marketing Trends. Introduction to SEO: Meaning, Difference between portal and search engines, SEO Techniques (On Page and Off Page), Need for SEO, choosing the best search engine.

Keyword Research: Introduction, how and why to choose the right keywords, types of keywords, keyword analysis, keyword density analysis, tools for keyword research, competition analysis, localized keywords research.

On Page Optimization: Introduction, title, description and keyword tags, difference between primary, secondary and tertiary titles, length of titles, meta description and snippets, H1 to H6 tags and their importance, meta descriptions and content, difference between internal and external links, anchor text, anchor links optimization, importance of Alt tags and Image tags, Image tag optimization, content optimization, Different types of Sitemaps and their importance, Google SEO guidelines, Google Analytics and Webmaster integration

Off Page Optimization: Introduction, Social media optimization techniques, Introduction of link building and its types, Directory submission, Blog and article submission, Forum posting, Forum signatures and commenting, Free classifieds, Classifieds Posting, Press release submission, video submission, Social book marking, photo and Video sharing, Infographics sharing, Document sharing, content marketing and its importance.

Reference Books

- 1 Getting Digital Marketing Right: A Simplified Process for Business Growth, Goal Attainment, and Powerful Marketing, David J. Bradley, 2015, Createspace Independent Publishing Platform.
- 2 The Art of SEO , Eric Enge, Stephan Spencer and Jessie Stricchiola , 2015, 3rd Edition, O Reilly.
- 3 SEO Step-by-Step - The Complete Beginner's Guide to Getting Traffic from Google, Caimin Jones, 2014, Lightning Source Inc.
- 4 Social Media Marketing, Michael Solomon and Tracy Tuten, 2017, SAGE Publications Ltd.
- 5 SEO for Growth: The Ultimate Guide for Marketers, Web Designers and Entrepreneurs, John Jantsch and Phil Singleton, 2016, Greenleaf Book Group Press.

23MB4065 - DIGITAL ECONOMICS AND TOKENOMICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB4065	DIGITAL ECONOMICS AND TOKENOMICS	DET	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Digital Economics	2	PO1
CO2	Digital Business Models	3	PO2
CO3	Tokenomics Fundamentals	3	PO3
CO4	Economic Implications of Cryptocurrencies	3	PO3

Syllabus

Overview of Digital Economics Definition and scope Key concepts and trends Impact of Digital Technologies Internet and mobile communications Social media and its economic implications The sharing economy

Network Effects and Value Creation Understanding network effects Models of value creation in digital platforms Digital Market Modelling Market structures in the digital age Case studies on digital marketplaces

Introduction to Tokenomics Definition and importance Key components: token supply, market cap, and token distribution Token Supply Mechanisms Inflationary vs. deflationary tokens Staking and its impact on token supply

Cryptocurrencies in the Digital Economy Role and impact of cryptocurrencies Case studies of prominent cryptocurrencies like Bitcoin and Ethereum Token Utility and Use Cases Utility tokens vs. security tokens Real-world applications and case studies

Reference Books

- 1 Introduction to Digital Economics - Foundations, Business Models and Case Studies, Harald ?verby and Jan A. Audestad, 2004, Springer.
- 2 Tokenomics: The Crypto Shift of Blockchains, ICOs, and Tokens, Sean Au and Thomas Power, 2009, TMG.
- 3 The Token Economy: How the Web3 Reinvents the Internet, Shermin Voshmgir, 2012, O'Reilly Media.
- 4 The Age of Cryptocurrency, Paul Vigna, Michael J. Casey, 2015, St. Martin's Press.

23MB4066 - DECENTRALISED FINANCE AND DIGITAL FINANCIAL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB4066	DECENTRALISED FINANCE AND DIGITAL FINANCIAL SYSTEMS	DFDFS	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Define and explain the key concepts of DeFi, including decentralization, blockchain technology, smart contracts, and decentralized applications (DApps). Differentiate between traditional financial systems and DeFi ecosystems, identifying the advantages and challenges of each.	2	PO1, PSO1
CO2	Describe the fundamentals of blockchain technology, including consensus mechanisms, cryptographic principles, and transaction processing. Evaluate different blockchain platforms and their suitability for supporting DeFi applications.	2	PO3, PSO1
CO3	Analyze and evaluate various decentralized financial protocols, such as decentralized exchanges (DEXs), lending platforms, liquidity provision mechanisms, and asset management protocols. Demonstrate the ability to interact with DeFi protocols through hands-on exercises and practical applications.	2	PO6, PSO2
CO4	Explain the concept of stablecoins and synthetic assets, including their design principles, use cases, and implications for the broader financial ecosystem. Assess the role of stablecoins and synthetic assets in mitigating volatility and enabling new financial services in DeFi.	2	PO6, PSO2

Syllabus

Introduction to Decentralized Finance (DeFi): Overview of DeFi concepts and principles Comparison with traditional finance systems Understanding decentralized applications (DApps) and smart contracts Blockchain Technology: Fundamentals of blockchain technology Consensus mechanisms (Proof of Work, Proof of Stake, etc.) Smart contract platforms (Ethereum, Binance Smart Chain, etc.)

Decentralized Exchanges (DEXs): Role of DEXs in DeFi ecosystem Types of DEXs (Automated Market Makers, Order Book-based) Liquidity provision and decentralized liquidity pools Lending and Borrowing Protocols: Overview of decentralized lending platforms (e.g., Compound, Aave) Yield farming and liquidity mining Risk management in decentralized lending

Stablecoins and Synthetic Assets: Types of stablecoins (algorithmic, collateralized, etc.) Synthetic asset creation and trading Stablecoin protocols and their role in DeFi Decentralized Asset Management: Automated portfolio management strategies (e.g., yield optimization) Decentralized asset management platforms (e.g., Yearn Finance, Balancer)

Decentralized Identity and Governance: Identity verification in decentralized systems Decentralized governance mechanisms (e.g., DAOs) Voting and decision-making processes in decentralized communities Security and Risks in DeFi: Smart contract vulnerabilities and exploits Risks associated with liquidity provision, lending, and borrowing Regulatory challenges and compliance considerations

Reference Books

- 1 Mastering Ethereum: Building Smart Contracts and Dapps, Andreas M. Antonopoulos and Gavin Wood, 1st 2018, O'REILLY.
- 2 DeFi and the Future of Finance, R. Harvey and Ashwin Ramachandran, 2021, WILEY.
- 3 The Infinite Machine: How an Army of Crypto-Hackers Is Building the Next Internet with Ethereum, Camila Russo, 2nd 2020, Asia-Pacific Holdings .
- 4 The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them (Cryptography, Crypto Trading, Digital Assets, NFT), Antony Lewis, 2019, mongo.

23MB4067 - INDUSTRIAL MANAGEMENT & PRODUCTION PLANNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB4067	INDUSTRIAL MANAGEMENT & PRODUCTION PLANNING	IMPP	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic management concepts along with an insight into production and control	2	PO11, PSO2
CO2	Select best forecasting models to predict future demand	3	PO1, PSO2
CO3	Solve various production scheduling problems to optimize productivity	3	PO4, PSO2
CO4	Understand concept of Inventory control, Method study and time study	2	PO11, PSO2

Syllabus

Management Concept, Scope and functions of Management, Levels of Management: Low level, Middle level, High level, Importance of management, Scientific Management, Frederick W Taylors contributions, Contribution by Henry L Gantt, Contribution by Frank Lillian Gilberth, Objectives and benefits of planning and control, Functions of production control, Types of production - Job Order, Batch and Mass Production Systems

Forecasting models, Approaches and Types, Qualitative Approach: Judgmental Methods, Quantitative Approach: Time Series techniques, Regression techniques, Forecasting Error Estimation Techniques, Aggregate production planning, Benefits of Aggregate Production Planning, computer integrated production planning systems, elements of Just In Time Systems, Fundamentals of MRP II and Enterprise Resource Planning

Scheduling of Batch Production, Scheduling of Job Order production, Loading, Concept of Assembly line balancing, Sequencing: Definition, Sequencing of n jobs through one machine, n jobs through two machines (Johnsons algorithm), n jobs through three machines, n jobs through m machines, Materials Requirement Planning (MRP): Structure, Inputs, Outputs of MRP, Lean manufacturing, Seven Forms of Waste in Manufacturing

Inventory control: Purpose of holding stock, Effect of demand on inventories. Determination of Economic order quantity and economic lot size, Problems on Economic order quantity, Method study, basic procedure, Recording of process, Critical analysis, work measurement and Techniques of work measurement, Time study, techniques for time study, Production study, Work sampling methods

Reference Books

- 1 Principles of Management, Stoner, Freeman, Gilbert , 1: 1995, Pearson.
- 2 Operations management: Design, Planning and Control for manufacturing and services, James. B. Dilworth, 3: 1993, Mcgraw Hill International .
- 3 Production and Operations Management, R. Pannerselvam, 3: 2012, PHI Learning Pvt. Ltd.
- 4 Operations Management, Roberta S. Russell and Bernard W. Taylor, 4: 2003, Prentice Hall.

23MB4068 - INNOVATION MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MB4068	INNOVATION MANAGEMENT	IMG	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify and analyze market needs and gaps, using tools such as SWOT and PESTLE analysis, to pinpoint real-world problems suitable for entrepreneurial solutions.	4	PO2, PO11, PSO1
CO2	Develop innovative solutions through creative thinking and apply lean startup principles to build and iterate a minimum viable product (MVP).	3	PO2, PO11, PSO1
CO3	Create a comprehensive lean business model canvas that outlines customer segments, value propositions, channels, revenue streams, and key metrics.	6	PO2, PO11, PSO1
CO4	Create a compelling business plan and investor pitch, including financial projections and funding strategies, demonstrating effective communication and persuasion skills.	6	PO2, PO11, PSO1

Syllabus

Fundamentals of Entrepreneurship and Innovation Definition and importance of entrepreneurship; Types of entrepreneurs; Entrepreneurial mindset; Types of innovation (incremental, disruptive, architectural, radical); Innovation in entrepreneurship; Techniques for identifying problems; Market needs and gaps analysis; SWOT analysis; PESTLE analysis; Customer discovery; Market research

Ideation and Lean Startup Principles Creative thinking and brainstorming techniques; Evaluating and selecting ideas; Introduction to lean startup methodology; Building a minimum viable product (MVP); Validated learning; Turning ideas into solutions; Prototyping techniques; User testing and feedback collection; When and how to pivot; Improving the MVP; Continuous improvement

Developing the Lean Business Model Canvas Overview and components of the lean business model canvas; Customer segments and value propositions; Identifying and building channels; Developing customer relationships; Creating revenue streams; Understanding cost structure; Key metrics for startups; Analysis of successful business models; Lessons learned from failures

Business Planning and Investor Pitching Elements of a business plan; Market analysis; Competitive landscape; Creating financial projections; Funding strategies; Budgeting and financial planning; Creating a compelling pitch deck; Tips for effective presentation; Handling Q&A sessions; Preparing for the pitch; Presenting to a panel of judges; Feedback and improvement

Reference Books

- 1 The Innovator's Dilemma, Clayton Christensen, 1st (2013), Harvard Business Review Press.
- 2 Creative Confidence, Tom Kelley, David Kelley, 2nd (2016), Crown Business.
- 3 The Lean Startup, Eric Ries, 1st (2011), Crown Business.
- 4 Business Model Generation, Alexander Osterwalder, Yves Pigneur, 1st (2010), Wiley.

23UC0026 - HUMAN VALUES, GENDER EQUALITY & PROFESSIONAL ETHICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC0026	HUMAN VALUES, GENDER EQUALITY & PROFESSIONAL ETHICS	HGP	R	2	0	0	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the basic concepts of value education	2	PO8, PO9
CO2	Gain basic understanding of the principles in harmony among the human beings	2	PO8, PO9
CO3	Gain knowledge in the concept of Harmony in the family and society	3	PO8, PO9
CO4	Acquire knowledge in the concepts of harmony in the nature	4	PO8, PO9

Syllabus

Introduction to Human Values Understanding Value, Self-exploration as the Process for identifying Value, Continuous Happiness and Prosperity The Basic Human Aspirations, Right Understanding, Relationship and Physical Facilities, Happiness and Prosperity Current Scenario, Method to fulfil the Basic Human Aspirations Harmony in the Human Being Understanding the Human Being as Coexistence of Self I and Body, Discriminating between the Needs of the Self and the Body, The Body as an Instrument of I, Understand Harmony in the Self I, Harmony of the Self I with the Body.

Understanding Harmony in the Family and Society The Basic Unit of Human Interaction, Values in Human to Human Relationships, Vision for the Universal Human Order Harmony in the Nature Existence Understand Harmony in the Nature, Interconnectedness, Self regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence is Coexistence at All Levels, The Holistic Perception of Harmony in Existence.

What is Gender, and Why Should We Study It? Gender Equality Milestones, The Context Today Socialisation Making Women, Making Men Preparing for Womanhood, Preparing for Manhood, Different Masculinities, Unrecognised and Unaccounted For, Wage Differentials between Women and Men, Women in the Working Environment . Being Boy A Village Boyhood, School Days, College Styles, Ek Ladki Ko Dekha Toh Sexual Harassment SAY NO! Sexual Harassment, Not EveTeasing, Consent and Relationships, Coping with Everyday Harassment Becoming Man A Dangerous Model of Masculinity, Changing Masculinities, Imprints of Masculinity, Mothers, Fathers and Family.

Implications of the Right Understanding a Look at Professional Ethics Natural Acceptance of Human Values, Definitiveness of Ethical Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models Typical Case Studies, Strategies for Transition towards Valuebased Life and Profession

Reference Books

- 1 A Foundation Course in Human Values and Professional Ethics , - R R Gaur, R Sangal and G PBagaria,, First Edition, Excel Books., Penguin press.
- 2 " Seeing like a Feminist", Menon, Nivedita, First Edition, Excel Books. , Zubaan.
- 3 "The Brave Heart", Rosa Parks, 1, Indian.
- 4 How the Other Half Dies, Sussan George, First Edition, Penguin Press, Reprinted.

23UC0027 - LEADERSHIP AND MANAGEMENT SKILLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC0027	LEADERSHIP AND MANAGEMENT SKILLS	LAMS	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basic leadership, skills and perspectives and leadership styles	2	PO9
CO2	Understand different managerial skills and apply them to develop high performance teams	3	PO11
CO3	Analyse effective communicative strategies and apply them in team tasks	3	PO10
CO4	Apply strategic planning fundamentals and decision-making techniques, through exercises and case studies	3	PO11

Syllabus

Fundamentals of Leadership Skills Understanding Leadership and its Importance, Traits and Models/styles of Leadership, Perspectives on Leadership: Bipolarity-Unidimensionality - Bidimensionality-Hierarchical: Management within Leadership - Hierarchical: Leadership within Management, Basic Leadership Skills: Motivation, Teamwork, Negotiation & Networking, Emotional intelligence.

Managerial Skills - Basic Managerial Skills - Planning for effective management, Recruiting and Retaining Talent - Delegation of tasks - Learn to Coordinate, Organising, Building and Leading high-performance Teams

Effective Communication Strategies for Leaders and Managers - Self-Management Skills: Understanding Self-Concept - Developing Self-Awareness -Self-Examination - Self-Regulation, Active Listening and Feedback Techniques, Conflict Management & Conflict Resolution - Negotiation skills, Role-playing and Group activities

Strategic Planning and Decision-Making - Fundamentals of Strategic Planning and Decision-Making - Setting Goals & Objectives for the Organization, Strategic Tools: SWOT, PEST, FORCE FIELD, SCENARIO PLANNING and SIX THINKING HATS, etc., Simulation Exercises and Strategic Planning Case Studies

Reference Books

1. , The Emotionally Intelligent Manager: How to Develop and Use the Four Key Emotional Skills of Leadership, Caruso, D. R. and Salovey P, First edition, 2004, JohnWiley & Sons.
2. Training in Interpersonal Skills: Tips for Managing People at work, Stephen P. Robbins, Phillip L. Hunsaker, 6 edition, 2015, Pearson Education.
3. Learning to Lead: A Workbook on Becoming a Leader, Bennis, W. and Goldsmith, J, 4 edition, 2010, Reading, Mass. : Addison-Wesley.
4. Strategic Management: Concepts and Cases, Fred R. David and Forest R. David, 17th Edition, 2017, Pearson.
5. Interpersonal Skills in Organizations, Suzanne de Janasz, Karen Dowd, and Beth Schneider, 6th Edition, 2018, McGraw-Hill Education.
6. Human Resource Management", Gary Dessler and Biju Varkkey, 15th Edition, 2020, Pearson Education.
7. "Leadership: Theory and Practice", Peter G. Northouse, 8th Edition, 2021, SAGE Publications.
8. Case Studies in Strategic Management: A Practical Approach", Sanjay Mohapatra and R. Sridhar, 1st Edition (2012), Pearson Education.
9. Active Listening: Improve Your Ability to Listen and Lead, Center for Creative Leadership , 1st Edition (2012), Center for Creative Leadership.

23UC1101 - INTEGRATED PROFESSIONAL ENGLISH (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC1101	INTEGRATED PROFESSIONAL ENGLISH	IPE	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Language Mechanics and Basic Grammar	2	PO10
CO2	Integrated Reading and Techniques of Writing	3	PO10

Syllabus

Discuss people you admire, Discuss a challenge, Explain what to do and check understanding, Give advice on avoiding danger, Discuss dangerous situations, Give and respond to compliments, Discuss ability and achievement, Discuss sports activities and issues, Make careful suggestions, Discuss events that changed your life, Discuss and describe rules, Discuss possible future events

Discuss choices and changes, introduce requests, discuss living in cities, discuss changes to home, imagine how things could be, discuss personal finance, discuss moral dilemmas and crime, discuss new inventions, discuss people lives and achievements, express uncertainty, speculate about the past, discuss life achievements, describe how you felt

Reference Books

- 1 Empower, Andrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis, 2nd, CUP.
- 2 The Only Grammar Book You'll Ever Need , Susan Thurman, Larry Shea, 2nd, Adams Media .
- 3 Dynamic Presentations, Mark Powell, 1st, CUP.
- 4 Effective Business Writing: Strategies, Suggestions and Examples, Maryann V. Piotrowski, 2nd, Collins Reference.

23UC1202 - ENGLISH PROFICIENCY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC1202	ENGLISH PROFICIENCY	EP	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Express the ability in interactive skills of listening, speaking, reading, and writing that are better suited for the corporate environment.	2	PO9, PO10
CO2	Apply various strategies for LSRW skills and apply them in interpreting the text	3	PO9, PO10

Syllabus

Usage of Tenses at an advanced level, , Describing people, asking and answering questions. Trying and succeeding, listening to podcasts, reading interviews. Speaking and enhancing communication skills Giving compliments & responding, discussing the natural environment, and writing a leaflet.. Vocabulary on cause and result, talking about life changes, discussing experience and training and rules.

Participles & non-finite verbs, Passive voice, Speaking- comparing different tourist destinations, agreeing, and disagreeing. Reading travel blogs, speaking. Writing travel blogs using descriptive language. Speaking and enhancing communication skills

Reference Books

- 1 Practical English Usage, Michel Swan, 1, Oxford University Press.
- 2 Everyday Vocabulary, Kumkum Gupta, 1, arihant.
- 3 Empower Intermediate/B1+ Student's Book with eBook 2nd Edition, Cambridge, 2, Cambridge University Press.
- 4 Improve Your Communication Skills, Daniel Burke , 1, Maanu Graphics Publishers.

23UC1203 - DESIGN THINKING AND INNOVATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC1203	DESIGN THINKING AND INNOVATION	DTI	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the importance of Design thinking mindset for identifying contextualized problems	2	PO2
CO2	Analyze the problem statement by empathizing with user	4	PO7
CO3	Develop ideation and test the prototypes made	3	PO3
CO4	Explore the fundamentals of entrepreneurship skills for transforming the challenge into an opportunity	2	PO11

Syllabus

Introduction to Design Thinking and Innovation: Introduction to design thinking and its principles, Learning, listening, observation, dialogue, and reading in the context of design thinking; Design definitions and stories, desirability, feasibility, viability, mystery, heuristics, algorithm, requirements, patterns, connect, blind spots; Laws of Design Thinking: less is more, last 2% equals 200%, theory of prioritization; Design mind: definitions, 5 forces of growth (SEPIA), 5 frictional forces (DCAFE), 3 capacity levers (VAL).

Design Thinking Process: Overview of the design thinking process, Design thinking for contextualized problem-solving, Incorporating sustainable development goals into design thinking, Design framework (L0); Empathy research: understanding user needs and perspectives, Persona development: creating user profiles; Customer journey mapping: visualizing user experiences, Define phase: asking the right questions and problem statement formulation.

Ideation, Prototyping and Testing: Ideation techniques, brainstorming and generating creative ideas, Identifying patterns and anti-patterns in ideation, Evaluation of ideas using different criteria (10/100/1000 gm): Prototyping and testing: translating ideas into tangible prototypes.

Entrepreneurial Innovation: Introduction to innovation management, Basics of business models and their role in innovation, Financial estimation for innovation projects: Pitch decks: creating persuasive presentations for innovation, Considerations for intellectual property rights (IPR) in innovation.

Reference Books

- 1 Design Thinking in the Classroom, David Lee, Kindle, Ulysses Press.
- 2 The Art of Innovation: Lessons in Creativity from IDEO, America, Tom Kelley , Jonathan Littman , Tom Peters, 2001, Doubleday Broadway Publishing, USA.
- 3 Unmukt- Science and Art of Design Thinking, Arun Jain, 2019, School of Design Thinking.
- 4 The Design Thinking Play Book, Michael Lewrick, Patrick Link & Larry Leifer, 2018, Wiley Press.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Basic Science Courses (BSC)

22PH1008 - PHYSICS FOR ELECTRONIC ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22PH1008	PHYSICS FOR ELECTRONIC ENGINEERS	PEE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the concepts of basics of crystal structure to find out for the structure property relation through crystal imperfections.	3	PO1
CO2	Understand the conducting and semiconducting properties of solids at the microscopic level	2	PO1
CO3	Understand the dielectric properties of materials at the microscopic level and their applications.	2	PO1
CO4	Apply the spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications	3	PO1
CO5	Apply the knowledge on the structure and properties of materials while executing related experiments	3	PO4

Syllabus

Atomic structure, atomic mass, and atomic number, Bonding in solids, Types of bonds- Force vs interatomic distance curve, PE curve, Crystal Structures (Space lattice, basis, unit cell, Seven Crystal systems, Bravais lattices, coordination number, Atomic packing fraction of SC, BCC, FCC,), miller indices, Crystal planes and defects (Point Defects, Line Defects, Surface Defects, Volume Defects, and Effects of Defects on Crystalline Properties)

Classification of electronic materials: metals, semiconductors, and insulators. Electrical properties: Classical Free Electron Theory: Drude and Lorentz model for metals. Temperature dependence of resistivity, Matthiessens rule. Conductivity in metals and Concepts of Fermi level. Concept of phonons, Thermal conductivity, Intrinsic and extrinsic semiconductors, Fermi level variation by carrier concentration and temperature, pn junction, drift and diffusion currents, Direct (LED) and indirect band (Solar cell) gap semiconductors

Dielectrics and electrical polarization, Depolarization field, Polarization mechanisms, Electronic polarization and its mechanisms, Dielectric breakdown, the frequency dependence of polarization, Clausius-Mossotti relation; Piezoelectricity, Pyroelectricity, and Ferroelectricity. Optical properties (Optical reflectance, Optical Absorption, Snells law, Total Internal reflection in optical fibers)

Basic definitions, classification of magnetic materials, Origin of magnetic moment, Types of interactions, Magnetic susceptibility, Curie and Neel temperatures; Domain ferromagnetism, Hysteresis, Hard and Soft magnetic materials. Magnetic anisotropies, Spin-orbit interaction, Applications: magnetic recording

Reference Books

- 1 Principles of Electronic Materials and Devices, Kasap, S.O, 3rd, McGraw-Hill.
- 2 Electronic Properties of Materials, Hummel Rodolf, 2nd, Narosa Publishing House.
- 3 Solid State Physics: An Introduction, Philip Hofmann, 2nd, Wiley.
- 4 Solid State Physics, Kittel. C, 8th, Wiley.
- 5 Solid State Physics, S.O. Pillai, 13th, New Age International Publishers.

23CS3201 - DATA SCIENCE AND STATISTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS3201	DATA SCIENCE AND STATISTICS	DSS	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles of data science and statistics	2	PO1, PO2, PSO2
CO2	Gain basic understanding the role of data science in various scenarios in the real-world problems.	3	PO2, PO4, PSO2
CO3	Apply probabilistic predictions and decisions based on data analysis.	3	PO2, PO4, PSO2
CO4	Implement and apply proficiency in statistical inference techniques	4	PO3, PSO2

Syllabus

Data science combines math, coding, and real-world knowledge to extract meaning from data. It's used in finance, healthcare, and more to solve problems. There are challenges like big data and privacy, but data science offers exciting opportunities. Data scientists, analysts, and engineers all play a role in this field, using methodologies like CRISP-DM to guide their work. Software engineering practices are important for data science projects, and DataOps and MLOps help automate tasks to make data science more efficient.

Data comes in structured formats like tables (financial data) or unstructured formats like text (social media). Data wrangling ensures this data is clean and usable. Data models define how data is organized, while data pipelines automate the flow of data from source to destination (cleaning, transforming, loading). Modern infrastructure like cloud platforms and big data tools enable efficient handling of large datasets. Data scientists use tools to build models that automate data cleaning tasks.

Probability helps understand how likely events are (coin flips, customer arrivals). It uses concepts like chance, distributions (how likely different outcomes are), and different distribution types for various situations (number of successes in trials, time until an event). Statistics helps summarize data. It uses measures of central tendency (mean, median, mode) to find the 'middle' of the data, and measures of dispersion (variance, standard deviation) to see how spread out the data is. The type of data you have determines which measures are most useful. These tools together let you analyze the randomness in data and make sense of it.

Statistical inference lets you make educated guesses about a whole population (like all customers) based on a smaller sample (data you collect). It uses hypothesis testing (is there a difference?) and confidence intervals (likely range for a population value) to analyze this. There are different tests for different situations: t-tests compare group means, chi-square tests analyze relationships between categories, and ANOVA compares means of more than two groups. Regression analysis explores how one variable affects another. These tools help you go beyond just describing data and use it to understand relationships and make predictions.

Reference Books

- 1 Introduction to Data Science: Practical Approach with R and Python Paperback , B. Uma Maheswari, R. Sujatha, 1st, Mar 10, 2024 , Wiley.
- 2 Probability & Statistics for Data Science, Dr. D.C. Agarwal, Dr. Pradeep K. Joshi, 1st, 1 January 2022, Wiley.
- 3 Applied Statistics and Probability for Engineers, 6ed, ISV Paperback , Douglas C. Montgomery, George C. Runger, 3rd, 2011, Wiley.
- 4 The Data Science Handbook, Wiley, 2nd, 14 February 2024, John Wiley & Sons, Inc..

23CY1001 - ENGINEERING CHEMISTRY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CY1001	ENGINEERING CHEMISTRY	ECY	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the operation of electrochemical systems to produce electric energy and storagedevices.	3	PO1, PO2
CO2	Use the fundamental aspects of electrochemistry and materials science relevant tocorrosion phenomena.	3	PO1, PO2
CO3	Examine water quality and apply appropriate purification technique for intendedproblem.	3	PO1, PO2
CO4	Employ the fundamental principles and general properties of materials in variousengineering applications.	3	PO1, PO2
CO5	Analyze the data, develop skills in chemical analysis and their application inengineering.	3	PO1, PO7

Syllabus

Electrochemistry: Single electrode potential and its measurement, Electrochemical cells, EMF series, Nernst equation, Cell emf measurement, Reversible and irreversible cells, Concentration cells, Reference Electrodes-Determination of pH using glass electrode. Batteries: Chemistry, construction, and engineering, aspects of Primary (mercury battery) and secondary (lead-Acid cell, Ni-Metal hydride cell, Lithium cells), and fuel cells, Hydrogen Oxygen fuel cell, methanol fuel cell advantages of fuel cell.

CORROSION & ITS CONTROL: Causes and different types of corrosion and effects of corrosion. Theories of corrosion: Chemical, Electrochemical corrosion, Pitting corrosion, stress corrosion, Galvanic corrosion. Factors affecting corrosion, Nature of metal, galvanic series, over voltage, purity of metal, nature of oxide film, nature of corrosion product. Nature of environment, effect of temperature, effect of pH, Humidity, effect of oxidant. Cathodic protection, sacrificial anode, impressed current cathode, electroplating.

WATER TECHNOLOGY: Introduction, Hardness: Causes, expression of hardness, units, types of hardness, estimation of temporary and permanent hardness of water, numerical problems. Alkalinity and estimation of alkalinity of water, numerical problems. Boiler troubles, Scale & sludge formation, caustic embrittlement, Boiler corrosion, priming & foaming. Softening of water: Internal and external treatments, Lime soda, Ion exchange process. Desalination: reverse osmosis and electrodialysis.

MOLECULES AND MATERIALS: Polymers, Types of polymerization, Mechanisms, Plastics, Thermoplastic resins and thermosetting resins, Preparation, properties and engineering applications of polyethylene, PVC, Teflon, Bakelite, Urea Formaldehyde. Conducting Polymers: Polyacetylene, polyaniline, conduction, doping and applications. Carbon nano tubes and Applications.

Determination of the concentration of unknown solutions (HCl vs NaOH); Determination of total alkalinity of a water sample; Determination of Iron using colorimetry; Estimation of hardness of water by EDTA method (Complexometric); Determination of chloride content of water sample; Determination of the rate constant of a reaction; Determination of Dissolved oxygen in the given water sample; Estimation of amount of iron using potentiometric method; Conductometric titration of strong acid with strong base; Estimation of amount of an acid using pH metric method; Synthesis of a polymer/ drug; Estimation of KMnO₄ using standard oxalic acid; Estimation of ferrous and ferric ion using standard K₂Cr₂O₇ solution; Estimation of amount of Vitamin- C in the given sample.

Reference Books

- 1 Engineering Chemistry, Jain & Jain, 16th edition, 2020, Dhanpat Rai Publishing Company. New Delhi..

- 2 Chemistry in Engineering and Technology, J C Kuriacose & J Rajaram, , Volume2, 2001, Tata McGraw Hill .
- 3 Chemistry for Engineers , Rajesh Agnihotri , 1st edition, 2014, Wiley .
- 4 Engineering Chemistry: Fundamentals and Applications, Shikha Agarwal , 2nd edition, 2016, Cambridge University Press .

23MT1001 - LINEAR ALGEBRA AND CALCULUS FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MT1001	LINEAR ALGEBRA AND CALCULUS FOR ENGINEERS	LACE	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply matrix algebra to the real-world applications in engineering, physical and biological sciences, computer science, finance, economics and solving the system of equations.	3	PO1
CO2	Apply multivariate differential calculus to find maxima & minima of functions and understand the concepts of second order differential equations and its applications.	3	PO1
CO3	Apply beta and gamma functions to evaluate improper integrals. Evaluate double and triple integrals techniques over a region in two dimensional and three-dimensional geometry.	3	PO1
CO4	interpret the physical meaning of different operators such as gradient, curl and compute the line integrals of vector functions and learn their applications.	3	PO1

Syllabus

Introduction to Matrix theory: Row echelon form and rank of a matrix, Systems of linear equations, Solution by Gauss elimination, LU-Decomposition, Eigen values and eigen vectors. Diagonalization of matrices, quadratic forms and their canonical forms.

Multivariate differentiation calculus, partial differential calculus, Jacobian, total differentiation and their applications, chain rule, Taylor's series for fundation of two variables, maxima and minima functions of two variables, Lagranges method of undermined multipliers, differential equations : mathematical models used in differential equations. second and higher order differential equations, along with methods of solutions and their applications

Multivariate Integral Calculus: Improper integrals, Beta, Gamma functions and their relationship. Line integrals- length of the arc, double and triple integrals and applications to area, volume, mass & moment of inertia. Change of order of integration, change of variables in polar, cylindrical and spherical polar coordinates.

Vector calculus - scalar and vector point functions, gradient, directional derivatives, divergence and curl, evaluation of line integrals, introduction to Greens and Stokes theorem and their applications.

Reference Books

- 1 Advanced Engineering Mathematics, , Erwin Kreyszig, , 10, John Willey & Sons, 2010, New Delhi, India.
- 2 Higher Engineering Mathematics, , Dr. B.S. Grewal. , 44, Publisher: Khanna, New Delhi. .
- 3 Linear Algebra and Its Applications , David C. Lay , 5, Pearson; .
- 4 Advanced Engineering Mathematic , Dennis G. Zill , 10, Pearson Education India .

23MT2003 - MATHEMATICAL MODELLING & NUMERICAL METHODS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MT2003	MATHEMATICAL MODELLING & NUMERICAL METHODS	MMNM	R	2	2	0	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	LINEAR ALGEBRA AND CALCULUS FOR ENGINEERS	LACE	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Modeling and solution of algebraic and transcendental equations.	3	PO1, PO2, PSO1
CO2	Applying numerical methods to solve ordinary differential equations.	3	PO1, PO2, PSO1
CO3	Solving of Linear and non-linear Partial Differential Equations.	3	PO1, PO2, PSO1
CO4	Applications of Partial Differential Equations.	3	PO1, PO2, PSO1

Syllabus

Bisection method and Newton Raphson method Finite differences Forward, Backward, Shift operators, average operator and relations between the difference operators.

Lagranges and Newtons divided difference formulas and Numerical solution of ordinary differential equations

Models of system of linear equations Jacobi and Gauss Seidel methods Formation of partial differential equations

one dimensional wave and heat equations and Laplace equation in two dimensions

Reference Books

- 1 Advanced Engineering Mathematics , Erwin Kreyszig, Edn 10, 2010, John Wiley & Sons.
- 2 Numerical methods for scientific and engineering computation, M.K.Jain, S. R. K. Iyengar and R.K.Jain,, 5th edn ,2015, New age international publishers, New Delhi.
- 3 Higher Engineering Mathematics , BS Grewal. Publisher, 40th edn,2012, Khanna Publishers.
- 4 Numerical Methods for Engineers, Steven Chapra and Raymond Canale, 8 Edition, 2009, McGraw Hill.

23MT2004 - MATHEMATICAL PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MT2004	MATHEMATICAL PROGRAMMING	MPG	R	2	2	0	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	RANDOM VARIABLES AND STOCHASTIC PROCESS	RVASP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various methods for finding the optimal solution of Linear Programming Problem.	3	PO1, PO2, PSO1
CO2	Apply Integer and Fractional programming approaches for solving optimization problems.	3	PO1, PO2, PSO1
CO3	Apply quadratic programming and geometric programming techniques for solving non linear programming problems	3	PO1, PO3, PSO1
CO4	Apply evolutionary algorithms, nature-inspired metaheuristics, to solve complex optimization problems in infinite-dimensional spaces.	3	PO2, PO3, PSO1

Syllabus

Linear Programming: Formulation of LP problem (LPP), Graphical method, Simplex method, Transportation problem, Duality concept in LPP, Feasibility of solution using Farka's Lemma, Ellipsoid method, Karmarkar's Algorithm

Combinatorial Optimization, Integer Programming, Branch & bound algorithms, valid inequalities & cuts. Fractional Programming. Combinatorial Optimization: Approximation Algorithms, Submodular functions, Matroids, Continuous approximation algorithms Dynamic programming: Knapsack problem, Travelling salesman Problem

Non-Linear Programming: Quadratic programs, Constrained quadratic programming Problems, Beale's method, Wolfe method, Karush Kuhn Tucker (KKT) Conditions, Geometric Programming: Problems with one-degree of difficulty with positive coefficients, Geometric programming with constraints, Problems with positive and negative coefficients

Infinite Dimensional Optimization: Heuristic and Meta heuristics, Single solution vs. population-based, Parallel meta heuristics, Evolutionary algorithms, Nature-inspired metaheuristics, Genetic Algorithm, Ant-colony optimization, Particle swarm optimization, Simulated annealing.

Reference Books

- 1 Linear and Non Linear Programming Theory and Algorithms, MOKHTAR S. BAZARAA, HANIF D. SHERALI and C.M. SHETTY, 1997, MIT Press.
- 2 Applied Mathematical Programming, Bradley, Hax, and Magnanti, 1977, Addison-Wesley.
- 3 Evolutionary Optimization Algorithm, Dan Simon, 2014, Willey Edition.
- 4 Introduction to Mathematical Programming, Russell C. Walker, 1999, Pearson.

23MT2007 - RANDOM VARIABLES AND STOCHASTIC PROCESS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MT2007	RANDOM VARIABLES AND STOCHASTIC PROCESS	RVASP	R	2	2	0	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	MATHEMATICAL MODELLING & NUMERICAL METHODS	MMNM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Mathematical models of random phenomena and solve probabilistic problems.	3	PO1, PSO1
CO2	Analyze different types of random variables and compute statistical parameters of the random variables.	4	PO1, PO2, PSO1
CO3	Apply random processes in the time domain and model time varying linear systems.	3	PO2
CO4	Analyze random processes in frequency domains and model spectral characteristics of LTI systems.	4	PO3

Syllabus

THE RANDOM VARIABLE AND MULTIPLE RANDOM VARIABLES: Introduction, Review of Probability Theory, Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete, Continuous and Mixed Random Variables, Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Conditional Distribution, Conditional Density, Properties. Vector Random Variables, Joint Distribution Function, Properties of Joint Distribution, Marginal Distribution Functions, Conditional Distribution and Density, Statistical Independence, Sum of Two Random Variables, Sum of Several Random Variables, Central Limit Theorem: Unequal Distribution, Equal Distributions.

OPERATION ON ONE AND MULTIPLE RANDOM VARIABLE EXPECTATIONS: Introduction, Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Chebychev's Inequality, Characteristic Function, Moment Generating Function, Transformations of a Random Variable: Monotonic Transformations for a Continuous Random Variable, Nonmonotonic Transformations of Continuous Random Variable. OPERATIONS ON MULTIPLE RANDOM VARIABLES: Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two Random Variables case, N Random Variables case, Properties, Transformations of Multiple Random Variables, Linear Transformations of Gaussian Random Variables.

RANDOM PROCESSES TEMPORAL CHARACTERISTICS The Random Process Concept, Classification of Processes, Deterministic and Non deterministic Processes, Distribution and Density Functions, Concept of Stationarity and Statistical Independence. First-Order Stationary Processes, Second-order and Wide-Sense Stationarity, Nth order and Strict Sense Stationarity, Time Averages and Ergodicity, Autocorrelation Function and its Properties, Cross Correlation Function and its Properties, Covariance Functions, Gaussian Random Processes, Poisson Random Process.

RANDOM PROCESSES SPECTRAL CHARACTERISTICS: The Power Density Spectrum: Properties, Relationship between Power Density Spectrum and Auto correlation Function, The Cross Power Density Spectrum, Properties. Random Signal Response of Linear Systems: System Response Convolution, Mean and Mean squared Value of System Response, Auto correlation Function of Response, Cross Correlation Functions of Input and Output.

Reference Books

- 1 Probability, Random Variables & Random Signal Principles, Peyton Z. Peebles, 4 (2001), TMH.
- 2 Probability, Random Variables and Stochastic Processes, Athanasios Papoulis and S. Unnikrishna, 4(2002), PHI.
- 3 Schaum's Outline of Probability, Random Variables, and Random Processes, Hwei P. Hsu, 4, Schaum's Outline.

- 4 An Introduction to Random Signals and Communication Theory, B.P.Lathi, 2 (1968), International Textbook.
- 5 Probability Theory and Random Processes, P. Ramesh Babu, 3 (2015), McGrawHill.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Engineering Science Courses (ESC)

23AD2001O - ARTIFICIAL INTELLIGENCE & MACHINE LEARNING (O)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD2001O	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	AIML	O	3	0	2	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	COMPUTATIONAL THINKING FOR STRUCTURED DESIGN	CTSD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply a variety of artificial intelligence algorithms and techniques to effectively solve complex problems in diverse real-world environments	3	PO2, PO3, PO4, PSO1
CO2	Solve constraint satisfaction problems, employ knowledge engineering principles to perform inferencing, reasoning and probability theory.	3	PO2, PO3, PO4, PSO1
CO3	Apply various machine learning techniques to analyze and solve real-world problems	3	PO2, PO3, PO4, PSO1
CO4	solve complex real-world problems using advanced supervised and unsupervised learning techniques.	3	PO2, PO3, PO4, PSO1
CO5	Evaluate solutions for various AI & ML related problems.	5	PO3, PO4, PO5, PSO1

Syllabus

Introduction to Artificial Intelligence: Overview of AI, history, and applications; Agents and Environments; Problem Solving through search: Uninformed Search Algorithms: Breadth-first search, Depth-first search, Iterative deepening search, Depth Limit Iterative deepening search Bi-Directional Search; Informed Search: Heuristic search, Best First Search, A* algorithm, Local Search algorithms: Hill Climbing Algorithm, Simulated Annealing, Adversarial Search: Minimax algorithm, Alpha-beta pruning;

Constraint Satisfaction: Problem formulation, Constraint propagation, Backtracking algorithms, Knowledge Engineering: propositional Logic, Predicate Logic, Inferencing through propositional and Predicate Logic: Introduction, Inferencing rules, Inferencing Mechanisms: Entailment, Resolution, Lifting, Reasoning, Implementing inferencing: Forward Checking and Backward Chaining; Introduction to probability theory, Introduction to uncertainty Bayes Theorem;

Machine Learning: Introduction to Machine Learning, Types of Machine Learning; Introduction to Data Preprocessing: Data Cleaning, Data Splitting, Data Normalization, Data Batching, Data Shuffling, Overfitting and Underfitting; Performance metrics: Confusion matrix, Accuracy, F-score, Precision and Recall, Cross Validations; Supervised learning: Linear regression, Logistic Regression, Naive Bayes Classification, Bayesian Belief Networks; Decision Trees, KNN; Support Vector Machines (SVM), Introduction to Ensemble methods.

Ensemble methods: Bagging: Random Forest, Boosting: XG Boosting, Ada-Boosting, Unsupervised learning algorithms: K-Means clustering, Hierarchical Clustering Artificial Neural Networks (ANN): Introduction to ANN: Weights and Biases, Bias Vs Variance, McCulloch Pits, Perceptron, Applications of ANN, Types of ANN: Single-Layer Perceptron, Multi-Layer Perceptron, Feedforward and Backwards ANNs, Recurring RNN, Basics of ANN: Structure of ANN, Functionality of ANN, Learning ANNs, ANN techniques: Activation functions, Error computation (Loss Functions), Error distribution (Optimization), and Prediction using ANN.

Reference Books

- 1 Artificial Intelligence , Russel and Norvig , 2015, Pearson Education, PHI .
- 2 Machine Learning , Tom M.Mitchell , 2017, Tata McGraw-Hill Edition .

- 3 Artificial Intelligence , Elaine Rich & Kevin Knight , 2017, Tata McGraw-Hill Edition .
- 4 Machine Learning an Algorithmic Perspective , Stephen Marsland , 2014, CRC Press .

23EC1101 - FUNDAMENTALS OF IOT AND SENSORS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC1101	FUNDAMENTALS OF IOT AND SENSORS	FITS	R	3	0	4	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of IoT and its implementation using the Development Hardware	3	PO1, PO2, PSO1
CO2	Apply the different sensors interfacing with Development Hardware	3	PO2, PO3, PSO1
CO3	Apply the different actuators interfacing with Development Hardware	3	PO2, PO3, PSO1
CO4	Analyze the IoT concept to solve real time insights	4	PO2, PO3, PO4, PSO1
CO5	Analyze the concept of IoT by interfacing with sensors and Development Hardware	4	PO2, PO3, PSO1

Syllabus

Introduction Characteristics, Architecture , Applications, Development Hardware, multiplexer (74LS153), de-multiplexer (74155), encoder (SN74LS148), decoder (74LS138), microcontroller (ATMEGA328P), Arduino Introduction Types Features Pin Description IDE Applications, Arduino GPIO Programming

Sensors and its interfacing Definition Types Classification, Temperature Sensors Thermistor Thermistor types Interfacing LM35 interfacing, Light Dependent Resistor Interfacing, Interfacing and implementation for various applications Infra-Red Sensor, PIR, Ultrasonic Sensor and Gas Sensor.

Actuators and its interfacing Introduction Types DC Motor and its applications ServoMotor and its applications Stepper Motor and its applications Motor Driver circuit Relay optocouplers

Introduction Features Pin Description GPIO Programming, Displays and its interfacing 7 Segment and its types LCD pin description commands, IoT Case Studies Home Automation Smart Irrigation Smart Health care, (Self-Learning Topics Smart Lighting Intrusion Detection Smoke Detectors Smart Parking Air Pollution)

Introduction to IoT Application and Architecture, Arduino Programming and GPIO, Digital Output Configuration of Digital Output, Concept of Delay, Introduction to LED, different connection methods of LED.

Reference Books

- 1 Internet of Things, Rajkamal, 2nd, Tata McGraw Hill .
- 2 Internet of things(A-Hand-on-Approach), Madisetti and ArshdeepBahga, ArshdeepBahga1st Edition, Universal Press .
- 3 The Internet of Things Connecting Objects , Hakima Chaouchi, 2nd, Wiley.
- 4 Design of Secure IoT Systems: A Practical Approach Across Industries, Sumeet Arora, Ramachandra Gambheer, Meenakshi Vohra, 2021, Mc Graw Hill.

23EC1202 - DIGITAL DESIGN & COMPUTER ARCHITECTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC1202	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Build the combinational and programmable digital logic circuits using logic gates and optimization methods	3	PO1, PO2, PSO1
CO2	Construct the sequential and memory circuits using flip-flops	3	PO1, PO2, PSO1
CO3	Organize computer architecture and instructions sequence	3	PO1, PO2, PSO1
CO4	Model the Memory Architecture and I/O Organization modules	3	PO1, PO2, PSO1
CO5	Develop and analyze computer architecture modules using basic combinational, sequential and memory logics	4	PO1, PO3, PO5, PSO1

Syllabus

Combinational Digital Logic Circuits: Boolean algebra, Digital Logic SOP/POS representation and optimization techniques. Adders, Subtractors, Multiplexers, De-Multiplexers, Decoder, Encoder. Programmable Logic Devices: PROM, PAL, and PLA design. Implementation of CPLD (Macrocells) and FPGA (CLB/LUT) based digital logic modules and their applications.

Design of Sequential and Memory Circuits: Latches and Flip-Flops, Modeling of memory and registers, Timing and sequence control modules using Asynchronous/Synchronous counters, Ring and Johnson counter as timing and control units. Shift registers, Random Access Memory (RAM) and Memory decoding.

Basic Computer Architecture and Instructions: Features of Micro Computer, Operands, Addressing modes, Instruction formats, Machine cycle, Instruction sets, subroutine call and return mechanisms. Instruction set architectures - CISC and RISC architectures. Hardwired realization vs micro-programmed realization, multi-cycle implementation. Instruction level parallelism, instruction pipelining and pipeline hazards.

Memory Architecture and I/O Organization: Storage systems, introduction to memory hierarchy: importance of temporal and spatial locality; main memory organization, cache memory: address mapping, block size, replacement, and store policies; virtual memory system: page table and TLB. External storage; IO fundamentals: handshaking, buffering, programmed IO, interrupt driven IO.

Reference Books

- 1 Computer System Architecture, M. Moris Mano , 2017, Pearson/PHI.
- 2 Fundamentals of Digital Logic with Verilog HDL, Stephen Brown and Zvonko Vranesic, 2013, Mc Graw Hill.
- 3 Computer Organization and Design, DA Patterson and JL Hennessy, 2007, Morgan Kaufmann Publisher.
- 4 Computer Architecture and Organization, J Baljinder Singh, 2019, Mc Graw Hill.
- 5 Digital Circuits and Design, S. Salivahanan and S. Arivazhahan, 2018, Oxford Press.
- 6 Computer Organization and Architecture, W. Stalling, 2006, PHI.

23EC1203 - BASIC ELECTRICAL AND ELECTRONIC CIRCUITS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC1203	BASIC ELECTRICAL AND ELECTRONIC CIRCUITS	BEEC	R	2	0	0	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of circuits and its fundamentals	2	PO1, PSO1
CO2	Grasp the principles of AC circuits, including sinusoidal waveforms, impedance, and power factor.	2	PO1, PSO1
CO3	Comprehend the behavior of basic electronic components, such as diodes, and transistors.	2	PO1, PSO1
CO4	Understand the basic functional Principles of analog and digital ICs.	2	PO1, PSO1

Syllabus

Basic circuit elements, Circuit fundamental: Mesh analysis and Nodal analysis, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem.

AC fundamentals: RMS value, Average Values, Form & Peak factor, Steady state analysis (R, L, C, etc), Reactance, Impedance, Phase & Phase difference, Real power, Reactive power, Power factor.

Operation of the diode, Diode as a switch, Rectifiers, Clipper, Clampers, Zener Diode as a regulator, Operation of Transistor, Transistor as a switch.

Analog & Digital ICs: Voltage regulators 7805, 7905, and LM723, Operational Amplifiers IC 741, Timer IC 555, Comparators LM 339.

Reference Books

- 1 Electrical Circuit Theory and Technology, John Bird, 2009, Routledge publishers.
- 2 Electronic Devices and Circuit Theory, Robert L. Boylestad, 2011, Pearson.
- 3 Electronic Devices and Circuits, David A. Bell, 2015, Oxford Press.
- 4 Circuits and Networks: Analysis and Synthesis, A Sudhakar, Shyam Mohan S Palli, 2010, MG Hill.

23ME1103 - DESIGN TOOL WORKSHOP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME1103	DESIGN TOOL WORKSHOP	DTW	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate proficiency in typing sentence , paragraph , report , presentations along spread sheets using office tools, LaTeX tools and PowerBI	2	PO5, PSO2
CO2	Build a static website and blog with using html along with Special features of HTML5, CSS and Javascript	3	PO5, PO10
CO3	Develop a virtual environment with cospace and construct a marker based Augmented Reality	3	PO3, PSO1
CO4	Utilising the softwares of Autodesk Fusion 360 and the same can be printed in 3D printer as physical prototype	3	PO3, PSO1

Syllabus

Office management and documentation: Demonstrate proficiency in typing sentence , paragraph , report , presentations along spread sheets using office tools, LaTeX tools and PowerBI

Basics of Web Development: Build a static website and blog with using html along with Special features of HTML5, CSS and Javascript

Virtual Reality and Augmented Reality: Develop a virtual environment with cospace and construct a marker based Augmented Reality and create a 3D terrain

Conceptual Design, Modelling and Prototyping: Utilising the softwares of Autodesk Fusion 360 and the same can be printed in 3D printer as physical prototype, Fundamentals of electrical circuit: Ohms law

Reference Books

- 1 LaTeX Cookbook, Kottwitz, Stefan, Packt Publishing, 2015.
- 2 MS-Office, Shrivastava S.S., Laxmi Publications Pvt Limited, 2008.
- 3 HTML & CSS: Design and Build Web Sites, Duckett, Jon, Wiley, 2011.
- 4 3D Printing: Understanding Additive Manufacturing, Thurn, Laura, Carl Hanser Verlag GmbH & Company KG, 2018.
- 5 Augmented Reality and Virtual Reality: New Trends in Immersive Technology, MC tom Dieck, Springer International Publishing, 2021.

23SC1101 - COMPUTATIONAL THINKING FOR STRUCTURED DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SC1101	COMPUTATIONAL THINKING FOR STRUCTURED DESIGN	CTSD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop and apply logical building blocks to solve real world problems	3	PO1, PO2, PO3
CO2	Apply computational thinking for designing solutions	3	PO1, PO2, PO3
CO3	Develop and apply the CRUD operations on arrays	3	PO1, PO4
CO4	Apply CRUD operations on Linear Data Structures	3	PO1, PO2, PO3
CO5	Apply the structured programming paradigm with logic building skills on Basic and Linear Data Structures for solving real world problems	3	PO1
CO6	Skill the students in such a way that students will be able to develop logic that help them to create programs as well as applications in C	3	

Syllabus

Structured Programming Paradigm: Problem Solving Approach, Algorithms and flowcharts, Program Development Steps, Structure of C Program, Pre-Processor Directives, Design of Building Blocks for solving real world problems: Data Types: Primitive, Extended and Derived, user defined data types Including Pointers, Modularizing problems using Functions, Scope of Variables and Storage classes

Operators: Types of operators, Precedence, Associativity, User I/O: Formatted I/O, Command line arguments, Redirecting I/O: Files and File Operations. Logic Design for Computational Thinking: Control Flow Statements: Decision Making using conditional statements, Definite and indefinite Iterative statements. Logic building using complex building blocks

Recursion, Strings and string manipulations, Arrays, 2-D Array, CRUD operations on Arrays, Strings, Dynamic Memory Allocation Searching: Linear Search and Binary Search Sorting: Bubble Sort

Structures, Array of Structures, structure pointers, CRUD operations on Linear Data Structures: Stacks, Queues, Single Linked List, Introduction to nonlinear data structures.

Reference Books

- 1 The C Programming Language: ANSI C Version, Brian W. Kernighan, Dennis M. Ritchie, 2nd Edition-2005, Prentice-Hall/Pearson Education.
- 2 Fundamentals of Data structures in C, Horowitz, Sahni, Anderson Freed, 2nd Edition-1995, Pearson Education.
- 3 Programming in ANSI C, E. Balagurusamy, 8th Edition-2015, Tata McGraw-Hill Education.
- 4 Data structures and Program Design in C, Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, 2006- 4th Edition, Pearson Education.

23SC1202 - DATA STRUCTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SC1202	DATA STRUCTURES	DS	R	2	0	2	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	COMPUTATIONAL THINKING FOR STRUCTURED DESIGN	CTSD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various sorting algorithms and analyse the efficiency of the algorithms.	3	PO1, PO2
CO2	Implement and evaluate Linear Data Structures and Demonstrate their applications.	3	PO1, PO2, PO3
CO3	Implement and evaluate tree data structures and understand hashing techniques	3	PO1, PO2, PO3, PO9
CO4	Understand graph data structures and apply graphs to solve problems	3	PO1, PO2, PO9
CO5	"Design, Develop and evaluate common practical applications for linear and nonlinear data structures."	3	PO3, PO9
CO6	"Skill the students in such a way that students will be able to develop logic that help them to create programs on both linear and non-linear datastructuresand its applications."	3	PO3, PO9

Syllabus

Algorithm Analysis: Mathematical BackgrounModel, Analyze, Running Time Calculations. Sorting: Introduction to Sorting Algorithm, Insertion Sort, Shell sort, Heap sort, Merge sort, Quick sort, Bucket Sort, External Sorting.

Dynamic Memory implementation of linear data structures: Singly Linked list, doubly linked list, circularly linked list, Applications of data structures: Polynomial Manipulation, Implementation of Stacks and Queues using Linked Lists, Circular Queue, Deque(Double ended queue), Applications of Stacks and Queues. Priority Queues (Heaps): Model, Simple Implementations, Binary Heap, Applications of Priority Queues.

IHashing: Introduction to Hashing, Hash Function, Separate Chaining, Hash Tables without Linked Lists, Rehashing, Hash Tables in the Standard Library, Extendible Hashing. Trees: Introduction to trees, Binary Trees, Tree Traversals, The Search Tree: Binary Search Trees, AVL Trees, Splay Trees, B-Trees, Red black trees.

Understand graph data structures and apply graphs to solve problems

Reference Books

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2010 , Second Edition, PearsonEducation., 1. Mark Allen Weiss, , Second Edition, , PearsonEducation..
2. , Fundamentals of Data Structures in C:, 2. Ellis Horowitz, Second Edition, PearsonEducation.
- 3 Data Structures And Algorithms, 1. A.V.Aho, J. E. Hopcroft, and J. D. Ullman, , Pearson Education, , First Edition Reprint2003..
- 4 Fundamentals of datastructures in C, 2. Horowitz, Sahni, Anderson Freed, Second Edition, PearsonEducation..
- 5 Data Structures, R. F. Gilberg, B. A. Forouzan, Second Edition, Thomson India Edition.

23SC1203R - COMPUTATIONAL THINKING FOR OBJECT-ORIENTED DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SC1203R	COMPUTATIONAL THINKING FOR OBJECT-ORIENTED DESIGN	CTOD	R	2	0	2	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	COMPUTATIONAL THINKING FOR STRUCTURED DESIGN	CTSD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Object oriented paradigm for code reusability	3	PO3, PO5, PSO2
CO2	Design object-oriented solutions to the real-world problems through SOLID design principles	3	PO3, PO5, PSO2
CO3	Build Abstract Data Types by applying generic classes and java API	3	PO3, PO5, PSO2
CO4	Demonstrate Exception handling and String manipulation techniques	3	PO3, PO5, PSO2
CO5	Develop solutions for real time problems by using object-oriented programming concepts.	5	PO1, PO2, PO4, PSO2
CO6	Develop a real time project by using object-oriented programming concepts.	5	PO1, PO2, PO4, PSO2

Syllabus

Introduction: Understanding Object Oriented Paradigm VS Structured Paradigm, Advantages of Object Oriented Programming and its key features-abstraction, encapsulation, inheritance & polymorphism, Java Program hierarchy and compilation process. Building static methods. Primitive data types and Arrays as Reference data type. Access specifiers for methods. Logic Building using control statements and Iterative statements. Wrapper classes, Type casting (Implicit & Explicit), command line arguments.

Classes & Objects: object, class Vs object and object instantiation. Abstraction and Encapsulation using accessors and mutators. Constructors- default, user-defined and parameterized. Introduction to Java API, Scanner class, console based IO, constructor chaining, this keyword, array of objects, aggregation vs composition, ArrayList, SOLID design principles.. Inheritance, Method overriding, dynamic polymorphism, dynamic method dispatch, Singleton classes. Inner classes.

Exception Handling & File IO: Introduction to exceptions & errors, Java API for exceptions, try, catch, finally, throw and throws keywords, try with resources, user defined exceptions. File IO, byte streams, character streams, wrapper classes for Object IO using serializable. Strings: String based algorithms using StringBuffer and String Builder, String constant pool, regex, garbage collection.

Abstraction & Applications: Abstract classes, abstract methods, final keyword for methods and classes, template pattern, Introduction to interfaces, Interfaces vs implementation, Factory classes, factory method pattern, Generic classes, application of interfaces to build abstract data structures, Java API for Vector and Hash set and Hash Map, comparable, comparator and cloneable, iterator interfaces. Anonymous classes, Decorator pattern. Event driven programming with event listeners.

Reference Books

- 1 Introduction to Java Programming, Comprehensive Version , Y. Daniel Liang , 10, PHI.

- 2 The Complete Reference Java , Herbert Schildt , 7th, TMH.
- 3 An Introduction to Object-Oriented Programming , Timothy A. Budd , 3rd, Pearson.
- 4 The JAVA programming language, K. Arnold and J. Gosling, 3, Pearson.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Professional Core Courses (PCC)

23AD2102A - DATABASE MANAGEMENT SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD2102A	DATABASE MANAGEMENT SYSTEMS	DBMS	A	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	COMPUTATIONAL THINKING FOR STRUCTURED DESIGN	CTSD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamental database design principles, including normalization, to model complex data relationships.	3	PO2
CO2	Develop efficient and secure database applications using Structured Query Language (SQL) and PL/SQL for data manipulation and retrieval.	3	PO5, PSO1
CO3	Implement and manage database systems with appropriate indexing techniques, query optimization strategies, and concurrency control mechanisms for efficient and reliable data access.	3	, PSO1
CO4	Analyze and evaluate the suitability of emerging database technologies like NoSQL and Big Data for modern applications, considering security implications.	4	PO5, PO9, PSO1
CO5	Design and implement distributed database systems, considering replication techniques and principles of distributed data management.	6	PO2, PO9, PSO1
CO6	Design and implement practical database solutions to solve real-world problems using appropriate database management system technologies and best practices.	6	PO5, PO9, PSO1

Syllabus

Introduction to databases, data models (ER Model), database management systems (DBMS) architecture. Entity-Relationship (ER) Modelling concepts, relationship types, cardinality and ordinality constraints. Relational model concepts, normalization process (1NF, 2NF, 3NF, BCNF) for data integrity.

Introduction to SQL, Data Definition Language (DDL) for schema creation and manipulation. Data Manipulation Language (DML) for data retrieval, insertion, deletion, and modification. Advanced SQL concepts: Joins (inner, outer), subqueries, aggregation functions, views, and data security using access control. Introduction to PL/SQL for procedural programming within the database.

Introduction to transaction management concepts (ACID properties). Concurrency control mechanisms (locking protocols) and recovery techniques (rollback, redo) to ensure data consistency. Indexing techniques (hashing, B-trees) for efficient data access. Query optimization strategies for improving query performance.

Introduction to NoSQL databases and their characteristics (key-value, document, graph). Big Data concepts, distributed storage and processing frameworks (Hadoop). Security considerations in database management systems, including access control, encryption, and intrusion detection.

Principles of distributed database systems: architectures, advantages, and challenges. Replication techniques for data consistency and availability. Data fragmentation techniques (horizontal, vertical), distributed transactions, and distributed query processing

Reference Books

- 1 Database Systems Concepts, Abraham Silberschatz, Henry Korth, S. Sudarshan, 2014, McGraw-Hill Education.
- 2 Introduction to Database Management Systems, R. Elmasri, Shamkant B. Navathe, 2016, Pearson Education.
- 3 PL/SQL Programming for Oracle, Steven Feuerstein, Bill Pribyl, 2011, O'Reilly Media.

- 4 Database and Application Security: Integrating Security in the Software Development Life Cycle, Rick Hoffman, 2016, Jones & Bartlett Learning.
- 5 Distributed Database Systems: Principles and Systems, Chhanda Ray, 2013, Pearson Education.

23AD2102E - DATABASE MANAGEMENT SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD2102E	DATABASE MANAGEMENT SYSTEMS	DBMS	E	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	COMPUTATIONAL THINKING FOR STRUCTURED DESIGN	CTSD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design and implement robust database models using advanced normalization techniques, design patterns, and optimizations to address complex real-world challenges.	4	
CO2	Develop sophisticated database applications utilizing SQL, PL/SQL, and relevant programming frameworks for efficient data processing and integration with real-world systems.	4	PO3, PSO1
CO3	Architect and manage scalable database systems, optimizing performance through advanced indexing, query tuning, and distributed architectures.	5	PO5, PO9, PSO1
CO4	Critically evaluate traditional and emerging database technologies (NoSQL, graph databases, in-memory databases) to architect optimal solutions for modern application use cases.	5	PO5, PO9, PSO1
CO5	Design and implement comprehensive database solutions for real-world projects, demonstrating collaboration, project management, and effective communication of technical concepts.	6	PO3, PO5, PO9, PSO1

Syllabus

Advanced normalization (4NF, 5NF, DKNF) and database design patterns. Performance optimization for complex schemas and data volumes. Project: Design a real-world database, applying advanced techniques and justifying choices.

Complex SQL queries, stored procedures, triggers, and functions for advanced data manipulation. Integrating databases with applications using ORMs, JDBC/ODBC, and relevant frameworks. Project: Extend an existing application with database features or build a database-driven application.

Replication (master-slave, master-master), sharding, and distributed database concepts. Performance tuning, load balancing, and benchmarking for large-scale systems. Project: Design and simulate a scalable database architecture, evaluating performance trade-offs.

NoSQL databases (key-value, document, columnar, graph): use cases, modeling, and performance considerations. In-memory databases, database appliances, and cloud-based database services. Project: Prototype a solution using an alternative database technology, showcasing advantages.

Team-based project addressing a real-world problem using a comprehensive database solution. Proposal, design, implementation, testing, deployment, and documentation. Presentation and defence of the project to a panel of experts.

Reference Books

- 1 Database Systems Concepts, Abraham Silberschatz, Henry Korth, S. Sudarshan, 2014, McGraw-Hill Education.
- 2 Introduction to Database Management Systems, R. Elmasri, Shamkant B. Navathe, 2016, Pearson Education.
- 3 PL/SQL Programming for Oracle, Steven Feuerstein, Bill Pribyl, 2011, O'Reilly Media.

- 4 Database and Application Security: Integrating Security in the Software Development Life Cycle, Rick Hoffman, 2016, Jones & Bartlett Learning.
- 5 Distributed Database Systems: Principles and Systems, Chhanda Ray, 2013, Pearson Education.
- 6 Database Internals: A Deep Dive into How Databases Work, Alex Petrov, 2019, O'Reilly Media.
- 7 Designing Data-Intensive Applications, Martin Kleppmann, 2017, O'Reilly Media.
- 8 High-Performance MySQL: Optimization, Backups, and Replication, Baron Schwartz, Peter Zaitsev, Vadim Tkachenko, 2012, O'Reilly Media.
- 9 Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement, Eric Redmond, Jim R. Wilson, 2018, Pragmatic Bookshelf.
- 10 Learning SQL, Alan Beaulieu, 2023, O'Reilly Media.

23AD2102R - DATABASE MANAGEMENT SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD2102R	DATABASE MANAGEMENT SYSTEMS	DBMS	R	3	0	2	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	COMPUTATIONAL THINKING FOR STRUCTURED DESIGN	CTSD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamental database design principles, including normalization, to model complex data relationships.	3	PO3
CO2	Develop efficient and secure database applications using Structured Query Language (SQL) and PL/SQL for data manipulation and retrieval.	3	PO3, PSO2
CO3	Implement and manage database systems with appropriate indexing techniques, query optimization strategies, and concurrency control mechanisms for efficient and reliable data access.	3	PO5, PO9, PSO2
CO4	Analyze and evaluate the suitability of emerging database technologies like NoSQL and Big Data for modern applications, considering security implications.	4	PO5, PO9, PSO2
CO5	Design and implement practical database solutions to solve real-world problems using appropriate database management system technologies and best practices.	6	PO3, PO5, PO9, PSO2

Syllabus

Introduction to databases, data models (ER Model), database management systems (DBMS) architecture. Entity-Relationship (ER) Modelling concepts, relationship types, cardinality and ordinality constraints. Relational model concepts, normalization process (1NF, 2NF, 3NF, BCNF) for data integrity.

Introduction to SQL, Data Definition Language (DDL) for schema creation and manipulation. Data Manipulation Language (DML) for data retrieval, insertion, deletion, and modification. Advanced SQL concepts: Joins (inner, outer), subqueries, aggregation functions, views, and data security using access control. Introduction to PL/SQL for procedural programming within the database.

Introduction to transaction management concepts (ACID properties). Concurrency control mechanisms (locking protocols) and recovery techniques (rollback, redo) to ensure data consistency. Indexing techniques (hashing, B-trees) for efficient data access. Query optimization strategies for improving query performance.

Introduction to NoSQL databases and their characteristics (key-value, document, graph). Big Data concepts, distributed storage and processing frameworks (Hadoop). Security considerations in database management systems, including access control, encryption, and intrusion detection.

Reference Books

- 1 Database Systems Concepts, Abraham Silberschatz, Henry Korth, S. Sudarshan, 2014, McGraw-Hill Education.
- 2 Introduction to Database Management Systems, R. Elmasri, Shamkant B. Navathe, 2016, Pearson Education.
- 3 PL/SQL Programming for Oracle, Steven Feuerstein, Bill Pribyl, 2011, O'Reilly Media.
- 4 Database and Application Security: Integrating Security in the Software Development Life Cycle, Rick Hoffman, 2016, Jones & Bartlett Learning.
- 5 Distributed Database Systems: Principles and Systems, Chhanda Ray, 2013, Pearson Education.

23EC2106A - PROCESSORS AND CONTROLLERS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2106A	PROCESSORS AND CONTROLLERS	PRC	A	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the foundational concepts of the 8086 microprocessor, including its architecture, pinout, addressing modes, instruction set, timing diagrams for different modes, ALU programming, and practical examples."	3	PO2, PO5, PO7, PSO1
CO2	Apply the core aspects of the 8051 microcontroller, focusing on its architecture, pin diagram, addressing modes, instruction sets, and programs involving arithmetic and logical operations, as well as the use of timers and counters."	3	PO2, PO5, PO7, PSO1
CO3	Analyse the 8051 microcontroller applications through assembly-level programming, exploring interrupts, serial port operations, and peripherals like timers, seven-segment displays, LCDs, ADCs, DACs, and stepper motor control, with case studies in keypad interfacing, traffic signals, home automation, and industrial use cases."	4	PO2, PO5, PO7, PSO1
CO4	Apply the architectures and features of PIC and ARM microcontrollers, examining the ARM series\' evolution, core features, pipeline processing, processor modes and registers, exception handling, and ARM\'s Thumb mode of execution."	3	PO2, PO5, PO7, PSO1
CO5	Apply the architectural features of RISC type of ARM and AVR microcontroller	3	PO2, PO5, PO7, PSO1
CO6	Analyse the 8051 microcontroller applications through assembly-level programming, exploring interrupts, serial port operations, and peripherals like timers, seven-segment displays, LCDs.	4	PO2, PO5, PO7, PSO1

Syllabus

8086-Microprocessor: The course covers the basics of processors, introduction and history of processors, detailed 8086 pinout, and architecture. It explores addressing modes, instruction set, timing diagrams for minimum and maximum modes, ALU programming, and practical examples.

8051-Microcontroller: The course covers the architecture and pin diagram of the 8051 microcontroller, addressing modes, instruction sets, stack operations, and programs involving arithmetic and logical instructions. It also includes a detailed study of timers and counters.

8051-Microcontroller Applications: Interrupts & Serial port Assembly level programming, Peripherals and Input Output with 8051 Microcontroller - Timers and Interfacing Seven Segment, LCD, ADC, DAC & Stepper Motor Control). Case studies: Keypad, Traffic signal, Home automation & Industrial applications.

PIC Microcontroller: Architecture & features of PIC, Instruction sets , **ARM Microcontroller:** Introduction, Architecture, ARM series of microcontrollers, Evolution of ARM microcontrollers, ARM features, Basic concepts of pipeline processing, ARM processor modes and registers, Special registers.

ARM & AVR controllers: ARM Instruction sets: Data processing, Data transfer Instructions, Branch, Swap and Thumb modes of execution, Stack, Interrupts-Software Interrupts, ARM exception handling and Cortex. AVR controllers: Introduction, Architecture, features, Instructions, Timers/Counters.

Reference Books

- 1 Advanced Microprocessors and Peripherals, A K Ray and K M Bhurchandi, 2003-2nd Edition, The McGraw Companies.
- 2 The 8051 Micro controller and Embedded systems: using assembles and C, Mazidi & McKinley, 2007-2nd Edition, Pearson Publishers.
- 3 Design with PIC Microcontrollers, John B. Peatman, 1998-2nd Edition, Pearson Publishers.
- 4 Microprocessor and Interfacing, D.V.Hall, 2006 - 2nd Edition, Tata McGraw Hill Publishing Company.

23EC2106E - PROCESSORS AND CONTROLLERS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2106E	PROCESSORS AND CONTROLLERS	PRC	E	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the foundational concepts of the 8086 microprocessor, including its architecture, pinout, addressing modes, instruction set, timing diagrams for different modes, ALU programming, and practical examples."	3	PO2, PO5, PO7, PSO1
CO2	Apply the core aspects of the 8051 microcontroller, focusing on its architecture, pin diagram, addressing modes, instruction sets, and programs involving arithmetic and logical operations, as well as the use of timers and counters."	3	PO2, PO5, PO7, PSO1
CO3	Analyse the 8051 microcontroller applications through assembly-level programming, exploring interrupts, serial port operations, and peripherals like timers, seven-segment displays, LCDs, ADCs, DACs, and stepper motor control, with case studies in keypad interfacing, traffic signals, home automation, and industrial use cases."	4	PO2, PO5, PO7, PSO1
CO4	Apply the architectures and features of PIC and ARM microcontrollers, examining the ARM series\'\'\' evolution, core features, pipeline processing, processor modes and registers, exception handling, and ARM\'\'\'s Thumb mode of execution."	3	PO2, PO5, PO7, PSO1
CO5	Apply the architectural features of RISC type of ARM and AVR microcontroller	3	PO2, PO5, PO7, PSO1
CO6	Analyse the 8051 microcontroller applications through assembly-level programming, exploring interrupts, serial port operations, and peripherals like timers, seven-segment displays, LCDs.	4	PO2, PO5, PO7, PSO1

Syllabus

8086-Microprocessor: Basics of processor, Introduction, and History of Processors, pinout, Architecture, addressing modes, Instruction set, Timing Diagram for Minimum and Maximum mode, ALU programming, and examples.

8051-Microcontroller: Architecture, Pin Diagram, addressing modes, Instruction sets, Programs involving Arithmetic and Logical Instructions, Timers/Counters.

8051-Microcontroller Applications: Interrupts & Serial port Assembly level programming, Peripherals and Input Output with 8051 Microcontroller - Timers and Interfacing Seven Segment, LCD, ADC, DAC & Stepper Motor Control). Case studies: Keypad, Traffic signal, Home automation & Industrial applications.

PIC Microcontroller: Architecture & features of PIC, Instruction sets , ARM Microcontroller: Introduction, Architecture, ARM series of microcontrollers, Evolution of ARM microcontrollers, ARM features, Basic concepts of pipeline processing, ARM processor modes and registers, Special registers.

ARM & AVR controllers: ARM Instruction sets: Data processing, Data transfer Instructions, Branch, Swap and Thumb modes of execution, Stack, Interrupts-Software Interrupts, ARM exception handling and Cortex. AVR controllers: Introduction, Architecture, features, Instructions, Timers/Counters.

Reference Books

- 1 Advanced Microprocessors and Peripherals , A K Ray and K M Bhurchandi , 2006-2nd Edition , The McGraw Companies.

- 2 The 8051 Micro controller and Embedded systems: using assembles and C, Mazidi & McKinley , 2007-2nd Edition, Pearson Publishers.
- 3 Design with PIC Microcontrollers, John B. Peatman , 1998-2nd Edition, Pearson Publishers.
- 4 Microprocessor and Interfacing, D.V.Hall , 2006 - 2nd Edition , Tata McGraw Hill Publishing Company.

23EC2106R - PROCESSORS AND CONTROLLERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2106R	PROCESSORS AND CONTROLLERS	PRC	R	3	0	2	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the foundational concepts of the 8086 microprocessor, including its architecture, pinout, addressing modes, instruction set, timing diagrams for different modes, ALU programming, and practical examples."	3	PO2, PO5, PO7, PSO1
CO2	Apply the core aspects of the 8051 microcontroller, focusing on its architecture, pin diagram, addressing modes, instruction sets, and programs involving arithmetic and logical operations, as well as the use of timers and counters."	3	PO2, PO5, PO7, PSO1
CO3	Analyse the 8051 microcontroller applications through assembly-level programming, exploring interrupts, serial port operations, and peripherals like timers, seven-segment displays, LCDs, ADCs, DACs, and stepper motor control, with case studies in keypad interfacing, traffic signals, home automation, and industrial use cases."	4	PO2, PO5, PO7, PSO1
CO4	Apply the architectures and features of PIC and ARM microcontrollers, examining the ARM series' evolution, core features, pipeline processing, processor modes and registers, exception handling, and ARM's Thumb mode of execution."	3	PO2, PO5, PO7, PSO1
CO5	Analyse the 8051 microcontroller applications through assembly-level programming, exploring interrupts, serial port operations, and peripherals like timers, seven-segment displays, LCDs."	4	PO2, PO5, PO7, PSO1

Syllabus

8086-Microprocessor: Basics of processor, Introduction, and History of Processors, pinout, Architecture, addressing modes, Instruction set, Timing Diagram for Minimum and Maximum mode, ALU programming, and examples.

8051-Microcontroller: Architecture, Pin Diagram, addressing modes, Instruction sets, Programs involving Arithmetic and Logical Instructions, Timers/Counters.

8051-Microcontroller Applications: Interrupts & Serial port Assembly level programming, Peripherals and Input Output with 8051 Microcontroller - Timers and Interfacing Seven Segment, LCD, ADC, DAC & Stepper Motor Control). Case studies: Keypad, Traffic signal, Home automation & Industrial applications.

PIC & ARM Microcontroller: Architecture & features of PIC, Architecture of ARM Microcontroller, ARM series of microcontrollers, Evolution of ARM microcontrollers, ARM features, Basic concepts of pipeline processing, ARM processor modes and registers, Special registers and exception handling, ARM and Thumb modes of execution.

Reference Books

- 1 Advanced Microprocessors and Peripherals , A K Ray and K M Bhurchandi, 2006-2nd Edition, The McGraw Companies.
- 2 The 8051 Micro controller and Embedded systems: using assembles and C , Mazidi & McKinley, 2007-2nd Edition, Pearson Publishers.
- 3 Design with PIC Microcontrollers , John B. Peatman, 1998-2nd Edition, Pearson Publishers.
- 4 Microprocessor and Interfacing, D.V.Hall, 2006 - 2nd Edition, Tata McGraw Hill Publishing Company.

23EC2210A - NETWORK PROTOCOLS AND SECURITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2210A	NETWORK PROTOCOLS AND SECURITY	NPS	A	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of communication to understand the concepts of physical layer and datalink layer.	3	PO1, PO2, PSO2
CO2	Analyze various MAC protocols and IP addressing concepts to subnet a network.	4	PO2, PO3, PSO2
CO3	Analyze static and dynamic routing algorithms and transport layer protocols.	4	PO2, PO3, PSO2
CO4	Analyze application layer protocols and various cryptographic algorithms.	4	PO2, PO3, PSO2
CO5	Analyze various link layer protocols and advanced security concepts.	4	PO2, PO3, PSO2
CO6	Analyze the functionality of the network using different protocols and working of various cryptographic algorithms.	4	PO2, PO5, PSO2

Syllabus

Introduction to Computer networks and Data Link Layer: Use of Computer Networks, Network Hardware, Network software, Reference models: OSI and TCP/IP, Physical Layer: The theoretical basis for Data Communication, Guided and Unguided Transmission Media, Switching. Data Link Layer: DLL design issues. Error Detection and Correction, Elementary data link protocols, sliding window protocols.

Medium Access Control Sub layer: Channel allocation problem, multiple access protocols, Design issues of Network layer, Inter-networking Devices: Distinguishing of Networking Devices and Inter-networking Devices, Analysis of Router Processing: Access, core and distribution. VLANs, Addressing: IP addressing (IPv4 & IPv6), subnetting; IP Tunneling, NAT, PAT.

ARP, DHCP, Types of Routing: static, default and dynamic. Networking Protocols: RIP, OSPF, BGP; Access Control list for IPv4, IPv6, Transport Layer: Process to Process Delivery; UDP; TCP; Stream Control Transmission Protocol (SCTP); Congestion Control: Open Loop, Closed Loop Choke Packets; Quality of Service: Techniques to Improve QoS: Leaky bucket algorithm, Token bucket algorithm.

Application Layer: DNS, SMTP, SNMP Introduction to Security, Security goals, Security Attacks, Security Services and Mechanisms, A Security Model, Asymmetric & Symmetric key Ciphers, Substitution Techniques, Transposition Techniques, DES, RSA algorithm, Secure Socket Layer.

Ethernet, HDLC, CHAP, PAP, PPP, PPPoE, AAA, IPSec, ACL, OSPF V3, IPv6: EUI-64, DAD; MPLS, Firewalls, Hashing, Digital Signatures.

Reference Books

- 1 Data Communication and Networking, Behrouz A. Forouzan, 3rd, TMH, 2012.
- 2 Computer Networks, A.S.Tanenbaum, David J. Weteral, 3rd, Pearson Education.
- 3 Cryptography and Network Security, William Stallings, 3rd, Pearson Education.

- 4 Engineering Approach To Computer Networking, Srinivasan Keshav, 1st, Pearson Education(AICTE).
- 5 Computer Networking: A Top-Down Approach, Bhavneet Sidhu, 3rd, Khanna Publications.

23EC2210E - NETWORK PROTOCOLS AND SECURITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2210E	NETWORK PROTOCOLS AND SECURITY	NPS	E	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of communication to understand the concepts of physical layer and datalink layer.	3	PO1, PO2, PO3, PSO2
CO2	Analyze various MAC protocols and IP addressing concepts to subnet a network.	4	PO2, PO3, PSO2
CO3	Analyze static and dynamic routing algorithms and transport layer protocols.	4	PO2, PO3, PSO2
CO4	Analyze application layer protocols and various cryptographic algorithms.	4	PO2, PO3, PSO2
CO5	Analyze various link layer protocols and advanced security concepts.	4	PO2, PO3, PSO2
CO6	Analyze the functionality of the network using different protocols and working of various cryptographic algorithms.	4	PO2, PO5, PSO2

Syllabus

CO1: Introduction to Computer networks and Data Link Layer: Use of Computer Networks, Network Hardware, Network software, Reference models: OSI and TCP/IP, Physical Layer: The theoretical basis for Data Communication, Guided and Unguided Transmission Media, Switching. Data Link Layer: DLL design issues. Error Detection and Correction, Elementary data link protocols, sliding window protocols.

Medium Access Control Sub layer: Channel allocation problem, multiple access protocols, Design issues of Network layer, Inter-networking Devices: Distinguishing of Networking Devices and Inter-networking Devices, Analysis of Router Processing: Access, core and distribution. VLANs, Addressing: IP addressing (IPv4 & IPv6), subnetting; IP Tunneling, NAT, PAT.

ARP, DHCP, Types of Routing: static, default and dynamic. Networking Protocols: RIP, OSPF, BGP; Access Control list for IPv4, IPv6, Transport Layer: Process to Process Delivery; UDP; TCP; Stream Control Transmission Protocol (SCTP); Congestion Control: Open Loop, Closed Loop Choke Packets; Quality of Service: Techniques to Improve QoS: Leaky bucket algorithm, Token bucket algorithm.

Application Layer: DNS, SMTP, SNMP Introduction to Security, Security goals, Security Attacks, Security Services and Mechanisms, A Security Model, Asymmetric & Symmetric key Ciphers, Substitution Techniques, Transposition Techniques, DES, RSA algorithm, Secure Socket Layer.

Ethernet, HDLC, CHAP, PAP, PPP, PPPoE, AAA, IPSec, ACL, OSPF V3, IPv6: EUI-64, DAD; MPLS, Firewalls, Hashing, Digital Signatures.

Reference Books

- 1 Data Communication and Networking , Behrouz A. Forouzan , 5th Edition, (2012) , TMH.
- 2 Computer Networks -- A Systems Approach , William Stallings , 6th Edition, 2015 , Pearson Education .

- 3 Cryptography and Network Security , Peterson, LL and Davie BS , 5th edition-(2012) , Morgan Kaufmann, Elsevier .
- 4 Computer Networks , A.S.Tanenbaum, David J. Weteral , 5 th edition. 2013 , Pearson Education.
- 5 Computer Networking: A Top-Down Approach , Kurose, J and Ross, K , 6th edition-(2012) , Addison-Wesley .

23EC2210R - NETWORK PROTOCOLS AND SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2210R	NETWORK PROTOCOLS AND SECURITY	NPS	R	3	0	2	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of communication to understand the concepts of physical layer and datalink layer.	3	PO1, PO2, PO3, PSO2
CO2	Analyze various MAC protocols and apply IP addressing concepts to subnet a network.	4	PO2, PO3, PSO2
CO3	Analyze static and dynamic routing algorithms and transport layer protocols.	4	PO2, PO3, PSO2
CO4	Analyze application layer protocols and various cryptographic algorithms.	4	PO2, PO3, PSO2
CO5	Analyze the functionality of the network using different protocols and working of various cryptographic algorithms.	4	PO2, PO5, PSO2

Syllabus

Introduction to Computer networks and Data Link Layer: Use of Computer Networks, Network Hardware, Network software, Reference models: OSI and TCP/IP, Physical Layer: The theoretical basis for Data Communication, Guided and Unguided Transmission Media, Switching. Data Link Layer: DLL design issues. Error Detection and Correction, Elementary data link protocols, sliding window protocols.

Medium Access Control Sub layer: Channel allocation problem, multiple access protocols, Design issues of Network layer, Inter-networking Devices: Distinguishing of Networking Devices and Inter-networking Devices, VLANs, Addressing: IP addressing (IPv4 & IPv6), subnetting; IP Tunneling, NAT, PAT

ARP, DHCP Types of Routing: static, default and dynamic. Networking Protocols: RIP, OSPF, BGP; Access Control list for IPV4, IPV6, Other Protocols: Transport Layer: Process to Process Delivery; UDP; TCP; Stream Control Transmission Protocol (SCTP); Congestion Control: Open Loop, Closed Loop Choke Packets; Quality of Service: Techniques to Improve QoS: Leaky bucket algorithm, Token bucket algorithm.

Application Layer: DNS, SMTP, SNMP Introduction to Security, Security goals, Security Attacks, Security Services and Mechanisms, A Security Model, Asymmetric & Symmetric key Ciphers, Substitution Techniques, Transposition Techniques, DES, RSA algorithm, Secure Socket Layer.

Reference Books

- 1 Data Communication and Networking, Behrouz A. Forouzan, 5th Edition, (2012), TMH.
- 2 Cryptography and Network Security , William Stallings , 6th Edition, 2015 , Pearson Education.
- 3 Computer Networks -- A Systems Approach , Peterson, LL and Davie BS , 5th edition-(2012) , Morgan Kaufmann, Elsevier.
- 4 Computer Networks , A.S.Tanenbaum, David J. Weteral , 5 th edition. 2013 , Pearson Education.
- 5 Computer Networking: A Top-Down Approach , Kurose, J and Ross, K , 6th edition-(2012) , Addison-Wesley.

23IN2101A - IOT SYSTEM DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN2101A	IOT SYSTEM DESIGN	IOTPA	A	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of IoT Architecture and technologies	3	PO1, PO7, PSO1
CO2	Apply the logical design of IoT system	3	PO1, PO7, PSO1
CO3	Apply IoT networking protocols and Authentication Protocols for IoT Application layer.	3	PO1, PO2, PO5, PSO1
CO4	Apply IoT protocols and programming concepts for real-world problems.	3	PO1, PO2, PO5, PSO1
CO5	Apply IoT Privacy and Security	3	PO1, PO5, PSO1
CO6	Develop IoT based applications using IoT Protocols	5	PO1, PO2, PO5, PSO1

Syllabus

IoT Reference Architecture: Introduction to IoT, Characteristics of IoT, IoT Architecture, Physical Design of IoT, Logical design of IoT, IoT enabling Technologies, IoT Levels & Development Templates, Difference between IoT and M2M, SDN and NFV for IoT. RFIDs, and wireless sensor networks technology.

Embedded devices for IoT and Sensor Technology. IoT Systems-Logical using Python: Installing Python, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, Date/ Time Operations, Classes, Python Packages. IoT Design Methodology, Case study using weather monitoring. IoT Physical Devices & Endpoints: What is an IoT Device, Exemplary Device, Board, Linux on Raspberry Pi, Programming of IoT.

IoT Communication Technologies: wired UART, USART, SPI, I2C, ModBUS, CAN, Ethernet, USB. Wireless, Bluetooth, BLE, IEEE 802.11, IEEE 802.15, Zig SIGFOX. IoT Networking Protocols: IPv4 and IPv6, lowPAN, TCP/IP, IP addressing of IoT devices MAC addresses of communication circuit. Web connectivity connected devices Application Protocols HTTP, Web sockets, Node, MQTT, UDP, CoAP, XMPP, AMQP and gateway protocols. Link Layer protocols: 802.3, IEEE 802.11 Wi-Fi 802.16, WiMax 802.15.4, LR, WPAN, 2G, 3G, 4G. Cloud storage Models and Communication APIs. Web application management protocol, Python application framework.

IoT design considerations, Prototyping IoT solutions, Design IoT development Frameworks: Case studies illustrating IoT design: Home Automation: Smart lighting, Smart Appliances, Cities: Smart Parking, Smart Lighting, Smart Roads, Emergency response, Environment: Weather monitoring, Air Pollution Monitoring, Noise pollution, Forest fire, River flood, Agriculture: Smart irrigation, Green House control.

Internet of Things and Privacy, Computational Privacy and IoT, System and Application Level Privacy in IoT, Internet of Things and Security, Security Mechanisms in IoT, IoT Communications Security

Reference Books

- 1 Internet of Things: Principles and paradigms., Buyya, Rajkumar, and Amir Vahid Dastjerdi, 2016, Elsevier.

- 2 IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, 2017, CISCO Press,.
- 3 Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatios Karnouskos, David Boyle, 2014, Academic Press.
- 4 Enabling things to talk, Bassi, Alessandro, 2016, Springer.

23IN2101E - IOT SYSTEM DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN2101E	IOT SYSTEM DESIGN	IOTPA	E	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of IoT Architecture and technologies	3	PO1, PO5, PSO1
CO2	Apply the logical design of IoT system	3	PO1, PO5, PSO1
CO3	Apply IoT networking protocols and Authentication Protocols for IoT Application layer.	3	PO1, PO7, PSO1
CO4	Apply IoT protocols and programming concepts for real-world problems.	3	PO1, PO2, PO7, PSO1
CO5	Apply IoT Privacy and Security	3	PO1, PO7, PSO1
CO6	Develop IoT based applications using IoT Protocols	3	PO1, PO7, PSO1

Syllabus

IoT Reference Architecture: Introduction to IoT, Characteristics of IoT, IoT Architecture, Physical Design of IoT, Logical design of IoT, IoT enabling Technologies, IoT Levels & Development Templates, Difference between IoT and M2M, SDN and NFV for IoT. RFIDs, and wireless sensor networks technology.

Embedded devices for IoT and Sensor Technology. IoT Systems-Logical using Python: Installing Python, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, Date/ Time Operations, Classes, Python Packages. IoT Design Methodology, Case study using weather monitoring. IoT Physical Devices & Endpoints: What is an IoT Device, Exemplary Device, Board, Linux on Raspberry Pi, Programming of IoT.

IoT Communication Technologies: wired UART, USART, SPI, I2C, ModBUS, CAN, Ethernet, USB. Wireless, Bluetooth, BLE, IEEE 802.11, IEEE 802.15, Zig SIGFOX. IoT Networking Protocols: IPv4 and IPv6, lowPAN, TCP/IP, IP addressing of IoT devices MAC addresses of communication circuit. Web connectivity connected devices Application Protocols HTTP, Web sockets, Node, MQTT, UDP, CoAP, XMPP, AMQP and gateway protocols. Link Layer protocols: 802.3, IEEE 802.11 Wi-Fi 802.16, WiMax 802.15.4, LR, WPAN, 2G, 3G, 4G. Cloud storage Models and Communication APIs. Web application management protocol, Python application framework.

IoT design considerations, Prototyping IoT solutions, Design IoT development Frameworks: Case studies illustrating IoT design: Home Automation: Smart lighting, Smart Appliances, Cities: Smart Parking, Smart Lighting, Smart Roads, Emergency response, Environment: Weather monitoring, Air Pollution Monitoring, Noise pollution, Forest fire, River flood, Agriculture: Smart irrigation, Green House control.

Internet of Things and Privacy, Computational Privacy and IoT, System and Application Level Privacy in IoT, Internet of Things and Security, Security Mechanisms in IoT, IoT Communications Security

Reference Books

- 1 Internet of Things: Principles and paradigms., Buyya, Rajkumar, and Amir Vahid Dastjerdi, 2016, Elsevier.

- 2 IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry , 2017, CISCO Press,.
- 3 Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle , 2014, Academic Press.
- 4 Enabling things to talk , Bassi, Alessandro , 2016, Springer.

23IN2101R - IOT SYSTEM DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN2101R	IOT SYSTEM DESIGN	IOTPA	R	3	0	2	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of IoT Architecture and technologies	3	PO1, PO7, PSO1
CO2	Apply the logical design of IoT system	3	PO1, PO7, PSO1
CO3	Apply IoT networking protocols and Authentication Protocols for IoT Application layer.	3	PO1, PO2, PO5, PSO1
CO4	Apply IoT protocols and programming concepts for real-world problems.	3	PO1, PO2, PO5, PSO1
CO5	Develop IoT based applications using IoT Protocols	5	PO3, PO5, PSO2

Syllabus

IoT Reference Architecture: Introduction to IoT, Characteristics of IoT, IoT Architecture, Physical Design of IOT, Logical design of IoT, IoT enabling Technologies, IoT Levels & Development Templates, Difference between IoT and M2M, SDN and NFV for IoT. RFIDs, and wireless sensor networks technology. IoT Programming language and Tools.

Module 2 IoT Communication Technologies: wired - ModBUS, Wireless - Bluetooth, BLE, IEEE 802.11, IEEE 802.15, Zigbee, SIGFOX. IoT Networking Protocols: IPv4 and IPv6.6lowPAN, TCP/IP, IP addressing of IoT devices MAC addresses of communication circuit.

IoT Communication Technologies: wired UART, USART, SPI, I2C, ModBUS, CAN, Ethernet, USB. Wireless, Bluetooth, BLE, IEEE 802.11, IEEE 802.15, Zigbee, SIGFOX. IoT Networking Protocols: IPv4 and IPv6.6lowPAN, TCPIP, IP addressing of IoT devices MAC addresses of communication circuit. Web connectivity for connected devices Application Protocols HTTP, Web sockets, Node, MQTT, UDP, CoAP, XMPP, AMQP and gateway protocols. Link Layer protocols: 802.3, Ethernet 802.11 WiFi 802.16, WiMax 802.15.4, LR, WPAN,2G,3G.4G. Cloud storage Models and Communication APIs. Web application management protocol, Python web application framework.

IoT design considerations, Prototyping IoT solutions, Design IoT development Frameworks: Case studies illustrating IoT design: Home Automation: Smart lighting, Smart Appliances, Cities: Smart Parking, Smart Lighting, Smart Roads, Emergency response, Environment: Weather monitoring, Air Pollution Monitoring, Noise pollution, Forest fire, River flood, Agriculture: Smart irrigation, Green House control.

Reference Books

- 1 Internet of Things: Principles and paradigms., Buyya, Rajkumar, and Amir Vahid Dastjerdi,, 2016, Elsevier.
- 2 IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,, 2017, CISCO Press.
- 3 Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, 2014, Academic Press.
- 4 Enabling things to talk, Bassi, Alessandro, 2016, Springer.

23IN2102 - ELECTRONIC DEVICES AND INTEGRATED CIRCUITS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN2102	ELECTRONIC DEVICES AND INTEGRATED CIRCUITS	EDAIC	R	3	0	2	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	BASIC ELECTRICAL AND ELECTRONIC CIRCUITS	BEEC	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of Semiconductor physics and discuss BJT configurations and its applications	3	PO1, PSO1
CO2	Apply the limitations of BJT and discuss the characteristics and applications of Field Effect Transistors	3	PO1, PSO1
CO3	Analyze the linear and nonlinear circuits approaches and realize the characteristics of operational Amplifiers	4	PO1, PO2, PSO1
CO4	Apply the knowledge of internal structure, operation and applications of different ICs	3	PO1, PSO1
CO5	Design and analyze analog circuits for real-time applications using Passive and Active Components	4	PO2, PO3, PO5, PSO1

Syllabus

The construction working and characteristics of BJTs, including DC load line analysis with the help of biasing and stability of operating point, the design of BJT amplifiers along with the small signal models

The construction working and characteristics of JFET like pinch-off voltage, drain saturation current, including the JFET biasing and amplification. Types of Metal Oxide Semiconductor Field Effect Transistor (NMOS, PMOS, CMOS) with their application.

Integrated circuits basics along with Ic741 and IC555 with the different operating modes and their application in arithmetic circuits, filters, oscillators, and multivibrators.

78xx/79xx voltage regulators used for maintaining stable voltage levels. Sample & hold circuits for capturing and holding analog signals, DAC and ADC for converting between digital and analog signals, and more complex devices such as CPLDs and FPGAs.

Reference Books

- 1 Electronic Devices and Circuit Theory, Robert L. Boylestad and Louis Nashelsky, 2021, Wiley.
- 2 Electronic Devices - Electron Flow Version, Thomas L. Floyd , 2017, Pearson.
- 3 Op-Amps and Linear IC Applications, Ramakanth A. Gaykwad , 2021, Wiley.
- 4 Digital Design: Principles and Practices, Wakerly J.F., 2016, Pearson.

23IN2203R - WIRELESS TECHNOLOGIES FOR IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN2203R	WIRELESS TECHNOLOGIES FOR IOT	WTIOT	R	3	0	2	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	NETWORK PROTOCOLS AND SECURITY	NPS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply RF spectrum analysis techniques to assess and optimize wireless communication systems	3	PO1, PSO1
CO2	Apply knowledge of various wireless personal area network technologies, including Bluetooth, UWB, and ZigBee, to implement efficient sensor networks.	3	PO1, PO2, PSO1
CO3	Apply the IEEE 802.11 standards to enhance WLAN connectivity and quality of service, including power-saving mechanisms.	3	PO1, PSO1
CO4	Illustrate the various cellular standards	2	PO1, PSO1
CO5	Design and Analyse various analog and digital communication circuits	4	PO3, PSO1

Syllabus

Introduction to Wireless Communications Systems: RF & Spectrum Analysis of RF Environment, communication -Analog and Digital communication. Factors affecting network : range and speed ,Environment ,Line-of- sight ,Interference ,Defining ,CDMA and OFDM.

WSN & WPN: Wireless Personal Area Networks, Bluetooth, Bluetooth Standards, Bluetooth Protocol Architecture, UWB, IEEE 802.15 standards, ZigBee, Sensor Networks, co-existence strategies in Sensor Networks, Routing protocols in Wireless Sensor Networks

Organizations and Standards: IEEE, Wi-Fi Alliance, WLAN Connectivity, WLAN QoS & Power-Save, IEEE 802.11 Standards, 802.11-2007, 802.11a/b/g, 802.11e/h/l, 802.11n. Introduction to wireless sensor Networks, Advantages of ad-hoc/sensor networks, Unique constraints and challenges. Applications Platforms for WSN.

Cellular Standards: Cellular carriers and Frequencies, Channel allocation, Cell coverage, Cell Splitting, Microcells, Picocells, Handoff; Evolution of Cellular system architecture from 2G to 5G, Frequency bands for new radio, RAN architectures, frame structure, 5G Core architecture.

Reference Books

- 1 Communication Systems, Simon , Simon Haykin , 3Rd Edition, Wiley India Pvt.Limited.
- 2 Advanced Electronic Communication Systems, Wayne Tomasi , 5th Edition, Pearson.
- 3 Wireless Communications - Principles and Practice , Theodore S Rappaport ,, 2nd Edition, Pearson Education Pte. Ltd.
- 4 Mobile and cellular telecommunication, William C.Y. Lee,, 2nd Edition, , TATA McGRAW-HILL .

23IN3104A - REAL TIME OPERATING SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN3104A	REAL TIME OPERATING SYSTEMS	RTOS	A	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand subsystem components of the Kernel and apply the CPU Scheduling algorithms.	3	PO1, PO2, PO5, PSO2
CO2	Understand memory and process virtualization and Paging, apply Page Replacement Algorithms	3	PO1, PO2, PO5, PSO2
CO3	Understand and Apply the threading issues for RTOS	3	PO1, PO2, PO5, PSO2
CO4	Understand and Apply the memory management concepts in RTOS	3	PO1, PSO2
CO5	Understand and Apply the Kernel Design Issues	3	PO1, PO5, PSO2
CO6	Able to perform experimentation Real-Time Operating Systems Other Basic Operating System Functions	3	

Syllabus

Operating System Functionalities, Types of Operating Systems, Process Virtualization: Processes, Process API code, Direct Execution, CPU Scheduling, Multi-level Feedback, Lottery Scheduling code, Multiprocessor Scheduling.

Memory Virtualization: Address Spaces, Memory API, Address Translation, Segmentation, Free Space Management, CPU Virtualization Basics, Introduction to Paging, Translation Look Aside Buffer, Swapping, Demand Paging, Thrashing, Page replacement algorithms.

Concepts, scheduling, IPC, RPC, CPU Scheduling, scheduling criteria, scheduling algorithms Threads: Multi-threading models, threading issues, thread libraries, synchronization Mutex: creating, deleting, prioritizing mutex, mutex internals.

Messages, Buffers, mailboxes, queues, semaphores, deadlock, priority inversion, PIPES MEMORY MANAGEMENT: - Process stack management, run-time buffer size, swapping, overlays, block/page management, replacement algorithms, real-time garbage collection.

Kernel Design Issues: structure, process states, datastructures, inter-task communication mechanism, Linux Scheduling

Reference Books

- 1 Kernel Design Issues: structure, process states, datastructures, inter-task communication mechanism, Linux Scheduling, Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne, 3rd, Wiley..
- 2 Real-time systems, Real-time systems, 2nd, Prentice Hall.
- 3 Linux Kernel Development, Robert Love, 3rd Edition (2010), Addison-Wesley Professional.
- 4 Operating Systems: Internals and Design Principles, William Stallings, 9th edition, Pearson.

23IN3104E - REAL TIME OPERATING SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN3104E	REAL TIME OPERATING SYSTEMS	RTOS	E	4	0	4	0	6

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand subsystem components of the Kernel and apply the CPU Scheduling algorithms.	3	PO1, PO5, PSO1
CO2	Understand memory and process virtualization and Paging, apply Page Replacement Algorithms	3	PO1, PO5, PSO1
CO3	Understand and Apply the threading issues for RTOS	3	PO1, PO5, PSO1
CO4	Understand and Apply the memory management concepts in RTOS	3	PO1, PO5, PSO1
CO5	Understand and Apply the Kernel Design Issues	3	PO1, PO5, PSO1
CO6	Able to perform experimentation Real-Time Operating Systems Other Basic Operating System Functions	3	PO1, PSO1

Syllabus

Operating System Functionalities, Types of Operating Systems, Process Virtualization: Processes, Process API code, Direct Execution, CPU Scheduling, Multi-level Feedback, Lottery Scheduling code, Multiprocessor Scheduling.

Memory Virtualization: Address Spaces, Memory API, Address Translation, Segmentation, Free Space Management, CPU Virtualization Basics, Introduction to Paging, Translation Look Aside Buffer, Swapping, Demand Paging, Thrashing, Page replacement algorithms.

Concepts, scheduling, IPC, RPC, CPU Scheduling, scheduling criteria, scheduling algorithms Threads: Multi-threading models, threading issues, thread libraries, synchronization Mutex: creating, deleting, prioritizing mutex, mutex internals.

Messages, Buffers, mailboxes, queues, semaphores, deadlock, priority inversion, PIPES MEMORY MANAGEMENT: - Process stack management, run-time buffer size, swapping, overlays, block/page management, replacement algorithms, real-time garbage collection.

Kernel Design Issues: structure, process states, datastructures, inter-task communication mechanism, Linux Scheduling

Reference Books

- 1 Kernel Design Issues: structure, process states, datastructures, inter-task communication mechanism, Linux Scheduling, Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne , 3rd , Wiley.
- 2 Real-time systems , Real-time systems , 2nd, Prentice Hall .
- 3 Linux Kernel Development, Robert Love, 3rd Edition (2010), Addison-Wesley Professional .
- 4 Operating Systems: Internals and Design Principles, William Stallings, 9th edition, Pearson.

23IN3104R - REAL TIME OPERATING SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN3104R	REAL TIME OPERATING SYSTEMS	RTOS	R	3	0	2	0	4

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand subsystem components of the Kernel and apply the CPU Scheduling algorithms.	3	PO1, PO7, PSO1
CO2	Understand memory and process virtualization and Paging, apply Page Replacement Algorithms	3	PO1, PO7, PSO1
CO3	Understand and Apply the threading issues for RTOS	3	PO1, PO2, PO5, PSO1
CO4	Understand and Apply the memory management concepts in RTOS	3	PO1, PO2, PO5, PSO1
CO5	Able to perform experimentation Real-Time Operating Systems Other Basic Operating System Functions	3	

Syllabus

Operating System Functionalities, Types of Operating Systems, Process Virtualization: Processes, Process API code, Direct Execution, CPU Scheduling, Multi-level Feedback, Lottery Scheduling code, Multiprocessor Scheduling.

Memory Virtualization: Address Spaces, Memory API, Address Translation, Segmentation, Free Space Management, CPU Virtualization Basics, Introduction to Paging, Translation Look Aside Buffer, Swapping, Demand Paging, Thrashing, Page replacement algorithms.

Concepts, scheduling, IPC, RPC, CPU Scheduling, scheduling criteria, scheduling algorithms Threads: Multi-threading models, threading issues, thread libraries, synchronization Mutex: creating, deleting, prioritizing mutex, mutex internals.

Module 4 Messages, Buffers, mailboxes, queues, semaphores, deadlock, priority inversion, PIPES MEMORY MANAGEMENT: - Process stack management, run-time buffer size, swapping, overlays, block/page management, replacement algorithms, real-time garbage collection.

Reference Books

- 1 Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne, 3rd , Wiley..
- 2 Real-time systems, Jane W. S. Liu, 2nd, Prentice Hall .
- 3 Linux Kernel Development, Robert Love, 3rd Edition (2010), Addison-Wesley Professional.
- 4 Operating Systems: Internals and Design Principles, William Stallings, 9th edition, Pearson.

23IN3105A - EMBEDDED SYSTEMS DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN3105A	EMBEDDED SYSTEMS DESIGN	ESD	A	3	0	4	0	5

Prerequisite

S#	Course Title	Acronym	Rule
1	PROCESSORS AND CONTROLLERS	PRC	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Embedded C programming concepts and apply for embedded system design.	2	PO3, PO5, PSO2
CO2	Apply GPIO and HAL concepts to interface various input output devices.	3	PO3, PO5, PSO2
CO3	Apply UART, I2C communication protocols to interface real time devices.	3	PO2, PO5, PSO2
CO4	Apply embedded applications to simulink based testing	3	PO3, PO5, PSO2
CO5	Analyze state flow models for embedded system applications	3	PO2, PO5, PSO2
CO6	Design and develop real world applications using embedded system design principles.	4	PO3, PO5, PSO2

Syllabus

Overview of embedded systems, importance of processors/microcontrollers, Embedded C programming, debugging tools, data types, arrays, pointers, and storage classes: comprehensive syllabus covering key aspects in embedded system design and programming.

Introduction to HAL library in embedded C, GPIO programming with external devices using HAL, configuring ADC registers: comprehensive syllabus covering hardware abstraction and peripheral interfacing in embedded systems.

Programming timers and related control registers, applications of timer in time-sharing system, Concept of compare/capture modes, and applications of timers in PWM control, Interrupt programming with Hal :Interrupt priorities. Communication Protocol: UART, SPI Programming

SPI, I2C, UART, and Bluetooth enable STM32 interfacing for data communication and peripheral connectivity: syllabus covering essential communication protocols for effective interfacing in embedded systems.

V-cycle and MBD workflow, programming with MATLAB (m-script), Simulink modeling of dynamic systems, Stateflow modeling, model architecture, and data management, covering model-based design and simulation techniques.

Reference Books

- 1 "Programming with STM32: Getting Started with the Nucleo-Board and C/C++" , Donald Norris , 2018, McGraw Hill Education .
- 2 "Programming Embedded Systems in C and C++" , Michael Barr and Anthony J. Massa , 1999, O'Reilly Media .
- 3 Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, Yifeng Zhu , 2018, Andrew Hayford .
- 4 The 8051 Microcontrollers & Embedded Systems, Muhammad Ali Mazidi , 2007, Pearson .

23IN3105E - EMBEDDED SYSTEMS DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN3105E	EMBEDDED SYSTEMS DESIGN	ESD	E	3	0	4	0	5

Prerequisite

S#	Course Title	Acronym	Rule
1	PROCESSORS AND CONTROLLERS	PRC	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Embedded C programming concepts and apply for embedded system design.	2	PO3, PO5, PSO2
CO2	Apply GPIO and HAL concepts to interface various input output devices.	3	PO3, PO5, PSO2
CO3	Apply UART, I2C communication protocols to interface real time devices.	3	PO2, PO5, PSO2
CO4	Apply embedded applications to Simulink based testing	3	PO3, PO5, PSO2
CO5	Analyze state flow models for embedded system applications	3	PO2, PO5, PSO2
CO6	Design and develop real world applications using embedded system design principles.	4	PO3, PO5, PSO2

Syllabus

Overview of embedded systems, importance of processors/microcontrollers, Embedded C programming, debugging tools, data types, arrays, pointers, and storage classes: comprehensive syllabus covering key aspects in embedded system design and programming.

Introduction to HAL library in embedded C, GPIO programming with external devices using HAL, configuring ADC registers: comprehensive syllabus covering hardware abstraction and peripheral interfacing in embedded systems.

Programming timers and related control registers, applications of timer in time-sharing system, Concept of compare/capture modes, and applications of timers in PWM control, Interrupt programming with Hal :Interrupt priorities. Communication Protocol: UART, SPI Programming

SPI, I2C, UART, and Bluetooth enable STM32 interfacing for data communication and peripheral connectivity: syllabus covering essential communication protocols for effective interfacing in embedded systems.

V-cycle and MBD workflow, programming with MATLAB (m-script), Simulink modeling of dynamic systems, Stateflow modeling, model architecture, and data management, covering model-based design and simulation techniques.

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- 2 "Programming Embedded Systems in C and C++", Michael Barr and Anthony J. Massa, 1999, O'Reilly Media .
- 3 Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, Yifeng Zhu , 2018, Andrew Hayford .
- 4 The 8051 Microcontrollers & Embedded Systems, Muhammad Ali Mazidi, 2007, Pearson .

23IN3105R - EMBEDDED SYSTEMS DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN3105R	EMBEDDED SYSTEMS DESIGN	ESD	R	2	0	2	0	3

Prerequisite

S#	Course Title	Acronym	Rule
1	PROCESSORS AND CONTROLLERS	PRC	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Embedded C programming concepts and apply for embedded system design.	2	PO3, PO5, PSO2
CO2	Apply GPIO and HAL concepts to interface various input output devices.	3	PO3, PO5, PSO2
CO3	Apply UART, I2C communication protocols to interface real time devices.	3	PO2, PO5, PSO2
CO4	Analyze state flow models for embedded system applications	4	PO3, PO5, PSO2
CO5	Design and develop real world applications using embedded system design principles.	4	PO2, PO5, PSO2

Syllabus

Overview of embedded systems, importance of processors/microcontrollers, Embedded C programming, debugging tools, data types, arrays, pointers, and storage classes: comprehensive syllabus covering key aspects in embedded system design and programming.

Introduction to HAL library in embedded C, GPIO programming with external devices using HAL, configuring ADC registers: comprehensive syllabus covering hardware abstraction and peripheral interfacing in embedded systems.

Programming timers and related control registers, applications of timer in time-sharing system, Concept of compare/capture modes, and applications of timers in PWM control, Interrupt programming with Hal :Interrupt priorities. Communication Protocol: UART, SPI Programming

SPI, I2C, UART, and Bluetooth enable STM32 interfacing for data communication and peripheral connectivity: syllabus covering essential communication protocols for effective interfacing in embedded systems.

Reference Books

- 1 "Programming with STM32: Getting Started with the Nucleo-Board and C/C++", Donald Norris, 2018, McGraw Hill Education.
- 2 "Programming Embedded Systems in C and C++", Michael Barr and Anthony J. Massa, 1999, O'Reilly Media.
- 3 Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, Yifeng Zhu, 2018, Andrew Hayford.
- 4 The 8051 Microcontrollers & Embedded Systems, Muhammad Ali Mazidi, 2007, Pearson.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Flexi Core Courses (FCC)

23AD2224F - CLOUD COMPUTING (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD2224F	CLOUD COMPUTING	CC	F	2	1	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Fundamental concepts and architecture of cloud computing.	2	PO5, PSO2
CO2	Analyze and Implement cloud-based solutions using various service models like IaaS, PaaS, and SaaS.	4	PO3, PO5, PSO2
CO3	Evaluate security measures and best practices in cloud environments.	5	PO3, PO5, PSO2
CO4	Develop scalable and resilient applications on popular cloud platforms.	3	PO4, PO5, PSO2

Syllabus

Overview of Cloud Computing: Introduction to Cloud Computing , History of Cloud computing, Cloud computing elements, Essential characteristics, cloud service models, cloud deployment models, NIST cloud computing reference architecture, ITU-T cloud computing reference architecture.

Virtualization: Introduction, Virtualization concepts Types of Virtualization Server Virtualization Overview and Importance Techniques: Full Virtualization, Paravirtualization, OS-Level Virtualization Examples and Use Cases Desktop Virtualization, Concept and Advantages Virtual Desktop Infrastructure (VDI) Application, Virtualization Network Virtualization Virtual LAN (VLAN), Virtual Private Network (VPN) Software-Defined Networking (SDN) Storage Virtualization Block-Level and File-Level Storage Virtualization Storage Area Networks (SAN), Network-Attached Storage (NAS) Application Virtualization Benefits and Use Cases, Application Streaming and Packaging Data Virtualization Data Integration and Management Benefits in Cloud Computing Environments- Introduction to Various Hypervisors, Characteristics of virtualized environments, Taxonomy of virtualization techniques,

Cloud Architecture Layers and Models: Layers in cloud architecture, Cloud Service Models: Software as a Service (SaaS) Introduction to Software as a Service (SaaS) Definition and characteristics of SaaS Advantages and disadvantages of SaaS Examples of popular SaaS applications Architecture of SaaS Solutions Multi-tenancy concept in SaaS Differences between single-tenant and in multi-tenant environments Customization and configuration options for tenants Strategies for tenant management and user provisioning Understanding the Multitenant Nature of SaaS Solutions multi-tenant architectures Scalability and performance considerations in multi-tenant environments Design Principles for SaaS Data isolation and security models

Cloud Platforms in Industry: Amazon Web Services, Compute Services, Storage Services, Communication Services and Additional Services. Google AppEngine Architecture and Core Concepts Overview of Cloud Service Models, Introduction to Google App Engine, App Engine , Architecture, Core Concepts of Google App Engine, Scaling and Load Balancing in App Engine, Data Storage Options in App Engine, App Engine Services and APIs, Security and Compliance in App Engine, Monitoring and Logging in App Engine

Reference Books

- 1 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, and Andrzej Goscinski, 2011, Wiley.
- 2 Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, and Geoffrey Fox, 2012, Morgan Kaufmann.
- 3 Mastering Cloud Computing: Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, 2013, Morgan Kaufmann.
- 4 Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis, 2014, Wiley.

23AD2229F - AI FOR HEALTH CARE (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD2229F	AI FOR HEALTH CARE	RTOS	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand ethical and regulatory considerations in deploying AI solutions in healthcare and a collection of AI Technologies used in healthcare.	2	PO1, PO2, PSO2
CO2	Apply Deep learning models of intelligence to real-world healthcare problems to identify the disease.	3	PO2, PO3, PSO1
CO3	Analyze the performance of a model after applying the standard evaluation metrics in diagnosing diseases.	4	PO1, PO3, PSO2
CO4	Implement an appropriate loss function for image segmentation, and apply a pre-trained U-net model to segment any disease regions from any Medical Image.	4	PO2, PO3, PSO2
CO5	Apply Machine learning and Deep Learning techniques for solving problems related to healthcare in the python environment.	3	PO2, PO3, PSO1

Syllabus

Introduction to AI in Healthcare: Objectives of AI in Healthcare, Applying AI in Healthcare, Common Challenges of AI in Healthcare, The future considerations in healthcare AI. AI Technologies used in Healthcare and their application: Introduction to Artificial Intelligence: basic concept. Machine learning: basic learning), Applications of ML in Healthcare, ANN: basic, its application in healthcare and its limitations, Natural Language Processing (NLP) basic and its application interactions, Computer vision: basic and its application for medical imaging analysis.

Fundamentals of Neural Networks: Introduction to Neural Networks: mimic brain function. Feedforward Neural Networks: Structure and functioning of basic neural networks. Backpropagation: Understanding the algorithm for learning optimization algorithms. Deep learning architecture applied in Healthcare: CNN, RNN, LSTM, Densenet, Deep Belief Network, Restricted Boltzmann machine (RBM) opportunities and challenges.

Confusion Matrix, Model evaluation and performance metrics, cross validation, Sensitivity, Specificity and Evaluation Metric Sensitivity, Specificity and Prevalence, PPV, NPV, ROC Curve and Threshold, Varying the Threshold, Sampling from the Total Population Confidence Intervals, 95% entropy, optimizing cost functions.

Handling Class Imbalance and small training set: Building and Training a Model for Medical Diagnosis, Image Classification and Loss, Binary Cross Entropy Loss Function, Training and Validation Loss, Accuracy and Loss Curves. AI for Medical Image Processing and Imaging: Medical Image Registration, U-Net Model architecture, Data Augmentation for Segmentation, Loss Function for Image Segmentation.

Reference Books

- 1 Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, Eric Topol, 2019, Basic Books.
- 2 Translational Application of Artificial Intelligence in Healthcare, Sandeep Reddy, 2023, Chapman & Hall.
- 3 Artificial Intelligence in Healthcare, Adam Bohr, Kaveh Memarzadeh, 2020, Academic Press.
- 4 AI-First Healthcare, Kerrie L. Holley, Siupo Becker, 2021, O'Reilly Media, Inc..

23BT2224F - BIOREACTOR OPERATIONS (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT2224F	BIOREACTOR OPERATIONS	BO	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding various process parameters for designing of bioreactor.	2	PO1, PSO1
CO2	Apply various unit operations for purification of value added products.	3	PO1, PSO1
CO3	Apply various bioreactors for production of value added products from microorganisms and enzymes.	3	PO3, PO5, PSO1
CO4	Interpret various Transport Processes for designing of bioreactor and unit operations.	3	PO3, PO5, PSO1
CO5	Analyze the kinetics of biological system involved in fermentation processes to enhance productivity and biomass.	4	PO3, PSO1

Syllabus

Overview of Biological Reactions, Types of Biological Reactions, Reaction Kinetics, Stoichiometry of Biological Reactions, Elements in Bioreactor Design, Bioreactor Types, Design Considerations, Instrumentation and Control Systems, Rate Expression in Biological Systems, Monod Equation, Enzyme Kinetics, Inhibition Kinetics, Basic Concept of Mass Transfer, Mass Transfer Mechanisms, Oxygen Transfer, Scale-Up Considerations, Basic Concept of Heat Transfer, Heat Transfer Mechanisms, Temperature Control, Heat Transfer in Bioprocesses

Development of Bioreactors, Historical evolution of bioreactor design, Fundamental design principles, Types of bioreactors: stirred-tank, airlift, packed bed, fluidized bed, Materials and construction considerations Purpose and Importance of Bioreactors, Optimization of growth conditions (pH, temperature, dissolved oxygen, nutrient supply), Scalability and production efficiency Bioreactor Development for Solid State Fermentation (SSF), Principles and advantages of SSF, Design considerations: substrate handling, moisture control, aeration strategies, Bioreactors for Animal Cell Cultivations, Unique requirements for animal cell cultures, Types of bioreactors: stirred-tank, wave, hollow-fiber, Scalability and production strategies, Regulatory and quality considerations Bioreactors for Immobilized Systems, Immobilization techniques: adsorption, covalent binding, entrapment, Design and operation of immobilized systems: packed bed, fluidized bed reactors, Bioreactors Used in Different Areas of Environmental Control and Management, Wastewater treatment: aerobic and anaerobic digesters, Bioremediation processes for soil and water, Biofiltration and air treatment: biofilters, bioscrubbers,

Scale-Up Methodologies for Bioreactors: Introduction to scale-up challenges, Criteria of scale-up: geometric, kinematic, and dynamic similarity, Similarity criteria: Reynolds, Froude, Péclet numbers, Scale-up methods: constant power input per unit volume, constant impeller tip speed, constant oxygen transfer rate, Generalized approaches to scale-up: computational fluid dynamics (CFD) simulations, integrative approaches combining multiple methods, Case studies in scale-up: industrial examples, challenges, solutions. Scale-Down Methodologies for Bioreactors: Introduction to scale-down challenges, Scale-down techniques: miniaturization of bioreactors, microfluidic systems, high-throughput screening platforms, Simulating large-scale conditions in small-scale systems, Application of scale-down models: case studies, process optimization, troubleshooting. Gas-Liquid and Liquid-Liquid Mass Transfer in Bioreactors: Fundamentals of mass transfer: mass transfer coefficients, interfacial area, diffusion rates, Factors affecting mass transfer: agitation speed, aeration rate, temperature, reactor geometry, Enhancing mass transfer: spargers, baffles, impellers, Modeling mass transfer: mathematical models, CFD simulations, Measurement techniques: oxygen uptake rate (OUR), carbon dioxide evolution rate (CER), tracer studies, Case studies in mass transfer: strategies, real-world examples, process performance improvements.

Design-of-Experiments for Development and Optimization of Bioreactor Media, Fundamentals of Design-of-Experiments (DoE), Evaluation of Experimental Design, Optimization of Culture Media by Design-of-Experiments, Integration with Computational Modeling, Artificial Liver Bioreactor Design, Principles of Artificial Liver Support Systems, Bioreactor Design Considerations, Clinical Applications and Challenges, Bioreactors Enabling Cell Production for Transplantation, Cell Culture Bioreactors, Stem Cell Bioreactors, Tissue Engineering Bioreactors.

Reference Books

- 1 Bioreactors Design, Operation and Novel Applications, Carl Fredrick, 2016, Wiley.
- 2 Bioprocess Engineering Principles, Pauline M. Doran, 2012, Academic Press.
- 3 Bioreactor System Design, Juan A. Asenjo, Jose C. Merchuk, 1994, CRC Press.
- 4 Principles of Fermentation Technology, Peter F. Stanbury, Allan Whitaker, Stephen J. Hall, 2016, Butterworth-Heinemann.

23CS2229F - APPLICATION DEVELOPMENT ON CLOUD (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2229F	APPLICATION DEVELOPMENT ON CLOUD	ADC	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the server based computing for hosting the web application with appropriate storage.	3	PO2, PO3, PSO2
CO2	Analyze the load balancing and security in the cloud infrastructure	4	PO5, PO11, PSO2
CO3	Apply the CI/CD services for hosting the web application.	3	PO3, PO5, PSO2
CO4	Analyze and optimize applications in cloud environment	4	PO3, PO11, PSO2
CO5	Apply the knowledge and implement the cloud concepts in real time.	4	PO3, PO5, PSO2

Syllabus

Compute: Amazon EC2- Elastic Beanstalk- AWS Lambda- AWS SAM. Storage: Elastic Block Store (EBS)-Elastic File System (EFS)- S3 -S3 Glacier, CloudFront. Networking: API Gateway-Route 53- VPC.

Content Delivery: Elastic Load Balancing, Auto Scaling. Database: Aurora- DynamoDB- ElastiCache- MemoryDB for Redis- RDS. Analytics: Amazon Athena- Amazon Kinesis - Amazon OpenSearch Service. Security, Identity, and Compliance: AWS Certificate Manager (ACM)- Amazon Cognito- IAM- AWS KMS- Secrets Manager- AWS STS-AWS WAF.

Developer Tools: AWS Amplify-Cloud9- AWS CloudShell- CodeArtifact- CodeBuild-CodeCommit- CodeDeploy- CodeGuru- CodePipeline- CodeStar- X-Ray. Containers: Copilot- ECR- ECS-EKS.

Management and Governance: AWS AppConfig- AWS CDK- CloudFormation- AWS CloudTrail- CloudWatch- CloudWatch Logs- AWS CLI- AWS Systems Manager. Application Integration: AWS AppSync- Amazon EventBridge(Amazon CloudWatch Events)- Amazon SNS- Amazon SQS-AWS Step Functions.

Amazon Connect, AWS Database Migration Service (AWS DMS), Amazon Polly, Amazon QuickSight, Amazon Rekognition, Amazon Lex, AWS Service Catalog, AWS Shield, AWS Database Migration Service

Reference Books

- 1 DVA-C02: AWS Certified Developer Associate: Volume 1: Technological Concepts and Development of AWS Services, Nouman Ahmed Khan, 2, 2023, Kindle.
- 2 Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud, Mark Wilkins, 1, 2019, Pearson.
- 3 AWS Certified Cloud Practitioner Study Guide: CLF-C01 Exam, Ben Piper and David Clinton, 1, 2019, Kindle.
- 4 AWS Certified Developer Official Study Guide: Associate (DVA-C01) Exam, Nick Alteen, 1, 2019, Sybex.

23CS2230F - SOLUTIONS ARCHITECTING ON CLOUD (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2230F	SOLUTIONS ARCHITECTING ON CLOUD	SAC	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design Resilient Architectures	3	PO3, PO4, PSO2
CO2	Design High-Performing Architectures	3	PO3, PO4, PSO2
CO3	Design Secure Applications and Architectures	3	PO3, PO4, PSO2
CO4	Design Cost-Optimized Architectures	3	PO3, PO4, PSO2
CO5	Implement, monitor, and manage important cloud services and components using Open Source Tools and commercial systems	4	PO3, PO4, PSO2

Syllabus

Design a multi-tier architecture solution: Design a multi-tier architecture solution, Design highly available and/or fault-tolerant architectures, Design decoupling mechanisms

Design High-Performing Architectures : Identify elastic and scalable compute solutions for a workload, Select high-performing and scalable storage solutions for a workload, Select highperforming networking solutions for a workload, Choose high-performing database solutions for a workload.

Design Secure Applications and Architectures: Design secure access to AWS resources, Design secure application tiers, Select appropriate data security options.

Design Cost-Optimized Architectures: Identify cost-effective storage solutions, Identify cost-effective compute and database services, Design costoptimized network architectures

Reference Books

- 1 AWS Certified Solutions Architect Study Guide, Ben Piper, David Clinton , 2018, Sybex publishers .
- 2 AWS Certified Solutions Architect Associate All-in-One Exam Guide , Joyjeet Banerjee , 2020, McGraw-Hill .
- 3 Architecting Cloud Computing Solutions, Kevin L. Jackson, Scott Goessling, 2018, packt.
- 4 Cloud Computing Solutions Architect: A Hands-On Approach, vijaymadisetty, 2019, oreilly.
- 5 AWS Certified Solutions Architect Official Study Guide Associate Exam, Joe Baron, Hisham Baz, Tim Bixler,, 2016, sybex.

23CS2231F - VISUAL PROGRAMMING (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2231F	VISUAL PROGRAMMING	VSP	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of the .NET framework using core C# concepts.	3	PO2, PO3, PO8, PSO1
CO2	Apply analytical skills to assess the effectiveness of ADO.NET in establishing database connectivity, evaluate the utilization of data providers, datasets, and data adapters, and justify appropriate strategies	3	PO1, PO3, PO5, PSO1
CO3	Apply practical skills to create desktop apps with pretty screens using Windows Forms.	3	PO2, PO5, PSO1
CO4	Apply foundational skills to build web applications with ASP.NET Web Forms	3	PO2, PO3, PO5, PO8
CO5	Acquire proficiency and mastery in dynamic .NET application development, showcasing expertise in UI design, efficient database management	3	PO5, PO8

Syllabus

Net framework Overview, .Net Architecture, Core C#-Variables, Data Types, Flow control, Objects and Types, Classes, Constructors and its types, Inheritance, polymorphism, Operator Overloading, sealed class and methods, interface, abstract class, exception handling, Generics -Arrays, Operators and Casts, Properties.

ADO.NET introduction, Data providers, Dataset, typed dataset, Data Adapter, updating database using stored procedures, SQL Server with ADO.NET, handling exceptions, GUI application development using Key events, Mouse events, OnClick_events.

using Web Forms: ASP.NET introduction, ASP.NET standard controls- displaying information, accepting user-input, Displaying images, Page and State management techniques, Data Controls with Asp Dot Net, Asp Dot Net validation controls

Designing websites with master pages, MVC folder structure, controllers, action methods, View Result, Content Result, File Result, Redirect Result, Redirect To RouteResult.

.NET applications, demonstrating expertise in crafting intuitive user interfaces, efficiently managing databases, and expertly building web applications.

Reference Books

- 1 Parallel Programming with C# & .NET Core, Rishabh Verma, 1, BPB Publications.
- 2 Programming C# 5.0: Building Windows 8 Metro, Web, and Desktop Applications for the .Net 4.5, Ian Griffiths, 1, O Reilly.
- 3 C# in Depth, Jon Skeet, 4, Manning; 4th edition.
- 4 Pro C# 10 with .NET 6: Foundational Principles and Practices in Programming, Andrew Troelsen, Phil Japikse, 11, Apress.

23CS2240F - .NET PROGRAMMING (EPAM) (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2240F	.NET PROGRAMMING (EPAM)	.NET-EPAM	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Fundamental concepts of .NET Framework and C#.NET by proficiently constructing software programs.	3	PO2, PO3, PO4
CO2	Build the console and desktop applications utilizing the C#.NET Framework.	3	PO2, PO3, PO4
CO3	Develop C#.NET desktop applications by integrating ADO.NET for database connectivity and manipulation.	3	PO2, PO3, PO4
CO4	Develop the ASP.NET Standard Server controls to develop robust applications, showcasing their mastery of web development concepts.	3	PO2, PO3, PO4
CO6	Develop programs for desktop, web, and enterprise applications by employing advanced .NET programming techniques, demonstrating their mastery of software development across various platforms.	3	, PSO1, PSO2

Syllabus

C# Essentials:.NET Ecosystem (.NET Framework and .NET Core),C# operator basics,OOP principles,Class & Object, Constructors. Methods. Access modifiers,Inheritance. Polymorphism,Upcasting and downcasting.new and override methods. Sealed methods and classes,Class relationships overview,Memory management.

Exception handling system,Collection types IEnumerable and IEnumerator Generics Inheritance in generics Variance in generics Generic collections,Creation and using delegates Anonymous methods and lambdas Event handling

LINQ overview Extension methods and query syntax Dynamic LINQ,Unit Testing,Multithreading,Data processing,T-SQL,ADO.NET

Design patterns and architecture patterns,MVC (MVP, MVVM),Multilayered and onion architectures,Data processing technologies:ADO.NET EF,EDM Entities and DbContext Entity relations Database First, Code First, Model First Configuration, Initializers,Querying data,Data Loading: lazy vs eager LINQ to Entities,Data Annotations,Fluent Configuration,Migrations,Repository and UoW patterns,Front end Overview:Web Fundamentals.

Reference Books

- 1 ".NET Core in Action", Dustin Metzgar, 1st(2018), Manning Publications.
- 2 "Pro C# 9 with .NET 5", Andrew Troelsen and Philip Japikse, 10th Edition 2010, A Press.
- 3 "Entity Framework Core in Action", Jon P Smith, 1st(2018), Manning Publications.
- 4 "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics", Jennifer Robbins, 5th Edition(2018), O'Reilly Media.

23CS2241F - FRONT END WEB DEVELOPMENT (EPAM) (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2241F	FRONT END WEB DEVELOPMENT (EPAM)	FEWD-	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of HTML5 and CSS3 for static web application.	3	PO1, PO3, PO5, PSO1
CO2	Apply the concepts of javascript to develop client-side web application	3	PO1, PO3, PO5, PSO1
CO3	Apply concepts of advanced UI Designing using extended Javascript	3	PO1, PO3, PO5, PSO1
CO4	Apply concepts of ngx, npm, typescript to build dynamic web application, Angular framework to build dynamic web application	3	PO1, PO3, PO5, PSO2
CO5	Develop the webapplication using various technologies like html, css, javascript, typescript using React/Angular frameworks	3	PO1, PO3, PO5, PSO1

Syllabus

Git Basics: Understand of distributed version control system and its features, Set-up Git in your system, create branches and track files, create a repository in Git and GitHub, describe merging, cloning, resolving conflicts and raising a PR flow with reviewers. Web fundamentals: HTML5 Basics-DOM Tree, Semantic HTML5, CSS Basics: CSS3 Features, CSS Layouts, Responsive Design- Responsive Web - Media Queries, CSS Frameworks- Flexbox, CSS grid

Data Types, Functions, Error and Storage, Date and Regular expression DOM Events, OOP Introduction: Understand Object prototype, Object. define property, Methods on objects, extending objects, Array prototype, understand prototype chain, Understand OOP in JS, Inheritance using ES5, Inheritance using ES6, Async JS

NodeJS: NodeJS fundamentals, Call-back, Events and event loop, event emitter, node modules and package. json, Nodejs Module system and patterns, CommonJS, ES6. React: ReactJS Fundamentals, Introducing JSX, Overview, Rendering Elements, Components and Props, State and Lifecycle Overview of React, elements and components, JSX Composition over inheritance, how browsers handle render, reflow/repaint VDOM concept + Fiber.js in v16 Dev infrastructure: webpack, babel, source-maps, react-hot-loader, react-dev-tools, (react-create app).

Introduction to Web Development, Introduction to Typescript , Typescript Basics: Directives Basics, Attribute Directives, Host Listener, Host Binding, Built in Directives, Structural Directives, Create Structural Directive, Angular Component Life Cycle Hooks , Introduction to Angular- Angular Architecture Angular Version History Angular CLI Basics, Setup Angular Project Angular Project Structure Components Modules Angular App Bootstrapping, Angular Decorators.

Reference Books

- 1 Murach's HTML5 and CSS3, Zak Ruvalcaba, Anne Boehm, 2001, Mike Murach & Associates.
- 2 JavaScript: The Definitive Guide: Master the World's Most-Used Programming Language, David Flanagan, 2006, O'Reilly Media.
- 3 Learning React: Functional Web Development with React and Redux, Alex Banks, 2005, O'Reilly Media.
- 4 Angular for Enterprise-Ready Web Applications, Doguhan Uluca, 2009, Packt Publishing.

23CS2242F - SOFTWARE TESTING (EPAM) (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2242F	SOFTWARE TESTING (EPAM)	ST-EPAM	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the test scenario that are appropriate for software development in many fields.	2	PO1
CO2	Choose the appropriate testcases that should be run and conduct a small-to-medium sized software project source code for inspection or review.	3	PO7
CO3	Apply automated testing tools for building test plan based on requirement and design documents.	3	PO11
CO4	Analyze a test plan dependent on document leveraging test automation tools.	4	PO10
CO5	Analyse test plan contingent on the document using automated testing tools	4	PO4, PO5, PS02

Syllabus

Software Testing Fundamentals Role of QA Software Development Methodologies GIT Working- PUSH ,PULL REQUESTS. Software Abstract Classes and Interfaces Methodologies Data Analytics Java Introduction Conditions and Loops Arrays Classes OOPS Abstract Classes and Interfaces Nested Classes Strings Collections Maps Exceptions, Annotations Generics Enum Wrapper Classes Optional Classes.

Optional Classes, Cloud Computing, Design patterns Maven, Working with different Maven Repositories, Maven lifecycle , setup WebDriver launch Chrome Browser Web Driver Interface Relative and Absolute Xpath Selenium.WebDriver Locators in Selenium Web Element Locator Strategies Xpath Axes in Selenium.

Handling multiple Windows, HTML DOM, Handling Dropdowns, Handling text links, Handling Auto suggestions, Handling Radio buttons, Actions class and its usages, mouse Events, Drag and Drop cases.

Waits in selenium,, Implicit Wait, Explicit wait, Assertions in TestNG, Annotations in testing, Listeners in TestNG,Rest Services, REST Architecture and discuss other architectures for POST methods.

step Definition File Test Parallel using RestAPI data provider,Generating test logs, Integrating test suite ,test scenarios.Study on Integration frameworks like JENKINS and its importance.

Reference Books

- 1 Introduction to Software Testing, Ammann & Offutt, 2012, Cambridge Press.
- 2 Software Testing and Quality Assurance, Naik, 2009, Wiley India Pub.
- 3 Java Concepts , Cay Horstmann, 2006, Wiley Publications .
- 4 Software Testing Strategies, Matthew Heusser, 2011, Packt Publishing.

23CS2243F - CLOUD DEVOPS (EPAM) (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2243F	CLOUD DEVOPS (EPAM)	CD-EPAM	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of Networks, Cloud and DevOps. Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software	2	PO5, PO6, PSO2
CO2	Inspect Configuration Management using Infrastructure as Code	4	PO5, PO6, PSO2
CO3	Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration.	4	PO4, PO5, PO6, PSO2
CO4	Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications using Pipeline and Examine the Software and Automation Testing Frameworks.	4	PO4, PO5, PSO2
CO5	Build and Inspect the Tools associated to DevOps Life Cycle.	4	PO4, PO5, PO6, PSO2

Syllabus

Networking Fundamentals: The OSI Model TCP vs UDP IP addressing & Subnetting, Protocols & Ports Network Topology Switching, Web servers.

Version Controlling: Git, GitHub fundamentals. Configuring gitbash, Pushing and pulling codes to and from repositories. Linux and Scripting: Linux Introduction, Basic Commands, Operations of running systems, User and Group management

AWS: Cloud Fundamentals, AWS Accounts, AWS Fundamentals IAM, ACCOUNTS AND AWS ORGANISATIONS, Simple Storage Service, VPC, Security. Terraform: Introduction, Understanding Infrastructure as a service, Deploying terraform Configurations, input and output variables, Modules. Ansible: Introduction Architecture Playbook Concepts, Ansible inventory and configurations,

Ansible: Introduction Architecture Playbook Concepts, Ansible inventory and configurations, Ansible Modules Docker & Kubernetes: Virtualization Fundamentals Docker Introduction Docker Image Management Docker Engine

Reference Books

- 1 Docker for Developers_ Develop and run your application with Docker containers using DevOps tools for continuous delivery, Richard Bullington-McGuire, Andrew K. Dennis, Michael Schwartz, 2020, Packt Publishing.
- 2 A Complete DevOps Cookbook_ Build and manage your applications, orchestrate containers, and deploy cloud-native services, Murat Karslioglu, 2020, Packt Publishing).
- 3 Computer Networking, Russell Scott (Author) ,Kindle Edition, 2019, Kindle Edition.
- 4 Beginning DevOps with Docker , Joseph Muli,, 2018, PACKT Publishing.

23CS2247F - CRYPTOGRAPHY AND SECURITY (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2247F	CRYPTOGRAPHY AND SECURITY	CS	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying security goals like Confidentiality, Integrity, Authentication algorithms.	3	PO3, PO5, PO6, PSO1
CO2	Analyzing Block Cipher, DES and AES	4	PO3, PO5, PO6, PSO1
CO3	Analyze Block Cipher mode of operation	4	PO3, PO5, PO6, PSO1
CO4	Analyze Public key Crypto Systems to ensure Secure communication of data.	4	PO3, PO5, PO6, PSO1
CO5	Analyze security goals like Confidentiality, Integrity, Authentication algorithms.	4	PO5, PO6, PO7, PSO1

Syllabus

Introduction to Security Security attacks and services ,Security Mechanisms & Models of Network Security,Introduction to cryptography, Substitution techniques, cryptanalysis,Transposition techniques, Cryptanalysis

Block cipher design principles DES algorithm,Simple DES (SDES) algorithm AES algorithm,Simplified AES (SAES) algorithm,Multiple encryption: TDES

Block Cipher Modes of Operation,Modes of Operation,Random Number Generators, Demonstrate types of Random Number Generators,Stream Ciphers & SRC4,RC4 Algorithm

Public Key Cryptography RSA Algorithm,Diffie-Hellman Key Exchange,Elgamal Algorithm,Elliptic Curve Arithmetic

Reference Books

- 1 Applied Cryptography: Protocols, Algorithms, and Source Code in C , Bruce Schneier , 2nd edition, John Wiley & Sons.
- 2 Cryptography and Network Security , Forouzon B, Indian Edition, TMH (2010)...
- 3 Cryptography and Network Security Principles and Practice , William Stallings , 5th Edition, Pearson .
- 4 Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering , Hamid R. Nemati and Li Yang , 2011, IGI Global .

23CS3203F - QUANTUM COMPUTING (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS3203F	QUANTUM COMPUTING	QCP	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the basics of quantum computing, including quantum states, qubits, single and multiple qubit gates, entanglement, quantum circuits, and various applications.	3	PO1, PO5, PSO2
CO2	Apply quantum computing algorithms like Deutsch-Jozsa, Bernstein-Vazirani, Simon's, Shor's, and Grover's algorithms, as well as the Quantum Fourier Transform and superdense coding.	3	PO4, PSO2
CO3	Implement quantum circuits and the intricacies of quantum measurement, providing hands-on experience in these areas.	3	PO2, PSO2
CO4	Demonstrate Quantum machine learning techniques like unsupervised and supervised learning, pattern recognition, neural networks, support vector machines, regression analysis, and boosting.	3	PO1, PSO2
CO5	Apply quantum computing algorithms using IBM QISKIT, Cirq, PennyLane, and AWS like implementing quantum circuits, and performing quantum measurements.	3	PO1, PSO2

Syllabus

Overview of classical mechanics, Drawbacks of classical mechanics, Quantum mechanics origin, Building blocks of quantum mechanics, Introduction to quantum computing, Quantum states and qubits, Single qubit gates, Multiple qubits and entanglement, Quantum circuits, Applications.

Deutsch Jozsa algorithm, Bernstein Vazirani algorithm, Simons algorithm, Quantum fourier transform, Shors algorithm, Grovers algorithm, Superdense coding

Setting up environment, Python and Jupiter notebooks configuring, Quantum circuits implementation, Quantum measurement

Unsupervised learning, Pattern recognition and neural networks, Supervised learning, Support vector machines, Regression analysis and boosting, Quantum clustering and classification, Adiabatic quantum computing, Quantum teleportation and game theory, Applications, Quantum Deep learning

Reference Books

- 1 Quantum Machine learning, Peter Wittek, 2019, Elsevier.
- 2 Quantum computing for everyone, Chris Bernhardt, 2016, MIT Press.
- 3 An Introduction to Quantum Computing, Kaye P., Laflamme R., Mosca M, 2017, Oxford.
- 4 Quantum Computation and Quantum Information, Nielsen M.A., Chuang I.L, 2020, Cambridge University Press.
- 5 Quantum Computing, Hirvensalo M, 2021, Springer.

23EC2223F - FUNDAMENTALS OF ROBOTICS (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2223F	FUNDAMENTALS OF ROBOTICS	FOR	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the functional elements to build different types of basic robotic systems with minimal cost	3	PO1, PO2, PSO1
CO2	Apply Denavit -Hattenberg parameters to describe the kinematic chain of manipulators	3	PO1, PO2, PSO1
CO3	Apply the differential motion through Jacobian to control the manipulator for precise movement and manipulation tasks	3	PO1, PO2, PO3, PSO1
CO4	Analyze the force control techniques using Lagrange dynamic model by understanding how forces and torques affect the motion of robotic systems.	4	PO1, PO2, PSO1
CO5	Analyze the movement of manipulator with the required kinematics to understand how the manipulator's joints and links contribute to its motion in Cartesian space	4	PO5, PSO1

Syllabus

Types of robots, Classification, usage, and the diverse Applications of Robots. Different Types and Ranges of Sensors Internal and External sensors. Common Sensors encoders, tachometers, strain gauge based force torque sensors, proximity, and distance measuring sensors. Different kinds of Actuators: Stepper, DC servo and AC motors.

Mathematical representation of Robots Position and orientation Homogeneous transformation Various joints Representation using the Denavit Hattenberg parameters Degrees of freedom Direct kinematics Inverse kinematics SCARA robots Solvability Solution Methods-Closed form solution.

Linear and angular velocities Manipulator Jacobian Prismatic and rotary joints Inverse Wrist and arm singularity Static analysis Force and moment Balance., Verify Stability and Equilibrium, Apply Equilibrium Equations

Lagrangian mechanics-2DOF Manipulator Lagrange Euler Formulation Dynamic model Manipulator control problem Linear control schemes PID control scheme Force control of robotic manipulator

Reference Books

- 1 Robotics and Control, R.K.Mittal and I. J. Nagrath, 2017, 1st Edition, Tata McGraw Hill.
- 2 Introduction to Robotics Mechanics and Control, John J. Craig, 2008, 2nd Edition, Pearson Education.
- 3 Industrial Robotics, M. P. Groover, M. Weiss, R. N. Nageland N. G. Odrej, 2010, 2nd Edition, Tata McGraw Hill.
- 4 Robotics-Fundamental Concepts and Analysis, Ashitava Ghoshal, 2015, 1st Edition, Oxford University Press.
- 5 Robotics, K. K.Appukuttan, 2017, 2nd Edition, I K International.

23EC2224F - DEEP NETWORK ARCHITECTURES (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2224F	DEEP NETWORK ARCHITECTURES	DNA	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To demonstrate the fundamentals of deep learning	3	PO1, PO3, PSO2
CO2	To demonstrate and apply the Recurrent Neural Network (RNN) algorithms for classification applications using sequential datasets	3	PO1, PO3, PSO2
CO3	To Apply and analyze the performance metrics for various CNN Architectures.	3	PO1, PO3, PSO2
CO4	To analyze and implement the deep learning models using MNIST, Cifar10, and ImageNet datasets.	3	PO1, PO3, PSO2
CO5	To analyze and execute the deep learning application by developing the Python code.	4	PO1, PO2, PO3, PO4, PSO2

Syllabus

Convolutional neural networks: Convolution neural networks (CNN), building blocks of CNN, fundamentals of CNN, the architecture of CNN, Convolution and Pooling Layers, Activations in CNN, and loss functions

SGD and Adam Optimizers: performance metrics of deep learning: accuracy, precision, and recall, F1 score, ROC plots, and confusion matrix.

Recurrent neural networks: Time series modeling of data. Recurrent Neural Network (RNN), Training and testing on time series data.

RNN Types: Long short-term memory (LSTM), gated recurrent unit (GRU), and Bi-directional RNNs, Advantages, and drawbacks. Training, testing, and inferencing.

CNN Architectures: Deep Multi-layer Perceptrons, DenseNets, AlexNet, ZFNet, VGG, Inception Nets, and ResNets

Layer composition, hyperparameter computation, filter kernels, pooling, and activations. Performance measures and comparison.

Building Models: Deep Learning Model building with Keras, TensorFlow, and Scikit-learn. Built-in datasets in Tensorflow.

Describe, Apply, and Analyze the MNIST, Fashion MNIST, Cifar10, and ImageNet datasets along with AlexNet, VGG, and ResNet. Evaluate and compare the performance of AlexNet, VGG, and Resnet on the considered datasets.

Reference Books

- 1 Deep learning with Python, Chollet, Francois., 1, Simon and Schuster.
- 2 Deep learning with Python: develop deep learning models on Theano and TensorFlow using Keras, Brownlee, Jason, 2, Machine Learning Mastery,.
- 3 Deep learning, Trask, Andrew W., 1, Manning Publications Co.
- 4 Deep Learning, Trask, Andrew W., 2, LW Christina Taylor, Aleksandar Dragosavljevic, ed.
- 5 Deep Learning, Ian Good fellow, Yoshua Bengio, Aaron Courville,, 1, Manning Publications Co..
- 6 Neural Networks and Deep Learning, Michael Nielsen, 3, LW Christina Taylor,.
- 7 Learning Deep Architectures for AI,, Yoshua Bengio, 2, Aleksandar Dragosavljevic, ed.

23EC2228F - BIOMEDICAL ELECTRONICS & IOT FOR HEALTHCARE (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2228F	BIOMEDICAL ELECTRONICS & IOT FOR HEALTHCARE	BEIH	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply principles of biopotential recording and different non-electric parameter measurements in the medical field	3	PO1, PO2, PSO1
CO2	Applying the various medical instrumentation and role of electronics in the medical field	3	PO2, PO3, PSO1
CO3	Apply IoT for Healthcare as a next-generation boon for electronics with a study of different sensors	3	PO2, PO3, PSO1
CO4	Utilise application-oriented approach in medical fields through IoT for integrated IoT Sensors, Polytronics Systems, Sensors swarm technology, printed electronics	3	PO2, PO3, PSO1
CO5	Analyze various lead configurations in ECG, EEG and EMG along with simulation of pacemaker and to develop the practical IoT applications for health care industry	4	PO3, PSO1

Syllabus

Biopotential recordings and measurements, the origin of biopotentials, bio potential electrodes, biological amplifiers, ECG, EEG, EMG, lead systems and recording methods, typical wave forms and signal characteristics, non electrical parameters measurements, PH, PO2, PCO2, calorimeter, auto analyser, blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood cell counters

Medical Instrumentations: Cardiac pacemakers, DC Defibrillator, Dialyser, Heart-lung machine, Diathermies-shortwave, ultrasonic and microwave type and their applications, surgical diathermy and telemetry principles, frequency selection, biotelemetry, radio pill, electrical safety, recent trends in biomedical instrumentation, thermograph, endoscopy unit, laser in medicine, cryogenic application, introduction to telemedicine

Internet of Things Promises, Sensors for IoT Applications, Structure of IoT, IOT Map Device, Industrial, Healthcare sensors, Description & Characteristics, First Generation, Advanced Generation, Integrated IoT Sensors, Polytronics Systems, Sensors swarm technology, printed electronics, IOT generation Road map.

Application of IOT In Healthcare: smart-wearables, smart-clothing, elderly fall- detection, infant care system, Monitor an aging family member, "Scalable-continuous"-heart rate monitoring.

Analyze various lead configurations in ECG, EEG and EMG along with simulation of pacemaker and to develop the practical IoT applications for health care industry

Reference Books

- 1 Handbook of Biomedical Instrumentation-Technology & Applications, R.S. Khandpur, 2003, Tata McGraw-Hill Publishing company limited, New Delhi.
- 2 Intelligent-information-and-database- systems, Jeng-Shyang Pan Shyi-Ming Chen Ngoc Thanh Nguyen, 2012, Springer.
- 3 Biomedical Instrumentation and Measurements, Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer, 2021, Prentice Hall Inc, New Jersey.
- 4 A Handbook of Internet of Things in Biomedical and Cyber-Physical System, Valentina E. Balas, Vijender Kumar Solanki, Raghvendra Kumar, Md. Atiqur Rahman Ahad, 2020, Springer.

23EC2229F - WIRELESS SENSOR NETWORKS (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2229F	WIRELESS SENSOR NETWORKS	WSN	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the various theoretical concepts related to wireless sensors and networking of the sensors	2	PO1, PSO1
CO2	Apply WSNs Architectures, Energy consumption of Sensor nodes for the development of the IoT based Systems	3	PO1, PSO1
CO3	Apply different MAC protocols, Routing mechanism used for the development of WSNs Application	3	PO5, PO7, PSO1
CO4	Apply node and network management related concepts for real time application of WSNs	3	PO5, PSO1
CO5	Evaluate and analyse the programming & interfacing of WSNs using the hardware/software tool	5	PO2, PO5, PSO1

Syllabus

Sensor network technology involves a complex architecture comprising various hardware components such as controllers, memory, communication devices, sensors, actuators, and power supplies. Wireless Sensor Networks (WSNs) face several challenges and hurdles, but advancements in enabling technologies are driving their development. Applications of sensor networks are diverse and impactful, including traffic control, healthcare, pipeline monitoring, and precision agriculture.

Sensor node architectures vary widely, impacting energy consumption across different operation states. Key components like microcontrollers, memory, and radio transceivers influence network topologies such as Single Hop Star, Multi Hop Mesh, and Grid, along with Two Tier Hierarchical Clusters. Optimization goals focus on improving gateway concepts and achieving desired figures of merit.

Networking sensors involves considerations at multiple layers: the physical layer includes transceiver design considerations, while the Data Link layer incorporates MAC (Medium Access Control) protocols. These protocols, categorized into Schedule Based and Random Access Based, cater to various performance requirements. Sensor MAC strategies like Periodic Listen and Sleep Operations optimize energy with schedule selection and synchronization. Low duty cycle protocols and wakeup concepts enhance efficiency, complemented by Adaptive Listening Routing Protocols addressing routing challenges in Wireless Sensor Networks (WSNs). Strategies like Data-centric, Energy-efficient, and Geographic routing aim to optimize network performance and energy consumption.

Node and network management in Wireless Sensor Networks (WSNs) involves critical aspects such as power management, including local considerations for the processor and communication subsystems. Dynamic power management strategies, including dynamic operation modes and scaling, optimize energy usage. Task scheduling ensures efficient utilization of resources, while time synchronization addresses the synchronization problem across nodes. Time synchronization protocols like Lightweight Tree Based, Flooding Time, Reference Broadcast, and Time Diffusion enhance synchronization accuracy in WSNs.

Programming concepts and applications of WSN and real time applications .

Reference Books

- 1 Fundamentals of Wireless sensor networks-Theory and Practice, W. Dargie,C. Poellabauer, 2010, John Wiley & Sons.
- 2 Protocols And Architectures for Wireless Sensor Networks, Holger Karl & Andreas Willig, 2005, John Wiley.

- 3 Wireless Sensor Network Technology- Protocols and Applications, K. Sohraby, D.Minoli and T.Znati, 2007, John Wiley & Sons.
- 4 Networking Wireless Sensors , B. Krishnamachari, 2005, Cambridge University Press.

23EE2225F - POWER QUALITY (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE2225F	POWER QUALITY	PQ	F	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various power quality issues.	2	PO1, PO2, PSO1
CO2	Analyze various power quality issues and its causes.	4	PO1, PO2, PO5, PSO1
CO3	Analyze voltage sag and swell using simulation tools.	4	PO1, PO2, PO4, PSO1
CO4	Apply different mitigating techniques for improving power quality	3	PO1, PO2, PSO2

Syllabus

Introduction to Power or voltage quality, terms and definitions: short duration voltage variations, Interruptions, Voltage sag, Swell, Surges, Harmonics, Voltage fluctuations. Long duration voltage variations: Over voltage, Under voltage, Sustained interruptions, Transients: Impulse transients, Oscillatory transient, Power quality terms. Long Interruptions, Definition, Interruptions, Causes of long interruptions, Origin of interruptions, Limits for the interruptions frequency, Limits for the interruption duration.

Short Interruptions: Definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to reclosing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping, voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

Voltage sag analysis: Voltage sag magnitude, Monitoring, Theoretical calculations, Examples, Sag magnitude in non-radial systems, Voltage calculation in meshed systems, Voltage sag duration, Fault clearing time, Magnitude duration plots- Measurement of sag duration, Magnitude and Phase angle jumps for three phase unbalanced sags, Phase to phase fault, Single phase faults, Two phase to ground faults, High impedance fault, Meshed systems.

Mitigation of Interruptions and Voltage Sags: Overview of mitigation methods, From fault to trip, Reducing the number of faults, Reducing the fault clearing time changing the power system, Installing mitigation equipment, Improving equipment immunity, Different events and mitigation methods. System equipment interface, Voltage source converter, series voltage controller, Shunt voltage controller, combined shunt and series controller. Typical wiring and grounding problems.

Reference Books

- 1 Understanding Power Quality Problems: voltage sags and interruptions, Math H J Bollen, 1999, IEEE Publications, U.S..
- 2 Electrical power systems quality , Roger C Dugan, Surya Santoso, Mark F. Mc Granaghan, H. Wayne Beaty , 2012, McGraw-Hill Professional .
- 3 Hand book of power quality , Angelo Baghini , 2008, John Wiley & Sons Inc .
- 4 Power Quality in Power System and Electrical Machine , Edward F Fuchr, Mohammad A S Masoum , 2023, Elsevier .

23EE2230F - ESSENTIALS OF AUTONOMOUS SYSTEMS (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE2230F	ESSENTIALS OF AUTONOMOUS SYSTEMS	EAS	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Feedback Control principles to determine stability of physical systems	3	PO1, PO5, PSO1
CO2	Model the characteristics of sensors and implement networking of sensors	3	PO1, PO5, PSO1
CO3	Model the characteristics of Actuators and energy sources for autonomous systems	3	PO1, PO5, PSO1
CO4	Apply the electronic control for fundamental units of autonomous systems	3	PO1, PO5, PSO1
CO5	Test the characteristics of sensors, actuators, and electronic control for autonomous systems	3	PO1, PO5, PSO1

Syllabus

Feedback Control Principles: Modelling of Physical systems, Transfer Function, Negative feedback systems-characteristics, Test Signals, Response to test signals, Stability of negative feedback systems, PID control, Frequency Response

Sensors and Sensor Networking: Characteristics of Sensors - Inertia, pressure, ultrasonic, infrared, microphone, gyroscope, speed encoder, Networking-fusion, calibration, data processing, communication and storage

Actuators and Energy Sources for Autonomous Systems: Operational principle and models for Motors, hydraulic actuation, electro-magnetic actuation, electro-mechanical actuation, piezoelectric actuation, Operation and Models of energy sources - Battery Bank, PV cell, ICE

Basic Electronics and Digital Control for Autonomous Systems: Power converters-DC/DC, DC/AC converters, vehicular networks, digital control applications: system safety- emergency braking, cruise control, advanced applications: parking assistance, drive assistance:

Reference Books

- 1 Control System Engineering, J Nagrath, M Gopal, 2011, New Age International Publication.
- 2 Understanding Smart Sensors, Randy Frank, 2013, Artech House Publications.
- 3 PIC Microcontroller and Embedded Systems: Using assembly and C for PIC 18, Mazidi, McKinley, 2008, CRC Press.

23IN2222F - CLOUD COMPUTING FOR IOT (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN2222F	CLOUD COMPUTING FOR IOT	CCIoT	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand different cloud deployment models and service models, including Platform as a Service (PaaS), Software as a Service (SaaS), and Infrastructure as a Service (IaaS).	2	PO1, PSO1
CO2	Apply IoT fundamentals, utilize various IoT cloud services, manage devices and identities, and design interactive dashboards for data visualization and management.	3	PO1, PSO1
CO3	Apply IoT services from Google Cloud Platform (GCP), Amazon Web Services (AWS), and Microsoft Azure, learning their core features and applications to design, implement, and manage IoT solutions.	3	PO1, PO2, PSO1
CO4	Students will examine how IoT technologies transform sectors, analyze challenges and solutions, and explore the latest advancements and innovations.	3	PO1, PO2, PSO1
CO5	In this hands-on lab course, students will analyze and develop IoT projects using the Raspberry Pi, connecting sensors and actuators, and integrating with cloud services for data collection and remote control. They will evaluate essential IoT concepts, Raspberry Pi basics, sensor interfacing, and cloud integration, gaining comprehensive IoT development skills.	4	PO1, PO3, PO4, PSO1

Syllabus

Introduction to Cloud Computing, Characteristics of Cloud Computing, Software Virtualization, Containerizing Applications, Virtual Machine Provisioning & Manageability, Cloud Deployment Models, Cloud Service Models: PaaS, SaaS, IaaS.

Introduction to IoT Platform, Cloud IoT Architecture, IoT Cloud Services, Identity & Device Management, Introduction to Dashboards & Web Portals.

Overview of IoT Core Services: Comparative Analysis: Google Cloud IoT Core, AWS IoT Core, and Azure IoT Central, Setting Up Cloud IoT Core, Data Ingestion and Processing.

Real-World Applications and Case Studies: Smart Cities, Industrial IoT (IIoT), Healthcare IoT, Consumer IoT.

Integrate IoT devices (raspberrypi/ESP32) with cloud services for data storage and analysis.

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl , Ricardo Puttini, Zaigham Mahmood, 2013, Parentice Hall.
- 2 Integration of Cloud Computing with Internet of Things: Foundations, Analytics and Applications (Advances in Learning Analytics for Intelligent Cloud-IoT Systems) , Monika Mangla, Suneeta Satpathy, Bhagirathi Nayak, Sachi Nandan Mohanty , 2021, wiley.
- 3 "Cloud Computing A Practical Approach for Learning and Implementation" , A Srinivasan, J Suresh , 2014, Pearson.
- 4 Internet of Things with Raspberry Pi 3, Maneesh Rao, 2021, Packt.

23ME1001F - ENGINEERING MECHANICS (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME1001F	ENGINEERING MECHANICS	EM	F	2	1	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of forces, governing static equations, and analyze the planar system of forces.	3	PO2
CO2	Use analytical techniques for analyzing forces in statically determinate structures.	3	PO3
CO3	Apply the concepts of planar and non-planar system of parallel forces and estimate the moment of inertia for lamina and material bodies.	3	PO4
CO4	Apply fundamental concepts of kinematics and kinetics of particles to solve simple practical problems.	3	PO4

Syllabus

TWO DIMENSIONAL FORCE SYSTEMS Introduction, Basic concepts, Laws of motion, Principle of Transmissibility of forces, Resultant of a force system, force laws, Resultant of two dimensional concurrent and Non Concurrent Force systems, Free body diagrams, Applications. **Equilibrium of Rigid bodies** Equilibrium and Equations of Equilibrium, Lamis theorem, Type of supports and their reactions, Moments and couples, Varignons theorem, Resultant moment and applications.

SPATIAL FORCE SYSTEM & TRUSSES Spatial force systems Forces in space, resultant and equilibrium of spatial force system. Truss Analysis Trusses Assumptions involved in the Method of joints and sections.

FRICTION AND PROPERTIES OF AREAS: Friction Introduction, Laws of Coulomb Friction, Equilibrium of Bodies involving Dry friction, Applications ladder friction, wedge friction. **CENTRIOD AND MOMENT OF INERTIA** Centroid, Centre of gravity, Moment of inertia Area and Mass polar moment of inertia, Parallel axis theorem.

KINEMATICS OF RIGID BODY Introduction, Plane Motion of Rigid Body, Velocity and Acceleration under Translation and Rotational motion. **Virtual Work** Introduction Principle of virtual work Equilibrium of ideal systems. **KINETICS OF RIGID BODY** Introduction, Force, Mass and Acceleration, Work and Energy, Impulse and Momentum, D'Alemberts Principles and Dynamic Equilibrium.

Reference Books

- 1 Engineering Mechanics Statics and Dynamics, A K Tayal, 2011, Umesh publications.
- 2 Engineering Mechanics Statics and Dynamics, R C Hibbeler, 2020, Pearson.
- 3 Engineering Mechanics, Irving H. Shames, 2016, Prentice-Hall..
- 4 Vector Mechanics for Engineers (in SI units) Statics & Dynamics, F. P. Beer and E.R. Johnston, 2001, Mc Graw Hill Publications..
- 5 Engineering Mechanics (Statics), J L Meriam and L G Kraige, 2008, J L Meriam and L G Kraige.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Honors Flexi Core Courses (HFC)

23IN01HF - 5G TECHNOLOGIES FOR IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN01HF	5G TECHNOLOGIES FOR IOT	5TAI	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the evolution, architecture, and applications of 5G technology, including RF Front-End advancements, IoT integration and millimeter wave communications	3	PO1, PO2, PSO1
CO2	Apply the intricacies of 5G waveforms, channels, and networking, exploring design principles, access technologies, propagation models, and cutting-edge applications	3	PO1, PO2, PSO1
CO3	Apply the intricacies of Machine-Type Communications (MTC) including fundamental techniques, massive MTC, ultrareliable low-latency MTC, D2D communication, multihop scenarios	3	PO1, PO2, PSO1
CO4	Apply the world of IEEE802 standards, exploring WiFi, Bluetooth, Zigbee, WiMAX, BLE, and their frame structures, alongside applications in both 4G and 5G networks	3	PO1, PO2, PSO1
CO5	Analyse the programming of NodeMCU or ESP microcontrollers, and learn to interface a variety of peripheral devices with them for comprehensive hardware integration	4	PO5, PSO1

Syllabus

Introduction To 5G , RF Front-End: LTE Beyond 4G, Building Blocks of 5G, 5G Architecture, 5G for IoT Applications: Introduction, Historical Trend of Wireless Communication, Evolution of LTE Technology to Beyond 4G, 5G Road map, 10 Pillars of 5G, IoT relation to 5G, From ICT to the whole economy, Rationale of 5G: High data volume, Global initiatives, Standardization activities, 5G system concept. The 5G Architecture IoT: relation to 5G. Millimetre Wave Communications: Spectrum and regulations, Channel propagations, Hardware technologies for mmW systems, Development scenario, Architecture and mobility, Beamforming, Physical layer techniques

5G Waveforms Channels Networking 5G Radio Access Technologies Design principles Multicarrier with filtering Nonorthogonal Multiple Access Radio access for dense deployments Radio Access for V2X Communication 5G wireless propagation channel models Modelling requirements and scenarios The METIS channel models.5G Evaluation Applications MTC D2D Communication Multihop D2D Multicarrier D2D

Machinetype communications Fundamental techniques for MTC Massive MTC Ultrareliable lowlatency MTC Devicetodevice (D2D) communications Multihop D2D communications Multioperator D2D communication Simulation methodology Evaluation methodology

IEEE802Std 802.11 (WiFi) 802.15.1 (Bluetooth) 802.15.4 (Zigbee) 802.16 (WiMAX) BLE 4G/5G Frame Structures and applications

Analyse the programming of Node MCU or ESP microcontroller and also interface various peripheral devices to the MCU or ESP microcontroller

Reference Books

- 1 Fundamentals of 5G Mobile Networks , Jonathan Rodriguez , 2015, FIRST, WILEY.
- 2 5G Mobile Communications , Xiang Kan Zheng Xuemin (Sherman) , 2016, FIRST, SPRINGER.
- 3 Millimeter Wave Wireless Communications, Theodore S. Rappaport, Robert W. Heath Jr., Robert C. Daniels, James N. Murdock, 2015, FIRST, Pearson.
- 4 Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency, Emil Björnson, Jakob Hoydis, Luca Sanguinetti, 2017, FIRST, Now Publishers.

23IN02HF - DEEP LEARNING FOR COMPUTER VISION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN02HF	DEEP LEARNING FOR COMPUTER VISION	DPNV	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Feature Descriptor Algorithms in Visual Feature Detection and Representation of images	3	PO1, PO2, PO3, PSO2
CO2	Analyze CNNs for Recognition, Verification, Detection, Segmentation	4	PO1, PO3, PO5, PSO2
CO3	Apply RNN Models for Video Understanding tasks using python	3	PO1, PO2, PO5, PSO2
CO4	Analyze Deep Generative Models for computer vision	4	PO1, PO3, PO4, PSO2
CO5	Demonstrate programs with deep learning over various computer vision problems using TensorFlow	3	PO1, PO4, PO5, PSO2

Syllabus

Introduction and Overview: Introduction to Image Formation, Capture and Representation; Linear Filtering, Correlation, Convolution Visual Features and Representations: Edge, Blobs, Corner Detection; Scale Space and Scale Selection; SIFT, SURF; HoG, LBP, etc. Visual Matching: Bag-of-words, VLAD; RANSAC, Hough transform; Pyramid Matching; Optical Flow

Deep Learning Review: Review of Deep Learning, Multi-layer Perceptrons, Backpropagation Convolutional Neural Networks (CNNs): Introduction to CNNs; Evolution of CNN Architectures: AlexNet, ZFNet, VGG, InceptionNets, ResNets, DenseNets Visualization and Understanding CNNs: Visualization of Kernels; Backprop-to-image/Deconvolution Methods; Deep Dream, Hallucination, Neural Style Transfer; CAM, Grad-CAM, Grad-CAM++; Recent Methods (IG, Segment-IG, SmoothGrad) CNNs for Recognition, Verification, Detection, Segmentation: CNNs for Recognition and Verification (Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss); CNNs for Detection: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, RetinaNet; CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN

Recurrent Neural Networks (RNNs): Review of RNNs; CNN + RNN Models for Video Understanding: Spatio-temporal Models, Action/Activity Recognition Attention Models: Introduction to Attention Models in Vision; Vision and Language: Image Captioning, Visual QA, Visual Dialog; Spatial Transformers; Transformer Networks

Deep Generative Models: Review of (Popular) Deep Generative Models: GANs, VAEs; Other Generative Models: PixelRNNs, NADE, Normalizing Flows, etc Variants and Applications of Generative Models in Vision: Applications: Image Editing, Inpainting, Superresolution, 3D Object Generation, Security; Variants: CycleGANs, Progressive GANs, StackGANs, Pix2Pix, etc Recent Trends: Zero-shot, One-shot, Few-shot Learning; Self-supervised Learning; Reinforcement Learning in Vision; Other Recent Topics and Applications

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, MIT press.
- 2 Neural Networks and Deep Learning, Michael Nielsen, 2016, determination press.
- 3 Learning Deep Architectures for AI, Yoshua Bengio, 2009, Foundations and Trends? in Machine Learning.
- 4 Deep Learning for Computer Vision, Rajalingappaa Shanmugamani, 2022, packt.
- 5 Fundamentals of Deep Learning and Computer Vision: A Complete Guide to become an Expert in Deep Learning and Computer Vision, Singh, Nikhil., 2020, packet.

23IN03HF - AR & VR APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN03HF	AR & VR APPLICATION DEVELOPMENT	ARVRAD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Basics of Augmented Reality and Interactions and Fundamentals of Augmented, Mixed Reality and its features	2	PO1, PO2, PO5, PSO2
CO2	Building a simple AR application for mobile devices	3	PO1, PO3, PO5, PSO2
CO3	Develop basic scripting skills in C# programming language for implementing functionality and interactions within the VR environment using Unity3D	3	PO1, PO3, PO5, PSO2
CO4	Analyze how to Design and prototype user interfaces for AR and VR applications	4	PO1, PO3, PO5, PSO2
CO5	Developing AR and VR applications using Unity3D for VR, ARCore/ARKit for AR	3	PO1, PO3, PO5, PSO2

Syllabus

Introduction to AR & VR Overview of augmented reality (AR) and virtual reality (VR) concepts-Brief history and evolution of AR and VR technologies-Applications and use cases of AR and VR in different industries-Introduction to development platforms and tools for AR and VR Basics of 3D Graphics and Rendering Introduction to 3D graphics concepts (e.g., vertices, polygons, textures)-Overview of rendering techniques (e.g., rasterization, ray tracing)-Introduction to 3D modeling tools (e.g., Blender, Maya) Hands-on lab: Creating and rendering simple 3D objects

AR Development Fundamentals Introduction to AR development frameworks (e.g., ARCore, ARKit)-Understanding motion tracking and environmental understanding in AR-Implementing basic AR features such as plane detection and object placement-Hands-on lab: Building a simple AR application for mobile devices

VR Development Fundamentals- Introduction to VR development platforms (e.g., Unity3D, Unreal Engine)-Understanding VR hardware (e.g., headsets, controllers)-Implementing basic VR interactions and locomotion techniques-Hands-on lab: Creating a simple VR environment using Unity3D

User Interface Design for AR & VR Principles of user interface design in AR and VR-Designing intuitive user interactions and navigation in immersive environments-Best practices for minimizing motion sickness and discomfort in VR-Hands-on lab: Designing and prototyping user interfaces for AR and VR applications

Reference Books

- 1 Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, Tony Parisi, 2015, O'Reilly Media.
- 2 Augmented Reality: Principles and Practice, Dieter Schmalstieg, Tobias Hollerer, 2016, Addison-Wesley.
- 3 Virtual Reality Blueprints: Create compelling VR experiences for mobile and desktop, Charles Palmer, John Williamson, 2018, Packt Publishing.
- 4 Unity Virtual Reality Projects: Learn Virtual Reality by Developing More than 10 Engaging Projects with Unity 2018, onathan Linowes and Jerry Alan Fails, 2018, packet.
- 5 Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR, Steve Aukstaklnis, 2016, Addison-Wesley.

23IN04HF - DEVOPS FOR IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN04HF	DEVOPS FOR IOT	DFIOT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand DevOps for IoT and the Challenges and complexities of IoT development and deployment	2	PO1, PO2, PO5, PSO2
CO2	Apply continuous deployment pipelines in IoT projects, such as Jenkins, GitLab CI/CD, or Azure DevOps.	3	PO1, PO2, PO5, PSO1
CO3	Analyze Infrastructure as Code (IaC) for IoT and Security and Compliance in IoT DevOps	4	PO1, PO2, PSO1
CO4	Analyze the process of setting up monitoring and logging solutions for IoT deployments	4	PO1, PO2, PO5, PSO1
CO5	Examining and implementing DevOps concepts learned using open source tools	4	PO1, PO2, PO5, PSO2

Syllabus

Introduction to DevOps for IoT Overview of DevOps principles and practices-Challenges and complexities of IoT development and deployment-Role of DevOps in streamlining IoT development lifecycle-Introduction to DevOps tools and technologies Continuous Integration for IoT Understanding continuous integration (CI) concepts and benefits-Setting up CI pipelines for IoT projects-Automated testing strategies for IoT applications-Hands-on lab: Implementing CI pipelines for IoT development using Jenkins or GitLab CI

Module-2 Continuous Deployment for IoT Overview of continuous deployment (CD) practices-Deployment strategies for IoT devices and gateways-Blue-green deployment and canary releases in IoT environments lab: Implementing CD pipelines for IoT deployments

Module-3 Infrastructure as Code (IaC) for IoT Introduction to Infrastructure as Code (IaC) concepts-Managing IoT infrastructure using configuration management tools (e.g., Ansible, Chef)-Provisioning IoT resources in cloud environments (e.g., AWS, Azure)-Hands-on lab: Implementing IaC for provisioning IoT infrastructureSecurity and Compliance in IoT DevOps Understanding security challenges in IoT deployments-Implementing security best practices in IoT DevOps pipelines-Compliance considerations and regulations for IoT projects-Hands-on lab: Integrating security checks into CI/CD pipelines for IoT

Monitoring and Logging for IoT Importance of monitoring and logging in IoT Deployments-Monitoring IoT devices, sensors, and gateways-Analyzing IoT data logs for troubleshooting and optimization-Hands-on lab: Setting up monitoring and logging solutions for IoT deployments Project Refinement and Optimization Optimizing performance and efficiency of IoT DevOps pipelines-Fine-tuning automation scripts and deployment processes IoT deployments and managing resources efficiently project presentations and demonstrations

Reference Books

- 1 Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Jez Humble and David Farley, 2010, Addison-Wesley.
- 2 Infrastructure as Code: Managing Servers in the Cloud, Kief Morris, 2009, O'Reilly Media.
- 3 Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale , Jennifer Davis, 2010, O'Reilly.
- 4 IoT And DevOps A Complete Guide, Gerardus Blokdyk , 2019, 5STARCook.
- 5 Microservices, IoT and Azure: Leveraging DevOps and Microservice Architecture to deliver SaaS Solutions, Bob Familiar, 2015, Apress.

23IN05HF - IOT BASED HEALTH MONITORING SYSTEM USING FPGA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN05HF	IOT BASED HEALTH MONITORING SYSTEM USING FPGA	IOTHM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of FPGA programming and its applications in IoT	2	PO2, PO3, PO5, PSO2
CO2	Learn how to interface sensors with FPGA for data acquisition	3	PO2, PO3, PO5, PSO2
CO3	Gain practical skills in real-time data processing and analysis on FPGA	4	PO2, PO3, PO5, PSO2
CO4	Develop an IoT-based health monitoring system for remote patient monitoring	5	PO2, PO3, PO5, PSO2
CO5	Build a prototype of the health monitoring system using FPGA and IoT components	5	PO2, PO3, PO5, PSO2

Syllabus

Introduction to FPGA and IoT: Overview of Field-Programmable Gate Arrays (FPGA)- Introduction to Internet of Things (IoT) and its applications in healthcare-Role of FPGA in IoT-based embedded systems-Selection of FPGA development boards and IoT platforms for the project

FPGA Programming Basics: Introduction to Verilog or VHDL programming languages-Basic FPGA architecture and design flow-Writing and simulating simple FPGA designs-Hands-on lab: Implementing basic logic gates and combinational circuits on FPGA

Sensor Interfacing with FPGA: Overview of sensors used in health monitoring systems (e.g., heart rate sensor, temperature sensor)-Interfacing sensors with FPGA using analog-to-digital converters (ADC)-Data acquisition and signal processing techniques on FPGA-Hands-on lab: Interfacing sensors with FPGA and acquiring real-time data

Real-time Data Processing on FPGA: Implementing real-time signal processing algorithms on FPGA-Digital filtering, noise reduction, and feature extraction techniques-Optimizing FPGA designs for performance and resource utilization-Hands-on lab: Implementing real-time data processing algorithms on FPGA

Communication Interfaces for IoT: Introduction to communication protocols for IoT (e.g., MQTT, HTTP)-Implementing UART, SPI, or I2C communication interfaces on FPGA-Designing custom communication protocols for IoT applications-Hands-on lab: Implementing communication interfaces for IoT on FPGA

IoT Platform Integration: Overview of IoT platforms (e.g., Arduino IoT Cloud, AWS IoT, Google Cloud IoT)-Integration of FPGA-based health monitoring system with IoT platform-Data transmission, storage, and visualization in the cloud-Hands-on lab: Integrating the health monitoring system with an IoT platform

Reference Books

- 1 Digital Design and Computer Architecture, David Money Harris and Sarah L. Harris, 2013, Elsevier.
- 2 FPGA Prototyping by Verilog Examples: Xilinx Spartan-3 Version, Pong P. Chu, 2008, Wiley-Interscience.
- 3 Design and Implementation of Smart Healthcare Monitoring System Using FPGA, Prem Kumar Badiganti, Sumanth Peddirsi, Alla Tirumala Jagannadha Rupesh & Suman Lata Tripathi , 2021, Proceedings of First International Conference on Computational Electronics for Wireless Communications Springer..
- 4 FPGA Implementation of IoT-Based Health Monitoring System, Shaker F. K. Abushukor; Infall Syafalni; Rahmat Mulyawan; Nana Sutisna; Nur Ahmadi; Trio Adiono, 2021, IEEE 15th International Conference on Telecommunication Systems, Services, and Applications (TSSA).

23IN06HF - ADVANCED IOT AND SENSOR BIG DATA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN06HF	ADVANCED IOT AND SENSOR BIG DATA ANALYTICS	AATA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the distributed computing, preprocess data effectively, and implement insights to optimize business operations.	3	PO1, PO3, PO5, PSO1
CO2	implement robust pipelines using Apache Kafka and Apache Flink, managing high-velocity, high-volume data streams to optimize operational insights.	3	PO1, PO3, PO5, PSO1
CO3	Apply architectures such as Apache Hadoop and Spark to ensure scalable, fault-tolerant storage and processing of big data, demonstrated through hands-on setup and execution of distributed computing jobs for IoT analytics.	3	PO1, PO3, PO5, PSO1
CO4	Apply the machine learning in IoT data analytics engineer and select algorithms	3	PO1, PO3, PO5, PSO1
CO5	develop application using the machine learning and deeplearning	5	PO1, PO3, PO5, PSO1

Syllabus

Introduction to IoT Big Data Analytics Overview of big data analytics and its applications in IoT-Characteristics and challenges of IoT big data-Introduction to distributed computing frameworks for IoT Analytics-Selection of tools and platforms for IoT big data analytics Data Acquisition and Preprocessing Techniques for data acquisition from IoT devices and sensors-Preprocessing steps for cleaning, filtering, and aggregating IoT data-Handling missing data and outlier detection in IoT datasets Hands-on lab: Preprocessing IoT data using Python libraries (e.g., Pandas, NumPy)

Real-time Stream Processing for IoT Introduction to stream processing and stream processing frameworks (e.g., Apache Kafka, Apache Flink)-Implementing real-time stream processing pipelines for IoT data-Handling data streams with high velocity and volume-Hands-on lab: Building a real-time stream processing pipeline for IoT data analytics

Distributed Computing for IoT Big Data Overview of distributed computing architectures (e.g., Apache Hadoop, Spark)-Distributed storage and processing of IoT big data-Scalability and fault tolerance considerations for distributed systems Hands-on lab: Setting up and running distributed computing jobs for IoT data analytics

Machine Learning for IoT Data Analytics Introduction to machine learning algorithms for IoT data analysis-Supervised, unsupervised, and semi-supervised learning techniques engineering and selection for IoT data-Hands-on lab: Implementing machine learning models for predictive analytics with IoT data Deep Learning for IoT Big Data Overview of deep learning architectures (e.g., convolutional neural networks, recurrent neural networks)-Applications of deep learning in IoT big data analytics-Training deep learning models for time-series analysis and anomaly detection-Hands-on lab: Building and training deep learning models for IoT big data analytics

Reference Books

- 1 Big Data:Principles and best practices of scalable realtime data systems , Nathan Marz and James Warren, First, Manning Publications.
- 2 IoT Analytics: Opportunities and Challenges, Amir H. Gandomi and Murtaza Haider., 2017, Springer.
- 3 Machine Learning: A Probabilistic Perspective, Kevin P. Murphy., 2022, MIT Press.
- 4 Deep Learning, Goodfellow, Yoshua Bengio, and Aaron Courville, 2022, MIT Press.

23IN07HF - DIGITAL FORENSICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN07HF	DIGITAL FORENSICS	DFS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic fundamentals of digital forensics and techniques	2	PO4, PO5, PO6, PSO1
CO2	Understand the Different types Investigation Procedures	2	PO4, PO5, PO6, PSO1
CO3	Apply data Acquisition methods and tools to a given scenario	3	PO4, PO5, PO6, PSO2
CO4	Analyze various Processing crimes and incident scenes	4	PO4, PO5, PO6, PSO2
CO5	Apply forensics tools and techniques to various scenarios	3	PO4, PO5, PO6, PSO2

Syllabus

Computer forensics fundamentals, Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues.

Understanding Computing Investigations , Procedure for corporate High Tech investigations, understanding data recovery work station and software, conducting and investigations.

understanding storage formats and digital evidence ,determining the best acquisition method and acquisition tools in order to validating data acquisitions,

Processing crimes and incident scenes with seizing digital evidence at scene and storing digital evidence. EMail servers with specialized EMail forensics tool.

Reference Books

- 1 Computer Forensics, Incident Response Essentials, 1. Warren G. Kruse II and Jay G. Heiser, 2, Addison Wesley.
- 2 Guide to Computer Forensics and Investigations, 2. Nelson, B, Phillips, A, Enfinger, F, Stuart, C, 2, Thomson Course Technology.
- 3 Computer Forensics, Computer Crime Scene Investigation, 1. Vacca, J, , 2, Charles River Media.
- 4 Computer Forensics and Cyber Crime , MarjieT.Britz, 3, Prentice Hall.



Y23: B.Tech. - Internet of Things

Category: Honors Through Research Courses (HRC)

23IE01RF - INDEPENDENT STUDY & RESEARCH (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE01RF	INDEPENDENT STUDY & RESEARCH	ISR	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Critically analyze research literature to identify existing gaps and formulate precise research questions.	4	PO2, PO4, PSO2
CO2	Apply advanced research methodologies to design and conduct experiments or studies and manage projects independently to achieve research objectives within specified timelines	3	PO1, PO2, PSO2
CO3	Utilize appropriate statistical and analytical tools to evaluate experimental data.	4	PO1, PO4, PSO2
CO4	Integrate research findings into comprehensive technical reports and presentations, and conduct peer reviews to provide in-depth, constructive feedback	4	PO2, PO10, PSO1
CO5	Demonstrate the ability to implement research methodologies in practical settings by conducting experiments, analyzing data, and interpreting results using advanced technical tools and software, culminating in the presentation of findings.	4	PO10, PSO2

Syllabus

Introduction to Research: Overview of research methodologies, Importance of independent study in engineering innovation, Identifying research problems and formulating research questions, Techniques for conducting a thorough literature review.

Research Design and Methodology: Qualitative and quantitative research methods, Designing experiments and studies, Advanced data collection techniques, Ethical considerations in research.

Data Analysis and Interpretation: Statistical and analytical tools for data analysis, Interpreting experimental results and drawing conclusions, Ensuring validity and reliability in research, Case studies and practical applications.

Technical Writing and Presenting Research: Structuring technical research papers and reports, Standards for academic and technical writing, Preparing technical presentations and posters, Effective communication of research findings.

Advanced Research Topics: Current trends and challenges in research, Emerging technologies and their impact on research, Interdisciplinary research, Case studies of groundbreaking research.

Developing a Comprehensive Research Proposal: Components of a research proposal, Crafting a clear and concise research hypothesis, Planning and outlining the research methodology, Budgeting and resource allocation for research projects.

Independent Study Project: Planning and execution of an independent research project, Data collection and analysis techniques specific to the project, Regular progress reporting and documentation, Overcoming challenges in independent research.

Peer Review and Feedback Process: Understanding the peer review process in academic publishing, Conducting peer reviews of engineering research papers, Providing constructive feedback to peers, Incorporating feedback into your research work.

Reference Books

- 1 Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, John W. Creswell, 5th Edition, SAGE Publications.
- 2 The Craft of Research, Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams, 4th Edition, University of Chicago Press.

- 3 Practical Research: Planning and Design, Paul D. Leedy and Jeanne Ellis Ormrod, 12th Edition, Pearson.
- 4 Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, 5th Edition, SAGE Publications.
- 5 Analyzing Qualitative Data: Systematic Approaches, H. Russell Bernard and Gery W. Ryan, 2nd Edition, SAGE Publications.

23IE02RF - RESEARCH METHODOLOGY, ETHICS & SCIENTIFIC WRITING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE02RF	RESEARCH METHODOLOGY, ETHICS & SCIENTIFIC WRITING	RMES	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand the fundamental concepts and methods in research and collect the data relevant to research problem.	3	PO1, PO2, PO3, PO8, PSO1
CO2	To analyze the data and gather the insights of the data and testing of hypothesis	4	PO1, PO2, PO3, PO8, PSO2
CO3	To be able to format a research paper, compile and interpret the results at the end, further scope of research	4	PO2, PO3
CO4	To be able to use the modern software tools for writing the research paper, test for plagiarism, identify suitable journal for possible publication	4	PO2, PO3
CO5	To be able to analyze the data using SPSS and interpret, test for plagiarism, prepare article/thesis using Latex	5	PO2, PO3

Syllabus

Objectives of research, Development of a research proposal. Research Design, Research Question, Investigation Question, Measurement Issues, Hypothesis Formulation, Levels of measurement, Nominal, Ordinal, Interval, Ratio. Sampling, Characteristics of a good sample. Probability Sample, Simple Random Sample, Systematic Sample, Stratified Random Sample, Multistage sampling. Determining size of the sample, Practical considerations in sampling and sample size.

Data Analysis, Hypothesis testing, Compilation and Interpretation of Data together with Paper Writing, Layout of a Research Paper, Impact factor of Journals, When and where to publish, Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Elements of Preparing a Paper and a Thesis: Title, Abstract, Keywords, Acknowledgements, Symbols and Abbreviations, Introduction, Literature Review, Materials and Methods, SI Units, Mathematical Materials, Graphical and Tabular Presentation, Results and Discussion, Conclusion, Interpretation, Generalization, Scope for Future Work, Citations and List of References, and Appendixes.

Usage of tools and techniques for Research: methods to search required information effectively, Reference Management Software like Zotero, Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

Reference Books

- 1 Research Methodology Methods and Techniques, Kothari C.K, 1990, New Age International.
- 2 Business Research Methods, Pamela S. Schindler, 2022, Mc Graw Hill.
- 3 Research Methodology for Engineers, Ganesan R, 2024, MJP Publishers.
- 4 Probability & Statistics for Engineers and Scientists, Walpole R.A., Myers R.H., Myers S.L. and Ye, King, 2012, Pearson.
- 5 Thesis and assignment writing, Anderson B.H., Dursaton, and Poole M., 2019, Wiley Eastern.
- 6 How to write and illustrate scientific papers?, Bijorn Gustavii, 2008, Cambridge University Press..

23IE04RF - TERM PAPER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE04RF	TERM PAPER	TP	R	0	0	4	4	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Literature Review	2	PO1, PO2, PO3, PSO1
CO2	Problem Identification	2	PO1, PO2, PO3, PSO2
CO3	Methodology	3	PO1, PO2, PO3, PSO2
CO4	Implementation	3	PO1, PO2, PO3, PSO1

Syllabus

NO Delivery Plan Exists

NO Delivery Plan Exists

NO Delivery Plan Exists

NO Delivery Plan Exists

Reference Books

- 1 Software Engineering: A Practitioner's Approach , Roger S. Pressman and Bruce Maxim, 9th Edition, McGraw-Hill Education.
- 2 Database System Concepts , Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, 7, McGraw-Hill Education.
- 3 Computer Security: Principles and Practice , William Stallings and Lawrie Brown, 4, Pearson.
- 4 Introduction to Algorithms", Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest,, 4th, The MIT Press, 2022.
- 5 Data and Computer Communications", William Stallings, 10th, Pearson, 2013.

23IE03RF - RESEARCH SEMINAR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE03RF	RESEARCH SEMINAR	RS	R	0	0	4	4	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and interpret research data using appropriate statistical and qualitative methods.	5	PO3, PO4, PO5, PSO2
CO2	Collaborate with peers, professionals and Communicate research findings, effectively through written reports, presentations, and publications.	5	PO4, PO5, PO6, PSO1
CO3	Design and Development of solutions for the complex problems	5	PO4, PO5, PO6, PSO1

Syllabus

Introduction to Research Methodologies, Quantitative Research Methods, Survey Design and Sampling Techniques, Statistical Analysis and Interpretation, Qualitative Research Methods, Interviews and Focus Groups, Thematic Analysis, Mixed Methods Research, Ethical Considerations in Research, Utilizing Technology in Research, Case Studies and Real-World Applications

2. Conducting a Literature Review, Identifying Relevant Literature, Synthesizing Information, Highlighting Research Gaps, Writing Research Papers, Structuring a Research Paper, Academic Writing Style, Citation and Referencing, Preparing Research Presentations, Designing Effective Slides, Public Speaking Skills

Designing Effective Slides, Public Speaking Skills, andling Q&A Sessions, Publishing Research Findings.

Reference Books

- 1 Presenting Your Research: Conferences, Symposiums, Poster Presentations and Beyond, Lucinda Becker, 1, SAGE Publications.
- 2 Qualitative Research Design: An Interactive Approach, Joseph A. Maxwell, 1, SAGE Publications.
- 3 Research Methodology: Methods and Techniques, C.R. Kothari, 1, New Age International Publishers.
- 4 Qualitative Inquiry and Research Design: Choosing Among Five Approaches, John W. Creswell, Cheryl N. Poth, 4, SAGE Publications.

23IN01RF - ADVANCED IOT APPLIED MACHINE LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN01RF	ADVANCED IOT APPLIED MACHINE LEARNING	AIAML	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand advanced machine learning algorithms and techniques	2	PO2, PO3, PO5, PSO2
CO2	Apply machine learning algorithms to IoT datasets	3	PO2, PO3, PO5, PSO2
CO3	Implement deep learning models for IoT applications	5	PO2, PO3, PO5, PSO2
CO4	Develop anomaly detection and time series forecasting solutions for IoT data	5	PO2, PO3, PO5, PSO2
CO5	Gain hands-on experience with IoT platforms and tools	5	PO2, PO3, PO5, PSO2

Syllabus

Introduction to Advanced Machine Learning Review of machine learning fundamentals, Introduction to deep learning Neural network architectures, Training deep neural networks, Convolutional Neural Networks (CNNs) for IoT data

Deep Learning for IoT Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks-Sequence-to-sequence models-Attention mechanisms-Implementing RNNs and LSTMs for time series data in IoT applications

Reinforcement Learning for IoT Introduction to reinforcement learning-Markov Decision Processes (MDPs)-Q-learning and Deep Q-Networks (DQN)-Implementing reinforcement learning algorithms for IoT control systems

Anomaly Detection in IoT Overview of anomaly detection techniques-Statistical methods for anomaly detection-Machine learning-based anomaly detection-Unsupervised and semi-supervised anomaly detection methods-Case studies and applications of anomaly detection in IoT

Time Series Forecasting for IoT Time series analysis fundamentals-Traditional time series forecasting methods (ARIMA, Exponential Smoothing)-Machine learning-based time series forecasting (LSTM, GRU)-Evaluation metrics for time series forecasting-Implementing time series forecasting models for IoT sensor data

Reference Books

- 1 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurelien Geron, 2019, Shroff/O'Reilly.
- 2 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 3 Reinforcement Learning: An Introduction, Richard S. Sutton, Andrew G. Barto, 2015, MIT Press.
- 4 Machine learning: A practitioner's Approach , Vinod Chandra S.S, S Hareendran , 2021, PHI.

23IN02RF - WIRELESS SENSOR NETWORKS AND THE INTERNET OF THINGS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN02RF	WIRELESS SENSOR NETWORKS AND THE INTERNET OF THINGS	WSNIOT	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the factors that influence the Wireless Sensor Network design, Network Topologies.	3	PO1, PO5, PSO1
CO2	Interpret the knowledge of applicability and limitations of MAC and routing protocols for real-time WSN applications.	3	PO1, PO5, PSO1
CO3	Apply the IoT architecture and building blocks for various application domains.	3	PO1, PO5, PSO1
CO4	Apply the IoT to device multidisciplinary case-to-case modelling and execute a wide range of applications.	3	PO1, PO5, PSO1
CO5	Evaluate and analyse the programming & interfacing of WSN and IoT applications using the hardware/software tool	5	PO3, PO5, PSO1

Syllabus

Basics of Wireless Sensor Networks: Introduction to WSN, Basic Overview of Wireless Technology, Basic Sensor Network Architectural Elements, Challenges, Applications of WSN. Some Examples of Sensor Nodes, Network Topologies: Single Hop Star, Multi Hop Mesh and Grid, Two-Tier Hierarchical Cluster.

Classifications of MAC Protocols for WSN, Sensor-MAC Case Study. Routing Protocols and Strategies in WSN, WSN Routing Techniques, Flooding and Its Variants.

IoT Applications in Smart Cities, Garbage Disposal, Vehicle Management, Smart Home.

Healthcare, Wearables Dairy, Agriculture, Traffic Monitoring & Control, Pollution Management, Inter-Vehicular Communication, Vehicle Tracking, Finance Transaction.

Analyse the programming & interfacing of WSNs using the hardware/software tool

Reference Books

- 1 Wireless Sensor Network: Technology, Protocols and Application, Kazem, Sohraby, Daniel Minoli, Taieb Zanti, 2007, John Wiley and Sons.
- 2 Internet of Things, A Hands-on Approach, Arshadeep Bahga, Vijay Madisetti, 2015, Universities Press Pvt. Ltd.
- 3 Protocols And Architectures for Wireless Sensor Networks, Holger Karl & Andreas Willig, 2005, John Wiley.
- 4 Networking Wireless Sensors , B. Krishnamachari , 2005, Cambridge University Press.

23IN03RF - ADVANCED SECURITY OF INTERNET OF THINGS AND CYBER-PHYSICAL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN03RF	ADVANCED SECURITY OF INTERNET OF THINGS AND CYBER-PHYSICAL SYSTEMS	ASICPS	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding IoT and CPS Architectures	2	PO2, PO5, PO11, PSO2
CO2	Apply Access control models for IoT and CPS systems	3	PO2, PO5, PO11, PSO2
CO3	Apply secure coding practices and conduct security testing for IoT and CPS software.	3	PO2, PO5, PO11, PSO2
CO4	Analyze the threat modeling methodologies and Risk assessment techniques for CPS	4	PO2, PO5, PO11, PSO2
CO5	Implementation of secure communication protocols in IoT devices and control mechanisms in CPS	4	PO2, PO5, PO11, PSO2

Syllabus

Overview of Internet of Things (IoT) and Cyber-Physical Systems (CPS) and Implementing secure communication protocols & access control mechanisms in a CPS environment

Access control models for IoT and CPS Authentication mechanisms (e.g., password based, biometric), Role-based access control (RBAC) and attribute based access control (ABAC)

Overview of intrusion detection and prevention systems (IDPS) and its types.

Secure coding guidelines and best practices for IoT and CPS applications with ,Secure software development lifecycle (SDLC) methodologies

Reference Books

- 1 Security for the Internet of Things: A Survey of Existing Protocols and Open Research Issues, by Jorge Granjal, Edmundo Monteiro, and Jorge S? Silva, 2, Apress.
- 2 Cyber physical Attacks and Defenses in the Internet of Things Era, Nils Ole Tippenhauer, Kasper B. Rasmussen, and Yun Shen, 3, packt .
- 3 Cyber Physical Systems Architectures, Protocols and Applications, Chi (Harold) Liu, Yan Zhang, 1, CRC press.
- 4 Security and Privacy in Cyber Physical Systems: Foundations, Principles and Applications, Houbing Song, Glenn A Fink, Sabina Jeschke, 1, wiley.

23IN04RF - ANTENNAS FOR WIRELESS AND BODY-CENTRIC COMMUNICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN04RF	ANTENNAS FOR WIRELESS AND BODY-CENTRIC COMMUNICATIONS	AWBCC	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the fundamental principles and parameters of antenna design and be proficient in using simulation tools to design and analyze basic antennas	2	PO1, PO3, PSO1
CO2	Apply the unique challenges and design considerations for wearable antennas in body-centric communication systems	3	PO1, PO3, PSO1
CO3	Design the UWB antennas for applications such as radar, localization, and wireless sensing	4	PO1, PO3, PSO1
CO4	Design of miniaturizing antennas and the role of metamaterials and metasurfaces in these designs.	4	PO1, PO3, PSO1
CO5	Design and analyze the antenna for different Application	4	PO1, PO3, PSO1

Syllabus

Introduction to Antennas Overview of antennas and their functions in wireless communication systems-Basic antenna parameters: gain, directivity, radiation pattern, impedance-Antenna types: wire antennas, patch antennas, monopole antennas, etc. Introduction to antenna modeling and simulation tools (e.g., MATLAB, HFSS) Antenna Design Fundamentals Antenna design considerations: frequency, bandwidth, polarization, size, and shape-Matching networks and impedance matching techniques-Radiation mechanisms and antenna efficiency Hands-on lab: Designing and simulating basic antennas using simulation software

Wearable Antennas and Body-Centric Communications Challenges and opportunities in body-centric communication systems-Design considerations for wearable antennas-Antenna integration techniques for on-body and in-body communication-Hands-on lab: Designing and simulating wearable antennas for body-centric communication

Ultra-Wideband (UWB) Antennas Overview of ultra-wideband (UWB) communication systems-Characteristics and design considerations of UWB antennas-Applications of UWB antennas in radar, localization, and wireless sensing-Hands-on lab: Designing and simulating UWB antennas for specific applications

Small Antennas and Metamaterials Miniaturization techniques for small antennas-Introduction to metamaterials and metasurfaces Antenna miniaturization using metamaterial-inspired designs-Hands-on lab: Designing and simulating small antennas using metamaterial concepts

Reference Books

- 1 ANTENNA AND WAVE PROPAGATION, K D PRASAD, REVISED EDITION, Satya Prakashan.
- 2 Antenna Theory: Analysis and Design, Constantine A. Balanis , 3rd edition, wiley.
- 3 Wearable Antennas and Body Centric Communication, Richa Bharadwaj, Shibani Kishen Koul , 1, Springer Verlag, Singapore.
- 4 Small Antennas:Miniaturization Techniques & Applications, Chi-Chih Chen, John Volakis , 1, McGraw-Hill Professional.

23IN05RF - ADVANCED SENSOR AND IOT DATA ANALYTICS WITH DEEP LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN05RF	ADVANCED SENSOR AND IOT DATA ANALYTICS WITH DEEP LEARNING	ASIDADL	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Preprocessing techniques and feature extraction from sensor data using Python libraries	3	PO1, PO2, PO5, PSO2
CO2	Building and training CNN models for sensor data classification	3	PO1, PO2, PO5, PSO2
CO3	Analyze how to Build and training RNN models for time-series sensor data analysis	4	PO1, PO2, PO5, PSO2
CO4	Implementing LSTM models for time-series prediction with sensor data	3	PO1, PO2, PO5, PSO1
CO5	Building and training autoencoder models for anomaly detection in sensor data	3	PO1, PO2, PO5, PSO2

Syllabus

Introduction to Sensor Data and IoT Analytics Overview of sensor data types and IoT applications-Characteristics and challenges of sensor data and IoT data-Introduction to deep learning and its applications in IoT analytics-Selection of deep learning frameworks for IoT data analytics Preprocessing and Feature Extraction for Sensor Data Data cleaning and preprocessing techniques for sensor data-Feature extraction and feature engineering from sensor data-Time-series analysis and feature selection methods-Hands-on lab: Preprocessing and feature extraction from sensor data using Python libraries

Convolutional Neural Networks (CNNs) for Sensor Data Introduction to Convolutional Neural Networks (CNNs)-Applications of CNNs in sensor data analytics-Training CNNs for sensor data classification and regression tasks-Hands-on lab: Building and training CNN models for sensor data classification

Recurrent Neural Networks (RNNs) for Time-Series Data Introduction to Recurrent Neural Networks (RNNs)-Applications of RNNs in time-series data analysis-Training RNNs for sequence prediction and anomaly detection in sensor data-Hands-on lab: Building and training RNN models for time-series sensor data analysis

Long Short-Term Memory (LSTM) Networks Introduction to Long Short-Term Memory (LSTM) networks-Advantages of LSTMs for modeling sequential data-Applications of LSTMs in time-series forecasting and anomaly detection-Hands-on lab: Implementing LSTM models for time-series prediction with sensor data Autoencoders and Unsupervised Learning for Anomaly Detection Introduction to autoencoders and unsupervised learning-Applications of autoencoders for anomaly detection in sensor data-Training autoencoder models for anomaly detection tasks Hands-on lab: Building and training autoencoder models for anomaly detection in sensor data

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 2 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, Third Edition 2022, O'Reilly.
- 3 Introduction to Machine Learning with Python A Guide for Data Scientists, Andreas Müller and Sarah Guido, 2016, Springer Nature Switzerland AG.
- 4 Hands-on Deep Learning for IoT, Dr. Mohammad Abdur Razzaque , Md. Rezaul Karim, 2019, Packt .
- 5 Deep Learning for Internet of Things Infrastructure, Uttam Ghosh , Mamoun Alazab , Ali Kashif Bashir , 2021, CRC Press.



Y23: B.Tech. - Internet of Things

Category: Honors Through Innovation Courses (HIC)

23DT01IF - ENTREPRENEURIAL TECHNOLOGY DEVELOPMENT AND PROTOTYPING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DT01IF	ENTREPRENEURIAL TECHNOLOGY DEVELOPMENT AND PROTOTYPING	ETDP	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze entrepreneurial challenges and opportunities, develop innovative mindsets, and conduct thorough market research to identify customer insights and market trends.	4	PO2, PO11, PSO1
CO2	Design actionable product requirements and innovative prototypes using design thinking principles, incorporating user feedback through iterative processes.	6	PO2, PO11, PSO1
CO3	Execute validation experiments to test product assumptions, analyze data to make informed product decisions, and develop strategic plans for scaling and commercialization.	3	PO2, PO11, PSO1
CO4	Develop comprehensive scaling and commercialization strategies, establish key performance indicators, and create continuous improvement plans for ongoing product development and market success.	6	PO2, PO11, PSO1

Syllabus

Introduction to the entrepreneurial journey; Overview of stages and proof of value; Challenges and opportunities for entrepreneurs; Developing an innovative mindset; Setting goals; Conducting market research; Gathering customer insights; Identifying market pain points; Customer segmentation; Analyzing market trends.

Translating customer insights into design requirements; Utilizing design thinking for ideation; Creating innovative prototypes; Developing proof of value prototypes; Incorporating user feedback; Iterative design process; Managing resources and constraints in prototyping.

Defining goals for validation experiments; Designing experiments to test assumptions; Data collection and analysis methods; Interpreting experimental results; Making informed product decisions; Using data to guide business strategies; Developing a scaling roadmap; Identifying key partnerships and marketing strategies; Assessing financial viability; Establishing success metrics.

Developing a scaling and commercialization plan; Creating a growth strategy; Identifying distribution channels; Building market relationships; Evaluating financial models; Defining KPIs; Planning for continuous improvement; Ongoing product development.

Reference Books

- 1 The Lean Startup, Eric Ries, 1st (2011), Crown Business.
- 2 Business Model Generation, Alexander Osterwalder, Yves Pigneur, 1st (2010), Wiley.
- 3 Design Thinking for Entrepreneurs and Small Businesses, Beverly Rudkin Ingle, 1st (2013), Apress.
- 4 The Innovator's Dilemma, Clayton M. Christensen, 1st (2013), Harvard Business Review Press.

23DT02IF - CUSTOMER DISCOVERY FOR STARTUPS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DT02IF	CUSTOMER DISCOVERY FOR STARTUPS	CDFS	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop the ability to create and articulate precise business hypotheses related to customer problems, solutions, and market opportunities.	3	PO2
CO2	Design and conduct insightful customer interviews to validate or invalidate business hypotheses.	4	PO3
CO3	Create MVPs based on validated customer needs and test these MVPs to gather actionable feedback.	5	PO6, PO11, PSO1
CO4	Validate various components of their business model, ensuring a viable market for their product.	5	PO11
CO5	Engage in continuous learning and adaptation, ensuring that their business ideas remain aligned with customer needs and market realities.	5	PO6

Syllabus

The module begins with an introduction to the significance of hypothesis-driven development in startups. Students will learn to identify genuine customer problems and formulate clear, testable hypotheses about customer needs and potential solutions. Through lectures, case studies, and group brainstorming sessions, they will develop problem and solution hypotheses and create detailed customer personas. Assignments include reflective essays, hypothesis development exercises, and peer reviews to ensure a deep understanding of articulating precise business hypotheses related to customer problems, solutions, and market opportunities.

Students will begin by learning techniques for creating insightful interview guides and best practices for conducting customer interviews. Activities will include role-playing interview scenarios, peer feedback sessions, and actual customer interviews. Students will analyze and synthesize qualitative data from these interviews to draw meaningful conclusions about customer needs and product-market fit. Assignments involve developing interview guides, conducting interviews, and writing reports summarizing the findings, ensuring students can design and conduct insightful customer interviews effectively.

The module covers the principles of MVP development, focusing on aligning MVPs with customer problems identified through previous discovery phases. Students will engage in hands-on workshops to create MVPs, simulate testing processes, and gather actionable feedback. They will also study supplementary texts on iterative product development to understand how to use feedback for continuous improvement. Assignments include creating MVP plans, conducting MVP tests, and reflecting on feedback to refine the products, equipping students with the skills to develop MVPs and gather valuable insights for product enhancement.

Students will start by learning key components of business model validation and utilizing tools like the Business Model Canvas. Through lectures, case studies, and workshops, they will test and validate value propositions, customer segments, channels, and revenue streams. Activities include creating and refining Business Model Canvases, conducting market validation techniques, and analyzing real-world cases of successful business model validation. Assignments involve developing validation plans and conducting market validation for startup ideas, ensuring students can ensure a viable market for their product.

Students will learn to implement iterative processes to refine business hypotheses, product features, and business strategies based on continuous customer feedback and market validation. The module includes lectures on iterative development and feedback loops, workshops on applying feedback to business hypotheses, and group discussions on adapting strategies. Students will document iterative changes and present their results, reflecting on how continuous feedback informs their product and business strategy adjustments. Assignments include reflective essays, feedback documentation, and adaptation plans, equipping students with the ability to engage in continuous learning and agile response in their entrepreneurial ventures.

Reference Books

- 1 The Startup Owner's Manual, Steve Blank and Bob Dorf, first edition, K&S Ranch Publishing Division.
- 2 Business Model Generation A Handbook for Visionaries, Game Changers, and Challengers :, Alexander Osterwalder, Yves Pigneur, Tim Clark, 2018, Wiley.

23DT03IF - CUSTOMER VALIDATION FOR STARTUPS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DT03IF	CUSTOMER VALIDATION FOR STARTUPS	CVFS	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding of Robotics, Entrepreneurship and the basic principles governing Robotics.	2	PO11
CO2	Apply methods for recognizing Entrepreneurial Opportunities and crafting Business Models	3	PO11
CO3	Understanding the concepts of Design Thinking in Robotics and explore the ecosystem of Robotics Entrepreneurship.	2	PO11
CO4	Apply Robotics Innovation and Commercialization techniques alongside Entrepreneurial Pitching and Presentation Skills to bring robotic ideas to market successfully.	3	PO11

Syllabus

Introduction to Robotics and Entrepreneurship: Overview of robotics technologies, Introduction to entrepreneurial mindset and innovation. Fundamentals of Robotics: Robot components and mechanisms, Sensors and actuators, Robot control systems

Entrepreneurial Opportunity Identification: Market analysis and opportunity assessment, Identifying robotics applications in various industries, Case studies of successful robotics start-ups. Business Model Development: Lean startup methodology, Value proposition canvas, Business model canvas for robotics ventures

Design Thinking for Robotics: Human-centered design principles, Prototyping and iteration, User testing and feedback. Robotics Entrepreneurship Ecosystem: Resources for robotics startups (incubators, accelerators, funding opportunities), Intellectual property considerations, Regulatory and ethical issues in robotics entrepreneurship.

Robotics Innovation and Commercialization: Technology transfer and commercialization strategies, Scaling up robotics ventures, Case studies of robotics innovations and their commercialization journey. Entrepreneurial Pitching and Presentation Skills: Crafting compelling pitches for robotics ventures, Effective communication of value proposition, Pitching to investors and potential customers

Reference Books

- 1 Robotics: Modelling, Planning and Control, Bruno Siciliano, Lorenzo Sciacivco, Luigi Villani, Giuseppe Oriolo, 2023, Springer.
- 2 Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, 2020, Crown Business.
- 3 Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Alexander Osterwalder, Yves Pigneur, 2022, Wiley.
- 4 Design Thinking: Integrating Innovation, Customer Experience, and Brand Value, Thomas Lockwood, Edgar Papke, 2020, Allworth Press.
- 5 The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company, Steve Blank, Bob Dorf, 2022, Wiley.

23DT04IF - CUSTOMER CREATION AND MARKETING FOR ENTREPRENEURS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DT04IF	CUSTOMER CREATION AND MARKETING FOR ENTREPRENEURS	CCME	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze various market segments and identify the target audience for a startups product or service	4	PO2
CO2	Evaluate different marketing channels and strategies to determine the most effective approaches for customer acquisition	5	PO4
CO3	Create a comprehensive customer creation plan that includes positioning, branding, and go-to-market strategies	6	PO3
CO4	Apply marketing principles to implement and optimize marketing campaigns for customer creation	3	PO11
CO5	Design, implement, and evaluate a real-world marketing project, applying theoretical knowledge to practical scenarios	5	PO11

Syllabus

Introduction to Customer Creation and Marketing: Overview of Customer Development, Introduction to customer creation and its importance in startups, Differences between traditional marketing and startup marketing, Understanding Customer Needs and Behaviors, Techniques for understanding customer needs and behaviors, Importance of customer-centric approach in marketing

Market Segmentation and Targeting: Market Segmentation, Identifying and analyzing different market segments, Criteria for effective segmentation: geographic, demographic, psychographic, and behavioral, Target Audience Identification, Selecting the most viable target audience, Developing customer personas to represent target segments

Marketing Channels and Strategies: Marketing Channels Overview, Traditional vs. digital marketing channels, Strengths and weaknesses of various marketing channels, Strategic Marketing Approaches, Content marketing, social media marketing, email marketing, and influencer marketing, Integrated marketing communications

Designing a Customer Creation Plan: Developing a Marketing Plan, Components of a comprehensive marketing plan, Setting marketing goals and objectives, Positioning and Branding, Crafting a compelling value proposition, Building a strong brand identity and message, Go-to-Market Strategy, Launching a product in the market, Timing and tactics for market entry

Implementing and Optimizing Marketing Campaigns: Campaign Implementation, Steps to launch and manage marketing campaigns, Budgeting and resource allocation, Performance Measurement and Optimization, Key Performance Indicators (KPIs) for marketing, Tools and techniques for tracking and analyzing marketing performance, Making data-driven adjustments to optimize campaigns

Reference Books

- 1 The Startup Owner's Manual, Steve Blank, Bob Dorf, 1st Edition, K & S Ranch.
- 2 The Lean Startup, Eric Ries, 1st Edition, Crown Business.
- 3 Crossing the Chasm, Geoffrey A. Moore, 3rd Edition, Harper Business.
- 4 Traction: How Any Startup Can Achieve Explosive Customer Growth, Gabriel Weinberg, Justin Mares, 1st Edition, Portfolio.
- 5 Marketing Management: A South Asian Perspective, Philip Kotler, Kevin Lane Keller, Abraham Koshy, Mithileshwar Jha, 14th Edition, Pearson.

- 6 Marketing for Entrepreneurs and SMEs A Global Perspective, Maja Konecnik Ruzzier, Robert D. Hisrich, Mitja Ruzzier, 1st Edition, Edward Elgar Publishing.



Y23: B.Tech. - Internet of Things

Category: Honors Through Experiential Learning Courses (HEC)

23IN01EF - BLOCKCHAIN TECHNOLOGY FOR IOT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN01EF	BLOCKCHAIN TECHNOLOGY FOR IOT	BCTI	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the blockchain technology fundamentals and applications of Blockchain in IoT	2	PO2, PO5, PO11, PSO2
CO2	Apply different consensus algorithms in blockchain for IoT	3	PO2, PO5, PO11, PSO2
CO3	Apply the smart contracts on Ethereum Platform	3	PO2, PO5, PO11, PSO2
CO4	Analyse applications of Blockchain on different sectors	4	PO2, PO5, PO11, PSO2

Syllabus

Cryptography basics for blockchain and Introduction to the Internet of Things (IoT) and discuss the Potential applications of blockchain in IoT

Identify the Challenges and opportunities in integrating blockchain and IoT

Decentralized application development frameworks using Solidity Programming

Building a simple IoT application with blockchain integration and Review of real world applications of blockchain and

Reference Books

- 1 Mastering Blockchain Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Imran Bashir, 2, Packt Publishing .
- 2 Ethereum for Architects and Developers, Debajani Mohanty, 13, Packt Publishing.
- 3 Building Blockchain Powered Applications, Xavier Decuyper and Frank Oortwijn, 3, Packt Publishing.
- 4 Blockchain Basics, Daniel Drescher, First Edition, Apress.

23IN02EF - DESIGN AND IMPLEMENTATION OF IOT SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN02EF	DESIGN AND IMPLEMENTATION OF IOT SYSTEMS	DIIS	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the architecture and components of IoT systems	2	PO1, PSO1
CO2	Analyze communication protocols and standards for IoT connectivity	4	PO2, PSO1
CO3	Apply data processing algorithms on IoT edge devices	3	PO5, PSO1
CO4	Analyze Cloud Integration and IoT Platforms	4	PO2, PSO1
CO5	Analyze and evaluate IoT architectures and deployment strategies	4	PO2, PO5, PSO1

Syllabus

Introduction to IoT Systems Overview of IoT concepts and applications-Architecture of IoT systems-IoT hardware components (sensors, actuators, microcontrollers)-Introduction to IoT development platforms and tools Sensor Technologies for IoT Types of sensors used in IoT applications (e.g., temperature, humidity, motion)-Sensor selection criteria and trade-offs-Interface protocols for sensor communication (e.g., I2C, SPI, UART)-Hands-on lab: Interfacing sensors with microcontrollers

Communication Protocols for IoT Overview of IoT communication protocols (e.g., MQTT, CoAP, HTTP)-Wireless communication standards for IoT (e.g., Wi-Fi, Bluetooth, LoRa)-IoT gateway architectures and edge computing Hands-on lab: Implementing MQTT-based communication between IoT devices and cloud platforms

Data Processing and Analytics in IoT Introduction to data processing techniques for IoT data streams-Real-time processing vs. batch processing-Edge computing and fog computing in IoT systems-Hands-on lab: Implementing data processing algorithms on IoT edge devices IoT Security and Privacy Security challenges in IoT systems (e.g., device authentication, data encryption)-Privacy considerations and regulations (e.g., GDPR)-Best practices for securing IoT deployments Hands-on lab: Implementing security features in an IoT prototype

Cloud Integration and IoT Platforms Overview of cloud computing platforms for IoT (e.g., AWS IoT, Azure IoT, Google Cloud IoT)-Device provisioning and management in IoT platforms-Cloud-based data storage and analytics-Hands-on lab: Integrating IoT devices with a cloud platform for data storage and visualization

Demonstrate programs with Google Cloud IoT for secure connecting and managing IoT devices to build rich applications

Reference Books

- 1 Building Arduino Projects for the Internet of Things: Experiments with Real-World Applications, Adeel Javed, 1, Apress.
- 2 Designing Connected Products: UX for the Consumer Internet of Things, Claire Rowland, Elizabeth Goodman, Martin Charlier, Ann Light, 1, Claire Rowland, Elizabeth Goodman, Martin Charlier, Ann Light.
- 3 Designing and Implementation of IoT, Dr. Saurabh Mehta, Michelle D Souza, 1, NEXUS STORIES PUBLICATION.
- 4 Designing the Internet of Things, Adrian McEwen, Hakim Cassimally, 1, Wiley.

23IN03EF - ADVANCED SENSOR SIGNAL PROCESSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN03EF	ADVANCED SENSOR SIGNAL PROCESSING	ASSP	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Gain in-depth knowledge of advanced signal processing techniques for sensor data, and Learn how to preprocess and condition sensor signals for optimal performance	2	PO1, PO2, PSO1
CO2	Explore feature extraction and selection methods for sensor data analysis	3	PO1, PO2, PSO1
CO3	Understand dimensionality reduction techniques and their application to sensor data, Develop practical skills through hands-on projects and case studies	2	PO1, PO2, PSO1
CO4	Apply techniques such as SVD and t-SNE to reduce the dimensionality of sensor data and visualize it effectively	3	PO1, PO2, PSO1

Syllabus

Introduction to Sensor Signal Processing Overview of sensor types and applications in processing sensor signals Signal conditioning techniques (e.g., amplification, filtering)-Introduction to feature extraction and selection Time and Frequency Domain Analysis Time-domain analysis of sensor signals-Fourier analysis and frequency-domain techniques Power spectral density estimation-Spectrogram analysis for time-frequency representation

Advanced Filtering Techniques Adaptive filtering methods (e.g., Least Mean Squares, Recursive Least Squares)-Kalman filtering and its application to sensor data fusion-Wavelet transforms for signal denoising and feature extraction-Hands-on lab

Implementing advanced filtering algorithms in Python or MATLAB Feature Extraction and Selection Importance of feature extraction in sensor signal processing -Popular feature extraction methods (e.g., wavelet transform, Principal Component Analysis)-Feature selection techniques (e.g., Mutual Information, Recursive Feature Elimination)-Hands-on lab: Extracting and selecting features from sensor data

Dimensionality Reduction Dimensionality reduction techniques (e.g., Singular Value Decomposition, t-distributed Stochastic Neighbor Embedding)- Manifold learning algorithms for sensor data visualization- Nonlinear dimensionality reduction methods (e.g., Isomap, Locally Linear Embedding)- Hands-on lab: Implementing dimensionality reduction techniques for sensor data analysis Classification and Pattern Recognition Introduction to classification algorithms (e.g., k-Nearest Neighbors, Support Vector Machines, Random Forests)-Evaluation metrics for classification performance assessment-Ensemble learning methods for improved classification accuracy-Hands-on lab: Building and evaluating classification models for sensor data

Reference Books

- 1 Digital Signal Processing, John G. Proakis, Dimitris G. Manolakis, 4, Pearson Education India.
- 2 FEATURE EXTRACTION AND IMAGE PROCESSING FOR COMPUTER VISION, Mark Nixon, Alberto S. Aguado, 4, Academic Press Inc.
- 3 Sensors and Low Power Signal Processing, Syed Kamrul Islam , Mohammad Rafiqul Haider, 1, Springer.
- 4 Audio Signal Processing and Coding, Andreas Spanias, Ted Painter, Venkatraman Atti, 1, Wiley.

23IN04EF - IOT APP DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IN04EF	IOT APP DEVELOPMENT	IAD	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design and implement IoT systems by integrating sensors with microcontrollers	5	PO1, PO3, PO5, PSO2
CO2	Develop the communication between the diverse IoT systems	5	PO1, PO3, PO5, PSO2
CO3	Develop mobile and web applications for IoT using Android, and iOS frameworks	5	PO1, PO3, PO5, PSO2
CO4	Develop mobile and web applications for IoT using Flutter, Android, and iOS frameworks, incorporating sensor data, BLE communication, RESTful APIs, real-time data streaming, and UI/UX design, with hands-on labs for practical implementation.	5	PO1, PO3, PO5, PSO2

Syllabus

Introduction to IoT Overview of the Internet of Things (IoT) ecosystem-Components of an IoT system: sensors, actuators, microcontrollers, gateways-IoT communication protocols: MQTT, CoAP, HTTP-Introduction to IoT development platforms and tools Sensor Integration and Data Collection Types of sensors and their applications in IoT-Interfacing sensors with microcontrollers (e.g., Arduino, Raspberry Pi)-Data acquisition techniques: analogue-to-digital conversion, sensor calibration-Hands-on lab: Collecting sensor data and transmitting it to a microcontroller.

Communication Protocols for IoT Overview of IoT communication protocols (e.g., MQTT, CoAP, HTTP)-Wireless communication standards for IoT (e.g., Wi-Fi, Bluetooth, LoRa)-Introduction to IoT gateway architectures and edge computing-Hands-on lab: Implementing MQTT-based communication between IoT devices and cloud platforms Cloud Computing for IoT Overview of cloud computing platforms for IoT (e.g., AWS IoT, Azure IoT, Google Cloud IoT)-Device provisioning and management in IoT platforms-Cloud-based data storage and analytics-Hands-on lab: Integrating IoT devices with a cloud platform for data storage and visualization

Mobile App Development for IoT Introduction to mobile app development frameworks (e.g., Android, iOS)-Designing user interfaces for IoT applications-Integrating sensor data into mobile apps-Hands-on lab: Building a mobile app to remotely monitor and control IoT devices Web Development for IoT Introduction to web development technologies (e.g., HTML, CSS, JavaScript)-Creating interactive dashboards for IoT data visualization-Real-time data streaming and updates in web applications Hands-on lab: Developing a web-based dashboard to visualize sensor data.

Introduction to IoT Mobile App Development with Flutter Overview of IoT and mobile app development-Introduction to Flutter framework and its advantages Setting up Flutter development environment-Basics of Dart programming language Bluetooth Communication with Flutter Understanding Bluetooth Low Energy (BLE)-Integrating BLE functionality into Flutter apps-Implementing basic Bluetooth communication protocols-Hands-on lab: Building a Flutter app to discover and connect to Bluetooth devices RESTful API Integration Overview of RESTful APIs and their role in IoT-Integrating RESTful APIs into Flutter apps Implementing CRUD operations using RESTful APIs-Hands-on lab: Building a Flutter app to interact with IoT devices via RESTful APIs Real-time Data Streaming Introduction to real-time data streaming protocols (e.g., WebSocket)-Implementing real-time data streaming in Flutter apps-Handling real-time updates and notifications-Hands-on lab: Building a Flutter app to receive real-time sensor data from IoT devices UI/UX Design for IoT Applications Principles of UI/UX design for mobile apps-Designing user-friendly interfaces for IoT applications Incorporating IoT functionalities into app UI/UX-Hands-on lab: Designing and prototyping UI/UX for an IoT mobile app using Flutter

Reference Books

- 1 Programming the Internet of Things (IoT): Getting Started with Microcontrollers and Python, Donald Norris, 2016, McGraw-Hill Education TAB.

- 2 Flutter for Beginners: An introductory guide to building cross-platform mobile applications with Flutter , Mark Clow, 2019, Packt Publishing.
- 3 Developing Mobile and Web Applications for IoT: Using Flutter, Android, and iOS Framework, John Smith, 2024, TechBooks Publishing.
- 4 IoT Mobile and Web Application Development: A Practical Guide with Flutter, Android, and iOS, Jane Doe, 2023, IoT Innovators Press.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Skill Development Courses (SDC)

23SDAD01A - DATA ANALYTICS AND VISUALIZATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD01A	DATA ANALYTICS AND VISUALIZATION	DAV	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	OBJECT ORIENTED PROGRAMMING	OOP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Data Science and its application.	3	PO1, PO3, PSO1
CO2	Apply various statistical tools for testing hypothesis.	3	PO1, PO2, PO3, PSO1
CO3	Apply Python concepts like Numpy and pandas to handle data.	3	PO2, PO3, PSO1
CO4	Apply visualization techniques for graphical representation of data	3	PO2, PO3, PSO1
CO5	Apply advanced Visualization techniques	3	PO2, PO3, PSO1
CO6	Analyzing Data through Python Visualization Techniques	4	PO2, PO3, PSO1
CO7	Analyzing data through visualization Tool Tableau	4	PO2, PO3, PSO1

Syllabus

Introduction AI, Machine Learning and Data Science, What is data Science Extracting Meaningful patterns, Building representative models, Combination of Statistics, Machine Learning and Computing, Learning Algorithms, Associated fields, Data Science Classification, Data objects and Attribute Types, Measuring Data similarity and dissimilarity Data Collection and Data PreProcessing overview Data Cleaning Data Integration and Transformation Data Reduction Data Discretization

Descriptive Statistics Sampling Techniques Data Classification Measures of Central Tendency Measures of Variation Quartiles and Percentiles Moments Skewness and Kurtosis Exploratory Data Analytics Descriptive Statistics Mean, Mode, and Standard Deviation Box Plots Pivot Table Heat Map Correlation Statistics ANOVA

Data Wrangling with NumPy and Pandas Python list vs NumPy arrays Whats the Difference Creating a NumPy Array, Shape and Reshaping of NumPy Array, Indexing and Slicing of NumPy Array, Stacking and Concatenating NumPy Arrays, Broadcasting in NumPy Arrays, Time series, Sorting in NumPy Arrays, Pandas Series, Data Frame, indexing, sorting, loading data from CSV, Aggregation, concatenation, group by

Visualization and simple metrics Data Analytics Communication, Data Types for Plotting Data Types and Plotting, Simple Line Plots, Simple Scatter Plots, Visualizing Errors, Density and Contour Plots, Histograms, Binnings, and Density Customizing Plot Legends, Customizing Colour bars, Multiple Subplots, Text and Annotation, Customizing Ticks

Reference Books

- 1 The Data Science Handbook, Field Cady, 1, Wiley Book.
- 2 Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython, Wes Mc Kinney, 2, O Reilly.

- 3 Statistical inference for data science, Brian Caffo, 1, Global Edition Leanpub.
- 4 Global Edition Leanpub, Alexander Loth , Nate Vogel, Sophie Sparkes, 1, Wiley.

23SDAD01E - DATA ANALYTICS AND VISUALIZATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD01E	DATA ANALYTICS AND VISUALIZATION	DAV	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	OBJECT ORIENTED PROGRAMMING	OOP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Data Science and its application.	3	PO1, PO3, PO4, PSO1
CO2	Apply various statistical tools for testing hypothesis.	3	PO1, PO2, PO3, PSO1
CO3	Apply Python concepts like Numpy and pandas to handle data.	3	PO2, PO3, PSO1
CO4	Apply visualization techniques for graphical representation of data	3	PO2, PO3, PSO1
CO5	Analyzing Data through Python Visualization Techniques	4	PO2, PO3, PSO1
CO6	Analyzing data through visualization Tool Tableau	4	PO2, PO3, PSO1

Syllabus

Introduction AI, Machine Learning and Data Science, What is data Science Extracting Meaningful patterns, Building representative models, Combination of Statistics, Machine Learning and Computing, Learning Algorithms, Associated fields, Data Science Classification, Data objects and Attribute Types, Measuring Data similarity and dissimilarity Data Collection and Data PreProcessing overview Data Cleaning Data Integration and Transformation Data Reduction Data Discretization

Descriptive Statistics Sampling Techniques Data Classification Measures of Central Tendency Measures of Variation Quartiles and Percentiles Moments Skewness and Kurtosis Exploratory Data Analytics Descriptive Statistics Mean, Mode, and Standard Deviation Box Plots Pivot Table Heat Map Correlation Statistics ANOVA

Data Wrangling with NumPy and Pandas Python list vs NumPy arrays Whats the Difference Creating a NumPy Array, Shape and Reshaping of NumPy Array, Indexing and Slicing of NumPy Array, Stacking and Concatenating NumPy Arrays, Broadcasting in NumPy Arrays, Time series, Sorting in NumPy Arrays, Pandas Series, Data Frame, indexing, sorting, loading data from CSV, Aggregation, concatenation, group by

Visualization and simple metrics Data Analytics Communication, Data Types for Plotting Data Types and Plotting, Simple Line Plots, Simple Scatter Plots, Visualizing Errors, Density and Contour Plots, Histograms, Binnings, and Density

Reference Books

- 1 The Data Science Handbook, Field Cady, 1, Wiley Book.
- 2 Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython, Wes Mc Kinney, 2, O Reilly.
- 3 Statistical inference for data science, Brian Caffo, 1, Global Edition Leanpub.
- 4 Global Edition Leanpub, Alexander Loth, Nate Vogel, Sophie Sparkes, 1, Wiley.

23SDAD01R - DATA ANALYTICS AND VISUALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD01R	DATA ANALYTICS AND VISUALIZATION	DAV	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	OBJECT ORIENTED PROGRAMMING	OOP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	The Python Software Foundation	3	PO1, PO3, PSO1
CO2	Apply various statistical tools for testing hypothesis.	3	PO2, PO3, PSO1
CO3	Apply Python concepts like Numpy and pandas to handle data.	3	PO1, PO2, PSO1
CO4	Apply visualization techniques for graphical representation of data	3	PO1, PO2, PSO1

Syllabus

Introduction AI, Machine Learning and Data Science, What is data Science Extracting Meaningful patterns, Building representative models, Combination of Statistics, Machine Learning and Computing, Learning Algorithms, Associated fields, Data Science Classification, Data objects and Attribute Types, Measuring Data similarity and dissimilarity Data Collection and Data PreProcessing overview Data Cleaning Data Integration and Transformation Data Reduction Data Discretization

Descriptive Statistics Sampling Techniques Data Classification Measures of Central Tendency Measures of Variation Quartiles and Percentiles Moments Skewness and Kurtosis Exploratory Data Analytics Descriptive Statistics Mean, Mode, and Standard Deviation Box Plots Pivot Table Heat Map Correlation Statistics ANOVA

Data Wrangling with NumPy and Pandas Python list vs NumPy arrays Whats the Difference Creating a NumPy Array, Shape and Reshaping of NumPy Array, Indexing and Slicing of NumPy Array, Stacking and Concatenating NumPy Arrays, Broadcasting in NumPy Arrays, Time series, Sorting in NumPy Arrays, Pandas Series, Data Frame, indexing, sorting, loading data from CSV, Aggregation, concatenation, group by

Visualization and simple metrics Data Analytics Communication, Data Types for Plotting Data Types and Plotting, Simple Line Plots, Simple Scatter Plots, Visualizing Errors, Density and Contour Plots, Histograms, Binnings, and Density

Reference Books

- 1 The Data Science Handbook, Field Cady, 1, Wiley Book.
- 2 Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython, Wes Mc Kinney, 2, O Reilly.
- 3 Statistical inference for data science, Brian Caffo, 1, Global Edition Leanpub.
- 4 Global Edition Leanpub, Alexander Loth, Nate Vogel, Sophie Sparkes, 1, Wiley.

23SDAD06A - ANALYSIS OF DIGITAL MARKETING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD06A	ANALYSIS OF DIGITAL MARKETING	ADM	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	MACHINE LEARNING	ML	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply WordPress for Website Hosting and Design	3	PO1, PO2, PSO1
CO2	Apply Keyword Research Techniques and Technical SEO Techniques.	3	PO1, PO2, PO5, PSO1
CO3	Apply the principles of Google AdWords, Social Media Optimization, Social Media Marketing.	3	PO2, PO3, PO5, PSO1
CO4	Analyze the Webmaster Tools to improve site indexing, Crawls stats and Errors, Google Web Analytics.	4	PO2, PO3, PO5, PSO1

Syllabus

Understand the basics of Digital Marketing, types of digital marketing, Understanding the functionality of WordPress, Install and Activate plugins, functionality of different plugins.

Analysis and keyword Research, Types Of Keywords, Tools Used For Keyword Research, Localized Keyword Research, Competitor Website Keyword Analysis, Choosing Right Keywords To The Project, SEO Fundamentals & Concepts(On page Optimization and Off page Optimization), Understanding the SERP, Indexing, Crawling.

Google Adwords, Adwords Account And Campaign Basics, Adwords Tools, Optimizing Performance, Performance Monitoring, Reports, Types Of Social Media Websites, Creating Advertising Campaigns.

Navigating Google Analytics, Real-Time Monitoring, Traffic Sources, Behavior, Visitors, Live Data, and Demographics, Adding site and verification, Setting Geo-target location, Search queries analysis, Filtering search queries, Crawls stats and Errors, Sitemaps.

Reference Books

- 1 Digital Marketing, S.Gupta, McGraw-Hill , 1st Edition, 2017, McGraw-Hill.
- 2 Marketing Strategies for Engaging the Digital Generation, D. Ryan, , 4th Edition,2000, IGI Global Publications.
- 3 Advanced Web Metrics with Google Analytics, Brian Clifton, 3rd Edition,2012, Brian Clifton.
- 4 A Do-It-Yourself Guide to PPC Advertising, Corey Rabazinski, 1st Edition, 2015, CreateSpace Independent .
- 5 The Google Webmaster Tools Handbook, sadie smith, 1st Edition, 2013, Emereo Publishing.

23SDAD06E - ANALYSIS OF DIGITAL MARKETING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD06E	ANALYSIS OF DIGITAL MARKETING	ADM	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	MACHINE LEARNING	ML	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply WordPress for Website Hosting and Design	3	PO1, PO2, PSO1
CO2	Apply Keyword Research Techniques and Technical SEO Techniques.	3	PO1, PO2, PO5, PSO1
CO3	Apply the principles of Google AdWords, Social Media Optimization, Social Media Marketing.	3	PO2, PO3, PO5, PSO1
CO4	Analyze the Webmaster Tools to improve site indexing, Crawls stats and Errors, Google Web Analytics.	4	PO2, PO3, PO5, PSO1

Syllabus

The fundamentals of digital marketing, including its various types and strategies for effective online engagement. It also delves into the functionality of WordPress and the installation and activation of plugins, and exploring the specific functions of different plugins to enhance website performance and user experience.

The comprehensive analysis and research of keywords, covering various types of keywords and the tools and SEO fundamentals and concepts such as on-page and off-page optimization, understanding the Search Engine Results Page (SERP), indexing, and crawling to ensure effective digital marketing and search engine visibility.

It provides an in-depth understanding of Google AdWords accounts and campaigns, utilizing various AdWords tools and optimizing performance through continuous monitoring and reporting. It also explores the different types of social media websites.

Its navigating Google Analytics, including real-time monitoring of traffic sources, visitor behavior, live data, and demographics and adding site verification, setting geo-target locations, analyzing search queries, filtering search queries, understanding crawl stats and errors.

Reference Books

- 1 Digital Marketing, S.Gupta, McGraw-Hill , 1st Edition,2017, McGraw-Hill.
- 2 Marketing Strategies for Engaging the Digital Generation, D. Ryan,Calvin Jones, 4th Edition, 2000, IGI Global Publications.
- 3 Advanced Web Metrics with Google Analytics, Brian Clifton, 3rd Edition, 2012, Brian Clifton.
- 4 A Do-It-Yourself Guide to PPC Advertising, Corey Rabazinski , 1st Edition, 2015, CreateSpace Independent.
- 5 The Google Webmaster Tools Handbook, sadie smith, 1st Edition, 2013, Emereo Publishing.

23SDAD06R - ANALYSIS OF DIGITAL MARKETING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD06R	ANALYSIS OF DIGITAL MARKETING	ADM	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	MACHINE LEARNING	ML	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Keyword Research Techniques and Technical SEO Techniques.	3	PO1, PO2, PO3, PSO1
CO2	Apply the principles of Google AdWords, Social Media Optimization, Social Media Marketing.	3	PO1, PO2, PO3, PO5, PSO1
CO3	Analyze the Webmaster Tools to improve site indexing, Crawls stats and Errors, Google Web Analytics.	4	PO2, PO3, PO5, PSO1

Syllabus

The fundamentals of digital marketing, including its various types and strategies for effective online engagement. It also delves into the functionality of WordPress and the installation and activation of plugins, and exploring the specific functions of different plugins to enhance website performance and user experience.

The comprehensive analysis and research of keywords, covering various types of keywords and the tools and SEO fundamentals and concepts such as on-page and off-page optimization, understanding the Search Engine Results Page (SERP), indexing, and crawling to ensure effective digital marketing and search engine visibility.

It provides an in-depth understanding of Google AdWords accounts and campaigns, utilizing various AdWords tools and optimizing performance through continuous monitoring and reporting. It also explores the different types of social media websites.

Reference Books

- 1 Digital Marketing, S.Gupta, McGraw-Hill, 1st Edition,2017, McGraw-Hill.
- 2 Marketing Strategies for Engaging the Digital Generation, D. Ryan,Calvin Jones, 4th Edition, 2000, IGI Global Publications.
- 3 Advanced Web Metrics with Google Analytics, Brian Clifton , 3rd Edition,2012, Brian Clifton.
- 4 A Do-It-Yourself Guide to PPC Advertising, Corey Rabazinski , 1st Edition, 2015, CreateSpace Independent.
- 5 The Google Webmaster Tools Handbook, sadie smith, 1st Edition, 2013, Emereo Publishing.

23SDAD08A - EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD08A	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	EBCMDC	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	DATA WAREHOUSING AND MINING	DWHM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Create the blockchain network	3	PO1, PO2, PO4, PO5
CO2	Apply ethereum network in digital currencies	3	PO1, PO2, PO4, PO5
CO3	Create the smart contract and validate the transactions	4	PO1, PO2, PO4, PO5
CO4	Apply smart contract in real time application	4	PO1, PO2, PO4, PO5, PSO2

Syllabus

Blockchain Network: Blockchain creation, Markle tree, Mining, Consensus algorithms

Digital Currencies: Wallet creation, Settingup the ethereum network, transfers the ethers from one network to another network.

Smart Contract: Solidity introduction, Programming concepts: control structures, looping statements, functions, scoping and declarations, error handling, events.

Smart contract for bank transaction validation, user verification, Transfer the money using smart contract.

Reference Books

- 1 Bitcoin and Cryptocurrency Technologies, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, 1, Princeton University Press.
- 2 Cryptocurrency and Blockchain for Beginners, Ollie Ruell , 1, Notion Press.
- 3 BLOCKCHAIN TECHNOLOGY, Chandramouli Subramanian,Asha A Geroge Abhilash K A and Meena Karthikeyan, 1, University Press.
- 4 Blockchain A to Z Explained, Rajesh Dhuddu, Srinivas Mahankali , 1, Bpb Publications.

23SDAD08E - EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD08E	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	EBCMDC	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	DATA WAREHOUSING AND MINING	DWHM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Create the blockchain network	3	PO1, PO2, PO4, PO5
CO2	Apply ethereum network in digital currencies	3	PO1, PO2, PO4, PO5
CO3	Create the smart contract and validate the transactions	4	PO1, PO2, PO4, PO5
CO4	Apply smart contract in Finance	4	PO1, PO2, PO4, PO5, PSO2

Syllabus

Blockchain Network: Blockchain creation, Markle tree, Mining, Consensus algorithms.

Digital Currencies: Wallet creation, Settingup the ethereum network, transfers the ethers from one network top another network.

Smart Contract: Solidity introduction, Programming concepts: control structures, looping statements, functions, scoping and declarations, error handling, events.

Smart contact for bank transaction validation, user verification, Transfer the money using smart contract.

Reference Books

- 1 Bitcoin and Cryptocurrency Technologies, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, 1, Princeton University Press.
- 2 Cryptocurrency and Blockchain for Beginners, Ollie Ruell, 1, Notion Press.
- 3 BLOCKCHAIN TECHNOLOGY, Chandramouli Subramanian, Asha A Geroge Abhilash K A and Meena Karthikeyan, 1, University Press.
- 4 The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them (Cryptography, Crypto Trading, Digital Assets, NFT), Antony Lewis, 1, Amazon.

23SDAD08R - EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD08R	EMERGING BLOCKCHAIN MODELS FOR DIGITAL CURRENCIES	EBCMDC	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	DATA WAREHOUSING AND MINING	DWHM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Create the blockchain network	3	PO1, PO2, PO4, PO5
CO2	Apply ethereum network in digital currencies	3	PO1, PO2, PO4, PO5
CO3	Create the smart contract and validate the transactions	4	PO1, PO2, PO4, PO5, PSO2

Syllabus

Blockchain Network: Blockchain creation, Markle tree, Mining, Consensus algorithms.

Digital Currencies: Wallet creation, Setting up the ethereum network, transfers the ethers from one network to another network.

Smart Contract: Solidity introduction, Programming concepts: control structures, looping statements, functions, scoping and declarations, error handling, events.

Reference Books

- 1 Bitcoin and Cryptocurrency Technologies, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, 1, Princeton University Press.
- 2 Cryptocurrency and Blockchain for Beginners, Ollie Ruell, 1, Noion Press.
- 3 BLOCKCHAIN TECHNOLOGY, Chandramouli Subramanian, Asha A George Abhilash K A and Meena Karthikeyan, 1, University Press.
- 4 The Blockchain Developer: A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects, Elad Elrom, 1, Apress.

23SDAD09A - AUTONOMOUS VEHICLE SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD09A	AUTONOMOUS VEHICLE SYSTEMS	AVS	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply basic toolboxes in MATLAB useful for vehicle dynamics. It included include Simulink for modeling and simulating vehicle dynamics, Control System Toolbox for designing and analyzing control systems, and Simscape Multibody for simulating mechanical systems and vehicle kinematics.	3	PO1, PO2, PSO1
CO2	Apply fuel dynamics to model a controlled vehicle system for regulated air-fuel ratio. This process ensures optimal combustion efficiency, minimizing emissions and maximizing engine performance under varying operating conditions.	3	PO1, PO2, PSO1
CO3	Build a map from sensor data sets to be used for autonomous vehicle working. This map includes information on road geometry, obstacles, lane markings, traffic signs, and landmarks, essential for navigation, localization, and decision-making algorithms to enable safe and efficient autonomous vehicle operation in real-world scenarios.	4	PO1, PO2, PSO1
CO4	Model Perception-based parking spot detection using engine simulation data. It enhances autonomous vehicle parking capabilities by integrating real-time engine dynamics with perception algorithms for accurate and efficient parking spot detection.	4	PO2, PO3, PSO1

Syllabus

Introduction to MATLAB, introduction to autonomous vehicle components, simulating vehicle subsystems for different control loops. Simulink for modeling and simulating vehicle dynamics, Matlab toolboxes like Control System Toolbox for designing and analyzing control systems, Simscape Multibody for simulating mechanical systems and vehicle kinematics.

Modeling vehicular subsystems such as intake manifold pressure, combustion process inside the cylinders, engine speed dynamics, wheel speed, anti-braking system, fuel system for overall working of an autonomous vehicle, simulating fuel dynamics control loop for regulated air-fuel ratio.

Analysing various sensors such as lidar, camera, and their fusion for working of an autonomous vehicle. Integrating the sensor data to algorithms for localization, perception, and decision making process for various applications such as navigation, object recognition and collision avoidance.

Analysing functioning of autonomous vehicle subsystem components and integration of these components for the overall working of the vehicle. Model perception-based system for automatic parking space detection in the parking area. by applying model-based and machine learning -based algorithms.

Reference Books

- 1 INTRODUCTION TO MATLAB FOR ENGINEERING STUDENTS, David Houcque, 2005, Northwestern University.
- 2 Vehicle Dynamics: Theory and Application, Reza N. Jazar , 2008, Springer.
- 3 Creating Autonomous Vehicle Systems, Shaoshan Liu, Liyun Li, Jie Tang..., 2017, Morgan & Claypool Publishers.
- 4 Autonomous Control Systems and Vehicles, Kenzo Nonami, Muljowidodo Kartidjo, Kwang-Joon Yoon, Agus Budiyo, 2013 , Springer.

23SDAD09E - AUTONOMOUS VEHICLE SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD09E	AUTONOMOUS VEHICLE SYSTEMS	AVS	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply basic toolboxes in MATLAB useful for vehicle dynamics. It included include Simulink for modeling and simulating vehicle dynamics, Control System Toolbox for designing and analyzing control systems, and Simscape Multibody for simulating mechanical systems and vehicle kinematics.	3	PO1, PO2, PSO1
CO2	Apply fuel dynamics to model a controlled vehicle system for regulated air-fuel ratio. This process ensures optimal combustion efficiency, minimizing emissions and maximizing engine performance under varying operating conditions.	3	PO1, PO2, PSO1
CO3	Build a map from sensor data sets to be used for autonomous vehicle working. This map includes information on road geometry, obstacles, lane markings, traffic signs, and landmarks, essential for navigation, localization, and decision-making algorithms to enable safe and efficient autonomous vehicle operation in real-world scenarios.	4	PO1, PO2, PSO1
CO4	Model Perception-based parking spot detection using engine simulation data. It enhances autonomous vehicle parking capabilities by integrating real-time engine dynamics with perception algorithms for accurate and efficient parking spot detection.	4	PO2, PO3, PSO1

Syllabus

Introduction to MATLAB, introduction to autonomous vehicle components, simulating vehicle subsystems for different control loops. Simulink for modeling and simulating vehicle dynamics, Matlab toolboxes like Control System Toolbox for designing and analyzing control systems, Simscape Multibody for simulating mechanical systems and vehicle kinematics.

Modeling vehicular subsystems such as intake manifold pressure, fuel system for overall working of an autonomous vehicle, simulating fuel dynamics control loop for regulated air-fuel ratio.

Analysing various sensors such as lidar, camera, and their fusion for working of an autonomous vehicle. Integrating the sensor data to algorithms for localization, perception, and decision making process for various applications such as navigation, object recognition and collision avoidance.

Analysing functioning of autonomous vehicle subsystem components and integration of these components for the overall working of the vehicle. Model perception-based system for automatic parking space detection in the parking area. by applying model-based and machine learning -based algorithms.

Reference Books

- 1 INTRODUCTION TO MATLAB FOR ENGINEERING STUDENTS, David Houcque , 2005, Northwestern University.
- 2 Vehicle Dynamics: Theory and Application, Reza N. Jazar, 2008, Springer.
- 3 Creating Autonomous Vehicle Systems, Shaoshan Liu, Liyun Li, Jie Tang..., 2017, Morgan & Claypool Publishers.
- 4 Autonomous Control Systems and Vehicles, Kenzo Nonami, Muljowidodo Kartidjo, Kwang-Joon Yoon, Agus Budiyo, 2013, Springer.

23SDAD09R - AUTONOMOUS VEHICLE SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD09R	AUTONOMOUS VEHICLE SYSTEMS	AVS	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply basic toolboxes in MATLAB useful for vehicle dynamics. It included include Simulink for modeling and simulating vehicle dynamics, Control System Toolbox for designing and analyzing control systems, and Simscape Multibody for simulating mechanical systems and vehicle kinematics.	3	PO1, PO2, PSO1
CO2	Apply fuel dynamics to model a controlled vehicle system for regulated air-fuel ratio. This process ensures optimal combustion efficiency, minimizing emissions and maximizing engine performance under varying operating conditions.	3	PO1, PO2, PSO1
CO3	Build a map from sensor data sets to be used for autonomous vehicle working. This map includes information on road geometry, obstacles, lane markings, traffic signs, and landmarks, essential for navigation, localization, and decision-making algorithms to enable safe and efficient autonomous vehicle operation in real-world scenarios.	4	PO2, PO3, PSO1

Syllabus

Introduction to MATLAB, introduction to autonomous vehicle components, simulating vehicle subsystems for different control loops. Simulink for modeling and simulating vehicle dynamics, Matlab toolboxes like Control System Toolbox for designing and analyzing control systems, Simscape Multibody for simulating mechanical systems and vehicle kinematics.

Modeling vehicular subsystems such as intake manifold pressure, combustion process inside the cylinders, engine speed dynamics, wheel speed, anti-braking system, fuel system for overall working of an autonomous vehicle, simulating fuel dynamics control loop for regulated air-fuel ratio.

Analysing various sensors such as lidar, camera, and their fusion for working of an autonomous vehicle. Integrating the sensor data to algorithms for localization, perception, and decision making process for various applications such as navigation, object recognition and collision avoidance..

Reference Books

- 1 INTRODUCTION TO MATLAB FOR ENGINEERING STUDENTS, David Houcque, 2005, Northwestern University.
- 2 Vehicle Dynamics: Theory and Application , Reza N. Jazar, 2008, Springer.
- 3 Creating Autonomous Vehicle Systems, Shaoshan Liu, Liyun Li, Jie Tang..., 2017, Morgan & Claypool Publishers.
- 4 Autonomous Control Systems and Vehicles, Kenzo Nonami, Muljowidodo Kartidjo, Kwang-Joon Yoon, Agus Budiyo, 2013, Springer.

23SDAD10A - COMPUTER VISION USING OPENCV (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD10A	COMPUTER VISION USING OPENCV	CVOCV	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply proficiency in using the OpenCV library for image manipulation and processing.	3	PO1, PO2, PO8, PSO1
CO2	Apply proficiency in using the OpenCV library for image and video processing.	3	PO1, PO2, PO8, PSO1
CO3	Implement common computer vision algorithms such as feature detection and object recognition.	3	PO2, PO3, PO8, PSO1
CO4	Analyze computer vision techniques to solve real-world problems in different domains.	4	PO2, PO3, PO8, PSO1

Syllabus

Introduction to Computer Vision Performance: Understand the basics of computer vision. Objective: Define computer vision and its real time applications and case studies.

Getting Started with OpenCV Performance: Acquire proficiency in using OpenCV. Objective: Set up OpenCV environment and perform basic operations. Pedagogy: Hands-on Lab, Demonstration Strategy: Provide step-by-step instructions and guided practice.

Image Processing Techniques Performance: Apply image processing techniques. Objective: Implement filtering, edge detection, and morphological operations. Pedagogy: Hands-on Lab, Coding Exercises Strategy: Provide coding challenges and real-world examples.

Feature Detection and Description Performance: Implement feature detection algorithms. Objective: Understand and apply keypoint detection and feature descriptors. Pedagogy: Hands-on Lab, Coding Exercises Strategy: Guide students through implementing feature detection algorithms.

Reference Books

- 1 Learning OpenCV 4 Computer Vision with Python 3, Adrian Kaehler and Gary Bradski, 2020, O'Reilly Media.
- 2 Mastering OpenCV 4 with Python, Alberto Fernandez Villan, 2019, Packt Publishing.
- 3 OpenCV Essentials, Oscar Deniz Suarez, M^o del Milagro Fernandez Carrobles, Noelia Vallez Enano, and Gloria Bueno Garcia, 2014, Packt Publishing.
- 4 OpenCV 4 for Secret Agents, Joseph Howse, 2019, Packt Publishing.

23SDAD10E - COMPUTER VISION USING OPENCV (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD10E	COMPUTER VISION USING OPENCV	CVOCV	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply proficiency in using the OpenCV library for image manipulation and processing.	3	PO1, PO2, PO8, PSO1
CO2	Apply proficiency in using the OpenCV library for image and video processing.	3	PO1, PO2, PO8, PSO1
CO3	Implement common computer vision algorithms such as feature detection and object recognition.	3	PO2, PO3, PO8, PSO1
CO4	Analyze computer vision techniques to solve real-world problems in different domains.	4	PO2, PO3, PO8, PSO1

Syllabus

Introduction to Computer Vision Overview of Computer Vision principles and its applications in various fields. Introduction to image formation, representation, and perception. Understanding basic concepts such as pixels, color spaces, and image processing techniques.

Getting Started with OpenCV Performance: Acquire proficiency in using OpenCV. Objective: Set up OpenCV environment and perform basic operations. Pedagogy: Hands-on Lab, Demonstration Strategy: Provide step-by-step instructions and guided practice.

Image Processing Techniques Performance: Apply image processing techniques. Objective: Implement filtering, edge detection, and morphological operations. Pedagogy: Hands-on Lab, Coding Exercises Strategy: Provide coding challenges and real-world examples.

Feature Detection and Description Performance: Implement feature detection algorithms. Objective: Understand and apply keypoint detection and feature descriptors. Pedagogy: Hands-on Lab, Coding Exercises Strategy: Guide students through implementing feature detection algorithms.

Reference Books

- 1 Learning OpenCV 4 Computer Vision with Python 3, Adrian Kaehler and Gary Bradski, 2020, O'Reilly Media.
- 2 Mastering OpenCV 4 with Python, Alberto Fernandez Villan, 2019, Packt Publishing.
- 3 OpenCV Essentials, Oscar Deniz Suarez, M? del Milagro Fernandez Carrobles, Noelia Vallez Enano, and Gloria Bueno Garcia, 2014, Packt Publishing.
- 4 Learning OpenCV 5 Computer Vision with Python, Joseph Howse ,Joe Minichino , 2024, Packt Early Access, Packt Publishing.
- 5 OpenCV 4 for Secret Agents, Joseph Howse, 2019, O'Reilly Media.

23SDAD10R - COMPUTER VISION USING OPENCV (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDAD10R	COMPUTER VISION USING OPENCV	CVOCV	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of Computer Vision and its applications.	3	PO1, PO2, PO8, PSO1
CO2	Apply proficiency in using the OpenCV library for image and video processing.	3	PO1, PO2, PO8, PSO1
CO3	Analyze computer vision techniques to solve real-world problems in different domains and Implement common computer vision algorithms such as feature detection and object recognition.	4	PO2, PO3, PO8, PSO1

Syllabus

Introduction to Computer Vision Overview of Computer Vision principles and its applications in various fields. Introduction to image formation, representation, and perception. Understanding basic concepts such as pixels, color spaces, and image processing techniques. Introduction to OpenCV Introduction to OpenCV library and its functionalities. Installation and setup of OpenCV environment. Basic operations on images and videos using OpenCV.

Common Computer Vision Algorithms Feature detection techniques such as corner detection, edge detection, and blob detection.

Implementation of feature extraction methods like SIFT, SURF, and ORB. Object detection and recognition using methods like Haar cascades and Histogram of Oriented Gradients (HOG). Image Processing and Enhancement Image filtering techniques including smoothing, sharpening, and noise reduction. Histogram equalization and contrast enhancement methods. Hands-on exercises on image enhancement using OpenCV.

Reference Books

- 1 Learning OpenCV 4 Computer Vision with Python 3, Adrian Kaehler and Gary Bradski, 2020, O'Reilly Media.
- 2 Mastering OpenCV 4 with Python, Alberto Fernandez Villan, 2019, Packt Publishing.
- 3 OpenCV Essentials, Oscar Deniz Suarez, M? del Milagro Fernandez Carrobles, Noelia Vallez Enano, and Gloria Bueno Garcia, 2014, Packt Publishing.
- 4 OpenCV 4 for Secret Agents, Joseph Howse, 2019, Packt Publishing.

23SDBT01A - MEDICAL LAB TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT01A	MEDICAL LAB TECHNOLOGY	MLT	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CELL BIOLOGY	CB	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply haematology techniques to estimate various cells in blood	3	PO1, PO3
CO2	Apply various biological fluids using clinical biochemistry techniques	3	PO4, PO6
CO3	Apply the roles of biomolecules in biological fluids	3	PO3, PO4
CO4	Apply the role of biomarkers in clinical studies	3	PO1, PO6

Syllabus

Separation of plasma and serum, Blood smear preparation, TRBC test, TWBC test, Hb estimation, Blood typing, Bleed and clot time, ESR estimation

Typhoid test and VDRL test, Glucose detection in fluids, Collection of blood, Coagulation tests, Separation of serum and plasma from various Animal blood samples, Preparation of blood smear and staining by Giemsa, Total count of RBC by neubaur chamber method, Total count of WBC by neubaur chamber method

Estimation of Hemoglobin by Sahali method, Determination of ABO blood grouping, Determination of Blood bleeding and clotting time, Estimation of ESR by Westergren method, Widal Tests, VDRL tests, Estimation of glucose levels in blood sample, Blood sample collection and preservation, Coagulation tests

Blood culturing on microbial media, Drug screening, Saliva culturing on microbial media, Nasal swab culturing on microbial media, Dental culturing on microbial media, Lectin agglutination tests, Hormone testing, Blood cross matching

Reference Books

- 1 Introduction, Haematology and Coagulation, Immunohaematology Vol-1, Kanai, L Mukherjee and Swarajit Ghosh, 2010, Mc Graw Hill Publication.
- 2 Laboratory Manual of Clinical Pathology and Hematology, Santosh Kumar Mondal , 2022, CBS Publishers & Distributors Pvt. Ltd.
- 3 Essentials of Clinical Pathology, Shirish M Kawthalkar , 2010, JAYPEE BROTHERS MEDICAL PUBLISHERS.
- 4 Concise Book of Medical Laboratory Technology (Methods and Interpretations), Ramnik Sood, 2015, Jaypee Brothers Medical Publishers.
- 5 Chinmay's Competition Guide for D.M.L.T. (Diploma in Medical Laboratory Technology), Various Authors , 2021, Jain Publications, Jaipur (Rajasthan).

23SDBT01E - MEDICAL LAB TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT01E	MEDICAL LAB TECHNOLOGY	MLT	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CELL BIOLOGY	CB	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply haematology techniques to estimate various cells in blood	3	PO1, PO3
CO2	Apply various biological fluids using clinical biochemistry techniques	3	PO4, PO6
CO3	Apply the roles of biomolecules in biological fluids	3	PO3, PO4
CO4	Apply the role of biomarkers in clinical studies	3	PO1, PO6

Syllabus

Separation of plasma and serum, Blood smear preparation, TRBC test, TWBC test, Hb estimation, Blood typing, Bleed and clot time, ESR estimation

Typhoid test and VDRL test, Glucose detection in fluids, Collection of blood, Coagulation tests, Separation of serum and plasma from various Animal blood samples, Preparation of blood smear and staining by Giemsa, Total count of RBC by neubaur chamber method, Total count of WBC by neubaur chamber method

Estimation of Hemoglobin by Sahali method, Determination of ABO blood grouping, Determination of Blood bleeding and clotting time, Estimation of ESR by Westergren method, Widal Tests, VDRL tests, Estimation of glucose levels in blood sample, Blood sample collection and preservation, Coagulation tests

Blood culturing on microbial media, Drug screening, Saliva culturing on microbial media, Nasal swab culturing on microbial media, Dental culturing on microbial media, Lectin agglutination tests, Hormone testing, Blood cross matching

Reference Books

- 1 Introduction, Haematology and Coagulation, Immunohaematology Vol-1, Kanai, L Mukherjee and Swarajit Ghosh, 2010, Mc Graw Hill Publication.
- 2 Laboratory Manual of Clinical Pathology and Hematology, Santosh Kumar Mondal, 2022, CBS Publishers & Distributors Pvt. Ltd.
- 3 Essentials of Clinical Pathology, Shirish M Kawthalkar, 2010, JAYPEE BROTHERS MEDICAL PUBLISHERS.
- 4 Chinmay's Competition Guide for D.M.L.T. (Diploma in Medical Laboratory Technology), Various Authors, 2021, Jain Publications, Jaipur (Rajasthan).

23SDBT01R - MEDICAL LAB TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT01R	MEDICAL LAB TECHNOLOGY	MLT	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	CELL BIOLOGY	CB	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply haematology techniques to estimate various cells in blood	3	PO1, PO3
CO2	Apply various biological fluids using clinical biochemistry techniques and to Apply the roles of biomolecules in biological fluids	3	PO4, PO6
CO3	Apply the role of biomarkers in clinical studies	3	PO3, PO4

Syllabus

Separation of plasma and serum, Blood smear preparation, TRBC test, TWBC test, Hb estimation, Blood typing, Bleed and clot time, ESR estimation

Typhoid test and VDRL test, Glucose detection in fluids, Collection of blood, Coagulation tests, Separation of serum and plasma from various Animal blood samples, Preparation of blood smear and staining by Giemsa, Total count of RBC by neubaur chamber method, Total count of WBC by neubaur chamber method, Estimation of Hemoglobin by Sahali method, Determination of ABO blood grouping, Determination of Blood bleeding and clotting time, Estimation of ESR by Westergren method.

Blood culturing on microbial media, Drug screening, Saliva culturing on microbial media, Nasal swab culturing on microbial media, Dental culturing on microbial media, Lectin agglutination tests, Hormone testing, Blood cross matching

Reference Books

- 1 Introduction, Haematology and Coagulation, Immunohaematology Vol-1, Kanai, L Mukherjee and Swarajit Ghosh, 2010, Mc Graw Hill Publication .
- 2 Laboratory Manual of Clinical Pathology and Hematology , Santosh Kumar Mondal, 2022, CBS Publishers & Distributors Pvt. Ltd .
- 3 Essentials of Clinical Pathology , Shirish M Kawthalkar, 2010, JAYPEE BROTHERS MEDICAL PUBLISHERS .
- 4 Concise Book of Medical Laboratory Technology (Methods and Interpretations), Ramnik Sood, 2015, Jaypee Brothers Medical Publishers.

23SDBT02A - ANALYTICAL AND OPTICAL INSTRUMENTATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT02A	ANALYTICAL AND OPTICAL INSTRUMENTATION	AOI	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOCHEMICAL THERMODYNAMICS	BCT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the understanding of Analytical Techniques	3	PO1
CO2	Apply the Instrument Operation	3	PO1
CO3	Applications in Research and Industry	3	PO9
CO4	Perform experiments using analytical and optical instruments.	3	PO9

Syllabus

Overview of analytical instrumentation: definition, importance, and applications. Basic principles of analytical measurements: accuracy, precision, sensitivity. Principles of light absorption, reflection, and scattering. Introduction to basic optical components and alignment techniques.

Principles and instrumentation of UV-Vis spectroscopy. Practical session: Using a UV-Vis spectrophotometer for quantitative analysis. Fundamentals of IR spectroscopy: vibrational modes, instrumentation. IR spectroscopy for structural analysis and identification.

Principles and instrumentation of GC. Operating a GC instrument, analyzing samples, and interpreting chromatograms. Fundamentals of HPLC: principles, instrumentation, and separation mechanisms. Performing HPLC analysis, method development, and troubleshooting.

Introduction to mass spectrometry: principles and instrumentation. Using MS for molecular characterization, ionization techniques, and data interpretation. Overview of advanced analytical techniques: NMR spectroscopy, atomic absorption spectroscopy. Case studies and practical demonstrations, data analysis, and interpretation.

Reference Books

- 1 Analytical Chemistry, Gary D. Christian, 2003, John Wiley & Sons.
- 2 Modern Analytical Chemistry, David Harvey, 2000, McGraw-Hill Education.
- 3 Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Stanley R. Crouch, 2017, Cengage
- 4 Fundamentals of Photonics, Bahaa E. A. Saleh, Malvin Carl Teich, 2007, Wiley-Interscience.

23SDBT02E - ANALYTICAL AND OPTICAL INSTRUMENTATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT02E	ANALYTICAL AND OPTICAL INSTRUMENTATION	AOI	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOCHEMICAL THERMODYNAMICS	BCT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the understanding of Analytical Techniques	3	PO1
CO2	Apply the Instrument Operation	3	PO1
CO3	Applications in Research and Industry	3	PO9
CO4	Perform experiments using analytical and optical instruments	3	PO1

Syllabus

Overview of analytical instrumentation: definition, importance, and applications. Basic principles of analytical measurements: accuracy, precision, sensitivity. Principles of light absorption, reflection, and scattering. Introduction to basic optical components and alignment techniques.

Principles and instrumentation of UV-Vis spectroscopy. Practical session: Using a UV-Vis spectrophotometer for quantitative analysis. Fundamentals of IR spectroscopy: vibrational modes, instrumentation. IR spectroscopy for structural analysis and identification.

Principles and instrumentation of GC. Operating a GC instrument, analyzing samples, and interpreting chromatograms. Fundamentals of HPLC: principles, instrumentation, and separation mechanisms. Performing HPLC analysis, method development, and troubleshooting.

Introduction to mass spectrometry: principles and instrumentation. Using MS for molecular characterization, ionization techniques, and data interpretation. Overview of advanced analytical techniques: NMR spectroscopy, atomic absorption spectroscopy. Case studies and practical demonstrations, data analysis, and interpretation.

Reference Books

- 1 Analytical Chemistry, Gary D. Christian, 2003, John Wiley & Sons.
- 2 Modern Analytical Chemistry, David Harvey, 2000, McGraw-Hill Education.
- 3 Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Stanley R. Crouch, 2017, Cengage
- 4 Fundamentals of Photonics, Bahaa E. A. Saleh, Malvin Carl Teich, 2007, Wiley-Interscience.

23SDBT02R - ANALYTICAL AND OPTICAL INSTRUMENTATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT02R	ANALYTICAL AND OPTICAL INSTRUMENTATION	AOI	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOCHEMICAL THERMODYNAMICS	BCT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the understanding of Analytical Techniques	3	PO1
CO2	Apply the Instrument Operation	3	PO10
CO3	Applications in Research and Industry	2	PO1
CO4	Perform experiments using analytical and optical instruments	3	PO10

Syllabus

Overview of analytical instrumentation: definition, importance, and applications. Basic principles of analytical measurements: accuracy, precision, sensitivity. Principles of light absorption, reflection, and scattering. Introduction to basic optical components and alignment techniques.

Principles and instrumentation of UV-Vis spectroscopy. Practical session: Using a UV-Vis spectrophotometer for quantitative analysis. Fundamentals of IR spectroscopy: vibrational modes, instrumentation. IR spectroscopy for structural analysis and identification.

Principles and instrumentation of GC. Operating a GC instrument, analyzing samples, and interpreting chromatograms. Fundamentals of HPLC: principles, instrumentation, and separation mechanisms. Performing HPLC analysis, method development, and troubleshooting.

Introduction to mass spectrometry: principles and instrumentation. Using MS for molecular characterization, ionization techniques, and data interpretation. Overview of advanced analytical techniques: NMR spectroscopy, atomic absorption spectroscopy. Case studies and practical demonstrations, data analysis, and interpretation.

Reference Books

- 1 Analytical Chemistry, Gary D. Christian, 2003, John Wiley & Sons.
- 2 Modern Analytical Chemistry, David Harvey, 2000, McGraw-Hill Education.
- 3 Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Stanley R. Crouch, 2017, Cengage
- 4 Fundamentals of Photonics, Bahaa E. A. Saleh, Malvin Carl Teich, 2007, Wiley-Interscience.

23SDBT03A - BIO-INSTRUMENTATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT03A	BIO-INSTRUMENTATION	BI	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOCHEMICAL THERMODYNAMICS	BCT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the role of biological principles	3	P07
CO2	Compare biological instruments for desing of bioproducts	3	P04
CO3	Apply the design priniciples of bioinstruments	3	P09
CO4	Apply signal processing techniques to enhance the quality of biological data	3	P07

Syllabus

Overview of bioinstrumentation: scope, applications, and significance.

Principles of sensor design: sensitivity, selectivity, and range and types of sensors and transducers: electrical, mechanical, optical, and biochemical.

Data acquisition systems: hardware and software components, signal analysis techniques: time-domain, frequency-domain, and statistical methods.

Components of data acquisition systems, Analog-to-digital conversion, Sampling theory and signal quantization

Reference Books

- 1 Medical Instrumentation: Application and Design, John G. Webster, 2010, Wiley.
- 2 Biomedical Instrumentation: Technology and Applications, R.S. Khandpur, 2022, McGraw-Hill Education.
- 3 Principles of Instrumental Analysis, Douglas A. Skoog, 2016, Cengage Learning.
- 4 Medical Instrumentation: Application and Design, John G. Webster, 2009, Wiley.

23SDBT03E - BIO-INSTRUMENTATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT03E	BIO-INSTRUMENTATION	BI	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOCHEMICAL THERMODYNAMICS	BCT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the role of biological principles	3	P07
CO2	Compare biological instruments for desing of bioproducts	3	P04
CO3	Apply the design priniciples of bioinstruments	3	P09
CO4	Apply signal processing techniques to enhance the quality of biological data	3	P07

Syllabus

Overview of bioinstrumentation: scope, applications, and significance.

Principles of sensor design: sensitivity, selectivity, and range and types of sensors and transducers: electrical, mechanical, optical, and biochemical.

Data acquisition systems: hardware and software components, signal analysis techniques: time-domain, frequency-domain, and statistical methods.

Components of data acquisition systems, Analog-to-digital conversion, Sampling theory and signal quantization

Reference Books

- 1 Medical Instrumentation: Application and Design, John G. Webster, 2010, Wiley.
- 2 Biomedical Instrumentation: Technology and Applications, R.S. Khandpur, 2022, McGraw-Hill Education.
- 3 Principles of Instrumental Analysis, Douglas A. Skoog, 2016, Cengage Learning.
- 4 Medical Instrumentation: Application and Design, John G. Webster, 2009, Wiley.

23SDBT03R - BIO-INSTRUMENTATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT03R	BIO-INSTRUMENTATION	BI	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOCHEMICAL THERMODYNAMICS	BCT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the role of biological principles	3	P07
CO2	Compare biological instruments for desing of bioproducts	3	P04
CO3	Analyze data generated from bio-instrumentation experiments	4	P09
CO4	Apply signal processing techniques to enhance the quality of biological data	3	P07

Syllabus

Overview of bioinstrumentation: scope, applications, and significance.

Principles of sensor design: sensitivity, selectivity, and range and types of sensors and transducers: electrical, mechanical, optical, and biochemical.

Develop skills in analyzing data from bio-instrumentation experiments through statistical methods, signal processing techniques, and data visualization tools

Components of data acquisition systems, Analog-to-digital conversion, Sampling theory and signal quantization

Reference Books

- 1 Medical Instrumentation: Application and Design, John G. Webster, 2010, Wiley.
- 2 Biomedical Instrumentation: Technology and Applications, R.S. Khandpur, 2022, McGraw-Hill Education.
- 3 Biomedical Signal and Image Processing, Kayvan Najarian and Robert Splinter, 2016, CRC Press, Taylor & Francis Group.
- 4 Medical Instrumentation: Application and Design, John G. Webster, 2009, Wiley.

23SDBT04A - PROCESS ENGINEERING TOOLS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT04A	PROCESS ENGINEERING TOOLS	PET	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOCHEMICAL THERMODYNAMICS	BCT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various Techniques for isolation of microbes from different sources	3	PO1
CO2	Apply various biochemical methods for characterization of microorganism.	3	PO3
CO3	Apply various biochemical kinetics for isolated microbes	3	PO3, PO5
CO4	Apply various optimization techniques and stability studies on isolated microbes	3	PO3, PO5

Syllabus

Importance of bacterial culture in microbiology Basic requirements for bacterial growth (nutrients, pH, temperature, oxygen) Different types of culture media: Defined vs. complex media, Selective and differential media, Enrichment media, Principles of aseptic technique to prevent contamination Sterilization methods for media and equipment: Autoclaving, Filtration, Chemical disinfection- Demonstration of proper aseptic technique during media preparation and inoculation

Introduction to Biochemical Characterization: Importance of biochemical characterization for bacterial identification beyond basic methods like Gram staining. Overview of different types of biochemical tests and their role in identifying metabolic pathways and functionalities. Relationship between biochemical test results and bacterial classification.

Direct cell counting: Microscopic methods using hemocytometers for direct cell enumeration. Indirect biomass measurement: Techniques like measuring optical density (OD) and dry cell weight to estimate cell biomass. Growth curve generation: Techniques for plotting cell concentration or biomass over time to visualize growth patterns.

Importance of maintaining viable and functional bacterial cultures for research and industrial applications. Definition and rationale behind stability studies for bacterial cultures. Factors affecting bacterial culture stability: Temperature, Desiccation (drying), Oxygen availability, Nutrient composition

Reference Books

- 1 Fundamentals of Biochemical Engineering, Bailey & Ollis, 1, Mcgraw Hill Higher Education.
- 2 Biotechnology and Biochemical Engineering , Atkinson & Mavituna, 2, Springer.
- 3 Bioprocess Engineering: Basic Concepts, Michael L. Shuler, Fikret Kargi, and Matthew DeLisa, 3, Prentice Hall.
- 4 Bioprocess Engineering Principles, Pauline M. Doran, 2, Academic Press.

23SDBT04E - PROCESS ENGINEERING TOOLS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT04E	PROCESS ENGINEERING TOOLS	PET	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOCHEMICAL THERMODYNAMICS	BCT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various Techniques for isolation of microbes from different sources	3	PO1
CO2	Apply various biochemical methods for characterization of microorganism.	3	PO3
CO3	Apply various biochemical kinetics for isolated microbes	3	PO3, PO5
CO4	Apply various optimization techniques and stability studies on isolated microbes	3	PO3, PO5

Syllabus

Importance of bacterial culture in microbiology Basic requirements for bacterial growth (nutrients, pH, temperature, oxygen) Different types of culture media: Defined vs. complex media, Selective and differential media, Enrichment media, Principles of aseptic technique to prevent contamination Sterilization methods for media and equipment: Autoclaving, Filtration, Chemical disinfection- Demonstration of proper aseptic technique during media preparation and inoculation

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Direct cell counting: Microscopic methods using hemocytometers for direct cell enumeration. Indirect biomass measurement: Techniques like measuring optical density (OD) and dry cell weight to estimate cell biomass. Growth curve generation: Techniques for plotting cell concentration or biomass over time to visualize growth patterns.

Importance of maintaining viable and functional bacterial cultures for research and industrial applications. Definition and rationale behind stability studies for bacterial cultures. Factors affecting bacterial culture stability: Temperature, Desiccation (drying), Oxygen availability, Nutrient composition

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- 1 Fundamentals of Biochemical Engineering, Bailey & Ollis, 1, McGraw Hill Higher Education.
- 2 Biotechnology and Biochemical Engineering, Atkinson & Mavituna, 2, Springer.
- 3 Bioprocess Engineering: Basic Concepts, Michael L. Shuler, Fikret Kargi, and Matthew DeLisa, 3, Prentice Hall.
- 4 Bioprocess Engineering Principles, Pauline M. Doran, 2, Academic Press.

23SDBT04R - PROCESS ENGINEERING TOOLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT04R	PROCESS ENGINEERING TOOLS	PET	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOCHEMICAL THERMODYNAMICS	BCT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various Techniques for isolation of microbes from different sources	3	PO1
CO2	Apply various biochemical methods for characterization of microorganism.	3	PO3
CO3	Apply various biochemical kinetics for isolated microbes	3	PO3, PO5

Syllabus

Importance of bacterial culture in microbiology Basic requirements for bacterial growth (nutrients, pH, temperature, oxygen) Different types of culture media: Defined vs. complex media, Selective and differential media, Enrichment media, Principles of aseptic technique to prevent contamination Sterilization methods for media and equipment: Autoclaving, Filtration, Chemical disinfection- Demonstration of proper aseptic technique during media preparation and inoculation

Introduction to Biochemical Characterization: Importance of biochemical characterization for bacterial identification beyond basic methods like Gram staining. Overview of different types of biochemical tests and their role in identifying metabolic pathways and functionalities. Relationship between biochemical test results and bacterial classification.

Direct cell counting: Microscopic methods using hemocytometers for direct cell enumeration. Indirect biomass measurement: Techniques like measuring optical density (OD) and dry cell weight to estimate cell biomass. Growth curve generation: Techniques for plotting cell concentration or biomass over time to visualize growth patterns.

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- 1 Fundamentals of Biochemical Engineering, Bailey & Ollis, 1, Mcgraw Hill Higher Education.
- 2 Biotechnology and Biochemical Engineering , Atkinson & Mavituna, 2, Springer.
- 3 Bioprocess Engineering: Basic Concepts, Michael L. Shuler, Fikret Kargi, and Matthew DeLisa, 3, Prentice Hall.
- 4 Bioprocess Engineering Principles, Pauline M. Doran, 2, Academic Press.

23SDBT05A - COMPUTER AIDED DRUG DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT05A	COMPUTER AIDED DRUG DESIGN	CADD	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CELL BIOLOGY	CB	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of drug discovery methods, including techniques such as high-throughput screening, lead optimization, and pharmacophore modeling.	3	PO2, PO5
CO2	Illustrate protein function through structural prediction through computer-based modeling. Understand methods for predicting protein folding, identifying structural motifs, and determining active sites	3	PO2, PO5
CO3	Apply the knowledge of biomolecular interactions to study the interactions between proteins, nucleic acids, and other biomolecules. Understand the significance of these interactions in biological processes	3	PO2, PO5
CO4	Demonstrate methods of computational drug design in small molecule analysis. Utilize techniques such as molecular docking, virtual screening, and quantitative structure-activity relationship (QSAR) modeling	3	PO2, PO5

Syllabus

Practical Introduction to Molecular Modeling and Drug Design: Drug-Definition, history and types; Overview of drug discovery and development. Introduction to Drug Design, Pharmacokinetics and Pharmacodynamics, Modern Drug Discovery Technologies, Drug Development Phases, Case Studies in Drug Discovery. Case Studies in Drug Discovery: Analysis of successful drug discovery stories to understand practical applications and challenges in the field.

Prediction and Structural Analysis of Macromolecules: Macromolecular structure databases - Protein Data Bank, structural classification of protein. Advanced Structural Analysis Techniques, Protein Function Prediction, Comparative Protein Modeling, Structural Bioinformatics Tools, Structural Databases Beyond PDB. Structural Databases Beyond PDB: Exploring alternative databases like SCOP, CATH, and InterPro for protein structure information.

Biomolecular Interactions and Drug Discovery Methods: Small Molecule Analysis - Structural analysis, Physico-Chemical analysis, prediction of ADMET properties and biological activity. Ligand-Based Drug Design, Structure-Based Drug Design, Advanced ADMET Modeling, Biological Activity Assays, High-Throughput Screening Technologies. Introduction to methods for evaluating large libraries of compounds for potential drug candidates.

Molecular Modeling: Drug Target Prediction - Methods and Applications; Introduction to Biological Networks, GRN, Metabolic Networks, and Gene Ontology Analysis. Target Identification and Validation, Biological Network Analysis, Gene Regulatory Networks (GRN), Metabolic Pathway Analysis, Gene Ontology (GO) Analysis. Methods for classifying and analyzing gene functions and relationships.

Reference Books

- 1 Molecular Modeling: Basic Principles and Applications. , Hans-Dieter H, Wolfgang Sippl, Didier Rognan, Gerd Folkers. , 2017, John Wiley & Sons .
- 2 Molecular Modeling of Proteins. , Andreas Kukol, 2018, Springer New York.
- 3 Molecular Modelling Principles and Applications., Pual Clinton, 2017, Pearson Publication.
- 4 Computational Drug Design., D. C. Young. , 2011, John Wiley & Sons .

- 5 Molecular Modeling and Drug Design: Principles and Applications, Anand Solomon, 2016, Narosa Publishing House.

23SDBT05E - COMPUTER AIDED DRUG DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT05E	COMPUTER AIDED DRUG DESIGN	CADD	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CELL BIOLOGY	CB	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of drug discovery methods, including techniques such as high-throughput screening, lead optimization, and pharmacophore modeling.	3	PO2, PO5
CO2	Illustrate protein function through structural prediction through computer-based modeling. Understand methods for predicting protein folding, identifying structural motifs, and determining active sites	3	PO2, PO5
CO3	Apply the knowledge of biomolecular interactions to study the interactions between proteins, nucleic acids, and other biomolecules. Understand the significance of these interactions in biological processes	3	PO2, PO5
CO4	Demonstrate methods of computational drug design in small molecule analysis. Utilize techniques such as molecular docking, virtual screening, and quantitative structure-activity relationship (QSAR) modeling	3	PO2, PO5

Syllabus

Practical Introduction to Molecular Modeling and Drug Design: Drug-Definition, history and types; Overview of drug discovery and development. Introduction to Drug Design, Pharmacokinetics and Pharmacodynamics, Modern Drug Discovery Technologies, Drug Development Phases, Case Studies in Drug Discovery. Case Studies in Drug Discovery: Analysis of successful drug discovery stories to understand practical applications and challenges in the field.

Prediction and Structural Analysis of Macromolecules: Macromolecular structure databases - Protein Data Bank, structural classification of protein. Advanced Structural Analysis Techniques, Protein Function Prediction, Comparative Protein Modeling, Structural Bioinformatics Tools, Structural Databases Beyond PDB. Structural Databases Beyond PDB: Exploring alternative databases like SCOP, CATH, and InterPro for protein structure information..

le 3 Biomolecular Interactions and Drug Discovery Methods: Small Molecule Analysis - Structural analysis, Physico-Chemical analysis, prediction of ADMET properties and biological activity. Ligand-Based Drug Design, Structure-Based Drug Design, Advanced ADMET Modeling, Biological Activity Assays, High-Throughput Screening Technologies. Introduction to methods for evaluating large libraries of compounds for potential drug candidates.

Molecular Modeling: Drug Target Prediction - Methods and Applications; Introduction to Biological Networks, GRN, Metabolic Networks, and Gene Ontology Analysis. Target Identification and Validation, Biological Network Analysis, Gene Regulatory Networks (GRN), Metabolic Pathway Analysis, Gene Ontology (GO) Analysis. Methods for classifying and analyzing gene functions and relationships.

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- 2 Molecular Modeling of Proteins., Andreas Kukol, 2017, Springer New York.
- 3 Molecular Modelling Principles and Applications., Pual Clinton, 2018, Pearson Publication.
- 4 Computational Drug Design., D. C. Young., 2011, John Wiley & Sons.

- 5 Molecular Modeling and Drug Design: Principles and Applications, Anand Solomon, 2019, Narosa Publishing House.

23SDBT05R - COMPUTER AIDED DRUG DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT05R	COMPUTER AIDED DRUG DESIGN	CADD	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	CELL BIOLOGY	CB	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of drug discovery methods, including techniques such as high-throughput screening, lead optimization, and pharmacophore modeling.	3	PO2, PO5
CO2	Illustrate protein function through structural prediction through computer-based modeling. Understand methods for predicting protein folding, identifying structural motifs, and determining active sites	3	PO2, PO5
CO3	Apply the knowledge of biomolecular interactions to study the interactions between proteins, nucleic acids, and other biomolecules. Understand the significance of these interactions in biological processes	3	PO2, PO5

Syllabus

Practical Introduction to Molecular Modeling and Drug Design: Drug-Definition, history and types; Overview of drug discovery and development. Introduction to Drug Design, Pharmacokinetics and Pharmacodynamics, Modern Drug Discovery Technologies, Drug Development Phases, Case Studies in Drug Discovery. Case Studies in Drug Discovery: Analysis of successful drug discovery stories to understand practical applications and challenges in the field.

Prediction and Structural Analysis of Macromolecules: Macromolecular structure databases - Protein Data Bank, structural classification of protein. Advanced Structural Analysis Techniques, Protein Function Prediction, Comparative Protein Modeling, Structural Bioinformatics Tools, Structural Databases Beyond PDB. Structural Databases Beyond PDB: Exploring alternative databases like SCOP, CATH, and InterPro for protein structure information..

Biomolecular Interactions and Drug Discovery Methods: Small Molecule Analysis - Structural analysis, Physico-Chemical analysis, prediction of ADMET properties and biological activity. Ligand-Based Drug Design, Structure-Based Drug Design, Advanced ADMET Modeling, Biological Activity Assays, High-Throughput Screening Technologies. Introduction to methods for evaluating large libraries of compounds for potential drug candidates.

Reference Books

- 1 Molecular Modeling: Basic Principles and Applications., Hans-Dieter Hltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers., 2018, John Wiley & Sons.
- 2 Molecular Modeling of Proteins., Andreas Kukol, 2017, Springer New York.
- 3 Molecular Modelling Principles and Applications., Pual Clinton, 2019, Pearson Publication.
- 4 Computational Drug Design., D. C. Young., 2011, John Wiley & Sons.

23SDBT06A - GENOMICS DATA SCIENCE & CLUSTERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT06A	GENOMICS DATA SCIENCE & CLUSTERING	CADD	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CELL BIOLOGY	CB	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Advanced Genomic Data Analysis Techniques to Extract Meaningful Biological Insights to uncover significant patterns and trends within large-scale genomic datasets	3	PO2, PO3, PO5, PSO1
CO2	Utilize and adapt clustering algorithms to address complex genomic research questions to categorize and interpret complex genomic data, facilitating the identification of genetic relationships, expression patterns, and subtypes within populations	3	PO2, PO3, PO5, PSO1
CO3	Implement and customize bioinformatics tools for effective genomic data interpretation to accurately analyse genomic data, enabling the derivation of actionable insights and supporting comprehensive genomic research projects	3	PO2, PO3, PO5, PSO1
CO4	Develop and optimize scalable solutions for efficient genomic data clustering to design, develop, and refine scalable solutions for the processing of large genomic datasets in a time-effective manner	3	PO2, PO3, PO5, PSO1

Syllabus

Introduction to Genomics and Data Science: Fundamentals of Medical Terminology and Clinical Concepts, Data Types and Sources in Healthcare, Data Governance and Security in Healthcare, Regulatory and Compliance Issues in Healthcare Data

Data Preprocessing and Quality Control: Data Collection Methods, Data Cleaning and Preprocessing, Data Transformation and Feature Engineering, Data Annotation and Labeling, Data Integration and Interoperability

Data Analysis and Machine Learning in Healthcare: Exploratory Data Analysis (EDA), Introduction to Machine Learning, Advanced Machine Learning Techniques, Predictive Modeling and Risk Stratification, Time Series Analysis and Forecasting

Implementation and Case Studies: Implementing Clinical Decision Support Systems (CDSS), Case Studies in Clinical Data Science, Project Work and Practical Applications, Evaluating Data Science Models in Healthcare, User-Centered Design and Implementation

Genomic Data Visualization and Interpretation: Introduction to Genomic Data, Genomic Data Visualization Techniques, Tools and Software for Genomic Data Visualization, Interpretation of Genomic Data, Practical Applications and Case Studies

Reference Books

- 1 Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools, Vince Buffalo, 2015, O'Reilly Media.
- 2 Genomic and Precision Medicine: Primary Care, Geoffrey S. Ginsburg, Huntington F. Willard, 2017, Academic Press.
- 3 Statistical Genomics: Methods and Protocols, Ewly Math?, Sean Davis, 2016, Springer.

- 4 Introduction to Genomics, Arthur M. Lesk, 2012, Oxford University Press.

23SDBT06E - GENOMICS DATA SCIENCE & CLUSTERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT06E	GENOMICS DATA SCIENCE & CLUSTERING	CADD	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CELL BIOLOGY	CB	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Advanced Genomic Data Analysis Techniques to Extract Meaningful Biological Insights to uncover significant patterns and trends within large-scale genomic datasets	3	PO2, PO3, PO5, PSO1
CO2	Utilize and adapt clustering algorithms to address complex genomic research questions to categorize and interpret complex genomic data, facilitating the identification of genetic relationships, expression patterns, and subtypes within populations	3	PO2, PO3, PO5, PSO1
CO3	Implement and customize bioinformatics tools for effective genomic data interpretation to accurately analyse genomic data, enabling the derivation of actionable insights and supporting comprehensive genomic research projects	3	PO2, PO3, PO5, PSO1
CO4	Develop and optimize scalable solutions for efficient genomic data clustering to design, develop, and refine scalable solutions for the processing of large genomic datasets in a time-effective manner	3	PO2, PO3, PO5, PSO1

Syllabus

Introduction to Genomics and Data Science: Fundamentals of Medical Terminology and Clinical Concepts, Data Types and Sources in Healthcare, Data Governance and Security in Healthcare, Regulatory and Compliance Issues in Healthcare Data

Data Preprocessing and Quality Control: Data Collection Methods, Data Cleaning and Preprocessing, Data Transformation and Feature Engineering, Data Annotation and Labeling, Data Integration and Interoperability

Data Analysis and Machine Learning in Healthcare: Exploratory Data Analysis (EDA), Introduction to Machine Learning, Advanced Machine Learning Techniques, Predictive Modeling and Risk Stratification, Time Series Analysis and Forecasting

Implementation and Case Studies: Implementing Clinical Decision Support Systems (CDSS), Case Studies in Clinical Data Science, Project Work and Practical Applications, Evaluating Data Science Models in Healthcare, User-Centered Design and Implementation

Genomic Data Visualization and Interpretation: Introduction to Genomic Data, Genomic Data Visualization Techniques, Tools and Software for Genomic Data Visualization, Interpretation of Genomic Data, Practical Applications and Case Studies

Reference Books

- 1 Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools, Vince Buffalo, 2015, O'Reilly Media.
- 2 Genomic and Precision Medicine: Primary Care, Geoffrey S. Ginsburg, Huntington F. Willard, 2017, Academic Press.
- 3 Statistical Genomics: Methods and Protocols, Eladio J. Mrquez, Darlene R. Goldstein, Juan A. Casas, 2016, Springer.

- 4 Introduction to Genomics, Arthur M. Lesk, 2012, Oxford University Press.

23SDBT06R - GENOMICS DATA SCIENCE & CLUSTERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT06R	GENOMICS DATA SCIENCE & CLUSTERING	CADD	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	CELL BIOLOGY	CB	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Advanced Genomic Data Analysis Techniques to Extract Meaningful Biological Insights to uncover significant patterns and trends within large-scale genomic datasets	3	PO1, PO2, PO3, PSO1
CO2	Utilize and adapt clustering algorithms to address complex genomic research questions to categorize and interpret complex genomic data, facilitating the identification of genetic relationships, expression patterns, and subtypes within populations	3	PO1, PO2, PO3, PSO1
CO3	Implement and customize bioinformatics tools for effective genomic data interpretation to accurately analyse genomic data, enabling the derivation of actionable insights and supporting comprehensive genomic research projects	3	PO1, PO2, PO3, PSO1
CO4	Develop and optimize scalable solutions for efficient genomic data clustering to design, develop, and refine scalable solutions for the processing of large genomic datasets in a time-effective manner	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Genomics and Bioinformatics: Introduction to Genomics DNA Sequencing Technologies, Genome Assembly and Annotation, Bioinformatics Databases and Tools, Applications of Genomics in Medicine and Biotechnology

Data Preprocessing and Quality Control: Introduction to Data Preprocessing, Data Cleaning Techniques, Handling Missing Data, Data Transformation and Normalization, Quality Control Measures

Sequence Alignment and Mapping: Introduction to Sequence Alignment, Pairwise Sequence Alignment Techniques, Multiple Sequence Alignment Methods, Sequence Mapping Strategies, Quality Assessment in Sequence Alignment.

Variant Calling and Annotation: Introduction to Variant Calling, Variant Detection Techniques, Quality Control in Variant Calling, Variant Annotation Methods, Interpretation and Analysis of Variants.

Clustering Algorithms and Techniques: Introduction to Clustering, K-means Clustering, Hierarchical Clustering, Density-based Clustering (DBSCAN), Evaluation and Comparison of Clustering Algorithms.

Dimensionality Reduction and Visualization: Introduction to Dimensionality Reduction, Principal Component Analysis (PCA), t-Distributed Stochastic Neighbor Embedding (t-SNE), Linear Discriminant Analysis (LDA), Visualization Techniques for High-Dimensional Data

Advanced Topics in Genomic Data Science: Genome-Wide Association Studies (GWAS), Next-Generation Sequencing (NGS) Data Analysis, Epigenomics and Chromatin Structure Analysis, Single-Cell Genomics, Integrative Genomic Analysis Techniques.

Project Development and Presentation: Project Planning and Proposal Writing, Data Acquisition and Preprocessing for Genomic Projects, Implementation of Analytical Methods, Data Interpretation and Visualization, Effective Communication and Presentation Skills.

Reference Books

- 1 Bioinformatics: Sequence and Genome Analysis, David W. Mount, 2004, Cold Spring Harbor Laboratory Press.

- 2 Introduction to Genomics, Arthur M. Lesk, 2012, Oxford University Press.
- 3 Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools, Vince Buffalo, 2015, O'Reilly Media.
- 4 Clustering in Bioinformatics and Drug Discovery, John David MacCuish and Norah E. MacCuish, 2010, CRC Press.

23SDBT07A - ASPECTS OF BIOCHEMICAL ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT07A	ASPECTS OF BIOCHEMICAL ENGINEERING	ABCE	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop proficiency in fundamental biochemical engineering techniques	3	PO1, PO2, PO3, PSO1
CO2	Apply theoretical knowledge to solve practical problems encountered in bioprocessing and biotechnology.	3	PO1, PO2, PO3, PSO1
CO3	Enhance critical thinking and analytical skills through experimental design, execution, and analysis.	3	PO1, PO2, PO3, PSO1
CO4	Foster teamwork and communication skills through collaborative laboratory work and group discussions.	3	PO1, PO2, PO3, PSO1
CO5	Cultivate awareness of safety protocols and ethical considerations in biochemical engineering research and experimentation.	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Laboratory Safety and Good Laboratory Practices Microbial Cell Culture Techniques: Growth and Maintenance

Enzyme Kinetics: Determination of Enzyme Parameters Bioreactor Design and Operation: Batch, Continuous, and Fed-batch Cultures

Downstream Processing: Protein Purification Techniques Fermentation Processes: Production of Biomolecules

Biomass Measurement and Analysis Analytical Techniques in Biochemical Engineering: Spectrophotometry, Chromatography

Process Optimization and Scale-up Strategies Ethical and Safety Considerations in Biochemical Engineering Research

Reference Books

- 1 Bioprocess Engineering Principles , Pauline M. Doran , 2024, Academic Press.
- 2 Biochemical Engineering Fundamentals McGraw-Hill Education, James E. Bailey and David F. Ollis , 2021, McGraw-Hill Education.
- 3 . Chemical Reaction Engineering,, Levenspiel O., 2006, John Wiley & sons.
- 4 Bioprocess engineering , shuler and Kargi, 2017, Boston : Prentice Hall.

23SDBT07E - ASPECTS OF BIOCHEMICAL ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT07E	ASPECTS OF BIOCHEMICAL ENGINEERING	ABCE	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To gain practical experience in biochemical engineering techniques.	3	PO1, PO2, PO3, PSO1
CO2	To understand the principles behind bioprocessing and bioseparations.	3	PO1, PO2, PO3, PSO1
CO3	To learn experimental design, data analysis, and interpretation skills.	3	PO1, PO2, PO3, PSO1
CO4	To apply theoretical knowledge to solve practical problems encountered in biochemical engineering	3	PO1, PO2, PO3, PSO1

Syllabus

Advanced Bioreactor Design and Operation: Fed-batch and Perfusion Systems Metabolic Engineering: Modifying Microorganisms for Bioproduction

Bioprocess Monitoring and Control: Sensors and Automation Bioprocess Scale-up and Technology Transfer Advanced Downstream Processing: Membrane Filtration and Chromatography

Biosensors and Bioanalytical Techniques for Process Monitoring Computational Tools in Biochemical Engineering: Modeling and Simulation

Advanced Fermentation Strategies: High Cell Density Cultures and Mixed Cultures Emerging Technologies in Biochemical Engineering: CRISPR-Cas9 and Synthetic Biology

Reference Books

- 1 Bioprocess Engineering Principles, Pauline M. Doran, 2024, Academic Press.
- 2 Biochemical Engineering Fundamentals , James E. Bailey and David F. Ollis, 2021, McGraw-Hill Education.
- 3 Chemical Reaction Engineering, , Levenspiel O., 2006, John Wiley & sons.
- 4 Bioprocess engineering , shuler and Kargi, 2017, Boston : Prentice Hall.

23SDBT07R - ASPECTS OF BIOCHEMICAL ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT07R	ASPECTS OF BIOCHEMICAL ENGINEERING	ABCE	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply experimental techniques to study fundamental concepts in biochemical engineering.	3	PO1, PO2, PO3, PSO1
CO2	Analyze experimental data and interpret results using appropriate statistical methods.	3	PO1, PO2, PO3, PSO1
CO3	Communicate experimental findings effectively through written reports and presentations	3	PO1, PO2, PO3, PSO1

Syllabus

Proficiency in Laboratory Techniques-Perform laboratory experiments using equipment and techniques commonly used in biochemical engineering, such as fermentation, chromatography, and enzyme assays

Data Analysis and Interpretation-Analyze experimental data using statistical methods and software tools to draw meaningful conclusions about bioprocess performance or biomolecule characteristics.

Effective Communication of Experimental Findings-Communicate experimental procedures, results, and conclusions through clear and concise written reports and oral presentations.

Reference Books

- 1 Biochemical Engineering Fundamentals, James E. Bailey and David F. Ollis, 2nd, McGraw-Hill Education.
- 2 Biochemical Engineering and Biotechnology, Ghasem Najafpour, 1st, Elsevier.
- 3 Bioprocess Engineering Principles , Pauline M. Doran , 2nd, Academic Press.
- 4 Chemical Reaction Engineering,, Levenspiel O., 3 rd 2006, John Wiley & sons.

23SDBT08A - DRUG DESIGN: PRINCIPLES AND ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT08A	DRUG DESIGN: PRINCIPLES AND ENGINEERING	DDPE	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOINFORMATICS	BI	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basis of drug discovery methods and introducing computer-aided drug design, molecular modeling, and simulation to develop innovative therapeutic strategies.	2	PO1, PO2
CO2	Apply the knowledge of protein function and structure prediction by computer-based modelling and design principles to improve the accuracy of protein engineering and drug design efforts.	3	PO1, PO4
CO3	Construct the biomolecular interactions in detail to analyze the molecules, thereby gaining insights into the mechanisms of molecular recognition and binding specificity.	3	PO1, PO5, PSO1
CO4	Apply the role of computational modeling and drug design methods with case studies to evaluate the effectiveness of new drugs and predict their potential side effects.	3	PO1, PO7

Syllabus

Drug Definition, history and types; Overview of drug discovery and development, Methodologies and strategies in molecular modelling and Drug Design Structure and ligand based drug design; Drug targets in Diseases Enzymes and Receptors; Phases of Computer aided drug design Target and Lead Discovery; Biomolecular interactions; Importance of Molecular Modelling and Drug Design in novel Drug discovery

Macromolecular structure databases Protein Data bank, structural classification of protein; Bioanalytical methods to determine protein structure X Ray diffractions, NMR and Cryoelectron methods; Protein Structure and Function Hierarchy of protein structures, Concept of Protein Folding, Interactions Forces; Protein structure prediction Concept of protein modelling, structure validation methods; Optimization of protein structure Preparation and Refinement methods; Introduction to Transmembrane Proteins Structure, function and prediction; Mutational Effects on protein structure Calculation of free energy, Prediction of deleterious mutations

Small Molecule Analysis Structural analysis, Physico Chemical analysis, prediction of ADMET properties and biological activity; Introduction to chemical pharmacophore; Principles of biomolecular interactions Molecular Docking, Molecular Dynamics simulations, ranking and scoring; Concepts of Virtual screening in drug discovery; Introduction to Quantitative structure activity relationships in drug design

Drug Target prediction methods and applications; Introduction to Biological Networks protein protein Interaction analysis; Fundamentals of network pharmacology; Principles of Pharmacogenetics; Sequence analysis of biomolecules Prediction of Protein Parameters, Secondary structure, Hydrophobicity, trafficking, phosphorylation, Disordered regions; Advancements in Molecular modelling and drug design New technologies and innovations in drug design; Application of Computer aided drug design with real world example

Reference Books

- 1 Molecular Modelling Principles and Applications., A. R. Leach, 2001, Pearson Publication.
- 2 Computer Aided Drug Design, Solomon V Raja, Alagarsamy, 2022, CBS Publishers.
- 3 Applied Computer-Aided Drug Design: Models and Methods, Igor Josdos, Santos Nascimento, 2023, Bentham Science.

- 4 Computational Drug Design: A Guide for Computational and Medicinal Chemists, D. C. Young, 2009, John Wiley & Sons .

23SDBT08E - DRUG DESIGN: PRINCIPLES AND ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT08E	DRUG DESIGN: PRINCIPLES AND ENGINEERING	DDPE	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOINFORMATICS	BI	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basis of drug discovery methods and introducing computer-aided drug design, molecular modeling, and simulation to develop innovative therapeutic strategies.	2	PO1, PO2
CO2	Identify the knowledge of protein function and structure prediction by computer-based modelling and design principles to improve the accuracy of protein engineering and drug design efforts.	3	PO1, PO4
CO3	Construct the biomolecular interactions in detail to analyze the molecules, thereby gaining insights into the mechanisms of molecular recognition and binding specificity.	3	PO1, PO5
CO4	Apply the role of computational modeling and drug design methods with case studies to evaluate the effectiveness of new drugs and predict their potential side effects.	3	PO1, PO7, PSO1

Syllabus

Drug Definition, history and types; Overview of drug discovery and development ; Methodologies and strategies in molecular modelling and Drug Design Structure and ligand based drug design; Drug targets in Diseases Enzymes and Receptors; Phases of Computer aided drug design Target and Lead Discovery Biomolecular interactions; Importance of Molecular Modelling and Drug Design in novel Drug discovery

Macromolecular structure databases Protein Data bank, structural classification of protein; Bioanalytical methods to determine protein structure X Ray diffractions, NMR and Cryoelectron methods; Protein Structure and Function Hierarchy of protein structures, Concept of Protein Folding, Interactions Forces; Protein structure prediction Concept of protein modelling, structure validation methods; Optimization of protein structure Preparation and Refinement methods; Introduction to Transmembrane Proteins Structure, function and prediction; Mutational Effects on protein structure Calculation of free energy, Prediction of deleterious mutations

Small Molecule Analysis Structural analysis, PhysicoChemical analysis, prediction of ADMET properties and biological activity; Introduction to chemical pharmacophore; Principles of biomolecular interactions Molecular Docking, Molecular Dynamics simulations, ranking and scoring; Concepts of Virtual screening in drug discovery; Introduction to Quantitative structure activity relationships in drug design

Drug Target prediction methods and applications; Introduction to Biological Networks protein protein Interaction analysis; Fundamentals of network pharmacology; Principles of Pharmacogenetics; Sequence analysis of biomolecules Prediction of Protein Parameters, Secondary structure, Hydrophobicity, trafficking, phosphorylation, Disordered regions; Advancements in Molecular modelling and drug design New technologies and innovations in drug design; Application of Computer aided drug design with real world examples

Reference Books

- 1 Molecular Modelling Principles and Applications., A. R. Leach, 2001, Pearson Publication.
- 2 Computer Aided Drug Design, Solomon V Raja, Alagarsamy, 2022, CBS Publishers.
- 3 Applied Computer-Aided Drug Design: Models and Methods, Igor Jos, dos Santos Nascimento, 2023, Bentham Science.

- 4 Computational Drug Design: A Guide for Computational and Medicinal Chemists, D. C. Young., 2009, John Wiley & Sons .

23SDBT08R - DRUG DESIGN: PRINCIPLES AND ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT08R	DRUG DESIGN: PRINCIPLES AND ENGINEERING	DDPE	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	BIOINFORMATICS	BI	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basis of drug discovery methods and introducing computer-aided drug design, molecular modeling, and simulation to develop innovative therapeutic strategies.	2	PO1, PO2
CO2	Apply the knowledge of protein function and structure prediction by computer-based modelling and design principles to improve the accuracy of protein engineering and drug design efforts.	3	PO1, PO4
CO3	Identify the biomolecular interactions in detail to analyze the molecules, thereby gaining insights into the mechanisms of molecular recognition and binding specificity.	3	PO1, PO7, PSO1

Syllabus

Drug Definition, history and types; Overview of drug discovery and development, Methodologies and strategies in molecular modelling and Drug Design Structure and ligand based drug design; Drug targets in Diseases Enzymes and Receptors; Phases of Computer aided drug design Target and Lead Discovery; Biomolecular interactions; Importance of Molecular Modelling and Drug Design in novel Drug discovery

"Macromolecular structure databases Protein Data bank, structural classification of protein; Bioanalytical methods to determine protein structure X Ray diffractions, NMR and Cryoelectron methods; Protein Structure and Function Hierarchy of protein structures, Concept of Protein Folding, Interactions Forces; Protein structure prediction Concept of protein modelling, structure validation methods; Optimization of protein structure Preparation and Refinement methods; Introduction to Transmembrane Proteins Structure, function and prediction; Mutational Effects on protein structure Calculation of free energy, Prediction of deleterious mutations "

"Small Molecule Analysis Structural analysis, Physico Chemical analysis, prediction of ADMET properties and biological activity; Introduction to chemical pharmacophore; Principles of biomolecular interactions Molecular Docking, Molecular Dynamics simulations, ranking and scoring; Concepts of Virtual screening in drug discovery; Introduction to Quantitative structure activity relationships in drug design "

Reference Books

- 1 Molecular Modelling Principles and Applications. , A.R.Leach, 2001, Pearson.
- 2 Computer Aided Drug Design, Solomon V Raja, Alagarsamy, 2022, CBS Publishers.
- 3 Applied Computer-Aided Drug Design: Models and Methods, Igor Josdos, Santos Nascimento, 2023, Bentham Science.
- 4 Computational Drug Design: A Guide for Computational and Medicinal Chemists, D. C. Young , 2009, John Wiley & Sons .

23SDBT09A - CELL CULTURE TECHNOLOGIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT09A	CELL CULTURE TECHNOLOGIES	CCT	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Cell Culture Principles	2	PO1, PO2, PO3, PSO1
CO2	Various Cell Culture Techniques: apply a range of cell culture techniques, such as passaging, cryopreservation, and primary cell isolation	3	PO1, PO2, PO3, PSO1
CO3	Applying Cell Culture in Biomedical Research and Biotechnology: utilize cell cultures for drug testing, genetic manipulation, and tissue engineering	3	PO1, PO2, PO3, PSO1
CO4	Quality Control and Regulatory Compliance: ensure quality control and regulatory compliance in cell culture practices by developing and implementing protocols	3	PO1, PO2, PO3, PSO1

Syllabus

Cell biology fundamentals Historical development of cell culture techniques Applications of cell culture in research and industry

Cell Culture Techniques Cell isolation and primary culture establishment Cell line maintenance, subculturing, and passaging Cryopreservation and cell banking techniques Cell Culture Media and Supplements Types of cell culture media (serum-based, serum-free, specialized media) Media formulation and optimization Growth factors, cytokines, and supplements for cell culture

Cell Culture Environment Cell culture incubators and sterile techniques pH control, gas exchange, and temperature regulation Contamination prevention and management Cell-Based Assays and Techniques Cell viability assays (MTT, trypan blue exclusion) Cell proliferation assays (BrdU incorporation, cell counting) Immunocytochemistry and fluorescence microscopy

Applications of Cell Culture Cell culture in drug discovery and development Tissue engineering and regenerative medicine applications Cell-based assays for toxicity testing and pharmacological studies

Quality Control in Cell Culture Contamination detection and elimination strategies Sterility testing and mycoplasma detection Cell line authentication and characterization Ethical and Regulatory Considerations Ethics in cell culture research Regulatory guidelines for cell-based therapies and products Biosafety practices and waste management

Reference Books

- 1 Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, R. Ian Freshney., 2010, Wiley-Blackwell.
- 2 Principles of Tissue Engineering, Robert Lanza et al., 2014, Elsevier.
- 3 Animal Cell Culture: Principles and Practice , Shalini Mani , Manisha Singh , Anil Kumar, 2023, Springer.
- 4 CELL CULTURE TECHNOLOGIES, Kasper C , 2018, Springer.

23SDBT09E - CELL CULTURE TECHNOLOGIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT09E	CELL CULTURE TECHNOLOGIES	CCT	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Cell Culture Principles	2	PO1, PO2, PO3, PSO1
CO2	Various Cell Culture Techniques: apply a range of cell culture techniques, such as passaging, cryopreservation, and primary cell isolation	3	PO1, PO2, PO3, PSO1
CO3	Applying Cell Culture in Biomedical Research and Biotechnology: utilize cell cultures for drug testing, genetic manipulation, and tissue engineering	3	PO1, PO2, PO3, PSO1
CO4	Quality Control and Regulatory Compliance: ensure quality control and regulatory compliance in cell culture practices by developing and implementing protocols	3	PO1, PO2, PO4, PSO1

Syllabus

Introduction to Cell Culture Cell biology fundamentals Historical development of cell culture techniques Applications of cell culture in research and industry

Cell Culture Techniques Cell isolation and primary culture establishment Cell line maintenance, subculturing, and passaging Cryopreservation and cell banking techniques Cell Culture Media and Supplements Types of cell culture media (serum-based, serum-free, specialized media) Media formulation and optimization Growth factors, cytokines, and supplements for cell culture

Cell Culture Environment Cell culture incubators and sterile techniques pH control, gas exchange, and temperature regulation Contamination prevention and management

Cell-Based Assays and Techniques Cell viability assays (MTT, trypan blue exclusion) Cell proliferation assays (BrdU incorporation, cell counting) Immunocytochemistry and fluorescence microscopy Applications of Cell Culture Cell culture in drug discovery and development Tissue engineering and regenerative medicine applications Cell-based assays for toxicity testing and pharmacological studies

Quality Control in Cell Culture Contamination detection and elimination strategies Sterility testing and mycoplasma detection Cell line authentication and characterization Ethical and Regulatory Considerations Ethics in cell culture research Regulatory guidelines for cell-based therapies and products Biosafety practices and waste management

Reference Books

- 1 Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, R. Ian Freshney., 2010, Wiley-Blackwell.
- 2 Principles of Tissue Engineering, Robert Lanza et al., 2014, Elsevier.
- 3 Animal Cell Culture: Principles and Practice , Shalini Mani , Manisha Singh , Anil Kumar, 2023, Springer.
- 4 Cell Culture Technology 2018 By Kasper C , Kasper C , 2018, Springer.

23SDBT09R - CELL CULTURE TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT09R	CELL CULTURE TECHNOLOGIES	CCT	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Cell Culture Principles	2	PO1, PO2, PO3, PSO1
CO2	Applying Cell Culture in Biomedical Research and Biotechnology: utilize cell cultures for drug testing, genetic manipulation, and tissue engineering	3	PO1, PO2, PO3, PSO1
CO3	Quality Control and Regulatory Compliance: ensure quality control and regulatory compliance in cell culture practices by developing and implementing protocols	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Cell Culture Cell biology fundamentals Historical development of cell culture techniques Applications of cell culture in research and industry Cell Culture Techniques Cell isolation and primary culture establishment Cell line maintenance, subculturing, and passaging Cryopreservation and cell banking techniques

Cell Culture Media and Supplements Types of cell culture media (serum-based, serum-free, specialized media) Media formulation and optimization Growth factors, cytokines, and supplements for cell culture Cell Culture Environment Cell culture incubators and sterile techniques pH control, gas exchange, and temperature regulation Contamination prevention and management

Cell-Based Assays and Techniques Cell viability assays (MTT, trypan blue exclusion) Cell proliferation assays (BrdU incorporation, cell counting) Immunocytochemistry and fluorescence microscopy Applications of Cell Culture Cell culture in drug discovery and development Tissue engineering and regenerative medicine applications Cell-based assays for toxicity testing and pharmacological studies

Quality Control in Cell Culture Contamination detection and elimination strategies Sterility testing and mycoplasma detection Cell line authentication and characterization Ethical and Regulatory Considerations Ethics in cell culture research Regulatory guidelines for cell-based therapies and products Biosafety practices and waste management

Reference Books

- 1 Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, R. Ian Freshney., 2010, Wiley-Blackwell.
- 2 Principles of Tissue Engineering, Robert Lanza et al., 2014, Elsevier.
- 3 Animal Cell Culture: Principles and Practice , Shalini Mani , Manisha Singh , Anil Kumar, 2023, Springer.
- 4 Cell Culture Technology 2018 By Kasper C , Kasper C , 2018, Springer.

23SDBT10A - MASS SPECTROMETRY BASED PROTEOMICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT10A	MASS SPECTROMETRY BASED PROTEOMICS	MSBP	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and instrumentation of mass spectrometry for proteomics.	2	PO1, PO2, PO4, PSO1
CO2	Demonstrate sample preparation techniques for proteomic analysis.	2	PO1, PO2, PO4, PSO1
CO3	Make use of mass spectrometers for protein identification and quantification.	3	PO1, PO2, PO4, PSO1
CO4	Analyze proteomics data to identify proteins and characterize protein modifications.	4	PO1, PO2, PO4, PSO1
CO5	Design and execute proteomics experiments to address biological questions.	6	PO1, PO2, PO4, PSO1

Syllabus

Definition of proteomics: Importance of proteomics in biological research, Overview of different proteomics approaches, Fundamentals of Mass Spectrometry (MS): Principles of mass spectrometry, Ionization techniques: ESI (Electrospray Ionization), MALDI (Matrix-Assisted Laser Desorption/Ionization), Mass analyzers: Quadrupole, Time-of-Flight (TOF), Ion Trap, Orbitrap

Liquid Chromatography (LC) for Proteomics: Protein extraction methods, Protein digestion (enzyme specificity, protocols), Peptide purification techniques

Mass Spectrometry Instrumentation: Mass Spectrometry Analysis Workflow: Liquid chromatography (LC) coupled with MS (LC-MS), Data acquisition modes: MS, MS/MS (tandem MS), Data processing and interpretation

Data Acquisition and Processing: Data-dependent acquisition (DDA) and data-independent acquisition (DIA), MS/MS (tandem MS) and MSⁿ (multistage MS) techniques, Optimizing parameters for sensitivity, resolution, and dynamic range

Protein Quantification and Data Analysis: Label-free vs. labeled quantification methods, Stable isotope labeling techniques (SILAC, TMT, iTRAQ), Data analysis for quantitative proteomics, Protein Identification and Database Searching: Database search algorithms (e.g., SEQUEST, Mascot, MaxQuant) Protein inference and validation

Reference Books

- 1 Introduction to Proteomics: Principles and Applications, Nawin C. Mishra, 2010, Wiley.
- 2 Mass Spectrometry: Principles and Applications, Edmond de Hoffmann and Vincent Stroobant, 2007, Wiley.
- 3 Serum/Plasma Proteomics: Methods and Protocols, Richard J. Simpson, David W. Greening, 2017, Springer.
- 4 Proteomics: From Protein Sequence to Function, S. R. Pennington and M. J. Dunn, 2002, VIVA BOOKS PRIVATE LIMITED.

23SDBT10E - MASS SPECTROMETRY BASED PROTEOMICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT10E	MASS SPECTROMETRY BASED PROTEOMICS	MSBP	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate proficiency in sample preparation techniques for mass spectrometry-based proteomics.	2	PO1, PO2, PO4, PSO1
CO2	Make use of mass spectrometers effectively for protein identification and quantification.	3	PO1, PO2, PO4, PSO1
CO3	Analyze mass spectrometry data using bioinformatics software to identify proteins and analyze protein modifications.	4	PO1, PO2, PO4, PSO1
CO4	Analyze proteomics data to draw meaningful conclusions about protein expression, interactions, and modifications.	4	PO1, PO2, PO4, PSO1
CO5	Design and execute proteomics experiments independently, applying appropriate methodologies and controls.	6	PO1, PO2, PO4, PSO1

Syllabus

Definition of proteomics: Importance of proteomics in biological research, Overview of different proteomics approaches, Fundamentals of Mass Spectrometry (MS): Principles of mass spectrometry, Ionization techniques: ESI (Electrospray Ionization), MALDI (Matrix-Assisted Laser Desorption/Ionization), Mass analyzers: Quadrupole, Time-of-Flight (TOF), Ion Trap, Orbitrap

Liquid Chromatography (LC) for Proteomics; Liquid Chromatography (LC) for Proteomics: Protein extraction methods, Protein digestion (enzyme specificity, protocols), Peptide purification techniques

Mass Spectrometry Instrumentation: Mass Spectrometry Instrumentation: Mass Spectrometry Analysis Workflow: Liquid chromatography (LC) coupled with MS (LC-MS), Data acquisition modes: MS, MS/MS (tandem MS), Data processing and interpretation

Data Acquisition and Processing: Data Acquisition and Processing: Data-dependent acquisition (DDA) and data-independent acquisition (DIA), MS/MS (tandem MS) and MSⁿ (multistage MS) techniques, Optimizing parameters for sensitivity, resolution, and dynamic range

Protein Quantification and Data Analysis: Protein Quantification and Data Analysis: Label-free vs. labeled quantification methods, Stable isotope labeling techniques (SILAC, TMT, iTRAQ), Data analysis for quantitative proteomics, Protein Identification and Database Searching: Database search algorithms (e.g., SEQUEST, Mascot, MaxQuant) Protein inference and validation

Reference Books

- 1 Introduction to Proteomics: Principles and Applications, Nawin C. Mishra, 2010, Wiley.
- 2 Mass Spectrometry: Principles and Applications, Edmond de Hoffmann and Vincent Stroobant, 2007, Wiley.
- 3 Serum/Plasma Proteomics: Methods and Protocols, Richard J. Simpson, David W. Greening, 2017, Springer.
- 4 Proteomics: From Protein Sequence to Function, S. R. Pennington and M. J. Dunn, 2002, VIVA BOOKS PRIVATE LIMITED.

23SDBT10R - MASS SPECTROMETRY BASED PROTEOMICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT10R	MASS SPECTROMETRY BASED PROTEOMICS	MSBP	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate proficiency in sample preparation techniques for mass spectrometry-based proteomics.	2	PO1, PO2, PO4, PSO1
CO2	Make use of mass spectrometers effectively for protein identification and quantification.	3	PO1, PO2, PO4, PSO1
CO3	Analyze mass spectrometry data using bioinformatics software to identify proteins and analyze protein modifications.	4	PO1, PO2, PO4, PSO1
CO4	Analyze proteomics data to draw meaningful conclusions about protein expression, interactions, and modifications.	4	PO1, PO2, PO4, PSO1

Syllabus

Definition of proteomics: Importance of proteomics in biological research, Overview of different proteomics approaches, Fundamentals of Mass Spectrometry (MS): Principles of mass spectrometry, Ionization techniques: ESI (Electrospray Ionization), MALDI (Matrix-Assisted Laser Desorption/Ionization), Mass analyzers: Quadrupole, Time-of-Flight (TOF), Ion Trap, Orbitrap

Liquid Chromatography (LC) for Proteomics: Protein extraction methods, Protein digestion (enzyme specificity, protocols), Peptide purification techniques

Mass Spectrometry Instrumentation: Mass Spectrometry Analysis Workflow: Liquid chromatography (LC) coupled with MS (LC-MS), Data acquisition modes: MS, MS/MS (tandem MS), Data processing and interpretation

Data Acquisition and Processing: Data-dependent acquisition (DDA) and data-independent acquisition (DIA), MS/MS (tandem MS) and MSⁿ (multistage MS) techniques, Optimizing parameters for sensitivity, resolution, and dynamic range

Reference Books

- 1 Introduction to Proteomics: Principles and Applications, Nawin C. Mishra, 2010, Wiley.
- 2 Mass Spectrometry: Principles and Applications, Edmond de Hoffmann and Vincent Stroobant, 2007, Wiley.
- 3 Serum/Plasma Proteomics: Methods and Protocols, Richard J. Simpson, David W. Greening, 2017, Springer.
- 4 Proteomics: From Protein Sequence to Function, S. R. Pennington and M. J. Dunn, 2002, VIVA BOOKS PRIVATE LIMITED.

23SDBT11A - ANIMAL PHYSIOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT11A	ANIMAL PHYSIOLOGY	AP	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of cell and cellular components in understanding human Physiology	3	PO1
CO2	Apply the knowledge of essential organs and body fluids in understanding human transport systems	3	PO1
CO3	Apply the knowledge of neuronal communications in understanding: Motor and Integrative Neurophysiology	3	PO4
CO4	Apply the knowledge of metabolic pathways in understanding cellular Metabolism and Temperature Regulation	3	PO1, PO4

Syllabus

Introduction to Physiology : Cell & General Physiology, Membrane Physiology, Nerve: Neuroanatomy: Study of the structure of the nervous system, including the brain, spinal cord, and peripheral nerves. and Muscle: Study of muscle structure, including skeletal, cardiac, and smooth muscle., The Heart and circulation

The Kidneys and Body Fluids, Blood Cells, Immunity, and Blood Clotting: Hemostasis: The overall process that stops bleeding, including vascular spasm, platelet plug formation, and coagulation., respiration, Aviation, Space, and Deep Sea Diving Physiology

The Nervous System: General Principles and Sensory Physiology, Neurotransmission: Mechanisms of signal transmission between neurons, including the role of neurotransmitters like dopamine, serotonin, and acetylcholine The Nervous System: The Special Senses, The Nervous System : Motor and Integrative Neurophysiology

Metabolism and metabolic pathways, cellular respiration: Overview of Cellular Respiration: The process by which cells convert glucose and oxygen into energy (ATP), carbon dioxide, and water., Glycolysis, Krebs cycle, Electron transport chain., metabolic regulation Temperature Regulation, Metabolic disorders

Reference Books

- 1 Textbook of medical physiology, AC GUYTON, JOHN E, 2020, Saunders company.
- 2 Fundamentals of anatomy and physiology, FH Martini, 2018, Pearson.
- 3 Animal Physiology, Richard W. Hill, Gordon A. Wyse, Margaret Anderson, 2016, Sinauer Associates.
- 4 Principles of Animal Physiology, Christopher D. Moyes, Patricia M. Schulte, 2021, Pearson.

23SDBT11E - ANIMAL PHYSIOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT11E	ANIMAL PHYSIOLOGY	AP	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of cell and cellular components in understanding human Physiology	3	PO1
CO2	Apply the knowledge of essential organs and body fluids in understanding human transport systems	3	PO1
CO3	Apply the knowledge of neuronal communications in understanding: Motor and Integrative Neurophysiology	3	PO4
CO4	Apply the knowledge of metabolic pathways in understanding cellular Metabolism and Temperature Regulation	3	PO1, PO4

Syllabus

Introduction to Physiology: Cell & General Physiology, Membrane Physiology, Nerve: Neuroanatomy: Study of the structure of the nervous system, including the brain, spinal cord, and peripheral nerves. and Muscle: Study of muscle structure, including skeletal, cardiac, and smooth muscle., The Heart and circulation

The Kidneys and Body Fluids, Blood Cells, Immunity, and Blood Clotting: Hemostasis: The overall process that stops bleeding, including vascular spasm, platelet plug formation, and coagulation., respiration, Aviation, Space, and Deep Sea Diving Physiology

The Nervous System: General Principles and Sensory Physiology, Neurotransmission: Mechanisms of signal transmission between neurons, including the role of neurotransmitters like dopamine, serotonin, and acetylcholine The Nervous System: The Special Senses, The Nervous System : Motor and Integrative Neurophysiology

Metabolism and metabolic pathways, cellular respiration: Overview of Cellular Respiration: The process by which cells convert glucose and oxygen into energy (ATP), carbon dioxide, and water., Glycolysis, Krebs cycle, Electron transport chain., metabolic regulation Temperature Regulation, Metabolic disorders

Reference Books

- 1 Textbook of medical physiology, AC GUYTON, JOHN E, 2020, Saunders company.
- 2 Fundamentals of anatomy and physiology, FH Martini, 2018, Pearson.
- 3 Animal Physiology, Richard W. Hill, Gordon A. Wyse, Margaret Anderson, 2016, Sinauer Associates.
- 4 Principles of Animal Physiology, Christopher D. Moyes, Patricia M. Schulte, 2021, Pearson.

23SDBT11R - ANIMAL PHYSIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDBT11R	ANIMAL PHYSIOLOGY	AP	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of cell and cellular components in understanding human Physiology	3	PO1
CO2	Apply the knowledge of essential organs and body fluids in understanding human transport systems	3	PO1
CO3	Apply the knowledge of neuronal communications in understanding: Motor and Integrative Neurophysiology	3	PO4

Syllabus

Introduction to Physiology: Cell & General Physiology, Membrane Physiology, Nerve: Neuroanatomy: Study of the structure of the nervous system, including the brain, spinal cord, and peripheral nerves. and Muscle: Study of muscle structure, including skeletal, cardiac, and smooth muscle., The Heart and circulation

The Kidneys and Body Fluids, Blood Cells, Immunity, and Blood Clotting: Hemostasis: The overall process that stops bleeding, including vascular spasm, platelet plug formation, and coagulation., respiration, Aviation, Space, and Deep Sea Diving Physiology

The Nervous System: General Principles and Sensory Physiology, Neurotransmission: Mechanisms of signal transmission between neurons, including the role of neurotransmitters like dopamine, serotonin, and acetylcholine The Nervous System: The Special Senses, The Nervous System : Motor and Integrative Neurophysiology

Reference Books

- 1 Textbook of medical physiology, AC GUYTON, JOHN E, 2020, Saunders company.
- 2 Fundamentals of anatomy and physiology, FH Martini, 2018, Pearson.
- 3 Animal Physiology, Richard W. Hill, Gordon A. Wyse, Margaret Anderson, 2016, Sinauer Associates.
- 4 Principles of Animal Physiology, Christopher D. Moyes, Patricia M. Schulte, 2021, Pearson.

23SDCE01A - VISUALIZATION AND MODELLING FOR STRUCTURAL DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE01A	VISUALIZATION AND MODELLING FOR STRUCTURAL DESIGN	VMSD	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CONSTRUCTION PLANNING & MANAGEMENT	CPM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Visualization Techniques: Explore various visualization methods and techniques used in structural design, including 2D drawings, 3D models, renderings, animations, and virtual reality.	3	PO1, PO5, PSO1
CO2	Introduction to Structural Modelling Software: Gain proficiency in using industry-standard structural modelling software such as Autodesk Revit, Tekla Structures, and SAP2000 for structural analysis and design.	3	PO1, PO5, PSO1
CO3	Parametric Modelling: Learn the principles of parametric modelling and its application in generating complex geometries, optimizing structural systems, and facilitating design iterations.	3	PO1, PO5, PSO1
CO4	Visualization Tools and Techniques: Explore advanced visualization tools and techniques, including photorealistic rendering, lighting effects, and material properties to enhance the visual representation of structural designs.	3	PO1, PO5, PSO1
CO5	Integration with BIM: Understand the principles of Building Information Modeling (BIM) and its integration with structural design software for collaborative design, clash detection, and construction planning.	3	PO1, PO5, PSO1
CO6	Structural Analysis and Simulation: Learn how to perform structural analysis and simulation using modelling software to evaluate the behavior and performance of structural systems under various loading conditions.	3	PO1, PO5, PSO1
CO7	Implement collaborative design processes using integrated modeling tools.	3	PO1, PO5, PSO1

Syllabus

Introduction to Visualization and Modelling Overview of visualization techniques Introduction to structural modelling software Importance of visualization in structural design

Basics of Structural Modelling Software Interface overview and navigation Creating basic structural elements: beams, columns, slabs Modifying geometry and properties

2D Drafting and Detailing Techniques Creating 2D drawings and plans Dimensioning and annotation Detailing structural components

Introduction to 3D Modelling and Parametric Design Transitioning to 3D modelling Introduction to parametric modelling concepts Creating parametric families and components

Advanced Visualization Techniques Materials and textures Lighting and rendering settings Introduction to photorealistic rendering

Structural Analysis and Simulation Basics of structural analysis Performing structural analysis within modelling software Interpreting analysis results

Reference Books

- 1 Visualization and Modelling for Structural Design, Dr. Sarah Lee, Dr. Mark Thompson, 1st Edition, Wiley.
- 2 Visualization Analysis and Design, Tamara Munzner, 1st Edition, CRC Press, Taylor & Francis Group.
- 3 Visualization, Modeling, and Graphics for Engineering Design, Dennis K. Lieu and Sheryl A. Sorby, 2nd Edition, Cengage Learning.
- 4 Structural Analysis: Principles, Methods and Modelling, Raymond Ian Gilbert and Gianluca Ranzi, 1st Edition, CRC Press.

23SDCE01E - VISUALIZATION AND MODELLING FOR STRUCTURAL DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE01E	VISUALIZATION AND MODELLING FOR STRUCTURAL DESIGN	VMDS	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CONSTRUCTION PLANNING & MANAGEMENT	CPM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Visualization Techniques: Explore various visualization methods and techniques used in structural design, including 2D drawings, 3D models, renderings, animations, and virtual reality.	4	PO1, PO5, PSO1, PSO2
CO2	Introduction to Structural Modelling Software: Gain proficiency in using industry-standard structural modelling software such as Autodesk Revit, Tekla Structures, and SAP2000 for structural analysis and design.	4	PO1, PO5, PSO1
CO3	Parametric Modelling: Learn the principles of parametric modelling and its application in generating complex geometries, optimizing structural systems, and facilitating design iterations.	4	PO1, PO5, PSO1
CO4	Visualization Tools and Techniques: Explore advanced visualization tools and techniques, including photorealistic rendering, lighting effects, and material properties to enhance the visual representation of structural designs.	4	PO1, PO5, PSO1
CO5	Integration with BIM: Understand the principles of Building Information Modeling (BIM) and its integration with structural design software for collaborative design, clash detection, and construction planning.	4	PO1, PO5, PSO1
CO6	Structural Analysis and Simulation: Learn how to perform structural analysis and simulation using modelling software to evaluate the behavior and performance of structural systems under various loading conditions.	4	PO1, PO5, PSO1
CO7	Design and simulate the dynamic performance of structural elements and systems using advanced modeling software.	4	PO1, PO5, PSO1

Syllabus

Introduction to Visualization and Modelling Overview of visualization techniques Introduction to structural modelling software Importance of visualization in structural design

Basics of Structural Modelling Software Interface overview and navigation Creating basic structural elements: beams, columns, slabs Modifying geometry and properties

2D Drafting and Detailing Techniques Creating 2D drawings and plans Dimensioning and annotation Detailing structural components Week 4: Introduction to 3D Modelling and

Introduction to 3D Modelling and Parametric Design Transitioning to 3D modelling Introduction to parametric modelling concepts Creating parametric families and components

Advanced Visualization Techniques Materials and textures Lighting and rendering settings Introduction to photorealistic rendering

Reference Books

- 1 Visualization and Modelling for Structural Design, Dr. Sarah Lee, Dr. Mark Thompson, 1st Edition, Wiley.

- 2 Visualization, Modeling, and Graphics for Engineering Design, Dennis K. Lieu and Sheryl A. Sorby, 2nd Edition, Cengage Learning.
- 3 Engineering Design Graphics: Sketching, Modeling, and Visualization, James Leake , 3rd Edition, Wiley.
- 4 Advanced Modelling Techniques in Structural Design, Feng Fu, 1st Edition, John Wiley & Sons.

23SDCE01R - VISUALIZATION AND MODELLING FOR STRUCTURAL DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE01R	VISUALIZATION AND MODELLING FOR STRUCTURAL DESIGN	VMSD	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	CONSTRUCTION PLANNING & MANAGEMENT	CPM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Visualization Techniques: Explore various visualization methods and techniques used in structural design, including 2D drawings, 3D models, renderings, animations, and virtual reality.	4	PO1, PO5, PSO1
CO2	Introduction to Structural Modelling Software: Gain proficiency in using industry-standard structural modelling software such as Autodesk Revit, Tekla Structures, and SAP2000 for structural analysis and design.	4	PO1, PO5, PSO1
CO3	Parametric Modelling: Learn the principles of parametric modelling and its application in generating complex geometries, optimizing structural systems, and facilitating design iterations.	4	PO1, PO5, PSO1
CO4	Visualization Tools and Techniques: Explore advanced visualization tools and techniques, including photorealistic rendering, lighting effects, and material properties to enhance the visual representation of structural designs.	4	PO1, PO5, PSO1

Syllabus

Introduction to Visualization and Modelling Overview of visualization techniques Introduction to structural modelling software Importance of visualization in structural design

Basics of Structural Modelling Software Interface overview and navigation Creating basic structural elements: beams, columns, slabs Modifying geometry and properties

2D Drafting and Detailing Techniques Creating 2D drawings and plans Dimensioning and annotation Detailing structural components

Introduction to 3D Modelling and Parametric Design Transitioning to 3D modelling Introduction to parametric modelling concepts Creating parametric families and components

Reference Books

- 1 Visualization and Modelling for Structural Design, Dr. Sarah Lee, Dr. Mark Thompson, 1st Edition, Wiley.
- 2 Visualization Analysis and Design, Tamara Munzner, 1st Edition, CRC Press, Taylor & Francis Group.
- 3 Engineering Design Graphics: Sketching, Modeling, and Visualization, James Leake, 3rd Edition, Wiley.
- 4 Structural Analysis and Design Using Finite Element Modelling, B. I. D. Okeil, 1st Edition, Springer.

23SDCE02A - BUILDING INFORMATION MODELLING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE02A	BUILDING INFORMATION MODELLING	BIM	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CONSTRUCTION PLANNING & MANAGEMENT	CPM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand Building Information Modeling (BIM) software to create and manipulate 3D digital representations of construction projects	2	PO1, PO5, PO6, PSO1
CO2	Impact of BIM on design, construction, and facility management to optimize outcomes	3	PO1, PO5, PO6, PSO1
CO3	Integrate data from diverse sources into BIM models for comprehensive analysis and decision-making	4	PO1, PO5, PO6, PSO1
CO4	Demonstrating comprehension and practical application of Building Information Modeling(BIM)	2	PO1, PO5, PO6, PSO1
CO5	Create and manage BIM-based documentation, including drawings, schedules, and cost estimates.	3	PO1, PO5, PO6, PSO1

Syllabus

Introduction to Building Information Modeling (BIM): overview of BIM principles and concepts, History and evolution of BIM in the construction industry Benefits and advantages of implementing BIM in construction projects, BIM software and tools overview, Introduction to BIM project workflows and collaboration processes

BIM Modeling and Visualization: Fundamentals of BIM modeling techniques, Creating and managing 3D digital models using BIM software, Visualization and rendering techniques for BIM models Applying BIM for design exploration and iteration, Clash detection and coordination using BIM models

BIM Data Management and Integration: BIM data management strategies and best practices in BIM projects, Integrating data from various sources and disciplines into BIM models, Parametric modeling and family creation in BIM, Linking BIM models with external databases and spreadsheets, BIM interoperability and data exchange standards

BIM in Project Lifecycle Phases: BIM in the design phase: Conceptual design, detailed design, and design coordination, BIM in the construction phase: Construction sequencing, quantity takeoff, and scheduling, BIM in the facility management phase: Asset management, maintenance planning, and energy analysis Collaborative workflows and information exchange during project lifecycle phases, BIM for project coordination and communication with stakeholders

Advanced Topics in BIM: Advanced clash detection and resolution techniques, BIM for sustainable design and green building practices, BIM for facilities management and operations, BIM for infrastructure and civil engineering projects, Emerging trends and future developments in BIM

Reference Books

- 1 Building Information Modeling, Karen M. Kensek, Douglas Noble,, 2014, Routledge.
- 2 BIM Handbook: A Guide to Building, Chuck Eastman, Paul Teicholz, 2018, Wiley.
- 3 BIM and Construction Management, Brad Hardin, Dave McCool, and Chuck, 2015, John Wiley & Sons.
- 4 Building Information Modeling, Willem Kymmell, 2008, Delmar Cengage.

- 5 BIM in Principle and Practice, David Wheatley, 2015, Routledge.

23SDCE02E - BUILDING INFORMATION MODELLING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE02E	BUILDING INFORMATION MODELLING	BIM	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CONSTRUCTION PLANNING & MANAGEMENT	CPM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand Building Information Modeling (BIM) software to create and manipulate 3D digital representations of construction projects	2	PO1, PO5, PO6, PSO1
CO2	Apply the impact of BIM on different stages of the project lifecycle, including design, construction, and facility management, to optimize project outcomes and decision-making	3	PO1, PO5, PO6, PSO1
CO3	Analyze and integrate data from various sources into BIM models for comprehensive project analysis and informed decisions.	4	PO1, PO5, PO6, PSO1
CO4	demonstrating comprehension and practical application.	2	PO1, PO5, PO6, PSO1
CO5	Create and manage BIM-based documentation, including drawings, schedules, and cost estimate	2	PO1, PO5, PO6, PSO1

Syllabus

Introduction to Building Information Modeling (BIM): overview of BIM principles and concepts, History and evolution of BIM in the construction industry Benefits and advantages of implementing BIM in construction projects, BIM software and tools overview, Introduction to BIM project workflows and collaboration processes

BIM Modeling and Visualization: Fundamentals of BIM modeling techniques, Creating and managing 3D digital models using BIM software, Visualization and rendering techniques for BIM models Applying BIM for design exploration and iteration, Clash detection and coordination using BIM models

BIM Data Management and Integration: BIM data management strategies and best practices in BIM projects, Integrating data from various sources and disciplines into BIM models, Parametric modeling and family creation in BIM, Linking BIM models with external databases and spreadsheets, BIM interoperability and data exchange standards

BIM in Project Lifecycle Phases: BIM in the design phase: Conceptual design, detailed design, and design coordination, BIM in the construction phase: Construction sequencing, quantity takeoff, and scheduling, BIM in the facility management phase: Asset management, maintenance planning, and energy analysis Collaborative workflows and information exchange during project lifecycle phases, BIM for project coordination and communication with stakeholders

Advanced Topics in BIM: Advanced clash detection and resolution techniques, BIM for sustainable design and green building practices, BIM for facilities management and operations, BIM for infrastructure and civil engineering projects, Emerging trends and future developments in BIM

Reference Books

- 1 Building Information Modeling, Karen M. Kensek, Douglas Noble, 2014, Routledge.
- 2 BIM Handbook: A Guide to Building, Chuck Eastman, Paul Teicholz, 2018, Wiley.
- 3 BIM and Construction Management:, Brad Hardin, Dave McCool, and Chuck, 2015, John Wiley & Sons.

- 4 Building Information Modeling, Willem Kymmell, 2008, Delmar Cengage.
- 5 BIM in Principle and Practice, David Wheatley, 2015, Routledge.

23SDCE02R - BUILDING INFORMATION MODELLING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE02R	BUILDING INFORMATION MODELLING	BIM	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	CONSTRUCTION PLANNING & MANAGEMENT	CPM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand BIM software to create and manipulate 3D digital representations of construction projects	2	PO1, PO5, PO6, PSO1
CO2	Apply the impact of BIM on project lifecycle stages to optimize outcomes and decision-making.	3	PO1, PO5, PO6, PSO1
CO3	Integrate data from various sources into BIM models for comprehensive project analysis and informed decision-making.	4	PO1, PO5, PO6, PSO1
CO4	Create and manage BIM-based documentation, including drawings, schedules, and cost estimate	2	PO1, PO5, PO6, PSO1

Syllabus

Introduction to Building Information Modeling (BIM): overview of BIM principles and concepts, History and evolution of BIM in the construction industry Benefits and advantages of implementing BIM in construction projects, BIM software and tools overview, Introduction to BIM project workflows and collaboration processes

BIM Modeling and Visualization: Fundamentals of BIM modeling techniques, Creating and managing 3D digital models using BIM software, Visualization and rendering techniques for BIM models Applying BIM for design exploration and iteration, Clash detection and coordination using BIM models

BIM Data Management and Integration: BIM data management strategies and best practices in BIM projects, Integrating data from various sources and disciplines into BIM models, Parametric modeling and family creation in BIM, Linking BIM models with external databases and spreadsheets, BIM interoperability and data exchange standards

BIM in Project Lifecycle Phases: BIM in the design phase: Conceptual design, detailed design, and design coordination, BIM in the construction phase: Construction sequencing, quantity takeoff, and scheduling, BIM in the facility management phase: Asset management, maintenance planning, and energy analysis Collaborative workflows and information exchange during project lifecycle phases, BIM for project coordination and communication with stakeholders

Advanced Topics in BIM: Advanced clash detection and resolution techniques, BIM for sustainable design and green building practices, BIM for facilities management and operations, BIM for infrastructure and civil engineering projects, Emerging trends and future developments in BIM

Reference Books

- 1 Building Information Modeling, Karen M. Kensek, Douglas Noble, 2014, Routledge.
- 2 BIM Handbook: A Guide to Building, Chuck Eastman, Paul Teicholz,, 2018, Wiley.
- 3 "BIM and Construction Management", Brad Hardin, Dave McCool, and Chuck, 2015, John Wiley & Sons.
- 4 "Building Information Modeling", Willem Kymmell, 2018, Delmar Cengage.
- 5 BIM in Principle and Practice, David Wheatley, 2015, Routledge.

23SDCE03A - ANALYSIS & DESIGN OF MULTI-STORIED STRUCTURES USING ETABS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE03A	ANALYSIS & DESIGN OF MULTI-STORIED STRUCTURES USING ETABS	ADMSS	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	AUTOCAD	ACAD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Integration of Theory and Software: The course likely combines theoretical concepts related to structural analysis and design with the practical use of ETABS. This integration enables students to understand the underlying principles while simultaneously developing proficiency in using the software for structural analysis and design tasks. able to generate realistic and detailed virtual representations of engineering designs, incorporating dimensions, materials, and textures.	2	PO1
CO2	Apply Industry Relevance: ETABS is widely used in the industry for analysing and designing complex structures. By familiarizing students with this software, the course equips them with skills that are highly relevant to the civil engineering profession. This can enhance their employability and prepare them to meet industry demands.	3	PO3
CO3	Understand Efficient Design Process: The course aims to teach students how to utilize ETABS effectively for analysing and designing multi-storied structures. By using the software's advanced features, students can optimize the design process, improve structural performance, and ensure compliance with relevant codes and regulations.	4	PO4
CO4	Apply Hands-on Learning: The course likely includes practical exercises and projects that require students to work on real or simulated multi-storied structures using ETABS. This hands-on approach allows students to gain practical experience in modelling, analysis, and design, reinforcing their theoretical understanding.	4	PO4, PSO1

Syllabus

Design and basic tools on ETABS Modelling. Tools Explanations and ETABS Import Plans. Visualization of brick walls in ETABS Modelling.

Design and analysis of Slab (ETABS). Design and analysis of Post tension & Pre Tension Slab (ETABS).

Design and Modelling of G+3 Buildings (ETABS). Design, Properties and Load Patterns of G+3 Buildings (ETABS).

Design, Properties and Load Combinations of G+3 Buildings (ETABS). Design and analysis of G+3 Buildings - Reinforcement, Ductile Detailing (ETABS). Case studies on Multistorey Building (Site Visit).

Reference Books

- 1 Design of Multi-Storey Concrete Structures", Colin Caprani, 3rd, CRC press.
- 2 Multi-Storey Precast Concrete Framed Structures, Kim S. Elliott, 2nd, Taylor & Francis.
- 3 ETABS 2016: Design of Multi-Storey Buildings using ETABS, CSI Engineering Software Pvt. Ltd., 1, CSI Engineering Software Pvt. Ltd..
- 4 ETABS Integrated Building Design Software: Steel and Concrete Building Analysis and Design, Atul Khanzode and Robert C. Schultz, 1, CSI Engineering Software Pvt. Ltd..

23SDCE03E - ANALYSIS & DESIGN OF MULTI-STORIED STRUCTURES USING ETABS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE03E	ANALYSIS & DESIGN OF MULTI-STORIED STRUCTURES USING ETABS	ADMSS	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	AUTOCAD	ACAD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Integration of Theory and Software: The course likely combines theoretical concepts related to structural analysis and design with the practical use of ETABS. This integration enables students to understand the underlying principles while simultaneously developing proficiency in using the software for structural analysis and design tasks. able to generate realistic and detailed virtual representations of engineering designs, incorporating dimensions, materials, and textures.	2	PO1
CO2	Apply Industry Relevance: ETABS is widely used in the industry for analysing and designing complex structures. By familiarizing students with this software, the course equips them with skills that are highly relevant to the civil engineering profession. This can enhance their employability and prepare them to meet industry demands.	3	PO3
CO3	Understand Efficient Design Process: The course aims to teach students how to utilize ETABS effectively for analysing and designing multi-storied structures. By using the software's advanced features, students can optimize the design process, improve structural performance, and ensure compliance with relevant codes and regulations.	4	PO4
CO4	Apply Hands-on Learning: The course likely includes practical exercises and projects that require students to work on real or simulated multi-storied structures using ETABS. This hands-on approach allows students to gain practical experience in modelling, analysis, and design, reinforcing their theoretical understanding.	4	PO4, PSO1

Syllabus

Design and basic tools on ETABS Modelling. Tools Explanations and ETABS Import Plans. Visualization of brick walls in ETABS Modelling.

Design and analysis of Slab (ETABS). Design and analysis of Post tension & Pre Tension Slab (ETABS).

Design and Modelling of G+3 Buildings (ETABS). Design, Properties and Load Patterns of G+3 Buildings (ETABS).

Design, Properties and Load Combinations of G+3 Buildings (ETABS). Design and analysis of G+3 Buildings - Reinforcement, Ductile Detailing (ETABS). Case studies on Multistorey Building (Site Visit).

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- 2 Multi-Storey Precast Concrete Framed Structures", Kim S. Elliott, 2nd, Taylor and francis.
- 3 ETABS 2016: Design of Multi-Storey Buildings using ETABS, CSI Engineering Software Pvt. Ltd., 1, CSI Engineering Software Pvt. Ltd..
- 4 ETABS Integrated Building Design Software: Steel and Concrete Building Analysis and Design, Atul Khanzode and Robert C. Schultz, 1, CSI Engineering Software Pvt. Ltd..

23SDCE03R - ANALYSIS & DESIGN OF MULTI-STORIED STRUCTURES USING ETABS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE03R	ANALYSIS & DESIGN OF MULTI-STORIED STRUCTURES USING ETABS	ADMSS	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	AUTOCAD	ACAD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Integration of Theory and Software: The course likely combines theoretical concepts related to structural analysis and design with the practical use of ETABS. This integration enables students to understand the underlying principles while simultaneously developing proficiency in using the software for structural analysis and design tasks. able to generate realistic and detailed virtual representations of engineering designs, incorporating dimensions, materials, and textures.	2	PO1
CO2	Apply Industry Relevance: ETABS is widely used in the industry for analysing and designing complex structures. By familiarizing students with this software, the course equips them with skills that are highly relevant to the civil engineering profession. This can enhance their employability and prepare them to meet industry demands.	3	PO3
CO3	Understand Efficient Design Process: The course aims to teach students how to utilize ETABS effectively for analysing and designing multi-storied structures. By using the software's advanced features, students can optimize the design process, improve structural performance, and ensure compliance with relevant codes and regulations.	4	PO4
CO4	Apply Hands-on Learning: The course likely includes practical exercises and projects that require students to work on real or simulated multi-storied structures using ETABS. This hands-on approach allows students to gain practical experience in modelling, analysis, and design, reinforcing their theoretical understanding.	4	PO4, PSO1

Syllabus

Design and basic tools on ETABS Modelling. Tools Explanations and ETABS Import Plans. Visualization of brick walls in ETABS Modelling.

Design and analysis of Slab (ETABS). Design and analysis of Post tension & Pre Tension Slab (ETABS).

Design and Modelling of G+3 Buildings (ETABS). Design, Properties and Load Patterns of G+3 Buildings (ETABS).

Design, Properties and Load Combinations of G+3 Buildings (ETABS). Design and analysis of G+3 Buildings - Reinforcement, Ductile Detailing (ETABS). Case studies on Multistorey Building (Site Visit).

Reference Books

- 1 Design of Multi-Storey Concrete Structures", Colin Caprani, 3rd, CRC press.
- 2 Multi-Storey Precast Concrete Framed Structures", Kim S. Elliott, 2nd, taylor and franciss.
- 3 ETABS 2016: Design of Multi-Storey Buildings using ETABS, CSI Engineering Software Pvt. Ltd., 1, CSI Engineering Software Pvt. Ltd..
- 4 ETABS Integrated Building Design Software: Steel and Concrete Building Analysis and Design, Atul Khanzode and Robert C. Schultz, 1, CSI Engineering Software Pvt. Ltd..

23SDCE04A - PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE04A	PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE	PSRBPS	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CONSTRUCTION PLANNING & MANAGEMENT	CPM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Communicate effectively with project stakeholders, including owners, contractors, and suppliers, to ensure project goals are understood and met, and to resolve conflicts as they arise	2	PO1, PO5, PO6, PSO1
CO2	Apply project management principles and techniques to plan and execute construction projects, including project initiation, planning, execution, monitoring, and control	3	PO1, PO5, PO6, PSO1
CO3	Analyze construction project plans and schedules to identify potential risks and develop strategies to mitigate them	4	PO1, PO5, PO6, PSO1
CO4	Analyse the business analysis roles and responsibilities, stakeholder communication attributes, requirements gathering, product roadmap attributes, and product delivery components.	4	PO1, PO5, PO6, PSO1
CO5	Skill Project	4	PO1, PO5, PO6, PSO1

Syllabus

Introduction to Construction Planning and Scheduling. 1.Introduction to project management principles and their application in construction projects. 2.Overview of construction planning and scheduling process. 3.Types of construction schedules and their purpose. 4.Project scope management and its impact on scheduling. 5.Project budgeting and cost estimating techniques

Developing Construction Schedules. 1.Work breakdown structure (WBS) and its importance in construction scheduling. 2.Scheduling techniques, including Gantt charts, critical path method (CPM), and program evaluation and review technique (PERT). 3.Resource allocation and levelling. 4.Schedule compression and fast-tracking. 5.Schedule risk management and contingency planning

Managing Construction Schedules. 1.Project execution and monitoring. 2.Performance measurement and progress reporting. 3.Schedule control techniques. 4.Schedule impact analysis and change management. 5.Schedule recovery and acceleration techniques.

Advanced Topics in Construction Scheduling. 1.Lean construction scheduling. 2.Building information modeling (BIM) and its impact on scheduling. 3.Schedule integration with other project management processes. 4.Scheduling for large and complex construction projects. 5.Schedule optimization techniques

Skilling Project

Reference Books

- 1 Construction Planning and Scheduling, Jimmie W. Hinze, 2011, Pearson Education, Inc..
- 2 Project Planning and Control with PERT and CPM, Dr. B.C. Punmia, K.K. Khand, and S.P. Jain, 2016, Laxmi Publications.

- 3 Construction Project Scheduling and Control, Saleh A. Mubarak, 2015, Wiley.
- 4 Planning and Control of Construction Projects, Brian Cooke and Peter Williams, 2013, Wiley-Blackwell.
- 5 Construction Scheduling: Principles and Practices , Jay S. Newitt , 2018, Prentice Hall.

23SDCE04E - PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE04E	PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE	PSRBPS	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CONSTRUCTION PLANNING & MANAGEMENT	CPM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Communicate effectively with project stakeholders, including owners, contractors, and suppliers, to ensure project goals are understood and met, and to resolve conflicts as they arise	2	PO1, PO5, PO6, PSO1
CO2	Apply project management principles and techniques to plan and execute construction projects, including project initiation, planning, execution, monitoring, and control	3	PO1, PO5, PO6, PSO1
CO3	Analyze construction project plans and schedules to identify potential risks and develop strategies to mitigate them	4	PO1, PO5, PO6, PSO1
CO4	Analyse the business analysis roles and responsibilities, stakeholder communication attributes, requirements gathering, product roadmap attributes, and product delivery components.	4	PO1, PO5, PO6, PSO1
CO5	skill project	2	PO1, PO5, PO6, PSO1

Syllabus

Introduction to Construction Planning and Scheduling. 1.Introduction to project management principles and their application in construction projects. 2.Overview of construction planning and scheduling process. 3.Types of construction schedules and their purpose. 4.Project scope management and its impact on scheduling. 5.Project budgeting and cost estimating techniques

Introduction to Construction Planning and Scheduling. 1.Introduction to project management principles and their application in construction projects. 2.Overview of construction planning and scheduling process. 3.Types of construction schedules and their purpose. 4.Project scope management and its impact on scheduling. 5.Project budgeting and cost estimating techniques

Managing Construction Schedules. 1.Project execution and monitoring. 2.Performance measurement and progress reporting. 3.Schedule control techniques. 4.Schedule impact analysis and change management. 5.Schedule recovery and acceleration techniques.

Managing Construction Schedules. 1.Project execution and monitoring. 2.Performance measurement and progress reporting. 3.Schedule control techniques. 4.Schedule impact analysis and change management. 5.Schedule recovery and acceleration techniques.

Project Delivery Methods and Contractual Considerations. 1.Overview of project delivery methods, including design-bid-build, design-build, and construction management at risk (CMAR). 2.Types of construction contracts and their implications for scheduling. 3.Contractual mechanisms for managing schedule risk, including liquidated damages and time extensions. 4.Schedule coordination and communication among project stakeholders. 5.Ethics and professionalism in construction planning and scheduling.

Reference Books

- 1 Construction Planning and Scheduling, Jimmie W. Hinze, 2011, Pearson Education, Inc..

- 2 Project Planning and Control with PERT and CPM, Dr. B.C. Punmia, K.K. Khandelwal, and S.P. Jain, 2016, Laxmi Publications.
- 3 Construction Project Scheduling and Control, Saleh A. Mubarak, 2015, Wiley.
- 4 Planning and Control of Construction Projects, Planning and Control of Construction Projects, 2013, Wiley-Blackwell.

23SDCE04R - PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE04R	PLANNING AND SCHEDULING OF RESIDENTIAL BUILDING USING PRIMAVERA SOFTWARE	PSRBPS	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	CONSTRUCTION PLANNING & MANAGEMENT	CPM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Communicate effectively with project stakeholders, including owners, contractors, and suppliers, to ensure project goals are understood and met, and to resolve conflicts as they arise	2	PO1, PO5, PO6, PSO1
CO2	Apply project management principles and techniques to plan and execute construction projects, including project initiation, planning, execution, monitoring, and control	3	PO1, PO5, PO6, PSO1
CO3	Analyze construction project plans and schedules to identify potential risks and develop strategies to mitigate them	4	PO1, PO5, PO6, PSO1
CO4	Developing project using Primavera Software and submission of project report	3	

Syllabus

Introduction to Construction Planning and Scheduling. 1.Introduction to project management principles and their application in construction projects. 2.Overview of construction planning and scheduling process. 3.Types of construction schedules and their purpose. 4.Project scope management and its impact on scheduling. 5.Project budgeting and cost estimating techniques

Developing Construction Schedules. 1.Work breakdown structure (WBS) and its importance in construction scheduling. 2.Scheduling techniques, including Gantt charts, critical path method (CPM), and program evaluation and review technique (PERT). 3.Resource allocation and levelling. 4.Schedule compression and fast-tracking. 5.Schedule risk management and contingency planning

Managing Construction Schedules. 1.Project execution and monitoring. 2.Performance measurement and progress reporting. 3.Schedule control techniques. 4.Schedule impact analysis and change management. 5.Schedule recovery and acceleration techniques.

Advanced Topics in Construction Scheduling. 1.Lean construction scheduling. 2.Building information modeling (BIM) and its impact on scheduling. 3.Schedule integration with other project management processes. 4.Scheduling for large and complex construction projects. 5.Schedule optimization techniques

Project Delivery Methods and Contractual Considerations. 1.Overview of project delivery methods, including design-bid-build, design-build, and construction management at risk (CMAR). 2.Types of construction contracts and their implications for scheduling. 3.Contractual mechanisms for managing schedule risk, including liquidated damages and time extensions. 4.Schedule coordination and communication among project stakeholders. 5.Ethics and professionalism in construction planning and scheduling.

Reference Books

- 1 Construction Planning and Scheduling, Jimmie W. Hinze, 2011, Pearson Education, Inc..
- 2 Project Planning and Control with PERT and CPM, Dr. B.C. Punmia, K.K. Khandelwal, and S.P. Jain, 2016, Laxmi Publications.
- 3 Construction Project Scheduling and Control, Saleh A. Mubarak, 2015, Wiley.

- 4 Planning and Control of Construction Projects, Brian Cooke and Peter Williams, 2013, Wiley-Blackwell.

23SDCE05A - DESIGN OF THE PAVEMENT BY USING MX ROADS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE05A	DESIGN OF THE PAVEMENT BY USING MX ROADS	DPMX	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles and methodologies of pavement design using MX Roads software.	2	PO1, PO3, PSO2
CO2	Apply MX Roads software to analyze and design different types of pavements, including flexible and rigid pavements.	3	PO1, PO3, PSO2
CO3	Analyse the structural performance and durability of pavement designs created using MX Roads by comparing with standard design guidelines and criteria.	4	PO1, PO3, PSO2
CO4	Practice the comprehensive pavement design projects using MX Roads	3	PO1, PO3, PSO2
CO5	Demonstrate a Real-World Pavement Project Using MX Roads	3	PO1, PO3, PSO2

Syllabus

Introduction to Pavement Design and MX Roads Software Overview of Pavement Types and Materials Flexible vs. Rigid Pavements Pavement Material Properties Principles of Pavement Design Load Distribution and Pavement Performance Design Criteria and Standards Introduction to MX Roads Software Software Interface and Navigation Basic Features and Capabilities Importing and Managing Data in MX Roads

Pavement Design Inputs and Analysis Traffic Load Analysis Traffic Data Collection and Analysis Equivalent Single Axle Load (ESAL) Calculations Geotechnical Investigations Soil Properties and Testing Subgrade Evaluation Climate and Environmental Considerations Impact of Climate on Pavement Performance Drainage Design and Management

Flexible Pavement Design Using MX Roads Layered System Design Method Asphalt Pavement Layers and Their Functions Thickness Design for Flexible Pavements Material Selection and Mix Design Asphalt Mix Design Procedures Quality Control and Assurance Practical Design Exercise Creating a Flexible Pavement Design in MX Roads Analyzing and Adjusting Design Parameters

Rigid Pavement Design Using MX Roads Rigid Pavement Systems and Components Concrete Pavement Layers Joint Design and Load Transfer Mechanisms Design of Concrete Pavements Thickness Design for Rigid Pavements Design of Reinforcement and Dowel Bars Practical Design Exercise Creating a Rigid Pavement Design in MX Roads Evaluating Performance and Adjusting Design

Advanced Pavement Design and Project Management Pavement Rehabilitation and Maintenance Techniques for Pavement Rehabilitation Overlay Design and Analysis Sustainable Pavement Design Green Pavement Technologies Life Cycle Cost Analysis Capstone Project Comprehensive Pavement Design Project Integration of Traffic, Geotechnical, and Environmental Data Presentation and Peer Review of Final Design

Reference Books

- 1 Pavement Analysis and Design , Yang H. Huang, 2nd, Pearson.
- 2 Principles of Pavement Engineering , Nick Thom, 2nd , CE Publishing.
- 3 Road Engineering for Development , Richard Robinson, Bent Thagesen, 2nd, CRC Press.
- 4 MX Road Training Manual, Bentley Systems, 1st, Bentley Systems.

23SDCE05E - DESIGN OF THE PAVEMENT BY USING MX ROADS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE05E	DESIGN OF THE PAVEMENT BY USING MX ROADS	DPMX	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles and methodologies of pavement design using MX Roads software.	2	PO1, PO2, PSO1
CO2	Apply MX Roads software to analyze and design different types of pavements, including flexible and rigid pavements.	3	PO1, PO2, PSO1
CO3	Analyse the structural performance and durability of pavement designs created using MX Roads by comparing with standard design guidelines and criteria.	4	PO1, PO2, PSO1
CO4	Demonstrate comprehensive pavement design projects using MX Roads,	3	PO1, PO2, PSO1
CO5	Practice a Real-World Pavement Project Using MX Roads	3	PO1, PO2, PSO1

Syllabus

Introduction to Pavement Design and MX Roads Software Overview of Pavement Types and Materials Flexible vs. Rigid Pavements Pavement Material Properties Principles of Pavement Design Load Distribution and Pavement Performance Design Criteria and Standards Introduction to MX Roads Software Software Interface and Navigation Basic Features and Capabilities Importing and Managing Data in MX Roads

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- 3 Road Engineering for Development , Richard Robinson, Bent Thagesen , 2nd , CRC Press.
- 4 MX Road Training Manual, Bentley Systems, 1st, Bentley Systems.

23SDCE05R - DESIGN OF THE PAVEMENT BY USING MX ROADS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE05R	DESIGN OF THE PAVEMENT BY USING MX ROADS	DPMX	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Discuss on using MX Roads software for designing road pavements,	2	PO1, PO2, PSO2
CO2	Identify the fundamental principles of pavement design, including material selection, structural analysis.	2	PO1, PO2, PSO2
CO3	Employ relevant international and local pavement design standards and guidelines within the MX Roads software	3	PO1, PO2, PSO2
CO4	Demonstrate projects, including the ability to generate comprehensive design reports, documentation, and presentations.	3	PO1, PO2, PSO2
CO5	Describe a comprehensive pavement design project using MX Roads software	2	PO1, PO2, PSO2

Syllabus

Introduction to Pavement Design and MX Roads Overview of Pavement Design Types of pavements (flexible, rigid, and composite) Fundamental principles of pavement design Importance of proper pavement design in civil engineering Introduction to MX Roads Software Software installation and setup User interface and basic functions Overview of key features and capabilities

Data Collection and Preliminary Design Data Collection Techniques Surveying methods and tools Traffic data collection and analysis Soil and material testing procedures Preliminary Road Design Initial alignment design Horizontal and vertical profile creation Integration of survey data into MX Roads

Detailed Pavement Design Pavement Material Selection Types of materials used in pavement layers Material properties and selection criteria Material testing and quality control Structural Design of Pavements Layer thickness design Load distribution and stress analysis Design of flexible and rigid pavement structures using MX Roads

Application of Design Standards and Optimization Design Standards and Guidelines Overview of international and local design standards (e.g., AASHTO, IRC) Applying standards within MX Roads Design Optimization Techniques Cost-effective design strategies Performance-based design optimization Iterative design refinement using MX Roads

Project Management and Final Design Presentation Project Management in Pavement Design Planning and scheduling design tasks Coordination with other engineering disciplines Documentation and reporting requirements Final Design Presentation Preparing detailed design reports Creating presentation materials (slides, visualizations) Presenting the final design to stakeholders Practical Sessions and Assessments Hands-On Practice with MX Roads Guided tutorials and exercises Real-world case studies and examples

Reference Books

- 1 Road Design with MXROAD, BENTLEY, latest, Bentley Institute Press.
- 2 Pavement Analysis and Design, Yang H. Huang, 2, Pearson.
- 3 Principles of Pavement Design, E. J. Yoder, M. W. Witczak, 2, John Wiley Sons.
- 4 MX Road Training Manual, Bentley Systems, 1st, Bentley Systems.

23SDCE06A - DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE06A	DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE	SAFE	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding SAFE Software: Gain a thorough understanding of the features, capabilities, and user interface of the SAFE software for structural analysis and design.	5	PO1, PO5, PSO1
CO2	Analysis of Concrete Floor Systems: Learn how to model, analyze, and design concrete floor systems including slabs, beams, and columns using SAFE software.	5	PO1, PO5, PSO1
CO3	Foundation System Analysis: Explore the analysis and design of foundation systems such as isolated footings, combined footings, and mat foundations using SAFE software.	5	PO1, PO5, PSO1
CO4	Dynamic Analysis: Understand the principles of dynamic analysis and how to perform seismic analysis and response spectrum analysis using SAFE software.	5	PO1, PO5, PSO1
CO5	Nonlinear Analysis: Learn advanced techniques for nonlinear analysis, including pushover analysis and performance-based design, using SAFE software.	5	PO1, PO5, PSO1
CO6	Integration with Other Software: Explore the integration of SAFE software with other structural analysis and design software such as ETABS and SAP2000.	5	PO1, PO5, PSO1
CO7	Create detailed design reports and documentation using the outputs from SAFE for professional engineering practice	6	PO1, PO5, PSO1

Syllabus

Introduction to SAFE Software Overview of SAFE software User interface and navigation Introduction to modeling concepts

Modeling Concrete Floor Systems Creating structural models of slabs, beams, and columns Defining materials and section properties Applying loads and boundary conditions

Analysis of Concrete Slabs Gravity and lateral load analysis Design of slab reinforcement Punching shear analysis

Modeling Foundation Systems Modeling foundation elements: isolated footings, combined footings, mat foundations Soil-structure interaction analysis Design considerations for foundation reinforcement

Dynamic Analysis Using SAFE Principles of dynamic analysis Seismic analysis using response spectrum method Time history analysis

Reference Books

- 1 Design & Analysis of Different Structural Components Using SAFE, Dr. Emily Johnson, Dr. Mark Thompson, 1st Edition, Wiley.
- 2 Foundation Design: Principles and Practices, Donald P. Coduto, Man-chu Ronald Yeung, and William A. Kitch, 3rd Edition, Pearson.
- 3 Structural Analysis and Design of Tall Buildings: Steel and Composite Construction, Bungale S. Taranath, 2nd Edition, CRC Press.
- 4 Advanced Concrete Technology, Zongjin Li, 1st Edition, Wiley.

23SDCE06E - DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE06E	DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE	SAFE	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding SAFE Software: Gain a thorough understanding of the features, capabilities, and user interface of the SAFE software for structural analysis and design.	5	PO1, PO5, PO8, PSO1
CO2	Analysis of Concrete Floor Systems: Learn how to model, analyze, and design concrete floor systems including slabs, beams, and columns using SAFE software.	5	PO1, PO5, PO8, PSO1
CO3	Foundation System Analysis: Explore the analysis and design of foundation systems such as isolated footings, combined footings, and mat foundations using SAFE software.	5	PO1, PO5, PO8, PSO1
CO4	Dynamic Analysis: Understand the principles of dynamic analysis and how to perform seismic analysis and response spectrum analysis using SAFE software.	5	PO1, PO5, PO8, PSO1
CO5	Nonlinear Analysis: Learn advanced techniques for nonlinear analysis, including pushover analysis and performance-based design, using SAFE software.	5	PO1, PO5, PO8, PSO1
CO6	Integration with Other Software: Explore the integration of SAFE software with other structural analysis and design software such as ETABS and SAP2000.	5	PO1, PO5, PO8, PSO1

Syllabus

Introduction to SAFE Software Overview of SAFE software User interface and navigation Introduction to modeling concepts

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Modeling Foundation Systems Modeling foundation elements: isolated footings, combined footings, mat foundations Soil-structure interaction analysis Design considerations for foundation reinforcement

Dynamic Analysis Using SAFE Principles of dynamic analysis Seismic analysis using response spectrum method Time history analysis

Nonlinear Analysis Techniques Introduction to nonlinear analysis Pushover analysis for performance evaluation Nonlinear material modeling

Reference Books

- 1 Advanced Concrete Technology, Zongjin Li, 1st Edition, Wiley.
- 2 Reinforced Concrete: Mechanics and Design, James K. Wight and James G. MacGregor, 7th Edition, Pearson.
- 3 Foundation Design: Principles and Practices, Donald P. Coduto, Man-chu Ronald Yeung, and William A. Kitch, 3rd Edition, Pearson.
- 4 Design & Analysis of Different Structural Components Using SAFE, Dr. Emily Johnson, Dr. Mark Thompson, 1st Edition, Wiley This comprehensive textb.

23SDCE06R - DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE06R	DESIGN & ANALYSIS OF DIFFERENT STRUCTURAL COMPONENTS USING SAFE	SAFE	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding SAFE Software: Gain a thorough understanding of the features, capabilities, and user interface of the SAFE software for structural analysis and design.	5	PO1, PO5, PSO1
CO2	Analysis of Concrete Floor Systems: Learn how to model, analyze, and design concrete floor systems including slabs, beams, and columns using SAFE software.	5	PO1, PO5, PSO1
CO3	Foundation System Analysis: Explore the analysis and design of foundation systems such as isolated footings, combined footings, and mat foundations using SAFE software.	5	PO1, PO5, PSO1
CO4	Dynamic Analysis: Understand the principles of dynamic analysis and how to perform seismic analysis and response spectrum analysis using SAFE software.	5	PO1, PO5, PSO1
CO5	Dynamic Analysis: Understand the principles of dynamic analysis and how to perform seismic analysis and response spectrum analysis using SAFE software.	5	PO1, PO5, PSO1

Syllabus

Introduction to SAFE Software Overview of SAFE software User interface and navigation Introduction to modeling concepts

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Dynamic Analysis Using SAFE Principles of dynamic analysis Seismic analysis using response spectrum method Time history analysis

Dynamic Analysis Using SAFE Principles of dynamic analysis Seismic analysis using response spectrum method Time history analysis

Reference Books

- 1 Design & Analysis of Different Structural Components Using SAFE, Dr. Emily Johnson, Dr. Mark Thompson, 1st Edition, Wiley This comprehensive textb.
- 2 Design of Reinforced Concrete, Jack C. McCormac and Russell H. Brown , 10th Edition, Wiley.
- 3 Reinforced Concrete: Mechanics and Design, James K. Wight and James G. MacGregor , 7th Edition, Pearson.
- 4 Advanced Concrete Technology, Zongjin Li, 1st Edition, Wiley.

23SDCE07A - ARC-GIS (PRO) (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE07A	ARC-GIS (PRO)	ARC	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Arc GIS tools	2	PO1, PO3, PO6, PSO1
CO2	Hand on practice using ArcGIS basic tool	3	PO1, PO3, PO6, PSO1
CO3	Application of Arc GIS toll for the natural resources management.	4	PO1, PO3, PO6, PSO1
CO4	Hand-on practices on watershed analysis using ArcGIS and other application	4	PO1, PO3, PO6, PSO1

Syllabus

Analysis of basin model as calibration, validation, and runoff

Hand-on practices on watershed analysis using ArcGIS

Display map features, add data to map, edit geographic data, Work with data tables, Query and select geographic features, create a summary graph, lay out and print a map, delineation.

Display map features, Add data to map, Edit geographic data, Work with data tables, Query and select geographic features, Create a summary graph, Lay out and print a map, delineation .

Reference Books

- 1 Getting to Know ArcGIS Pro, Michael Law, Amy Collins, 2nd Edition, Esri Press.
- 2 Mastering ArcGIS Pro, Maribeth H. Price, 1st Edition, McGraw-Hill Education.
- 3 Advanced Python Scripting for ArcGIS Pro, Paul A. Zandbergen, 2nd Edition, Esri Press.
- 4 The ArcGIS Book: 10 Big Ideas about Applying The Science of Where, Christian Harder, Clint Brown, 2nd Edition, ESRI.

23SDCE07E - ARC-GIS (PRO) (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE07E	ARC-GIS (PRO)	ARC	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Arc GIS tools	2	PO1, PO5, PO7, PSO2
CO2	Hand on practice using ArcGIS basic tool	3	PO1, PO5, PO7, PSO2
CO3	Application of Arc GIS toll for the natural resources management.	4	PO1, PO5, PO7, PSO2
CO4	Hand-on practices on watershed analysis using ArcGIS and other application	4	PO1, PO5, PO7, PSO2

Syllabus

Analysis of basin model as calibration, validation, and runoff

Hand-on practices on watershed analysis using ArcGIS

Display map features, add data to map, edit geographic data, Work with data tables, Query and select geographic features, create a summary graph, lay out and print a map, delineation.

Display map features, Add data to map, Edit geographic data, Work with data tables, Query and select geographic features, Create a summary graph, Lay out and print a map, delineation .

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- 1 Getting to Know ArcGIS Pro, Michael Law, Amy Collins, 2nd Edition, Esri Press.
- 2 Mastering ArcGIS Pro, Maribeth H. Price, 1st Edition, McGraw-Hill Education.
- 3 Advanced Python Scripting for ArcGIS Pro, Paul A. Zandbergen, 2nd Edition, Esri Press.
- 4 The ArcGIS Book: 10 Big Ideas about Applying The Science of Where, Christian Harder, Clint Brown, 2nd Edition, ESRI.

23SDCE07R - ARC-GIS (PRO) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCE07R	ARC-GIS (PRO)	ARC	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Arc GIS tools	2	PO1, PO3, PO6, PSO1
CO2	Hand on practice using ArcGIS basic tool	3	PO1, PO3, PO6, PSO1
CO3	Illustrate the skill procedure and interpretation of results using Arc GIS	4	PO1, PO3, PO6, PSO1

Syllabus

Display map features, Add data to map, Edit geographic data, Work with data tables.

Query and select geographic features, Create a summary graph, Lay out and print a map, delineation.

Hand-on practices on watershed analysis using ArcGIS and other application

Reference Books

- 1 Getting to Know ArcGIS Pro, Michael Law, Amy Collins, 2nd Edition, Esri Press.
- 2 Mastering ArcGIS Pro, Maribeth H. Price, 1st Edition, McGraw-Hill Education.
- 3 The ArcGIS Book: 10 Big Ideas about Applying The Science of Where, Christian Harder, Clint Brown , 2nd Edition, ESRI.
- 4 Advanced Python Scripting for ArcGIS Pro, Paul A. Zandbergen, 2nd Edition, Esri Press, 2024.

23SDCI04A - ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCI04A	ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES	AAMA	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Android app development tools like Android Studio and Kotlin to create robust, feature-rich applications.	3	PO1, PO5, PSO2
CO2	APPLY and Develop the Jetpack Compose concepts and apply them on Jetpack Consume APIs	3	PO1, PO5, PSO2
CO3	Design and develop advanced mobile app features, such as push notifications, location-based services, and in-app purchasing on cloud data bases	3	PO1, PO5, PSO2
CO4	Apply Design and Develop the Web services rendering and hosting through the cloud hosting	3	PO1, PO5, PSO2

Syllabus

Introduction to Kotlin: An overview of the Kotlin programming language, including its syntax, features, and benefits for Android development. Designing wireframes and mock-ups Conducting user testing and feedback gathering Mobile App Development

Material Design and Material UI Components: A deep dive into the Material UI components available in the Android Material Design library, including buttons, lists, cards, and more. Navigation, Networking: Making HTTP requests with Retrofit and parsing JSON data with Gson. Persistence: An introduction to storing and retrieving data in Android, including SQLite databases and the Room persistence library. Testing: An overview of testing strategies for Android applications, including unit testing, integration testing, and UI testing. Jetpack Compose Fundamentals: An overview of Jetpack Compose, including its benefits, architecture, and essential components. Composable Functions, Material Design, Navigation, Animations, and Networking: including making HTTP requests with Retrofit and parsing JSON data with Gson. Persistence An introduction to storing and retrieving data in Jetpack Compose, including using SQLite databases. Testing: including unit testing, integration testing, and UI testing.

"Web server Deployment in Cloud and App Publish in Google Play Console Node.js REST API: Node.js is a popular server-side JavaScript platform for building scalable, event-driven applications. REST (Representational State Transfer) is a web service architecture that provides a standard way of building HTTP-based APIs. Node.js can be used to build REST APIs consumed by client-side applications. Cloud: Hosting Node.js, including servers, storage, databases, and networking, And also includes such as scalability, reliability, and cost-effectiveness. Publishing: Publishing an Android application on the Google Play Store, including preparing the application for release and submitting it to the store."

" Implementing user authentication using Firebase Authentication in Flutter, Managing user registration, login, and logout functionality, Exploring different authentication methods like email/password, Google Sign-In, etc., Implementing user management features such as password reset and email verification, Integrating Firebase Cloud Firestore as the backend database for the Flutter app, Understanding Firestore's document and collection structure, Implementing CRUD operations (Create, Read, Update, Delete) for data manipulation in Firestore, Querying Firestore for data retrieval based on specific conditions and sorting"

Reference Books

- 1 Jetpack Compose for Android App Development: An Introduction to Building Native UIs with Kotlin, J. A. Sanchez, 2021, Packt Publishing.
- 2 Learning Jetpack Compose with Kotlin: A Hands-On Guide to Modern Android UI Development, Peter Sommerhoff, 2012, O'Reilly Media.
- 3 RESTful Web APIs, Leonard Richardson and Mike Amundsen, 2011, O'Reilly .

- 4 Node.js Design Patterns, Mario Casciaro and Luciano Mammino, 2009, Packt .

23SDCI04E - ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCI04E	ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES	AAMA	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Android app development tools like Android Studio and Kotlin to create robust, feature-rich applications.	3	PO1, PO2, PSO2
CO2	APPLY and Develop the Jetpack Compose concepts and apply them on Jetpack Consume APIs	3	PO1, PO2, PSO2
CO3	Design and develop advanced mobile app features, such as push notifications, location-based services, and in-app purchasing on cloud data bases	3	PO1, PO2, PSO2
CO4	Apply Design and Develop the Web services rendering and hosting through the cloud hosting	3	PO1, PO2, PSO2

Syllabus

Introduction to Kotlin: An overview of the Kotlin programming language, including its syntax, features, and benefits for Android development. Designing wireframes and mock-ups Conducting user testing and feedback gathering Mobile App Development

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"Web server Deployment in Cloud and App Publish in Google Play Console Node.js REST API: Node.js is a popular server-side JavaScript platform for building scalable, event-driven applications. REST (Representational State Transfer) is a web service architecture that provides a standard way of building HTTP-based APIs. Node.js can be used to build REST APIs consumed by client-side applications. Cloud: Hosting Node.js, including servers, storage, databases, and networking, And also includes such as scalability, reliability, and cost-effectiveness. Publishing: Publishing an Android application on the Google Play Store, including preparing the application for release and submitting it to the store."

" Implementing user authentication using Firebase Authentication in Flutter, Managing user registration, login, and logout functionality, Exploring different authentication methods like email/password, Google Sign-In, etc., Implementing user management features such as password reset and email verification, Integrating Firebase Cloud Firestore as the backend database for the Flutter app, Understanding Firestore's document and collection structure, Implementing CRUD operations (Create, Read, Update, Delete) for data manipulation in Firestore, Querying Firestore for data retrieval based on specific conditions and sorting"

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- 2 Learning Jetpack Compose with Kotlin: A Hands-On Guide to Modern Android UI Development, Peter Sommerhoff, 2021, O'Reilly Media.
- 3 RESTful Web APIs, Leonard Richardson and Mike Amundsen , 2022, O'Reilly.

- 4 Node.js Design Patterns, Mario Casciaro and Luciano Mammino , 2022, Packt.

23SDCI04R - ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCI04R	ADVANCED ANDROID MOBILE APPLICATION WITH CLOUD-BASED WEB SERVICES	AAMA	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Android app development tools like Android Studio and Kotlin to create robust, feature-rich applications.	3	PO1, PO2
CO2	APPLY and Develop the Jetpack Compose concepts and apply them on Jetpack Consume APIs	3	PO1, PO2
CO3	Design and develop advanced mobile app features, such as push notifications, location-based services, and in-app purchasing on cloud data bases	4	PO1, PO2
CO4	Apply Design and Develop the Web services rendering and hosting through the cloud hosting	3	PO1, PO2

Syllabus

Introduction to Kotlin: An overview of the Kotlin programming language, including its syntax, features, and benefits for Android development. Designing wireframes and mock-ups Conducting user testing and feedback gathering Mobile App Development

Material Design and Material UI Components: A deep dive into the Material UI components available in the Android Material Design library, including buttons, lists, cards, and more. Navigation, Networking: Making HTTP requests with Retrofit and parsing JSON data with Gson. Persistence: An introduction to storing and retrieving data in Android, including SQLite databases and the Room persistence library. Testing: An overview of testing strategies for Android applications, including unit testing, integration testing, and UI testing. Jetpack Compose Fundamentals: An overview of Jetpack Compose, including its benefits, architecture, and essential components. Composable Functions, Material Design, Navigation, Animations, and Networking: including making HTTP requests with Retrofit and parsing JSON data with Gson. Persistence An introduction to storing and retrieving data in Jetpack Compose, including using SQLite databases. Testing: including unit testing, integration testing, and UI testing.

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Implementing user authentication using Firebase Authentication in Flutter, Managing user registration, login, and logout functionality, Exploring different authentication methods like email/password, Google Sign-In, etc., Implementing user management features such as password reset and email verification, Integrating Firebase Cloud Firestore as the backend database for the Flutter app, Understanding Firestore's document and collection structure, Implementing CRUD operations (Create, Read, Update, Delete) for data manipulation in Firestore, Querying Firestore for data retrieval based on specific conditions and sorting"

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- 1 Jetpack Compose for Android App Development: An Introduction to Building Native UIs with Kotlin, J. A. Sanchez, 2012, Packt Publishing.
- 2 Learning Jetpack Compose with Kotlin: A Hands-On Guide to Modern Android UI Development, Peter Sommerhoff, 2019, O'Reilly Media.
- 3 RESTful Web APIs, Sanchez, 2016, Packt .

- 4 Node.js Design Patterns, Sommerhoff, 2014, O'Reilly .

23SDCI05A - CLOUD DEVOPS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCI05A	CLOUD DEVOPS	CDP	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	"Understand the basic concepts of Cloud and Devops Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software"	2	PO5, PO6, PSO2
CO2	Analyze Configuration Management using Infrastructure as Code	4	PO5, PO6, PSO2
CO3	"Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration. "	4	PO4, PO5, PO6, PSO2
CO4	"Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications using Pipeline and Examine the Software and Automation Testing Frameworks."	4	PO2, PO4, PO5, PO6, PSO2

Syllabus

Networking Fundamentals: The OSI Model TCP vs UDP IP addressing & Subnetting, Protocols & Ports Network Topology Switching, Web servers. Version Controlling: Git, GitHub fundamentals. Configuring gitbash, Pushing and pulling codes to and from repositories. Linux and Scripting: Linux Introduction, Basic Commands, Operations of running systems, User and Group management. AWS: Cloud Fundamentals, AWS Accounts, AWS Fundamentals IAM, ACCOUNTS AND AWS ORGANISATIONS, Simple Storage Service, VPC, Security.

Terraform: Introduction, Understanding Infrastructure as a service, Deploying terraform Configurations, input and output variables, Modules. Ansible: Introduction Architecture Playbook Concepts, Ansible inventory and configurations, Ansible Modules

Dockers & Kubernetes Virtualization Fundamentals Docker Introduction Docker Image Management Docker Engine Networking Docker Engine Storage Docker Compose Docker Swarm Kubernetes Architecture

Jenkins Jenkins Introduction to Jenkins Continuous Integration with Jenkins Configure Jenkins Jenkins Management Scheduling build Jobs Maven Build Scripts Support for the GIT version control System Jenkins Build Pipeline Parent and Child Builds Sequential Builds Jenkins Master & Slave Node Configuration Installing Jenkins Plugins SCM plugin Build and test

Reference Books

- 1 DevOps for Web Development , MiteshSoni, , 2016, PACKT Publishing .
- 2 Beginning DevOps with Docker , Joseph Muli, , 2018, PACKT Publishing.
- 3 Hands-on DevOps with Linux , Alisson Machado de Menezes, 2018, BPB PUBLICATIONS.
- 4 Cracking Containers with Docker and Kubernetes: The definitive guide to Docker, Kubernetes, and the Container Ecosystem across Cloud and on-premises, Nisarg Vasavada , 2018, BPB PUBLICATIONS.

23SDCI05E - CLOUD DEVOPS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCI05E	CLOUD DEVOPS	CDP	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	"Understand the basic concepts of Cloud and DevOps Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software"	2	PO5, PO6, PSO2
CO2	Inspect Configuration Management using Infrastructure as Code	4	PO5, PO6, PSO2
CO3	"Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration. "	4	PO4, PO5, PO6, PSO2
CO4	"Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications using Pipeline and Examine the Software and Automation Testing Frameworks."	4	PO1, PO4, PO5, PO6, PSO2

Syllabus

Networking Fundamentals: The OSI Model TCP vs UDP IP addressing & Subnetting, Protocols & Ports Network Topology Switching, Webservers. Version Controlling: Git, GitHub fundamentals. Configuring gitbash, Pushing and pulling codes to and from repositories. Linux and Scripting: Linux Introduction, Basic Commands, Operations of running systems, User and Group management. AWS: Cloud Fundamentals, AWS Accounts, AWS Fundamentals IAM, ACCOUNTS AND AWS ORGANISATIONS, Simple Storage Service, VPC, Security.

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Dockers & Kubernetes Virtualization Fundamentals Docker Introduction Docker Image Management Docker Engine Networking Docker Engine Storage Docker Compose Docker Swarm Kubernetes Architecture

Jenkins Jenkins Introduction to Jenkins Continuous Integration with Jenkins Configure Jenkins Jenkins Management Scheduling build Jobs Maven Build Scripts Support for the GIT version control System Jenkins Build Pipeline Parent and Child Builds Sequential Builds Jenkins Master & Slave Node Configuration Installing Jenkins Plugins SCM plugin Build and test

Reference Books

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- 2 Beginning DevOps with Docker, Joseph Muli,, Third, PACKT Publishing 2018.
- 3 Hands-on DevOps with Linux, Alisson Machado de Menezes, FIRST, BPB PUBLICATIONS.
- 4 Cracking Containers with Docker and Kubernetes: The definitive guide to Docker, Kubernetes, and the Container Ecosystem across Cloud and on-premises, Nisarg Vasavada, FIRDT, BPB PUBLICATIONS.

23SDCI05R - CLOUD DEVOPS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCI05R	CLOUD DEVOPS	CDP	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	"Understand the basic concepts of Cloud and DevOps Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software"	2	PO5, PO6, PSO2
CO2	Inspect Configuration Management using Infrastructure as Code	4	PO4, PO5, PO6, PSO2
CO3	"Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration. "	4	PO1, PO4, PO5, PO6, PSO2

Syllabus

Networking Fundamentals: The OSI Model TCP vs UDP IP addressing & Subnetting, Protocols & Ports Network Topology Switching, Webservers. Version Controlling: Git, GitHub fundamentals. Configuring gitbash, Pushing and pulling codes to and from repositories. Linux and Scripting: Linux Introduction, Basic Commands, Operations of running systems, User and Group management. AWS: Cloud Fundamentals, AWS Accounts, AWS Fundamentals IAM, ACCOUNTS AND AWS ORGANISATIONS, Simple Storage Service, VPC, Security.

Terraform: Introduction, Understanding Infrastructure as a service, Deploying terraform Configurations, input and output variables, Modules. Ansible: Introduction Architecture Playbook Concepts, Ansible inventory and configurations, Ansible Modules

Dockers & Kubernetes Virtualization Fundamentals Docker Introduction Docker Image Management Docker Engine Networking Docker Engine Storage Docker Compose Docker Swarm Kubernetes Architecture

Reference Books

- 1 DevOps for Web Development, MiteshSoni,, Fourth, PACKT Publishing 2016..
- 2 Beginning DevOps with Docker, Joseph Muli,, Third, PACKT Publishing 2018.
- 3 Hands-on DevOps with Linux, Alisson Machado de Menezes, first, BPB PUBLICATIONS.
- 4 Cracking Containers with Docker and Kubernetes: The definitive guide to Docker, Kubernetes, and the Container Ecosystem across Cloud and on-premises, Nisarg Vasavada, FIRST, BPB PUBLICATIONS.

23SDCS04A - CLOUD BASED SOLUTIONS ARCHITECT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS04A	CLOUD BASED SOLUTIONS ARCHITECT	CBSA	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	REAL TIME OPERATING SYSTEMS	RTOS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design Resilient Architectures	3	PO1, PO2, PO3, PO4, PSO1
CO2	Design High-Performing Architectures	3	PO1, PO2, PO3, PO4, PSO1
CO3	Design Secure Applications and Architectures	3	PO1, PO2, PO3, PO4, PSO1
CO4	Design Cost-Optimized Architectures, Designing solutions to the architecture of Cloud	3	PO1, PO2, PO3, PO4, PSO1

Syllabus

Design a multi-tier architecture solution: Design a multi-tier architecture solution, Design highly available and/or fault-tolerant architectures, Design decoupling mechanisms using AWS services, Choose appropriate resilient storage.

Design High-Performing Architectures : Identify elastic and scalable compute solutions for a workload, Select high-performing and scalable storage solutions for a workload, Select high-performing networking solutions for a workload, Choose high-performing database solutions for a workload.

Design Secure Applications and Architectures: Design secure access to AWS resources, Design secure application tiers, Select appropriate data security options.

Design Cost-Optimized Architectures: Identify cost-effective storage solutions, Identify cost-effective compute and database services, Design cost-optimized network architectures

Reference Books

- 1 Mastering Cloud Computing Foundations and Applications Programming , Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi , 2013, Morgan kauffman, Elsevier .
- 2 Cloud Computing Bible , Barrie Sosinsky , 2011, John Wiley & Sons .
- 3 Architecting Cloud Computing Solutions, L. Jackson, Kevin, first edition, packt.
- 4 Cloud Computing Solutions Architect, Arshdeep Bahga , Vijay Madiseti , 2019, VPT .

23SDCS04E - CLOUD BASED SOLUTIONS ARCHITECT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS04E	CLOUD BASED SOLUTIONS ARCHITECT	CBSA	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	REAL TIME OPERATING SYSTEMS	RTOS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design Resilient Architectures	3	PO1, PO2, PO3, PO4, PSO1
CO2	Design High-Performing Architectures, Designing solutions to the architecture of Cloud	3	PO1, PO2, PO3, PO4, PSO1
CO3	Design Secure Applications and Architectures	3	PO1, PO2, PO3, PO4, PSO1
CO4	Design Cost-Optimized Architectures	3	PO1, PO2, PO3, PO4, PSO1

Syllabus

Design a multi-tier architecture solution: Design a multi-tier architecture solution, Design highly available and/or fault-tolerant architectures, Design decoupling mechanisms using AWS services, Choose appropriate resilient storage.

Design High-Performing Architectures : Identify elastic and scalable compute solutions for a workload, Select high-performing and scalable storage solutions for a workload, Select high-performing networking solutions for a workload, Choose high-performing database solutions for a workload.

Design Secure Applications and Architectures: Design secure access to AWS resources, Design secure application tiers, Select appropriate data security options.

Design Cost-Optimized Architectures: Identify cost-effective storage solutions, Identify cost-effective compute and database services. Design cost-optimized network architectures

Reference Books

- 1 Mastering Cloud Computing Foundations and Applications Programming , Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi , 2013, Morgan kauffman, Elsevier .
- 2 Cloud Computing Bible , Barrie Sosinsky , 2011, John Wiley & Sons .
- 3 Architecting Cloud Computing Solutions , L. Jackson, Kevin , first edition , packt.
- 4 Cloud Computing Solutions Architect , Arshdeep Bahga , Vijay Madisetti , 2019, VPT.

23SDCS04R - CLOUD BASED SOLUTIONS ARCHITECT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS04R	CLOUD BASED SOLUTIONS ARCHITECT	CBSA	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	REAL TIME OPERATING SYSTEMS	RTOS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design Resilient Architectures	3	PO1, PO2, PO3, PO4, PSO1
CO2	Design High-Performing Architectures, Designing solutions to the architecture of Cloud	3	PO1, PO2, PO3, PO4, PSO1
CO3	Design Secure Applications and Architectures, Design Cost-Optimized Architectures	3	PO1, PO2, PO3, PO4, PSO1

Syllabus

Design a multi-tier architecture solution: Design a multi-tier architecture solution, Design highly available and/or fault-tolerant architectures, Design decoupling mechanisms using AWS services, Choose appropriate resilient storage.

Design High-Performing Architectures : Identify elastic and scalable compute solutions for a workload, Select high-performing and scalable storage solutions for a workload, Select high-performing networking solutions for a workload, Choose high-performing database solutions for a workload.

Design Secure Applications and Architectures: Design secure access to AWS resources, Design secure application tiers, Select appropriate data security options., Design Cost-Optimized Architectures: Identify cost-effective storage solutions, Identify cost-effective compute and database services, Design cost-optimized network architectures

Reference Books

- 1 Mastering Cloud Computing Foundations and Applications Programming , Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi , 2013, Morgan kauffman, Elsevier .
- 2 Cloud Computing Bible , Barrie Sosinsky , 2011, John Wiley & Sons .
- 3 Architecting Cloud Computing Solutions, L. Jackson, Kevin, first edition, packt.
- 4 Cloud Computing Solutions Architect, Arshdeep Bahga , Vijay Madiseti, 2019, vpt.

23SDCS05A - CLOUD BASED SECURITY SPECIALITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS05A	CLOUD BASED SECURITY SPECIALITY	CBSS	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	NETWORK PROTOCOLS AND SECURITY	NPS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of cloud computing and its security implications.	2	PO1, PSO1
CO2	Identify and assess various cloud security threats and vulnerabilities.	3	PO1, PO2, PSO1
CO3	Apply best practices for securing cloud infrastructure and services.	3	PO2, PSO1
CO4	Design and implement security measures to protect data in transit and at rest in the cloud.	4	PO3, PSO1

Syllabus

Introduction to Cloud Computing and Security- Overview of cloud computing models (IaaS, PaaS, SaaS)- Key concepts and benefits of cloud computing- Cloud security fundamentals and shared responsibility model.

Cloud Security Threats and Vulnerabilities-Common cloud security threats (DDoS, data breaches, etc.)- Vulnerabilities specific to cloud environments- Risk management and mitigation strategies

Securing Cloud Infrastructure- Best practices for cloud infrastructure security- Network security in cloud environments- Securing virtual machines and containers.

Data Security in the Cloud- Data encryption methods for cloud storage- Data integrity and confidentiality- Key management practices and tools

Reference Books

- 1 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, 1st, O'Reilly Media.
- 2 Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis, 1st, Wiley.
- 3 Cloud Computing Security: Foundations and Challenges, John R. Vacca, 1st, CRC Press.
- 4 Securing the Cloud: Cloud Computer Security Techniques and Tactics, Vic (J.R.) Winkler, 1st, Syngress.
- 5 AWS Security Best Practices on AWS: Security and Compliance in AWS, Albert Anthony, 1st, Packt Publishing.
- 6 Practical Cloud Security: A Guide for Secure Design and Deployment, Melvin B. Greer, 1st, Addison-Wesley.

23SDCS05E - CLOUD BASED SECURITY SPECIALITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS05E	CLOUD BASED SECURITY SPECIALITY	CBSS	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	NETWORK PROTOCOLS AND SECURITY	NPS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of cloud computing and its security implications.	2	PO1, PSO1
CO2	Identify and assess various cloud security threats and vulnerabilities.	3	PO1, PSO1
CO3	Apply best practices for securing cloud infrastructure and services.	3	PO1, PO2, PSO1
CO4	Design and implement security measures to protect data in transit and at rest in the cloud.	4	PO2, PO3, PSO1

Syllabus

Introduction to Cloud Computing and Security- Overview of cloud computing models (IaaS, PaaS, SaaS)- Key concepts and benefits of cloud computing- Cloud security fundamentals and shared responsibility model.

Cloud Security Threats and Vulnerabilities-Common cloud security threats (DDoS, data breaches, etc.)- Vulnerabilities specific to cloud environments- Risk management and mitigation strategies.

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- 6 Practical Cloud Security: A Guide for Secure Design and Deployment, Melvin B. Gree, 1st, Addison-Wesley.

23SDCS05R - CLOUD BASED SECURITY SPECIALITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS05R	CLOUD BASED SECURITY SPECIALITY	CBSS	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	NETWORK PROTOCOLS AND SECURITY	NPS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of cloud computing and its security implications.	2	PO1, PSO1
CO2	Identify and assess various cloud security threats and vulnerabilities.	3	PO1, PO2, PSO1
CO3	Apply best practices for securing cloud infrastructure and services.	3	PO2, PO3, PSO1

Syllabus

Introduction to Cloud Computing and Security- Overview of cloud computing models (IaaS, PaaS, SaaS)- Key concepts and benefits of cloud computing- Cloud security fundamentals and shared responsibility model.

Cloud Security Threats and Vulnerabilities-Common cloud security threats (DDoS, data breaches, etc.)- Vulnerabilities specific to cloud environments- Risk management and mitigation strategies

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- 2 Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis, 1st, Wiley.
- 3 Cloud Computing Security: Foundations and Challenges, John R. Vacca, 1st, CRC Press.
- 4 Securing the Cloud: Cloud Computer Security Techniques and Tactics, Vic (J.R.) Winkler, 1st, Syngress.
- 5 Practical Cloud Security: A Guide for Secure Design and Deployment, Melvin B. Greer, 1st, Addison-Wesley.

23SDCS06A - CERTIFIED GAME DEVELOPER (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS06A	CERTIFIED GAME DEVELOPER	CGD	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Mastery of Game Design Principles	2	PO1, PO4, PO8, PSO2
CO2	Proficiency in Game Programming	3	PO1, PO4, PO8, PSO2
CO3	Skill in 3D Modeling and Animation	3	PO1, PO4, PO8, PSO2
CO4	Expertise with Game Engines	4	PO1, PO4, PO8, PSO2

Syllabus

The origins of video games: From Pong to Pac-Man, Exploring different gaming genres: From platformers to RPGs, The impact of technological advancements on game development The rise of independent game development

Mechanics vs Dynamics vs Aesthetics (MDA): Deconstructing the game experience Core gameplay loops: Identifying the driving force of player engagement Systems thinking: Analyzing how interconnected mechanics create emergent gameplay Designing for different player types: Understanding motivations and goals

Introduction to Programming Paradigms: Procedural vs. Object-Oriented Exploring C++: A powerful and versatile language for game development (focus on core concepts) Learning C#: A popular choice for game development on the Unity platform (focus on core concepts) Demystifying Python: A beginner-friendly language for scripting and game logic (focus on core concepts)

Introduction to 3D Modeling: Polygons, vertices, edges, and the 3D space Interface exploration: Learning the layout and tools of Blender, Maya, and 3ds Max (choose one for primary use) Basic modeling techniques: Creating simple shapes, manipulating objects, and using modifiers Texturing fundamentals: Applying textures and materials to enhance realism

Reference Books

- 1 Jason Gregory, Game Engine Architecture, Second Edition, Jason Gregory, 2, 2014, Mike .
- 2 Tomas Akenine Mollar, Eric Haines, Naty Hoffman, Real Time Rendering, Third Edition, Tomas Akenine Mollar, Eric Haines, Naty Hoffman, 3, 2018, Direct X, Open GL .
- 3 James M Van Verth, Lars M Bishop, Essential Mathematics for Games and Interactive Applications, Third Edition, James M Van Verth, Lars M Bishop, 3, 2015, Direct X, Open GL (GLES) .
- 4 Jesse Schell, The Art of Game Design, A Book of Lenses, Fourth Edition, Jesse Schell, 4, 2023, IGDA .
- 5 Mike McShaffry, David Graham, Game Coding Complete, Fourth Edition, Mike McShaffry, David Graham, 4, 2012, Mike .

23SDCS06E - CERTIFIED GAME DEVELOPER (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS06E	CERTIFIED GAME DEVELOPER	CGD	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Fundamental Game Design Principles	2	PO1, PO4, PO8, PSO2
CO2	Programming and Scripting	3	PO1, PO4, PO8, PSO2
CO3	Game Engine Proficiency	3	PO1, PO4, PO8, PSO2
CO4	Graphics and Animation	3	PO1, PO4, PO8, PSO2

Syllabus

The origins of video games: From Pong to Pac-Man, Exploring different gaming genres: From platformers to RPGs, The impact of technological advancements on game development The rise of independent game development

Mechanics vs Dynamics vs Aesthetics (MDA): Deconstructing the game experience Core gameplay loops: Identifying the driving force of player engagement Systems thinking: Analyzing how interconnected mechanics create emergent gameplay Designing for different player types: Understanding motivations and goals

Introduction to Programming Paradigms: Procedural vs. Object-Oriented Exploring C++: A powerful and versatile language for game development (focus on core concepts) Learning C#: A popular choice for game development on the Unity platform (focus on core concepts) Demystifying Python: A beginner-friendly language for scripting and game logic (focus on core concepts)

Introduction to 3D Modeling: Polygons, vertices, edges, and the 3D space Interface exploration: Learning the layout and tools of Blender, Maya, and 3ds Max (choose one for primary use) Basic modeling techniques: Creating simple shapes, manipulating objects, and using modifiers Texturing fundamentals: Applying textures and materials to enhance realism

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- 2 Tomas Akenine Mollar, Eric Haines, Naty Hoffman, Real Time Rendering, Third Edition, Tomas Akenine Mollar, Eric Haines, Naty Hoffman, 3, 2008, Direct X, Open GL .
- 3 James M Van Verth, Lars M Bishop, Essential Mathematics for Games and Interactive Applications, Third Edition, James M Van Verth, Lars M Bishop, 3, 2015, Direct X, Open GL (GLES) .
- 4 Jesse Schell, The Art of Game Design, A Book of Lenses, Fourth Edition, Jesse Schell, 4, 2019, IGDA .
- 5 Mike McShaffry, David Graham, Game Coding Complete, Fourth Edition, Mike McShaffry, David Graham, 4, 2012, Mike .

23SDCS06R - CERTIFIED GAME DEVELOPER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS06R	CERTIFIED GAME DEVELOPER	CGD	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Mastery of Game Design Principles	2	PO1, PO4, PO8, PSO2
CO2	Proficiency in Game Programming	3	PO1, PO4, PO8, PSO2
CO3	Skill in 3D Modeling and Animation	3	PO1, PO4, PO8, PSO2
CO4	Game Development in Unity platform	3	PO1, PO4, PO8, PSO2

Syllabus

The origins of video games: From Pong to Pac-Man, Exploring different gaming genres: From platformers to RPGs, The impact of technological advancements on game development The rise of independent game development

Mechanics vs Dynamics vs Aesthetics (MDA): Deconstructing the game experience Core gameplay loops: Identifying the driving force of player engagement Systems thinking: Analyzing how interconnected mechanics create emergent gameplay Designing for different player types: Understanding motivations and goals

Introduction to Programming Paradigms: Procedural vs. Object-Oriented Exploring C++: A powerful and versatile language for game development (focus on core concepts) Learning C#: A popular choice for game development on the Unity platform (focus on core concepts) Demystifying Python: A beginner-friendly language for scripting and game logic (focus on core concepts)

Implement advanced gameplay features (AI, animation, and multiplayer), optimize performance, and deploy games to platforms like Android, iOS, or PC.

Reference Books

- 1 Jason Gregory, Game Engine Architecture, Second Edition, Jason Gregory, 2, 2014, Mike .
- 2 Tomas Akenine Mollar, Eric Haines, Naty Hoffman, Real Time Rendering, Third Edition, Tomas Akenine Mollar, Eric Haines, Naty Hoffman, 3, 2008, Direct X, Open GL .
- 3 James M Van Verth, Lars M Bishop, Essential Mathematics for Games and Interactive Applications, Third Edition, James M Van Verth, Lars M Bishop, 3, 2015, Direct X, Open GL (GLES) .
- 4 Jesse Schell, The Art of Game Design, A Book of Lenses, Fourth Edition, Jesse Schell, 4, 2019, IGDA
- 5 Mike McShaffry, David Graham, Game Coding Complete, Fourth Edition, Mike McShaffry, David Graham, 4, 2012, Mike .

23SDCS07A - CLOUD BASED AI/ML SPECIALITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS07A	CLOUD BASED AI/ML SPECIALITY	CBAIMLS	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	AIML	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop cloud-based data repositories and ingestion pipelines that seamlessly integrate batch and streaming data job styles tailored for machine learning applications.	3	PO2, PO3, PSO1
CO2	Analyze cloud resources for preparing data using various graphing techniques and interpret different clustering methodologies for machine learning insights.	4	PO2, PO3, PSO2
CO3	Examine diverse business challenges and translating them into machine learning problems to selecting appropriate models for optimizing hyperparameters during model training to evaluate model performance using machine learning solutions with basic AWS security practices.	4	PO2, PO3, PSO2
CO4	Analyze cloud principles and algorithms to evaluate models generated from data and expertise in selecting, implementing, securing, deploying, and maintaining machine learning solutions on the AWS platform.	4	PO2, PO3, PSO2

Syllabus

Data Engineering through Cloud: Create data repositories for machine learning. Identify and implement a data ingestion solution: Data job styles/types (batch load, streaming), Data ingestion pipelines (Batch-based ML workloads and streaming-based ML workloads). Identify and implement a data transformation solution.

Exploratory Data Analysis through Cloud: Sanitize and prepare data for modeling, perform feature engineering, Analyze and visualize data for machine learning, Graphing (scatter plot, time series, histogram, box plot), Interpreting descriptive statistics (correlation, summary statistics, p value), Clustering (hierarchical, diagnosing, elbow plot, cluster size)

Modeling through Cloud: Frame business problems as Machine learning problems, Select the appropriate model(s) for a given machine learning problem, Train machine learning models, perform hyperparameter optimization, Evaluate machine learning models. apply basic AWS security practices to machine learning solutions, Deploy and operationalize machine learning solutions.

Recommend and Implement the appropriate machine learning services and features for a given problem, apply basic AWS security practices to machine learning solutions, Deploy and operationalize machine learning solutions

Reference Books

- 1 Cloud Computing for Machine Learning and Cognitive Applications , Kai Hwang , 2017, MIT PRESS.
- 2 Machine learning an algorithmic perspective , Stephen Marsland , 2009 , CRC PRESS.
- 3 TensorFlow Machine Learning Cookbook , N.McClure , 2017 , Packt Publishing Limited .
- 4 Pragmatic AI: An Introduction to Cloud-Based Machine Learning, Noah Gift, 2018, Pearson.

23SDCS07E - CLOUD BASED AI/ML SPECIALITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS07E	CLOUD BASED AI/ML SPECIALITY	CBAIMLS	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	AIML	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop cloud-based data repositories and ingestion pipelines that seamlessly integrate batch and streaming data job styles tailored for machine learning applications.	3	PO2, PO3, PSO1
CO2	Analyze cloud resources for preparing data using various graphing techniques and interpret different clustering methodologies for machine learning insights.	4	PO2, PO3, PSO2
CO3	Analyze diverse business challenges and translating them into machine learning problems to selecting appropriate models for optimizing hyperparameters during model training to evaluate model performance using machine learning solutions with basic AWS security practices.	4	PO2, PO3, PSO2
CO4	Analyze cloud principles and algorithms to evaluate models generated from data and expertise in selecting, implementing, securing, deploying, and maintaining machine learning solutions on the AWS platform.	4	PO2, PO3, PSO2

Syllabus

Data Engineering through Cloud: Create data repositories for machine learning. Identify and implement a data ingestion solution: Data job styles/types (batch load, streaming), Data ingestion pipelines (Batch-based ML workloads and streaming-based ML workloads). Identify and implement a data transformation solution.

Exploratory Data Analysis through Cloud: Sanitize and prepare data for modeling, perform feature engineering, Analyze and visualize data for machine learning, Graphing (scatter plot, time series, histogram, box plot), Interpreting descriptive statistics (correlation, summary statistics, p value), Clustering (hierarchical, diagnosing, elbow plot, cluster size)

Modeling through Cloud: Frame business problems as Machine learning problems, Select the appropriate model(s) for a given machine learning problem, Train machine learning models, perform hyperparameter optimization, Evaluate machine learning models. apply basic AWS security practices to machine learning solutions, Deploy and operationalize machine learning solutions.

Recommend and Implement the appropriate machine learning services and features for a given problem, apply basic AWS security practices to machine learning solutions, Deploy and operationalize machine learning solutions

Reference Books

- 1 Cloud Computing for Machine Learning and Cognitive Applications , Kai Hwang , 2017, MIT PRESS.
- 2 Machine learning an algorithmic perspective , Stephen Marsland , 2009 , CRC PRESS.
- 3 TensorFlow Machine Learning Cookbook , N.McClure , 2017 , Packt Publishing Limited .
- 4 Pragmatic AI: An Introduction to Cloud-Based Machine Learning, Noah Gift, 2018, Pearson.

23SDCS07R - CLOUD BASED AI/ML SPECIALITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS07R	CLOUD BASED AI/ML SPECIALITY	CBAIMLS	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING	AIML	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop cloud-based data repositories and ingestion pipelines that seamlessly integrate batch and streaming data job styles tailored for machine learning applications.	3	PO1, PSO1
CO2	Analyze cloud resources for preparing data using various graphing techniques and interpret different clustering methodologies for machine learning insights.	4	PO2, PSO2
CO3	Analyze diverse business challenges and translating them into machine learning problems to selecting appropriate models for optimizing hyperparameters during model training to evaluate model performance using machine learning solutions with basic AWS security practices.	4	PO2, PSO2

Syllabus

Data Engineering through Cloud: Create data repositories for machine learning. Identify and implement a data ingestion solution: Data job styles/types (batch load, streaming), Data ingestion pipelines (Batch-based ML workloads and streaming-based ML workloads). Identify and implement a data transformation solution.

Exploratory Data Analysis through Cloud: Sanitize and prepare data for modeling, perform feature engineering, Analyze and visualize data for machine learning, Graphing (scatter plot, time series, histogram, box plot), Interpreting descriptive statistics (correlation, summary statistics, p value), Clustering (hierarchical, diagnosing, elbow plot, cluster size)

Modeling through Cloud: Frame business problems as Machine learning problems, Select the appropriate model(s) for a given machine learning problem, Train machine learning models, perform hyperparameter optimization, Evaluate machine learning models. apply basic AWS security practices to machine learning solutions, Deploy and operationalize machine learning solutions.

Reference Books

- 1 Cloud Computing for Machine Learning and Cognitive Applications , Kai Hwang , 2017, MIT PRESS.
- 2 Machine learning an algorithmic perspective , Stephen Marsland , 2009 , CRC PRESS.
- 3 TensorFlow Machine Learning Cookbook, N.McClure, 2017, Packt Publishing Limited.
- 4 Pragmatic AI: An Introduction to Cloud-Based Machine Learning, Noah Gift, 2018, PEARSON.

23SDCS08A - CLOUD BASED DATA ANALYTICS SPECIALITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS08A	CLOUD BASED DATA ANALYTICS SPECIALITY	CBDAS	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	DATA SCIENCE & STATISTICS	DSS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Core Data Concepts on Azure	3	PO1, PO2, PSO1
CO2	Visualize and analyze How to work with Relational data on Azure	4	PO1, PO2, PSO1
CO3	Analyze how to work with non-relational data on Azure	4	PO1, PO2, PSO1
CO4	Analyze and Implement a Mitncrosoft Azure AI Solution	4	PO1, PO2, PSO1

Syllabus

Core Data Concepts: Ways to represent data: Structured data, semi-structured and unstructured data; Options for data storage: Common format for data files and types of databases

common data workloads: Transactional and Analytical workloads; Identify roles and responsibilities for data workloads which includes data database administrators, data engineers and data analysts.

Considerations on Relational Concepts and Azure Data Services. considerations for working with non-relational data, capabilities and features of Azure Cosmos DB. Data analytics workload on Azure: common elements of large-scale analytics, consideration for real-time data analytics and data visualization in Microsoft Power BI.

Analyze solution requirements, Design AI solutions, Implement and monitor AI solutions

Reference Books

- 1 Microsoft Azure Data Fundamentals: Exam Ref DP-900, Abhishek Chaudhary, Third Edition, (Azure Certifications Journey Book 2.
- 2 Microsoft Certified Azure Data Fundamentals (Exam DP900) , Marcelo Leite, Certification Guide book, Microsoft.
- 3 Exam Ref DP900 Microsoft Azure Data Fundamentals book, Leite, Second Edition, Microsoft.
- 4 Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking, Foster Provost, First Edition, O'Reilly Media.

23SDCS08E - CLOUD BASED DATA ANALYTICS SPECIALITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS08E	CLOUD BASED DATA ANALYTICS SPECIALITY	CBDAS	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	DATA SCIENCE & STATISTICS	DSS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Core Data Concepts on Azure	3	PO1, PO2, PSO1
CO2	Visualize and analyze How to work with Relational data on Azure	4	PO1, PO2, PSO1
CO3	Analyze how to work with non-relational data on Azure	4	PO1, PO2, PSO1
CO4	Analyze and Implement a Mitncrosoft Azure AI Solution	4	PO1, PO2, PSO1

Syllabus

Core Data Concepts: Ways to represent data: Structured data, semi-structured and unstructured data; Options for data storage: Common format for data files and types of databases

common data workloads: Transactional and Analytical workloads; Identify roles and responsibilities for data workloads which includes data database administrators, data engineers and data analysts.

Considerations on Relational Concepts and Azure Data Services. considerations for working with non-relational data, capabilities and features of Azure Cosmos DB. Data analytics workload on Azure: common elements of large-scale analytics, consideration for real-time data analytics and data visualization in Microsoft Power BI.

Analyze solution requirements, Design AI solutions, Implement and monitor AI solutions

Reference Books

- 1 Microsoft Azure Data Fundamentals: Exam Ref DP-900 , Abhishek Chaudhary, Third Edition , (Azure Certifications Journey Book 2).
- 2 Machine Learning Approach for Cloud Data Analytics in IoT, Sachi Nandan Mohanty, Edition, WILEY.
- 3 Exam Ref DP900 Microsoft Azure Data Fundamentals book, Nicola Farquharson, 2nd Edition, Microsoft.
- 4 Data Science for Business, Tom Fawcett, Edition, O'Reilly Media.

23SDCS08R - CLOUD BASED DATA ANALYTICS SPECIALITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS08R	CLOUD BASED DATA ANALYTICS SPECIALITY	CBDAS	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	DATA SCIENCE & STATISTICS	DSS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Core Data Concepts on Azure	3	PO1, PO2, PSO1
CO2	Visualize and analyze How to work with Relational data on Azure	4	PO1, PO2, PSO1
CO3	Analyze how to work with non-relational data on Azure	4	PO1, PO2, PSO1

Syllabus

Core Data Concepts: Ways to represent data: Structured data, semi-structured and unstructured data; Options for data storage: Common format for data files and types of databases

common data workloads: Transactional and Analytical workloads; Identify roles and responsibilities for data workloads which includes data database administrators, data engineers and data analysts.

Considerations on Relational Concepts and Azure Data Services. considerations for working with non-relational data, capabilities and features of Azure Cosmos DB. Data analytics workload on Azure: common elements of large-scale analytics, consideration for real-time data analytics and data visualization in Microsoft Power BI.

Reference Books

- 1 Microsoft Azure Data Fundamentals: Exam Ref DP-900., Abhishek Chaudhary, Third Edition, Azure Certifications Journey Book 2.
- 2 Data Science for Business, Foster Provost, Tom Fawcett , Edition, O'Reilly Media.
- 3 Exam Ref DP-900 Microsoft Azure Data Fundamentals, Nicola Farquharson, 2nd Edition, Microsoft.
- 4 Machine Learning Approach for Cloud Data Analytics in IoT, Sachi Nandan Mohanty, Suneeta Satpathy, Sirisha Potluri, Jyotir Moy Chatterjee, Monika Mangla , Edition, Wiley.

23SDCS10A - IT VENTURE MANAGEMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS10A	IT VENTURE MANAGEMENT	ITVM	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of business start-ups	3	PO7, PO9, PO11, PSO1
CO2	Application of marketing, management, accounting, and financial knowledge to venture creation	3	PO7, PO9, PO11, PSO1
CO3	Apply knowledge in data collection and analysis	4	PO7, PO9, PO11, PSO1
CO4	Analyse strategies and operational planning techniques to a business venture	4	PO7, PO9, PO11, PSO1

Syllabus

Explore entrepreneurial traits, profile analysis, behaviors, motivations, startup skills, ecosystem dynamics, and strategic decision-making to develop successful, resilient entrepreneurs and thriving businesses.

Sustainability of entrepreneurship involves navigating dilemmas for long-term success, addressing challenges and uncertainties, and handling doubts about business survival. Entrepreneurs must balance innovation, ethical practices, and market demands while fostering resilience and adaptability to sustain growth and ensure enduring success in a competitive landscape.

Explore struggles and causes of failure, including product-market fit, financing, and managerial resilience. Understand legal fundamentals of incorporation, and conduct market analysis and customer validation to ensure business viability and strategic growth.

Developing Your Business Model, Crafting Your Value Proposition, Product Development, Managing the Product Development Process and Product Launch Goals, Go to Market Strategy the Financial Road Map Planning Budgeting, Developing a Financial Roadmap

Reference Books

- 1 The Lean Startup, Eric Ries, 2011, Crown Business (USA).
- 2 New Venture Management The Entrepreneur s Road Map development management and Growth, Donald F. Kuratko and Jeffrey S. Hornsby, 2021, Routledge.
- 3 Entrepreneurship New Venture Management, Safal Batra, 2023, Cengage.
- 4 Entrepreneurship and New Venture Management, Isa Van Aardt, 2018 , Oxford University Press.

23SDCS10E - IT VENTURE MANAGEMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS10E	IT VENTURE MANAGEMENT	ITVM	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of business startups	3	PO1, PO7, PO9, PO11, PSO1
CO2	Application of marketing, management, accounting, and financial knowledge to venture creation	3	PO1, PO7, PO9, PO11, PSO1
CO3	Apply knowledge in data collection and analysis	4	PO1, PO7, PO9, PO11, PSO1
CO4	Analyse strategies and operational planning techniques to a business venture	4	PO1, PO7, PO9, PO11, PSO1

Syllabus

Explore entrepreneurial traits, profile analysis, behaviors, motivations, startup skills, ecosystem dynamics, and strategic decision-making to develop successful, resilient entrepreneurs and thriving businesses

Sustainability of entrepreneurship involves navigating dilemmas for long-term success, addressing challenges and uncertainties, and handling doubts about business survival. Entrepreneurs must balance innovation, ethical practices, and market demands while fostering resilience and adaptability to sustain growth and ensure enduring success in a competitive landscape.

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Developing Your Business Model, Crafting Your Value Proposition, Product Development, Managing the Product Development Process and Product Launch Goals, Go to Market Strategy the Financial Road Map Planning Budgeting, Developing a Financial Roadmap

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- 1 The Lean Startup, Eric Ries, 2011, Crown Business (USA).
- 2 New Venture Management The Entrepreneur s Road Map development management and Growth, Donald F. Kuratko and Jeffrey S. Hornsby, 2021, Routledge.
- 3 Entrepreneurship New Venture Management, Safal Batra, 2023, Cengage.
- 4 Entrepreneurship and New Venture Management, Isa Van Aardt, 2018, Oxford University Press.

23SDCS10R - IT VENTURE MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS10R	IT VENTURE MANAGEMENT	ITVM	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of business start-ups	3	PO1, PO7, PO9, PO11, PSO1
CO2	Application of marketing, management, accounting, and financial knowledge to venture creation	3	PO1, PO7, PO9, PO11, PSO1
CO3	Apply and Analyse knowledge in data collection and implementation of venture	4	PO1, PO7, PO9, PO11, PSO1

Syllabus

Introduction to the Entrepreneur, Define design in Profile Analysis, Know about Behaviour, and Motivations of Entrepreneurship, To know and Learn to Startup, The Entrepreneurial Ecosystem Entrepreneurs, and Strategic Decisions.

Sustainability of Entrepreneurship: Dilemmas of an Entrepreneur for Success, Handling Doubts on Survival of Business Struggles Causes of Failure Product Market, Financing, Managerial Resilience. Legal Fundamentals When, How, and Where to Incorporate, Market Analysis, Customer Validation

The value proposition is central to product management and operations, guiding product strategy, development, and marketing efforts. It ensures alignment across teams towards delivering customer value, influencing product features, pricing, and market positioning. A well-defined value proposition aids in making informed decisions, prioritizing customer-valued features, and crafting compelling messages for customer acquisition and retention.

Reference Books

- 1 The Lean Startup, Eric Ries, 2011, Crown Business (USA).
- 2 New Venture Management The Entrepreneur s Road Map development management and Growth, Donald F. Kuratko and Jeffrey S. Hornsby, 2021, Routledge.
- 3 Entrepreneurship New Venture Management, Safal Batra, 2023, Cengage.
- 4 Entrepreneurship and New Venture Management, Isa Van Aardt, 2018, Oxford University Press.

23SDCS11A - LINUX ADMINISTRATION AND AUTOMATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS11A	LINUX ADMINISTRATION AND AUTOMATION	LAA	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Use Essential Tools; Manage Local Users and Groups; Create Simple Shell Scripts; Operate Running Systems	2	PO2, PO5, PSO1
CO2	Understanding the Configuration of Local Storage and File Systems	2	PO2, PO5, PSO1
CO3	Evaluate and implement robust network configurations and security measures, including firewall settings and SELinux policies, to ensure system security and integrity.	4	PO5, PSO1
CO4	Apply container management techniques using podman and skopeo to deploy, manage, and automate containerized applications, integrating persistent storage and systemd service configurations.	3	PO5, PSO1

Syllabus

Understand and use essential tools: Access a shell prompt and issue commands with correct syntax, Use input-output redirection (>, >>, |, 2>, etc.), Use grep and regular expressions to analyze text, Access remote systems using SSH, Log in and switch users in multiuser targets, Archive, compress, unpack, and uncompress files using tar, gzip, and bzip2, Create and edit text files, Create, delete, copy, and move files and directories, Create hard and soft links, List, set, and change standard ugo/rwx permissions, Locate, read, and use system documentation including man, info, and files in /usr/share/doc Manage Local Users and Groups: Create, delete, and modify local user accounts, change passwords and adjust password aging for local user accounts, Create, delete, and modify local groups and group memberships, Configure superuser access, Create simple shell scripts: Conditionally execute code (use of: if, test, [], etc.), Use Looping constructs (for, etc.) to process file, command line input, Process script inputs (\$1, \$2, etc.), Processing output of shell commands within a script Operate running systems: Boot, reboot, and shut down a system normally, Boot systems into different targets manually, Interrupt the boot process in order to gain access to a system, Identify CPU/memory intensive processes and kill processes, Adjust process scheduling, Manage tuning profiles, Locate and interpret system log files and journals, Preserve system journals, Start, stop, and check the status of network services, Securely transfer files between systems

Configure local storage: List, create, delete partitions on MBR and GPT disks, Create and remove physical volumes, Assign physical volumes to volume groups, Create and delete logical volumes, Configure systems to mount file systems at boot by universally unique ID (UUID) or label, Add new partitions and logical volumes, and swap to a system non-destructively Create and configure file systems: Create, mount, unmount, and use vfat, ext4, and xfs file systems, Mount and unmount network file systems using NFS, Configure autoofs, Extend existing logical volumes, Create and configure set-GID directories for collaboration, Diagnose and correct file permission problems, Deploy, configure, and maintain systems: Schedule tasks using at and cron, Start and stop services and configure services to start automatically at boot, Configure systems to boot into a specific target automatically, Configure time service clients, Install and update software packages from Red Hat Network, a remote repository, or from the local file system, Modify the system bootloader

Manage networking & Security: Configure IPv4 and IPv6 addresses, Configure hostname resolution, Configure network services to start automatically at boot, Restrict network access using firewall-cmd/firewall, Configure firewall settings using firewall-cmd/firewalld, Manage default file permissions, Configure key-based authentication for SSH, Set enforcing and permissive modes for SELinux, List and identify SELinux file and process context, Restore default file contexts, Manage SELinux port labels, Use boolean settings to modify system SELinux settings, Diagnose and address routine SELinux policy violations, Manage Basic Storage, Manage Storage Stack, Access Network-Attached Storage, Control the Boot Process, Manage Network Security, Install Red Hat Enterprise Linux

Manage containers: Find and retrieve container images from a remote registry, Inspect container images, Perform container management using commands such as podman and skopeo, Build a container from a Container file, Perform basic container management such as running, starting, stopping, and listing running containers, Run a service inside a container, Configure a container to start automatically as a systemd service, Attach persistent storage to a container

Reference Books

- 1 Red Hat Enterprise Linux System Administrator Guide Deployment configuration and administration of RHEL, Redhat, 2024, Redhat Inc.
- 2 Red Hat RHCSA 8 Cert Guide: EX200 , Sander van Vugt, 2021, Pearson IT Certification.
- 3 Red Hat Certified System Administrator & Engineer: Training Guide and a Quick Deskside Reference, Exams EX200, Asghar Ghori, 2022, Redhat Inc.
- 4 Red Hat Certified System Administrator (RHCSA), William Maning, 2022, Emereo Publishing.
- 5 RHCSA/RHCE Red Hat Linux Certification Study Guide (Exams EX200 & EX300), Jang Michael, 2024, McGraw Hill Education India.

23SDCS11E - LINUX ADMINISTRATION AND AUTOMATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS11E	LINUX ADMINISTRATION AND AUTOMATION	LAA	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Use Essential Tools; Manage Local Users and Groups; Create Simple Shell Scripts; Operate Running Systems	2	PO2, PO5, PSO1
CO2	Understanding the Configuration of Local Storage and File Systems	2	PO2, PO5, PSO1
CO3	Evaluate and implement robust network configurations and security measures, including firewall settings and SELinux policies, to ensure system security and integrity.	3	PO5, PSO1
CO4	Apply container management techniques using podman and skopeo to deploy, manage, and automate containerized applications, integrating persistent storage and systemd service configurations.	3	PO5, PSO1

Syllabus

Understand and use essential tools: Access a shell prompt and issue commands with correct syntax, Use input-output redirection (>, >>, |, 2>, etc.), Use grep and regular expressions to analyze text, Access remote systems using SSH, Log in and switch users in multiuser targets, Archive, compress, unpack, and uncompress files using tar, gzip, and bzip2, Create and edit text files, Create, delete, copy, and move files and directories, Create hard and soft links, List, set, and change standard ugo/rwx permissions, Locate, read, and use system documentation including man, info, and files in /usr/share/doc Manage Local Users and Groups: Create, delete, and modify local user accounts, change passwords and adjust password aging for local user accounts, Create, delete, and modify local groups and group memberships, Configure superuser access, Create simple shell scripts: Conditionally execute code (use of: if, test, [], etc.), Use Looping constructs (for, etc.) to process file, command line input, Process script inputs (\$1, \$2, etc.), Processing output of shell commands within a script Operate running systems: Boot, reboot, and shut down a system normally, Boot systems into different targets manually, Interrupt the boot process in order to gain access to a system, Identify CPU/memory intensive processes and kill processes, Adjust process scheduling, Manage tuning profiles, Locate and interpret system log files and journals, Preserve system journals, Start, stop, and check the status of network services, Securely transfer files between systems

Configure local storage: List, create, delete partitions on MBR and GPT disks, Create and remove physical volumes, Assign physical volumes to volume groups, Create and delete logical volumes, Configure systems to mount file systems at boot by universally unique ID (UUID) or label, Add new partitions and logical volumes, and swap to a system non-destructively Create and configure file systems: Create, mount, unmount, and use vfat, ext4, and xfs file systems, Mount and unmount network file systems using NFS, Configure autoofs, Extend existing logical volumes, Create and configure set-GID directories for collaboration, Diagnose and correct file permission problems, Deploy, configure, and maintain systems: Schedule tasks using at and cron, Start and stop services and configure services to start automatically at boot, Configure systems to boot into a specific target automatically, Configure time service clients, Install and update software packages from Red Hat Network, a remote repository, or from the local file system, Modify the system bootloader

Manage networking & Security: Configure IPv4 and IPv6 addresses, Configure hostname resolution, Configure network services to start automatically at boot, Restrict network access using firewall-cmd/firewall, Configure firewall settings using firewall-cmd/firewalld, Manage default file permissions, Configure key-based authentication for SSH, Set enforcing and permissive modes for SELinux, List and identify SELinux file and process context, Restore default file contexts, Manage SELinux port labels, Use boolean settings to modify system SELinux settings, Diagnose and address routine SELinux policy violations, Manage Basic Storage, Manage Storage Stack, Access Network-Attached Storage, Control the Boot Process, Manage Network Security, Install Red Hat Enterprise Linux

Manage containers: Find and retrieve container images from a remote registry, Inspect container images, Perform container management using commands such as podman and skopeo, Build a container from a Container file, Perform basic container management such as running, starting, stopping, and listing running containers, Run a service inside a container, Configure a container to start automatically as a systemd service, Attach persistent storage to a container

Reference Books

- 1 Red Hat Enterprise Linux System Administrator Guide Deployment configuration and administration of RHEL, Redhat, 2024, Redhat Inc.
- 2 Red Hat RHCSA 8 Cert Guide: EX200, Sander van Vugt, 2021, Pearson IT Certification.
- 3 Red Hat Certified System Administrator & Engineer: Training Guide and a Quick Deskside Reference, Exams EX200, Asghar Ghori , 2022, Redhat Inc.
- 4 Red Hat Certified System Administrator (RHCSA), William Maning, 2022, Emereo Publishing.
- 5 RHCSA/RHCE Red Hat Linux Certification Study Guide (Exams EX200 & EX300), Jang Michael , 2024, McGraw Hill Education India.

23SDCS11R - LINUX ADMINISTRATION AND AUTOMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS11R	LINUX ADMINISTRATION AND AUTOMATION	LAA	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Redirection and creating and managing files using VIM Editor and Managing Users and Groups	2	PO2, PO5, PSO1
CO2	Understanding Process Management SSH connections, Network Fundamentals, Managing Network utility and utilize Automation tools for Process Scheduling	2	PO2, PO5, PSO1
CO3	Managing Network utility and utilize Automation tools for Process Scheduling and Apply Package Management and File system and Analyze Booting Process with Red hat Linux and design running of Containers	3	PO5, PSO1

Syllabus

Manage Files from the Command Line, Get Help in Red Hat Enterprise Linux, Create, View, and Edit Text Files, Manage Local Users and Groups

Control Access to Files, Monitor and Manage Linux Processes, Control Services and Daemons, Configure and Secure SSH, Analyze and Store Logs, Manage Networking, Archive and Transfer Files, Install and Update Software Packages, Access Linux File Systems, Analyze Servers and Get Support

Improve Command-line Productivity, Schedule Future Tasks, Tune System Performance, Manage SELinux Security, Manage Basic Storage, Manage Storage Stack, Access Network-Attached Storage, Control the Boot Process, Manage Network Security, Install Red Hat Enterprise Linux, Run Containers

Reference Books

- 1 Red Hat Enterprise Linux System Administrator Guide Deployment configuration and administration of RHEL, Redhat, 2024, Redhat Inc.
- 2 Red Hat RHCSA 8 Cert Guide: EX200, Sander van Vugt, 2021, Pearson IT Certification.
- 3 Red Hat Certified System Administrator & Engineer: Training Guide and a Quick Deskside Reference, Exams EX200, Asghar Ghori, 2022, Redhat Inc.
- 4 Red Hat Certified System Administrator (RHCSA), William Maning, 2022, Emereo Publishing.
- 5 RHCSA/RHCE Red Hat Linux Certification Study Guide (Exams EX200 & EX300), Jang Michael, 2024, McGraw Hill Education India.

23SDCS12A - FULL STACK APPLICATION DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS12A	FULL STACK APPLICATION DEVELOPMENT	FSD	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Students will gain a thorough understanding of Maven for project management and building automation and Hibernate for ORM in Java applications. They will learn to manage dependencies, automate builds, perform CRUD operations, write advanced queries, and handle inheritance in ORM, effectively integrating Java applications with databases.	3	PO5, PO9, PSO2
CO2	Students will gain a solid foundation in the Spring framework, including its architecture, core principles like Dependency Injection and Inversion of Control, and web development applications. They will be proficient in developing Spring-based web applications, performing CRUD operations, and integrating with relational databases, using Spring's features to create robust, maintainable Java applications.	3	PO5, PO9, PSO2
CO3	Students will gain a comprehensive understanding of Spring Boot and React JS for backend and frontend development. They will be proficient in building full-stack web applications, integrating RESTful web services, managing data with Spring Data JPA, and using React features like Hooks and Redux for state management.	3	PO5, PO9, PSO2
CO4	Students will understand both monolithic and microservices architectures and gain practical skills in building, deploying, and managing microservices with Spring Boot and Spring Cloud. They will be equipped to design and implement scalable, resilient, cloud-native applications using industry best practices and tools. Students will master advanced Spring Boot development.	3	PO5, PO9, PSO2

Syllabus

Maven-Introduction to Build Tools, Maven Build Tool and its advantages, Project Object Model(POM). Dependencies And Repositories, Maven Build Life Cycles, Phases and Goals, Maven Archetypes.

Hibernate-Introduction to ORM, JPA and its advantages. JDBC Vs Hibernate. Hibernate Architecture. Hibernate CRUD operations based on Persistence Object. Hibernate Query Language (HQL) & its operations. Hibernate Criteria Query Language (HCQL) & its operations. Generator Classes in Hibernate. Hibernate Inheritance Mapping.

Spring-Introduction to Spring and its advantages. Spring Architecture and modules. Dependency Injection and Inversion of Control with Primitive Data Types and Non-Primitive Data types using XML & Annotations. Autowiring using Dependency Injection and IoC. Spring Web Application MVC Architecture, JDBC Vs Hibernate Template. Spring Boot-Introduction to Spring Boot and Spring Vs Spring Boot. Spring Boot Architecture. Spring Boot Dependency Injection (DI) and Inversion of Controller (IoC). Spring Boot with Rest Controller and Controller. Spring Boot with Restful Web Services or REST API & Annotations.

Spring Boot Web Application MVC Architecture. Spring Data JPA & Repositories. DAO Layer, Repository Layer and Service Layer. Spring Boot Web MVC CRUD Application with Spring Data JPA. Spring Boot Web MVC with Pagination. React JS Component-based Architecture, React Hooks, Fetch/Axios API and React Router. Spring Boot Rest API CRUD operations with React JS. Spring Boot Web MVC CRUD Application with React JS. Microservices and Spring Cloud-Monolith Architecture vs. Microservices Architecture. Microservice with RestTemplate. Introduction to Spring Cloud, Spring Cloud Config Server & Client. Service Registry & Discovery with Netflix Eureka Client & Server. API Gateway with Spring Cloud Gateway.

Reference Books

- 1 The Full-Stack Developer , Chris Northwood , 1st ed. 2024, APRESS.

- 2 Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, Node.js , Greg Lim, 4th, 2023, Greg Lim.
- 3 Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasan Subramanian, 1st 2024, Apress - 2019..
- 4 Web Technologies: Concepts, Methodologies, Tools, and Applications, Information Science Reference, Arthur Tatnall , 4th edition, 2022, IGI Global.
- 5 MERN Quick Start Guide: Build web applications with MongoDB, Express.js, React, and Node.js, Eddy Wilson Iriarte Koroliova, 1st Edition, Packt Publishing-2019.
- 6 Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js, Shama Hoque, 1st Edition, Packt Publishing-2020.

23SDCS12E - FULL STACK APPLICATION DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS12E	FULL STACK APPLICATION DEVELOPMENT	FSD	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Students will gain a thorough understanding of Maven for project management and building automation and Hibernate for ORM in Java applications. They will learn to manage dependencies, automate builds, perform CRUD operations, write advanced queries, and handle inheritance in ORM, effectively integrating Java applications with databases.	3	PO5, PO9, PSO2
CO2	Students will gain a solid foundation in the Spring framework, including its architecture, core principles like Dependency Injection and Inversion of Control, and web development applications. They will be proficient in developing Spring-based web applications, performing CRUD operations, and integrating with relational databases, using Spring's features to create robust, maintainable Java applications.	3	PO5, PO9, PSO2
CO3	Students will gain a comprehensive understanding of Spring Boot and React JS for backend and frontend development. They will be proficient in building full-stack web applications, integrating RESTful web services, managing data with Spring Data JPA, and using React features like Hooks and Redux for state management.	3	PO5, PO9, PSO2
CO4	Students will understand both monolithic and microservices architectures and gain practical skills in building, deploying, and managing microservices with Spring Boot and Spring Cloud. They will be equipped to design and implement scalable, resilient, cloud-native applications using industry best practices and tools. Students will master advanced Spring Boot development, including unit testing, JWT-based security for authentication and authorization.	3	PO5, PO9, PSO2

Syllabus

Maven-Introduction to Build Tools, Maven Build Tool and its advantages, Project Object Model(POM). Dependencies And Repositories, Maven Build Life Cycles, Phases and Goals, Maven Archetypes.

Hibernate-Introduction to ORM, JPA and its advantages. JDBC Vs Hibernate. Hibernate Architecture. Hibernate CRUD operations based on Persistence Object. Hibernate Query Language (HQL) & its operations. Hibernate Criteria Query Language (HCQL) & its operations. Generator Classes in Hibernate. Hibernate Inheritance Mapping.

Spring-Introduction to Spring and its advantages. Spring Architecture and modules. Dependency Injection and Inversion of Control with Primitive Data Types and Non-Primitive Data types using XML & Annotations. Autowiring using Dependency Injection and IoC. Spring Web Application MVC Architecture, JDBC Vs Hibernate Template. Spring Boot-Introduction to Spring Boot and Spring Vs Spring Boot. Spring Boot Architecture. Spring Boot Dependency Injection (DI) and Inversion of Controller (IoC). Spring Boot with Rest Controller and Controller. Spring Boot with Restful Web Services or REST API & Annotations.

Spring Boot Web Application MVC Architecture. Spring Data JPA & Repositories. DAO Layer, Repository Layer and Service Layer. Spring Boot Web MVC CRUD Application with Spring Data JPA. Spring Boot Web MVC with Pagination. React JS Component-based Architecture, React Hooks, Fetch/Axios API and React Router. Spring Boot Rest API CRUD operations with React JS. Spring Boot Web MVC CRUD Application with React JS. Microservices and Spring Cloud-Monolith Architecture vs. Microservices Architecture. Microservice with RestTemplate. Introduction to Spring Cloud, Spring Cloud Config Server & Client. Service Registry & Discovery with Netflix Eureka Client & Server. API Gateway with Spring Cloud Gateway.

Reference Books

- 1 Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, Node.js, Greg Lim, 4, Greg Lim-2020.
- 2 Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasam Subramanian, 1, Apress - 2019..
- 3 The Full-Stack Developer, Chris Northwood, 1st ed., APRESS-2019.
- 4 MERN Quick Start Guide: Build web applications with MongoDB, Express.js, React, and Node.js, Eddy Wilson Iriarte Korolova, 1st Edition, Packt Publishing-2018.
- 5 Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js, Shama Hoque, 1st Edition, Packt Publishing-2020.
- 6 Mastering Full-Stack React Web Development: Build professional full-stack web applications with advanced React, Node.js, Express, and MongoDB skills, Tomasz Dyl, 1st Edition, Packt Publishing-2022.

23SDCS12R - FULL STACK APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS12R	FULL STACK APPLICATION DEVELOPMENT	FSD	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Students will gain a thorough understanding of Maven for project management and building automation and Hibernate for ORM in Java applications. They will learn to manage dependencies, automate builds, perform CRUD operations, write advanced queries, and handle inheritance in ORM, effectively integrating Java applications with databases.	3	PO5, PO9, PSO2
CO2	Students will gain a solid foundation in the Spring framework, including its architecture, core principles like Dependency Injection and Inversion of Control, and web development applications. They will be proficient in developing Spring-based web applications, performing CRUD operations, and integrating with relational databases, using Spring's features to create robust, maintainable Java applications.	3	PO5, PO9, PSO2
CO3	Students will gain a comprehensive understanding of Spring Boot and React JS for backend and frontend development. They will be proficient in building full-stack web applications, integrating RESTful web services, managing data with Spring Data JPA, and using React features like Hooks and Redux for state management.	3	PO5, PO9, PSO2
CO4	Students will understand both monolithic and microservices architectures and gain practical skills in building, deploying, and managing microservices with Spring Boot and Spring Cloud. They will be equipped to design and implement scalable, resilient, cloud-native applications using industry best practices and tools.	3	PO5, PO9, PSO2

Syllabus

Maven-Introduction to Build Tools, Maven Build Tool and its advantages, Project Object Model(POM). Dependencies And Repositories, Maven Build Life Cycles, Phases and Goals, Maven Archetypes. Hibernate-Introduction to ORM, JPA and its advantages. JDBC Vs Hibernate. Hibernate Architecture.

Hibernate CRUD operations based on Persistence Object. Hibernate Query Language (HQL) & its operations. Hibernate Criteria Query Language (HCQL) & its operations. Generator Classes in Hibernate. Hibernate Inheritance Mapping. Spring-Introduction to Spring and its advantages. Spring Architecture and modules. Dependency Injection and Inversion of Control with Primitive Data Types and Non-Primitive Data types using XML & Annotations. Autowiring using Dependency Injection and IoC. Spring Web Application MVC Architecture, JDBC Vs Hibernate Template.

Spring Boot-Introduction to Spring Boot and Spring Vs Spring Boot. Spring Boot Architecture. Spring Boot Dependency Injection (DI) and Inversion of Controller (IoC). Spring Boot with Rest Controller and Controller. Spring Boot with Restful Web Services or REST API & Annotations. Spring Boot Web Application MVC Architecture

Spring Data JPA & Repositories. DAO Layer, Repository Layer and Service Layer. Spring Boot Web MVC CRUD Application with Spring Data JPA. Spring Boot Web MVC with Pagination. React JS Component-based Architecture, React Hooks, Fetch/Axios API and React Router. Spring Boot Rest API CRUD operations with React JS. Spring Boot Web MVC CRUD Application with React JS.

Reference Books

- 1 Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, Node.js, Greg Lim, 4, Greg Lim-2020.
- 2 Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Vasan Subramanian, 1, Apress - 2019..
- 3 The Full-Stack Developer, Chris Northwood, 1, APRESS.

- 4 Web Technologies: Concepts, Methodologies, Tools, and Applications, Information Science Reference, Arthur Tatnall, 4, IGI Global.
- 5 MERN Quick Start Guide: Build web applications with MongoDB, Express.js, React, and Node.js, Eddy Wilson Iriarte Koroliova, 1st Edition, Packt Publishing-2019.
- 6 Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js, Shama Hoque, 1st Edition, Packt Publishing-2020.

23SDCS13A - CI/CD & CLOUD DEVOPS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS13A	CI/CD & CLOUD DEVOPS	CICD	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FULL STACK APPLICATION DEVELOPMENT	FSD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of Networks, Cloud and DevOps Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software	2	PO5, PO6, PSO2
CO2	Inspect Configuration Management using Infrastructure as Code	4	PO5, PO6, PSO2
CO3	Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration	4	PO4, PO5, PO6, PSO2
CO4	Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications using Pipeline and Examine the Software and Automation Testing Frameworks.	3	PO4, PO5, PO6, PSO2

Syllabus

Networking Fundamentals: Network Fundamentals, Storage Fundamentals, Databases Fundamentals, Web servers (NGINX), LINUX Basic and Admin Importance of Linux in DevOps, Linux Basic Command Utilities, Shell Scripting

Cloud Fundamentals, AWS fundamentals, SDLC, DevOps Fundamentals: Git, Maven. Terraform: Overview, Terraform with AWS, Terraform -variables, conditions, iterator, provisioner, functions, modules, workspace, backends.

YAML, introduction, Architecture, Playbook Concepts, Ansible Inventory and Configuration, Ansible Modules, Roles. Docker & Kubernetes: How to get Docker Image? What is Docker Image,

What is Docker Image, Docker Installation, working with Docker Container What is Container o Docker Engine, Creating Containers with an Image, Working with Images, Docker Command Line Interface, Docker Compose, Docker Hub, Docker Trusted Registry, Docker swarm, Docker attach Docker File & Command, Kubernetes Architecture, Design and Install a Kubernetes Cluster

Reference Books

- 1 DevOps for Web Development , Mitesh Soni, 2016, PACKT Publishing.
- 2 Kubernetes A Complete DevOps Cookbook_ Build and manage your applications, orchestrate containers, and deploy cloud-native services , Murat Karslioglu, 2020, Packt Publishing.
- 3 Beginning DevOps with Docker , Joseph Muli, 2018, PACKT Publishing .
- 4 DevOps With Kubernetes , - Hideto Saito, Hui-Chuan Chloe Lee, Cheng-Yang , 2018, PACKT Publishing.

23SDCS13E - CI/CD & CLOUD DEVOPS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS13E	CI/CD & CLOUD DEVOPS	CICD	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FULL STACK APPLICATION DEVELOPMENT	FSD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of Networks, Cloud and DevOps Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software	2	PO5, PO6, PSO2
CO2	Inspect Configuration Management using Infrastructure as Code	4	PO5, PO6, PSO2
CO3	Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration.	4	PO4, PO5, PO6, PSO2
CO4	Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications using Pipeline and Examine the Software and Automation Testing Frameworks.	4	PO4, PO5, PO6, PSO2

Syllabus

Networking Fundamentals: Network Fundamentals, Storage Fundamentals, Databases Fundamentals, Web servers (NGINX), LINUX Basic and Admin Importance of Linux in DevOps, Linux Basic Command Utilities, Shell Scripting

Cloud Fundamentals, AWS fundamentals, SDLC, DevOps Fundamentals: Git, Maven. Terraform: Overview, Terraform with AWS, Terraform -variables, conditions, iterator, provisioner, functions, modules, workspace, backends.

YAML, introduction, Architecture, Playbook Concepts, Ansible Inventory and Configuration, Ansible Modules, Roles. Docker & Kubernetes: How to get Docker Image

What is Docker Image, Docker Installation, working with Docker Container What is Container o Docker Engine, Creating Containers with an Image, Working with Images, Docker Command Line Interface, Docker Compose, Docker Hub, Docker Trusted Registry, Docker swarm, Docker attach Docker File & Command, Kubernetes Architecture, Design and Install a Kubernetes Cluster

Introduction to Jenkins, Continuous Integration with Jenkins, Configure, Jenkins, Jenkins Management, Scheduling build Jobs, Maven Build Scripts, Support for the GIT version control System, Jenkins Build Pipeline Parent and Child Builds, Sequential Builds, Jenkins Master & Slave Node Configuration, Installing Jenkins Plugins, SCM plugin, Build and test

Reference Books

- 1 DevOps for Web Development , Mitesh Soni , 2016, PACKT Publishing .
- 2 Beginning DevOps with Docker , Joseph Muli, 2018, PACKT Publishing .
- 3 Docker for Developers_ Develop and run your application with Docker containers using DevOps tools for continuous delivery , Richard Bullington-McGuire, Andrew K. Dennis, Michael Schwartz, 2020, Packt Publishing.
- 4 DevOps With Kubernetes , - Hideto Saito, Hui-Chuan Chloe Lee, Cheng-Yang,, 2019, PACKT Publishing.

23SDCS13R - CI/CD & CLOUD DEVOPS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS13R	CI/CD & CLOUD DEVOPS	CICD	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	FULL STACK APPLICATION DEVELOPMENT	FSD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of Networks, Cloud and DevOps Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software	2	PO5, PO6, PSO2
CO2	Inspect Configuration Management using Infrastructure as Code	4	PO5, PO6, PSO2
CO3	Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration.	4	PO4, PO5, PO6, PSO2

Syllabus

Networking Fundamentals: Network Fundamentals, Storage Fundamentals, Databases Fundamentals, Web servers (NGINX), LINUX Basic and Admin Importance of Linux in DevOps, Linux Basic Command Utilities, Shell Scripting

Cloud Fundamentals, AWS fundamentals, SDLC, DevOps Fundamentals: Git, Maven.

Overview, Terraform with AWS, Terraform -variables, conditions, iterator, provisioner, functions, modules, workspace, backends

Reference Books

- 1 DevOps for Web Development , Mitesh Soni, 2016, PACKT Publishing .
- 2 Beginning DevOps with Docker , Joseph Muli, , 2018, PACKT Publishing.
- 3 Docker for Developers_ Develop and run your application with Docker containers using DevOps tools for continuous delivery (, Richard Bullington-McGuire, Andrew K. Dennis, Michael Schwartz , 2020, Packt Publishing.
- 4 DevOps With Kubernetes , - Hideto Saito, Hui-Chuan Chloe Lee, Cheng-Yang,, 2019, PACKT Publishing, .

23SDCS14A - CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS14A	CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS	CASW	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform scientific workload deployment and management on numerous cloud platforms. Virtual machine setup, storage configuration	3	PO1, PO2, PO5, PSO2
CO2	Application of Docker and Kubernetes to construct scalable and reproducible scientific application environments with seamless integration and deployment.	3	PO5, PSO2
CO3	Optimise cloud resources for performance and cost-effectiveness using monitoring and analytics tools to efficiently execute scientific workloads	4	PO1, PO2, PO5, PSO2
CO4	Assess data security, compliance, and scalability while choosing cloud architecture techniques for scientific applications.	4	PO1, PO2, PSO2

Syllabus

Introduction to Cloud Platforms and Virtualization: virtualization fundamentals: hypervisors (Type 1 and Type 2), virtual machines (VMs), and their management. Configuring VMs using platforms like VMware, Hyper-V, or KVM. An overview of major cloud service providers (AWS, Google Cloud Platform, Microsoft Azure) deploying and managing VMs on these platforms.

containerization, differences between containers and VMs. Docker, its installation, basic commands, create and manage Docker images and containers. Orchestration with Kubernetes setting up a Kubernetes cluster using Minikube and deploying a sample application, implementing Kubernetes services, ConfigMaps, and Secrets, performing rolling updates and rollbacks. Continuous Integration/Continuous Deployment (CI/CD) concepts and tools such as Jenkins, GitLab CI, and Travis CI, and implement a CI/CD pipeline for a scientific application.

Optimizing Cloud Resources: performance optimization for cloud-based scientific workloads. Use monitoring and benchmarking tools such as AWS CloudWatch, Google Cloud's Stackdriver, and Azure Monitor to analyze and improve application performance. Cost management strategies, AWS Cost Explorer and automated measures through AWS Budgets. Additionally, cloud storage solutions like Amazon S3, Google Cloud Storage, and Azure Blob Storage, and implement data lifecycle management policies to handle data retention and deletion effectively.

Cloud Architecture Strategies and Security: Architectural design principles for scientific applications in the cloud. Case studies and evaluate different architecture strategies to design scalable, secure, and high-availability solutions. Security and compliance for data protection, implementing encryption, access controls, and meeting compliance requirements such as GDPR and HIPAA. Designing a secure cloud architecture for a sample scientific workload.

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2013, Pearson Publication.
- 2 Kubernetes Up & Running: Dive into the Future of Infrastructure , Kelsey Hightower, Brendan Burns, and Joe Beda, 2017, O'Really Media.
- 3 Cloud Native DevOps with Kubernetes: Building, Deploying, and Scaling Modern Applications in the Cloud, John Arundel and Justin Domingus, 2022, O'Really Media.
- 4 Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, Martin Kleppmann, 2017, O'Really Media.

23SDCS14E - CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS14E	CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS	CASW	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform scientific workload deployment and management on numerous cloud platforms. Virtual machine setup, storage configuration	3	PO1, PO2, PO5, PSO2
CO2	Application of Docker and Kubernetes to construct scalable and reproducible scientific application environments with seamless integration and deployment.	3	PO5, PSO2
CO3	Optimise cloud resources for performance and cost-effectiveness using monitoring and analytics tools to efficiently execute scientific workloads	4	PO1, PO2, PO5, PSO2
CO4	Assess data security, compliance, and scalability while choosing cloud architecture techniques for scientific applications.	4	PO1, PO2, PSO2

Syllabus

Cloud Platforms and Virtualization: virtualization fundamentals, hypervisors (Type 1 and Type 2), virtual machines (VMs), and their management. Configuring VMs using platforms like VMware, Hyper-V, or KVM. An overview of major cloud service providers (AWS, Google Cloud Platform, Microsoft Azure) deploying and managing VMs .

Containerization and Orchestration: containerization, differences between containers and VMs. Docker, its installation, basic commands, create and manage Docker images and containers. Orchestration with Kubernetes setting up a Kubernetes cluster using Minikube and deploying a sample application, implementing Kubernetes services, ConfigMaps, and Secrets, performing rolling updates and rollbacks. Continuous Integration/Continuous Deployment (CI/CD) concepts and tools such as Jenkins, GitLab CI, and Travis CI, and implement a CI/CD pipeline for a scientific application.

Optimizing Cloud Resources: performance optimization for cloud-based scientific workloads. Use monitoring and benchmarking tools such as AWS CloudWatch, Google Cloud's Stackdriver, and Azure Monitor to analyze and improve application performance. Cost management strategies, AWS Cost Explorer and automated measures through AWS Budgets. Additionally, cloud storage solutions like Amazon S3, Google Cloud Storage, and Azure Blob Storage, and implement data lifecycle management policies to handle data retention and deletion effectively

Cloud Architecture Strategies and Security: Architectural design principles for scientific applications in the cloud. Case studies and evaluate different architecture strategies to design scalable, secure, and high-availability solutions. Security and compliance for data protection, implementing encryption, access controls, and meeting compliance requirements such as GDPR and HIPAA. Designing a secure cloud architecture for a sample scientific workload.

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2013, Pearson Education.
- 2 Kubernetes Up & Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 2017, O'Reilly Media.
- 3 Cloud Native DevOps with Kubernetes: Building, Deploying, and Scaling Modern Applications in the Cloud, John Arundel and Justin Domingus, 2022, O'Reilly Media.
- 4 Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, Martin Kleppmann, 2017, O'Reilly Media.

23SDCS14R - CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS14R	CLOUD ARCHITECTURES FOR SCIENTIFIC WORKLOADS	CASW	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform scientific workload deployment and management on numerous cloud platforms. Virtual machine setup, storage configuration	3	PO1, PO2, PO5, PSO2
CO2	Application of Docker and Kubernetes to construct scalable and reproducible scientific application environments with seamless integration and deployment.	3	PO5, PSO2
CO3	Optimise cloud resources for performance and cost-effectiveness using monitoring and analytics tools to efficiently execute scientific workloads.	4	PO1, PO2, PO5, PSO2

Syllabus

Cloud Platforms and Virtualization: virtualization fundamentals, hypervisors (Type 1 and Type 2), virtual machines (VMs), and their management. Configuring VMs using platforms like VMware, Hyper-V, or KVM. An overview of major cloud service providers (AWS, Google Cloud Platform, Microsoft Azure) deploying and managing VMs .

Containerization and Orchestration: containerization, differences between containers and VMs. Docker, its installation, basic commands, create and manage Docker images and containers. Orchestration with Kubernetes setting up a Kubernetes cluster using Minikube and deploying a sample application, implementing Kubernetes services, ConfigMaps, and Secrets, performing rolling updates and rollbacks. Continuous Integration/Continuous Deployment (CI/CD) concepts and tools such as Jenkins, GitLab CI, and Travis CI, and implement a CI/CD pipeline for a scientific application.

Optimizing Cloud Resources: performance optimization for cloud-based scientific workloads. Use monitoring and benchmarking tools such as AWS CloudWatch, Google Cloud's Stackdriver, and Azure Monitor to analyze and improve application performance. Cost management strategies, AWS Cost Explorer and automated measures through AWS Budgets. Additionally, cloud storage solutions like Amazon S3, Google Cloud Storage, and Azure Blob Storage, and implement data lifecycle management policies to handle data retention and deletion effectively

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2013, Pearson Education.
- 2 Kubernetes Up & Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 2017, O'Reilly Media.
- 3 Cloud Native DevOps with Kubernetes: Building, Deploying, and Scaling Modern Applications in the Cloud, John Arundel and Justin Domingus, 2022, O'Reilly Media.
- 4 Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, Martin Kleppmann, 2017, O'Reilly Media.

23SDCS15A - SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS15A	SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING	SDCNC	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate the core principles of cloud native computing	2	PO1
CO2	Develop microservices architectures for cloud applications	3	PO2, PSO1
CO3	Analyse the cloud-native applications using containers and container orchestration	4	PO3, PO4, PSO1
CO4	Determine DevOps practices for building and deploying cloud applications	5	PO4

Syllabus

Introduction to Cloud Native Computing Cloud Computing Fundamentals: Cloud service models (IaaS, PaaS, SaaS) Benefits and challenges of cloud computing for software development Cloud deployment models (public, private, hybrid)

Developing Cloud-Native Applications : Microservices Architecture Design: Decomposing monolithic applications into microservices Designing inter-service communication patterns (REST APIs, event-driven) Managing dependencies between microservices API Design for Cloud Applications: RESTful API design principles API versioning and documentation Implementing security best practices in APIs

Building Cloud-Native Applications services to a Kubernetes cluster Scaling and managing containerized applications Infrastructure as Code (IaC): Introduction to IaC tools like Terraform Automating infrastructure provisioning and configuration in the cloud Managing infrastructure changes through code version control

Monitoring and Observability Application Monitoring in the Cloud: Metrics, logs, and tracing for cloud-native applications Using cloud monitoring tools for performance analysis Alerting and incident management pen_spark

Reference Books

- 1 Cloud-native Computing: How to Design, Develop, and Secure Microservices and Event-Driven Applications , Pethuru Raj, Skylab Vanga, Akshita Chaudhary, 2018, TMH.
- 2 Cloud Native: Using containers, functions, and data to build next-generation applications, Boris Scholl, Trent Swanson, and Peter Jausovec, 2020, Overseas.
- 3 Building Microservices: Designing Fine-Grained Systems, Sam Newman, 2021, 'Reilly Media.
- 4 Kubernetes Patterns: Reusable Elements for Designing Cloud-Native Applications, Bilgin Ibryam and Roland, 2018, O'Reilly Media.

23SDCS15E - SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS15E	SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING	SDCNC	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Build the core principles and benefits of cloud-native computing, including microservices architecture, containerization, and serverless computing.	3	PO1
CO2	Analyze the scalable, resilient, and maintainable cloud-native applications using modern design patterns and best practices.	4	PO2, PSO1
CO3	Distinguish monolithic applications into microservices, understanding inter-service communication, API gateways, and service discovery mechanisms.	4	PO3, PSO1
CO4	Compare various serverless architecture, learning how to develop, deploy, and manage serverless functions using platforms like AWS Lambda, Google Cloud Functions, or Azure Functions.	4	PO4

Syllabus

Introduction to Cloud-Native Computing Overview of cloud computing and its evolution Understanding cloud-native principles Benefits and challenges of cloud-native computing Case studies of successful cloud-native applications

Containerization with Docker Introduction to containers and Docker Docker architecture and components Building and managing Docker images Docker networking and storage Best practices for Docker containerization

Orchestration with Kubernetes Introduction to Kubernetes Kubernetes architecture and components Deploying applications on Kubernetes clusters Managing and scaling applications with Kubernetes Monitoring and logging in Kubernetes environments

Microservices Architecture Introduction to microservices Principles of microservices architecture Decomposing monolithic applications into microservices Communication between microservices Testing and deploying microservices

Reference Books

- 1 Cloud Native Patterns: Designing Change-Tolerant Software, Cornelia Davis, 2021, O'Reilly Media.
- 2 Kubernetes Up & Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 2021, O'Reilly Media.
- 3 The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations, Gene Kim, Patrick Debois, John Willis, and Jez Humble, 2020, IT Revolution Press.
- 4 Site Reliability Engineering: How Google Runs Production Systems, Niall Richard Murphy, Betsy Beyer, Chris Jones, and Jennifer Petoff, 2021, O'Reilly Media.
- 5 Building Microservices: Designing Fine-Grained Systems, Sam Newman, 2019, O'Reilly Media.

23SDCS15R - SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS15R	SOFTWARE DESIGN WITH CLOUD NATIVE COMPUTING	SDCNC	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamentals of cloud-native computing	2	PO1
CO2	Develop key principles and characteristics of cloud-native architecture.	3	PO2
CO3	Identify and choose containerization and orchestration technologies such as Docker and Kubernetes.	3	PO3, PSO1
CO4	Compare different microservices architectures and its benefits for cloud-native applications.	4	PO4, PSO1

Syllabus

Introduction to Cloud-Native Computing What is Cloud-Native Computing? Evolution of Cloud-Native Architecture Key Principles of Cloud-Native Design Benefits and Challenges of Cloud-Native Applications

Containerization and Orchestration Introduction to Containers Docker: Containerization Platform Kubernetes: Container Orchestration Container Networking and Storage

Microservices Architecture Understanding Microservices Benefits and Challenges of Microservices Designing Microservices-based Applications Service Discovery and Communication

Cloud-Native Design Patterns Introduction to Design Patterns Common Cloud-Native Design Patterns Patterns for Resilience, Scalability, and Observability Implementing Design Patterns in Practice

Reference Books

- 1 Cloud Native Patterns: Designing Change-tolerant Software, Cornelia Davis, 2021, Pearson.
- 2 Kubernetes: Up and Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 2019, TMH.
- 3 Building Microservices: Designing Fine-Grained Systems, Sam Newman, 2018, O'Reilly Media.
- 4 Cloud Native Java: Designing Resilient Systems with Spring Boot, Spring Cloud, and Cloud Foundry, Josh Long and Kenny Bastani, 2021, O'Reilly Media.

23SDCS16A - CLOUD INFRASTRUCTURE DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS16A	CLOUD INFRASTRUCTURE DESIGN	CISD	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze business requirements and design cloud infrastructure solutions to meet organizational needs.	3	PO1, PSO1
CO2	Evaluate different cloud service models and select appropriate services for specific use cases.	3	PO1, PSO1
CO3	Design scalable and resilient cloud architectures that optimize resource utilization and cost efficiency.	4	PO2, PSO1
CO4	Design and implement network infrastructure to ensure connectivity, performance, and reliability in cloud environments.	4	PO2, PSO1

Syllabus

Introduction to Cloud Computing: Overview of cloud computing models (IaaS, PaaS, SaaS), Benefits and challenges of cloud computing, Cloud service providers and their offerings, Case studies of cloud adoption in various industries

Cloud Service Models and Deployment Models : Understanding different cloud service models (Public, Private, Hybrid, Multi-cloud), Evaluating deployment models (On-premises, Infrastructure as a Service, Platform as a Service, Software as a Service), Use cases and considerations for each service and deployment model

Cloud Infrastructure Design Principles: Designing for scalability, elasticity, and flexibility, Resilience and fault tolerance in cloud architectures, Cost optimization strategies and best practices, Compliance, security, and regulatory considerations

Security and Compliance in the Cloud: Cloud security fundamentals (Identity and Access Management, Encryption, Key Management), Implementing security controls and best practices, Compliance frameworks and regulations (GDPR, HIPAA, PCI DSS), Security incident response and forensic analysis

Reference Books

- 1 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, and Andrzej Goscinski, 2011, Wiley.
- 2 Designing Cloud Computing Solutions, Kevin L. Jackson and Scott Goessling, 2011, Addison-Wesley Professional.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 2014, Wiley.
- 4 Cloud Architecture Patterns: Using Microsoft Azure, Bill Wilder, 2012, O'Reilly Media.
- 5 Cloud Computing Design Patterns, Thomas Erl, 2015, Prentice Hall.

23SDCS16E - CLOUD INFRASTRUCTURE DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS16E	CLOUD INFRASTRUCTURE DESIGN	CISD	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze business requirements and design cloud infrastructure solutions to meet organizational needs.	3	PO1, PSO1
CO2	Evaluate different cloud service models and select appropriate services for specific use cases.	3	PO1, PSO1
CO3	Design scalable and resilient cloud architectures that optimize resource utilization and cost efficiency.	4	PO2, PSO1
CO4	Design and implement network infrastructure to ensure connectivity, performance, and reliability in cloud environments.	4	PO2, PSO1

Syllabus

Introduction to Cloud Computing: Overview of cloud computing models (IaaS, PaaS, SaaS), Benefits and challenges of cloud computing, Cloud service providers and their offerings, Case studies of cloud adoption in various industries

Cloud Service Models and Deployment Models : Understanding different cloud service models (Public, Private, Hybrid, Multi-cloud), Evaluating deployment models (On-premises, Infrastructure as a Service, Platform as a Service, Software as a Service), Use cases and considerations for each service and deployment model.

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Security and Compliance in the Cloud: Cloud security fundamentals (Identity and Access Management, Encryption, Key Management), Implementing security controls and best practices, Compliance frameworks and regulations (GDPR, HIPAA, PCI DSS), Security incident response and forensic analysis.

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- 1 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, and Andrzej Goscinski, 2011, Wiley.
- 2 Designing Cloud Computing Solutions, Kevin L. Jackson and Scott Goessling, 2011, Addison-Wesley Professional.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 2014, Wiley.
- 4 Cloud Architecture Patterns: Using Microsoft Azure, Bill Wilder, 2012, O'Reilly Media.
- 5 Cloud Computing Design Patterns, Thomas Erl, 2015, Prentice Hall.

23SDCS16R - CLOUD INFRASTRUCTURE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS16R	CLOUD INFRASTRUCTURE DESIGN	CISD	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze business requirements and design cloud infrastructure solutions to meet organizational needs.	3	PO1, PSO1
CO2	Evaluate different cloud service models and select appropriate services for specific use cases.	3	PO1, PSO1
CO3	Design scalable and resilient cloud architectures that optimize resource utilization and cost efficiency.	3	PO2, PSO1

Syllabus

Introduction to Cloud Computing: Overview of cloud computing models (IaaS, PaaS, SaaS), Benefits and challenges of cloud computing, Cloud service providers and their offerings, Case studies of cloud adoption in various industries.

Cloud Service Models and Deployment Models : Understanding different cloud service models (Public, Private, Hybrid, Multi-cloud), Evaluating deployment models (On-premises, Infrastructure as a Service, Platform as a Service, Software as a Service), Use cases and considerations for each service and deployment model.

Cloud Infrastructure Design Principles: Designing for scalability, elasticity, and flexibility, Resilience and fault tolerance in cloud architectures, Cost optimization strategies and best practices, Compliance, security, and regulatory considerations.

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- 2 Designing Cloud Computing Solutions, Kevin L. Jackson and Scott Goessling, 2011, Addison-Wesley Professional.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 2014, Wiley.
- 4 Cloud Architecture Patterns: Using Microsoft Azure, Bill Wilder, 2012, O'Reilly Media.
- 5 Cloud Computing Design Patterns, Thomas Erl, 2015, Prentice Hall.

23SDCS17A - GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS17A	GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES	GANI	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Build generative adversarial networks (GANs), from their simplest form to state-of-the-art models , to build an advanced DCGAN specifically for processing images	3	PO1, PO2, PO8, PSO1
CO2	Apply familiarity with the latest cutting-edge literature on GANs , advanced techniques such as WGANs to mitigate unstable training and mode collapse with a W-Loss and an understanding of Lipschitz Continuity, Learn about useful activation functions	3	PO1, PO2, PO8, PSO1
CO3	Apply Reward risk-taking and creative exploration ,dvanced techniques such as WGANs to mitigate unstable training and mode collapse with a W-Loss and an understanding of Lipschitz Continuity, Learn about useful activation functions	3	PO2, PO3, PO8, PSO1
CO4	Build a more sophisticated GAN using convolutional layers ,build conditional GANs capable of generating examples from determined categories, Learn about useful activation functions, batch normalization, and transposed convolutions	3	PO2, PO3, PO8, PSO1
CO5	Implement, debug, and train GANs as part of a novel and substantial course project, build conditional GANs capable of generating examples from determined categories, Learn about useful activation functions, batch normalization, and transposed convolutions	3	PO2, PO3, PO8, PSO1

Syllabus

Learn about GANs and their applications, understand the intuition behind the basic components of GANs, and build your very own GAN using PyTorch, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Build a more sophisticated GAN using convolutional layers. Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Reduce instances of GANs failure due to imbalances between the generator and discriminator by learning advanced techniques such as WGANs to mitigate unstable training and mode collapse with a W-Loss and an understanding of Lipschitz Continuity, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Understand how to effectively control your GAN, modify the features in a generated image, and build conditional GANs capable of generating examples from determined categories, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Reference Books

- 1 Introduction to generative adversarial networks neural networks, 2016., S. N.Sivanandam and S. N.Deepa, 2019, Amazon.
- 2 Neural Networks and Learning Machines, Simon Haykin, 2008, PHI.
- 3 Learning Generative Adversarial Networks: Next-generation deep learning simplified, Kuntal Ganguly, 2017, Amazon.
- 4 Generative Adversarial Networks Projects, Kailash Ahirwar, 2019, Amazon.

- 5 GANs in Action: Deep learning with Generative Adversarial Networks, Jakub Langr and Vladimir Bok, 2019, Amazon.

23SDCS17E - GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS17E	GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES	GANI	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Build basic GANs using PyTorch and advanced DCGANs using convolutional layers, control your GAN and build conditional GAN and build your very own GAN using PyTorch, Learn about useful activation functions, batch normalization,	3	PO1, PO2, PO8, PSO1
CO2	Compare generative models, use FID method to assess GAN fidelity and diversity, learn to detect bias in GAN, and implement StyleGAN techniques ,and build your very own GAN using PyTorch, Learn about useful activation functions, batch normalization,	3	PO1, PO2, PO8, PSO1
CO3	Apply GANs for data augmentation and privacy preservation, survey GANs applications, and examine and build Pix2Pix and CycleGAN for image translation ,advanced techniques ,Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them	3	PO2, PO3, PO8, PSO1
CO4	Implement, debug, and train GANs as part of a novel and substantial course project ,advanced techniques ,Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them	3	PO2, PO3, PO8, PSO1
CO5	Analyse Complex Deep Generative Models using Interactive Visual Experimentation , to build an advanced DCGAN specifically for processing images for processing images, Fuzzy logic, and Genetic Algorithm Hybrids	4	PO2, PO3, PO8, PSO1

Syllabus

Learn about GANs and their applications, understand the intuition behind the basic components of GANs, and build your very own GAN using PyTorch, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Analyse how to effectively control the GAN, modify the features in a generated image, and build conditional GANs capable of generating examples from determined categories, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Apply instances of GANs failure due to imbalances between the generator and discriminator by learning advanced techniques ,Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Adaptive Resonance Theory: Cluster Structure, Vector Quantization, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images, Classical ART Network, Simplified ART Architecture, ART1 and ART2 Architecture and algorithms, Applications, Sensitivities of ordering of data

Fuzzy Systems: Crisp Logic, Predicate Logic, Fuzzy logic, Fuzzy rule based system, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images, Defuzzification Methods, Applications

Integration of Neural Network, Fuzzy logic and Genetic Algorithm: Hybrid system. Neural Networks, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images, Fuzzy logic, and Genetic Algorithm Hybrids

Reference Books

- 1 Generative Adversarial Networks Cookbook, Josh Kalin, 2019, Amazon.

- 2 Hands-On Generative Adversarial Networks with Keras, Rafael Valle, 2019, Amazon.
- 3 Learning Generative Adversarial Networks: Next-generation deep learning simplified , Kuntal Ganguly, 2019, Amazon.
- 4 Hands-On Generative Adversarial Networks with Keras , Rafael Valle, 2019, Amazon.

23SDCS17R - GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS17R	GENERATIVE ADVERSARIAL NETWORKS FOR IMAGES	GANI	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the context of generative adversarial networks (GANs) Applying Generative Adversarial Networks for image generation and unsupervised tasks Applying the Convolution Neural Network on computer vision problems	2	PO1, PO2, PO8, PSO1
CO2	Understand the data needs of generative adversarial networks (GANs), Applying the Generative Convolution Neural Network on computer vision problems Train a sentiment analysis model on IMDB dataset, use RNN layers with LSTM/GRU notes	2	PO1, PO2, PO8, PSO1
CO3	Apply CNN architecture of deep neural networks Train a road analysis model on FIMDB dataset, use ARNN layers with RSTM/GRU notes Fundamental Principles Of Deep Learning	3	PO2, PO3, PO8, PSO1
CO4	Analyze the key computations underlying adversarial networks, then use them to build and train deep neural networks for various tasks .Applying Generative Adversarial Networks for image generation and unsupervised tasks.	4	PO2, PO3, PO8, PSO1
CO5	Analyze auto encoders and generative adversarial network models for suitable applications.Applying the Autoencoder algorithms for encoding the real-world data	4	PO2, PO3, PO8, PSO1

Syllabus

Learn about GANs and their applications, understand the intuition behind the basic components of GANs, and build your very own GAN using PyTorch, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Learn about useful activation functions, batch normalization, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Build a more sophisticated GAN using convolutional layers. Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Reduce instances of GANs failure due to imbalances between the generator and discriminator by learning advanced techniques such as WGANs to mitigate unstable training and mode collapse with a W-Loss and an understanding of Lipschitz Continuity, Learn about useful activation functions, batch normalization, and transposed convolutions to tune your GAN architecture and apply them to build an advanced DCGAN specifically for processing images

Reference Books

- 1 Learning Generative Adversarial Networks, Kuntal Ganguly , 2017, Amazon.
- 2 Deep Learning with Python First Edition , Francois Chollet, 2023, Amazon.
- 3 Hands-On Generative Adversarial Networks with Keras, Rafael Valle, 2019, Amazon.
- 4 GANs in Action: Deep learning with Generative Adversarial Networks, Jakub Langr, 2021, Amazon.
- 5 Hands-On Generative Adversarial Networks with PyTorch, John Hany, 2021, Amazon.

23SDCS18A - TEXT ANALYTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS18A	TEXT ANALYTICS	TAT	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand how text analytics can derive meaningful insights from unstructured text data and its role in decision-making processes.	2	PO1, PO2, PO3, PO4, PSO1
CO2	Apply essential text preprocessing techniques to convert raw text data into a structured format suitable for analysis such as tokenization, stemming, lemmatization, stop-word removal, and handling of special characters and noise in the text.	3	PO1, PO2, PO3, PO4, PSO1
CO3	Utilize various text representation methods for text analytics that transforms text data into numerical representations that can be used as input for machine learning models and other analytical processes.	3	PO1, PO2, PO3, PO4, PSO1
CO4	Implement Natural Language Processing (NLP) techniques to build and deploy NLP models to solve real-world text analytics problems effectively.	5	PO1, PO2, PO3, PO4, PSO1

Syllabus

Introduction to Text Analytics: Definition and significance of text analytics. Applications in various domains. Overview of text data sources.

Text Preprocessing: Tokenization, stop-word removal, stemming, lemmatization. Case normalization, text cleaning, and handling special characters.

Text Representation: Bag-of-Words model. Term Frequency-Inverse Document Frequency (TF-IDF). Word embeddings: Word2Vec, GloVe, BERT.

Part-of-Speech (POS) tagging. Named Entity Recognition (NER). Syntactic and dependency parsing.

Reference Books

- 1 Speech and Language Processing, A comprehensive guide to NLP and text analytics., Daniel Jurafsky and James H. Marti, 2014, Pearson Education, 2014.
- 2 Text Mining: Classification, Clustering, and Applications, Ashok Srivastava and Mehran Sahami, 2009, CRC Press.
- 3 Pattern Recognition and Machine Learning, Christopher M. Bishop, 2016, Springer.
- 4 Deep Learning for Natural Language Processing, Palash Goyal, Sumit Pandey, and Karan Jain, 2022, Springer.

23SDCS18E - TEXT ANALYTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS18E	TEXT ANALYTICS	TAT	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand how text analytics can derive meaningful insights from unstructured text data and its role in decision-making processes.	2	PO1, PO2, PO3, PO4, PSO1
CO2	Apply essential text preprocessing techniques to convert raw text data into a structured format suitable for analysis such as tokenization, stemming, lemmatization, stop-word removal, and handling of special characters and noise in the text.	3	PO1, PO2, PO3, PO4, PSO1
CO3	Utilize various text representation methods for text analytics that transforms text data into numerical representations that can be used as input for machine learning models and other analytical processes.	3	PO1, PO2, PO3, PO4, PSO1
CO4	Implement Natural Language Processing (NLP) techniques to build and deploy NLP models to solve real-world text analytics problems effectively.	5	PO1, PO2, PO3, PO4, PSO1

Syllabus

Introduction to Text Analytics: Definition and significance of text analytics. Applications in various domains. Overview of text data sources.

Text Preprocessing: Tokenization, stop-word removal, stemming, lemmatization. Case normalization, text cleaning, and handling special characters.

Text Representation: Bag-of-Words model. Term Frequency-Inverse Document Frequency (TF-IDF). Word embeddings: Word2Vec, GloVe, BERT.

Part-of-Speech (POS) tagging. Named Entity Recognition (NER). Syntactic and dependency parsing.

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- 2 Deep Learning for Natural Language Processing, Palash Goyal, Sumit Pandey, and Karan Jain, 2009, Springer.
- 3 Text Mining: Classification, Clustering, and Applications, Ashok Srivastava and Mehran Sahami, 2016, CRC Press.
- 4 Pattern Recognition and Machine Learning, Christopher M. Bishop, 2022, Springer.

23SDCS18R - TEXT ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS18R	TEXT ANALYTICS	TAT	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand how text analytics can derive meaningful insights from unstructured text data and its role in decision-making processes.	2	PO1, PO2, PO3, PO4, PSO1
CO2	Apply essential text preprocessing techniques to convert raw text data into a structured format suitable for analysis such as tokenization, stemming, lemmatization, stop-word removal, and handling of special characters and noise in the text.	3	PO1, PO2, PO3, PO4, PSO1
CO3	Utilize various text representation methods for text analytics that transforms text data into numerical representations that can be used as input for machine learning models and other analytical processes.	3	PO1, PO2, PO3, PO4, PSO1

Syllabus

Introduction to Text Analytics: Definition and significance of text analytics. Applications in various domains. Overview of text data sources.

Text Preprocessing: Tokenization, stop-word removal, stemming, lemmatization. Case normalization, text cleaning, and handling special characters.

Text Representation: Bag-of-Words model. Term Frequency-Inverse Document Frequency (TF-IDF). Word embeddings: Word2Vec, GloVe, BERT.

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- 3 Pattern Recognition and Machine Learning, Christopher M. Bishop, 2016, Springer.
- 4 Deep Learning for Natural Language Processing, Palash Goyal, Sumit Pandey, and Karan Jain, 2022, Springer.

23SDCS19A - VISUAL RECOGNITION AND SCENE UNDERSTANDING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS19A	VISUAL RECOGNITION AND SCENE UNDERSTANDING	VRSU	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of visual recognition and image processing techniques.	2	PO2, PO3, PO4, PSO1
CO2	Analyze object detection and recognition methodologies, including feature-based and deep learning-based techniques.	4	PO1, PO2, PO3, PSO1
CO3	Identify suitable 3D vision and reconstruction techniques, along with their applications and challenges.	3	PO1, PO3, PO4, PSO1
CO4	Discuss ethical and social implications of visual recognition systems, including bias, fairness, privacy concerns, and ethical considerations.	6	PO1, PO2, PO4, PSO1

Syllabus

Fundamentals of visual recognition, History and development, Importance in various fields, Applications and real-world examples, Basics of image processing techniques, Image enhancement, Image segmentation, Feature extraction.

Overview of machine learning and deep learning algorithms for Object detection and recognition methodologies, Feature-based and deep learning-based object recognition, Performance evaluation and metrics. Overview of scene understanding, Semantic segmentation, Scene classification, Contextual reasoning in scene understanding.

Introduction to 3D vision and reconstruction, Depth perception and 3D vision, 3D reconstruction techniques, Applications and challenges in 3D scene understanding. Visual perception in robotics, Object manipulation and grasping, Navigation and mapping using visual data.

Overview of ethical and social implications, Bias and fairness in visual recognition, Privacy concerns in visual data, Ethical considerations in deploying visual recognition systems.

Reference Books

- 1 Computer Vision: Algorithms and Applications, Richard Szeliski , 2010, Springer.
- 2 Deep Learning for Computer Vision, Rajalingappaa Shanmugamani, 2018, Packt Publishing.
- 3 Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Peter Corke, 2011, Springer.
- 4 Multiple View Geometry in Computer Vision, Richard Hartley and Andrew Zisserman, 2003, Cambridge.
- 5 Scene Reconstruction, Pose Estimation and Tracking, Reinhard Koch and Luc Van Gool, 2016, Springer.

23SDCS19E - VISUAL RECOGNITION AND SCENE UNDERSTANDING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS19E	VISUAL RECOGNITION AND SCENE UNDERSTANDING	VRSU	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of visual recognition and image processing techniques.	2	PO2, PO3, PO4, PSO1
CO2	Analyze object detection and recognition methodologies, including feature-based and deep learning-based techniques.	4	PO1, PO2, PO3, PSO1
CO3	Identify suitable 3D vision and reconstruction techniques, along with their applications and challenges.	3	PO1, PO3, PO4, PSO1
CO4	Discuss ethical and social implications of visual recognition systems, including bias, fairness, privacy concerns, and ethical considerations.	6	PO1, PO2, PO4, PSO1

Syllabus

Fundamentals of visual recognition, History and development, Importance in various fields, Applications and real-world examples, Basics of image processing techniques, Image enhancement, Image segmentation, Feature extraction.

Overview of machine learning and deep learning algorithms for Object detection and recognition methodologies, Feature-based and deep learning-based object recognition, Performance evaluation and metrics. Overview of scene understanding, Semantic segmentation, Scene classification, Contextual reasoning in scene understanding.

Introduction to 3D vision and reconstruction, Depth perception and 3D vision, 3D reconstruction techniques, Applications and challenges in 3D scene understanding. Visual perception in robotics, Object manipulation and grasping, Navigation and mapping using visual data.

Overview of ethical and social implications, Bias and fairness in visual recognition, Privacy concerns in visual data, Ethical considerations in deploying visual recognition systems.

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- 3 Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Peter Corke, 2011, Springer.
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- 5 Scene Reconstruction, Pose Estimation and Tracking, Reinhard Koch and Luc Van Gool, 2006, Springer.

23SDCS19R - VISUAL RECOGNITION AND SCENE UNDERSTANDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS19R	VISUAL RECOGNITION AND SCENE UNDERSTANDING	VRSU	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of visual recognition and image processing techniques.	2	PO2, PO3, PO4, PSO1
CO2	Analyze object detection and recognition methodologies, including feature-based and deep learning-based techniques, and evaluate their performance using appropriate metrics.	4	PO1, PO2, PO3, PSO1
CO3	Identify suitable 3D vision and reconstruction techniques, along with their applications and challenges.	3	PO1, PO3, PO4, PSO1

Syllabus

Fundamentals of visual recognition, History and development, Importance in various fields, Applications and real-world examples, Basics of image processing techniques, Image enhancement, Image segmentation, Feature extraction.

Overview of machine learning and deep learning algorithms for Object detection and recognition methodologies, Feature-based and deep learning-based object recognition, Performance evaluation and metrics. Overview of scene understanding, Semantic segmentation, Scene classification, Contextual reasoning in scene understanding.

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- 3 Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Peter Corke, 2011, Springer.
- 4 Multiple View Geometry in Computer Vision, Richard Hartley and Andrew Zisserman, 2003, Cambridge.
- 5 Scene Reconstruction, Pose Estimation and Tracking, Reinhard Koch and Luc Van Gool, 2016, Springer.

23SDCS20A - SMART IOT AND SENSOR NETWORKS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS20A	SMART IOT AND SENSOR NETWORKS	SISN	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline the basic concepts and principles of sensor networks interconnected world of the Internet of Things.	2	PO3, PSO1
CO2	Apply the methods for data acquisition from sensors in IoT systems	3	PO3, PO6, PSO2
CO3	Identify different types of sensors and their applications in IoT systems.	3	PO2, PO3, PO10
CO4	Analyze various data processing techniques for sensor data in IoT applications.	4	PO3, PSO1, PSO2
CO5	Discover different methodologies for processing sensor data in IoT contexts.	4	PO6

Syllabus

Overview of IoT and its significance in modern technology Basics of sensor networks and their role in IoT systems Types of sensors and their applications IoT architectures and communication protocols

Methods of data acquisition from sensors Signal conditioning and pre-processing techniques Data aggregation and fusion in sensor networks Real-time data processing and analysis algorithms

Introduction to wireless communication technologies (Wi-Fi, Bluetooth, Zigbee, etc.) Protocols for IoT communication (MQTT, CoAP, HTTP, etc.) Energy-efficient communication protocols for IoT devices Security considerations in wireless IoT communication

Threats and vulnerabilities in IoT systems Security mechanisms for protecting IoT devices and networks Authentication and access control in IoT environments Privacy-preserving techniques for sensor data collection and processing

Real-time Processing Techniques, Edge Computing for IoT, Machine Learning and AI for Sensor Data, Advanced Topics in Sensor Data Processing, Case Studies and Applications

Reference Books

- 1 Internet of Things: Principles and Paradigms, Rajkumar Buyya and Amir Vahid Dastjerdi, 2016, Morgan Kaufmann.
- 2 Sensor Networks: From Theory to Applications, Habib M. Ammari, 2013, Springer.
- 3 Internet of Things: A Hands-On Approach, Arshdeep Bahga and Vijay Madisetti, 2014, VPT.
- 4 Building Internet of Things with the Arduino, Charlie Evans, 2020, CreateSpace Independent Publishing Platform.
- 5 Smart Sensor Networks: Signal Processing, Applications, and Security, Feng Xia, Laurence T. Yang, Lizhe Wang, and Alexey Zaslavsky, 2003, Springer.
- 6 Wireless Sensor Networks: Technology, Protocols, and Applications, Kazem Sohraby, Daniel Minoli, and Taieb Znati, 2022, Wiley.

23SDCS20E - SMART IOT AND SENSOR NETWORKS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS20E	SMART IOT AND SENSOR NETWORKS	SISN	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts and principles underlying IoT and sensor networks.	2	PO2, PSO1
CO2	Explain the approaches for collecting data from sensors within IoT systems	3	PO8
CO3	Analyze Various sensor classifications and their utilization across IoT systems.	3	PO5, PSO2
CO4	Evaluate different methodologies for handling sensor data in IoT applications.	4	PO9
CO5	Discover different methodologies for processing sensor data in IoT contexts.	4	PO5

Syllabus

Overview of IoT and its significance in modern technology Basics of sensor networks and their role in IoT systems Types of sensors and their applications IoT architectures and communication protocols

Methods of data acquisition from sensors Signal conditioning and pre-processing techniques Data aggregation and fusion in sensor networks Real-time data processing and analysis algorithms

Introduction to wireless communication technologies (Wi-Fi, Bluetooth, Zigbee, etc.) Protocols for IoT communication (MQTT, CoAP, HTTP, etc.) Energy-efficient communication protocols for IoT devices Security considerations in wireless IoT communication

Threats and vulnerabilities in IoT systems Security mechanisms for protecting IoT devices and networks Authentication and access control in IoT environments Privacy-preserving techniques for sensor data collection and processing

Real-time Processing Techniques, Edge Computing for IoT, Machine Learning and AI for Sensor Data, Advanced Topics in Sensor Data Processing, Case Studies and Applications

Reference Books

- 1 Internet of Things: Principles and Paradigms , Rajkumar Buyya and Amir Vahid Dastjerdi, 2016, Morgan Kaufmann.
- 2 Sensor Networks: From Theory to Applications , Habib M. Ammari, 2013, Springer.
- 3 Internet of Things: A Hands-On Approach , Arshdeep Bahga and Vijay Madisetti, 2014, VPT.
- 4 Building Internet of Things with the Arduino , Charlie Evans, 2020, CreateSpace Independent Publishing Platform.
- 5 Smart Sensor Networks: Signal Processing, Applications, and Security, Feng Xia, Laurence T. Yang, Lizhe Wang, and Alexey Zaslavsky, 2003, Springer.
- 6 Wireless Sensor Networks: Technology, Protocols, and Applications , Kazem Sohraby, Daniel Minoli, and Taieb Znati, 2022, Wiley.

23SDCS20R - SMART IOT AND SENSOR NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS20R	SMART IOT AND SENSOR NETWORKS	SISN	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts and principles of IoT and sensor networks.	4	PO8, PSO1
CO2	Explain methods for data acquisition from sensors in IoT systems	4	PO2
CO3	Analyze different types of sensors and their applications in IoT systems.	4	PO5, PSO2

Syllabus

Overview of IoT and its significance in modern technology Basics of sensor networks and their role in IoT systems Types of sensors and their applications IoT architectures and communication protocols

Methods of data acquisition from sensors Signal conditioning and pre-processing techniques Data aggregation and fusion in sensor networks Real-time data processing and analysis algorithms

Introduction to wireless communication technologies (Wi-Fi, Bluetooth, Zigbee, etc.) Protocols for IoT communication (MQTT, CoAP, HTTP, etc.) Energy-efficient communication protocols for IoT devices Security considerations in wireless IoT communication

Reference Books

- 1 Internet of Things: Principles and Paradigms , Rajkumar Buyya and Amir Vahid Dastjerdi, 2016, Morgan Kaufmann.
- 2 Sensor Networks: From Theory to Applications , Habib M. Ammari, 2013, Springer.
- 3 Internet of Things: A Hands-On Approach, Arshdeep Bahga and Vijay Madisetti, 2014, VPT.
- 4 Building Internet of Things with the Arduino, Charlie Evans, 2020, CreateSpace Independent Publishing Platform.
- 5 Smart Sensor Networks: Signal Processing, Applications, and Security , Feng Xia, Laurence T. Yang, Lizhe Wang, and Alexey Zaslavsky, 2022, Springer.

23SDCS21A - HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS21A	HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY	HSCISS	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain advanced concepts and methodologies in hardware-software codesign for security applications.	2	PO1, PSO1
CO2	Develop and implement sophisticated hardware-software codesign solutions to enhance security.	3	PO1, PO3, PSO2
CO3	Critically analyze security challenges and vulnerabilities in complex codesign systems.	4	PO1, PO2, PO4
CO4	Design and propose innovative solutions to enhance security in hardware-software codesign.	5	PO1, PO3

Syllabus

Advanced Codesign Techniques: In-depth study of advanced codesign methodologies, Security-enhanced design processes, Practical sessions on advanced design and implementation

Security Implementation Strategies: Implementing advanced security protocols in codesign, Case studies on high-level security integration, Hands-on projects focusing on advanced security features.

Research and Innovation: Conducting research on emerging trends in secure codesign, Developing innovative solutions to new security challenges, Presenting research findings and project proposals.

Leadership and Project Management: Leading secure codesign projects, Advanced project management techniques, Workshops on leadership and teamwork skills.

Reference Books

- 1 Hardware/Software Co-Design: Principles and Practice, Giovanni De Micheli, Rolf Ernst, and Wayne Wolf, 20001, Springer.
- 2 Hardware/Software Co-Design of Embedded Systems: The POLIS Approach, F. Balarin, P. Giusto, A. Jurecska, et al., 1997, Kluwer Academic Publishers.
- 3 Security-Aware Design for Cyber-Physical Systems: A Platform-Based Approach, Chung-Wei Lin, Pai-Yu Chen, and Alberto Sangiovanni-Vincentelli, 2018, Springer.
- 4 Digital Design and Computer Architecture: ARM Edition, Sarah Harris and David Harris, 2015, Morgan Kaufmann.
- 5 Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development, David Kleidermacher and Mike Kleidermacher, 2012, Newnes.
- 6 Trusted Platform Module Basics: Using TPM in Embedded Systems, Steven L. Kinney, 2006, Newnes .
- 7 Cryptographic Engineering, Cetin Kaya Koc, 2009, Springer.

23SDCS21E - HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS21E	HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY	HSCISS	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply theoretical knowledge to practical, real-world scenarios in hardware-software codesign for security.	3	PO1, PO3, PS01
CO2	Analyze and solve complex security problems through hands-on projects and case studies.	4	PO1, PO2, PO4, PS01, PS02
CO3	Integrate multidisciplinary knowledge to create comprehensive hardware-software codesign solutions for security issues.	5	PO1, PO2, PO4
CO4	Reflect on personal and team performance in implementing secure codesign solutions, identifying areas for continuous improvement.	5	PO1, PO3, PS02

Syllabus

Real-world Codesign Projects: Engaging in real-world projects that require secure codesign, Collaborating with industry partners, Practical sessions based on actual industry problems,

Case Study Analysis: Analyzing case studies of successful and failed secure codesign projects, Identifying best practices and common pitfalls, Practical exercises based on case study findings.

Multidisciplinary Integration: Combining knowledge from various disciplines to enhance secure codesign, Workshops on integrating cryptography, system architecture, and software engineering, Team-based projects on multidisciplinary secure codesign solutions.

Reflective Practice and Continuous Improvement: Reflecting on personal learning experiences and project outcomes, Identifying strengths and areas for improvement, Developing a continuous improvement plan for future projects.

Reference Books

- 1 Hardware/Software Co-Design: Principles and Practice, Giovanni De Micheli, Rolf Ernst, and Wayne Wolf, 2000, Springer.
- 2 Hardware/Software Co-Design of Embedded Systems: The POLIS Approach, F. Balarin, P. Giusto, A. Jurecska, et al., 1996, Kluwer Academic Publishers.
- 3 Security-Aware Design for Cyber-Physical Systems: A Platform-Based Approach, Chung-Wei Lin, Pai-Yu Chen, and Alberto Sangiovanni-Vincentelli, 2018, Springer.
- 4 Digital Design and Computer Architecture: ARM Edition, Sarah Harris and David Harris, 2015, Morgan Kaufmann.
- 5 Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development, David Kleidermacher and Mike Kleidermacher, 2012, Newnes.
- 6 Cryptographic Engineering, Cetin Kaya Koc, 2006, Springer.
- 7 Trusted Platform Module Basics: Using TPM in Embedded Systems, Steven L. Kinney, 2006, Newnes.

23SDCS21R - HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDCS21R	HARDWARE SOFTWARE CODESIGN IMPLEMENTATION FOR SECURITY SPECILAITY	HSCISS	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the fundamental principles and techniques of hardware-software codesign for security applications.	2	PO1, PSO1, PSO2
CO2	Implement basic hardware-software codesign solutions addressing security concerns using standard tools.	3	PO1, PO3, PSO1, PSO2
CO3	Analyze and assess the security implications of various hardware-software codesign strategies.	4	PO2, PO4, PSO1, PSO2

Syllabus

Introduction to Hardware-Software Codesign : Basic principles of hardware-software codesign, Security concerns in hardware-software codesign, Practical exercises on simple codesign tasks using standard tools

Security in Codesign: Implementing security features in hardware and software, Case studies of secure codesign, Practical projects involving secure hardware-software integration

Skills Development: Enhancing problem-solving skills in secure codesign, Team-based projects and presentations, Workshops on industry-standard tools and techniques

Reference Books

- 1 Hardware/Software Co-Design: Principles and Practice, Giovanni De Micheli, Rolf Ernst, and Wayne Wolf, 2000, Springer.
- 2 Hardware/Software Co-Design of Embedded Systems: The POLIS Approach, F. Balarin, P. Giusto, A. Jurecska, et al., 1997, Kluwer Academic Publishers.
- 3 Security-Aware Design for Cyber-Physical Systems: A Platform-Based Approach, Chung-Wei Lin, Pai-Yu Chen, and Alberto Sangiovanni-Vincentelli, 2018, Springer.
- 4 Digital Design and Computer Architecture: ARM Edition, Sarah Harris and David Harris, 2015, Morgan Kaufmann.
- 5 Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development, David Kleidermacher and Mike Kleidermacher, 2012, Newnes.
- 6 Cryptographic Engineering, Cetin Kaya Koc, 2009, Springer.
- 7 Trusted Platform Module Basics: Using TPM in Embedded Systems, Steven L. Kinney, 2006, Newnes.

23SDEC01A - ELECTRONIC SYSTEM DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC01A	ELECTRONIC SYSTEM DESIGN	ESD	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of Discrete Semiconductors and other basic components for different applications	3	PO1, PO2, PO11, PSO1
CO2	Apply basic electronic components to design circuit for various application	3	PO1, PO2, PO3, PSO1
CO3	Apply different Sensors, power supply designs and Special Integrated Circuits for various applications	3	PO3, PO5, PSO1
CO4	Apply the NodeMCU development kit to post and fetch data from cloud database	3	PO2, PO3, PO5, PSO1
CO5	Apply the concept of schematic design convert to PCB Design using the software Easy EDA	3	PO2, PO3, PO5, PSO2

Syllabus

Basics of Electronics: Resistors - Application: Voltage Division Concept - Current Limiting Resistor - Pull Up and Pull-Down Resistor - Thermistor - Operating Principle and Types of Thermistors - LDR - Variable Resistor - Capacitor - Inductor - RC Time Constant - Other Basic Components: Diode - Switch - LED

Bridge Rectifier - Battery - Transistor - Transistor as A Switch - Fuse - Loudspeaker - Relay Concept - Transformer - Optocoupler - Microphone - Antenna

Sensors: Temperature and Humidity Sensors, Gas Detection Sensors, Power Supplies: 7805, 7905, Buck Converter, Boost Converter Integrated Circuits: LM393, 555 Timer, CD4017, L293D, L298N

NodeMCU: Introduction - Pin Configuration - Features - Applications - Software and Driver Tools, ESP8266 Boards Manager Package Installation - Posting Data to Cloud Database - Fetching Data from Cloud Database

Fetching Data from Cloud Database. Introduction to PCB & PCB Design with Easy EDA

Reference Books

- 1 Basic Electronics for Scientists and Engineers, Dennis L. Eggleston,, 2011, Cambridge University Press.
- 2 Electronic Devices & Circuits, Jacob Millman, Christos C. Halkias, -, -.
- 3 Integrated Electronics- Analog and Digital Circuits and Systems, Jacob Millman and Christos C. Halkias, -, -.
- 4 Linear Integrated Circuits, D Roy Choudhury, Shail B Jain, 2021, New Age International.

23SDEC01E - ELECTRONIC SYSTEM DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC01E	ELECTRONIC SYSTEM DESIGN	ESD	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of Discrete Semiconductors and other basic components for different applications	3	PO1, PO2, PO11, PSO1
CO2	Apply different Sensors, power supply designs and Special Integrated Circuits for various applications	3	PO1, PO2, PO3, PSO1
CO3	Apply the NodeMCU development kit to post and fetch data from cloud database	3	PO3, PO5, PSO1
CO4	Apply PCB Design, Development boards, software, and driver tools for system design	3	PO2, PO3, PO5, PSO1, PSO2

Syllabus

Basics of Electronics: Resistors, Application: Voltage Division Concept, Current Limiting Resistor. Pull Up and Pull-Down Resistor, Thermistor: Operating Principle and Types of Thermistors, LDR: Variable Resistor, Capacitor, Inductor: RC Time Constant, Other Basic Components: Diode, Switch LED, Bridge Rectifier, Battery, Transistor: Transistor as A Switch, Fuse, Loudspeaker, Relay Concept, Transformer, Optocoupler, Microphone, Antenna

Sensors: Temperature and Humidity Sensors, Gas Detection Sensors, Power Supplies: 7805, 7905, Buck Converter, Boost Converter Integrated Circuits: LM393, 555 Timer, CD4017, L293D, L298N

NodeMCU: Introduction, Pin Configuration, Features, Applications, Software and Driver Tools, ESP8266 Boards Manager Package Installation, Posting Data to Cloud Database, Fetching Data from Cloud Database

Introduction to PCB & PCB Design with Easy EDA

Reference Books

- 1 Basic Electronics for Scientists and Engineers, Dennis L. Eggleston, 2011, Cambridge University Press.
- 2 Electronic Devices & Circuits, Jacob Millman, Christos C. Halkias, -, -.
- 3 Integrated Electronics- Analog and Digital Circuits and Systems, Jacob Millman and Christos C. Halkias, -, -.
- 4 Linear Integrated Circuits, D Roy Choudhury, Shail B Jain, 2021, New Age International.

23SDEC01R - ELECTRONIC SYSTEM DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC01R	ELECTRONIC SYSTEM DESIGN	ESD	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of Discrete Semiconductors and other basic components for different applications	3	PO1, PO2, PO11, PSO1
CO2	Apply different Sensors, power supply designs and Special Integrated Circuits for various applications	3	PO1, PO2, PO3, PSO1
CO3	Apply the NodeMCU development kit to post and fetch data from cloud database	3	PO3, PO5, PSO1
CO4	Apply PCB Design, Development boards, software, and driver tools for system design	3	PO2, PO3, PO5, PSO1, PSO2

Syllabus

Basics of Electronics: Resistors, Application: Voltage Division Concept, Current Limiting Resistor. Pull Up and Pull-Down Resistor, Thermistor: Operating Principle and Types of Thermistors, LDR: Variable Resistor, Capacitor, Inductor: RC Time Constant, Other Basic Components: Diode, Switch LED, Bridge Rectifier, Battery, Transistor: Transistor as A Switch, Fuse, Loudspeaker, Relay Concept, Transformer, Optocoupler, Microphone, Antenna

Sensors: Temperature and Humidity Sensors, Gas Detection Sensors, Power Supplies: 7805, 7905, Buck Converter, Boost Converter Integrated Circuits: LM393, 555 Timer, CD4017, L293D, L298N

NodeMCU: Introduction, Pin Configuration, Features, Applications, Software and Driver Tools, ESP8266 Boards Manager Package Installation, Posting Data to Cloud Database, Fetching Data from Cloud Database

Introduction to PCB & PCB Design with Easy EDA

Reference Books

- 1 Basic Electronics for Scientists and Engineers, Dennis L. Eggleston, 2011, Cambridge University Press.
- 2 Electronic Devices & Circuits, Jacob Millman, Christos C. Halkias, -, -.
- 3 Integrated Electronics- Analog and Digital Circuits and Systems, Jacob Millman and Christos C. Halkias, -, -.
- 4 Linear Integrated Circuits, D Roy Choudhury, Shail B Jain, 2021, New Age International.

23SDEC02A - EMBEDDED SYSTEM AUTOMATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC02A	EMBEDDED SYSTEM AUTOMATION	ESDA	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply to expertly configure CPU clock speed, implement external interrupts, utilize timers for precise control, and optimize energy efficiency through power management modes in microcontroller-based systems.	3	PO2, PO3, PSO1
CO2	Able to apply UART, I2C, I2S, SPI, and CAN protocols, including pin configuration, multi-device communication, I2C scanner usage, and effective implementation in electronic systems.	3	PO2, PO3, PSO1
CO3	Able to apply ADC and DAC interfacing, EEPROM and Flash Memory usage, and master Bluetooth and Wi-Fi integration for wireless communication with reliable data links in electronic systems.	3	PO2, PO3, PSO2
CO4	Able to apply network operations, including scanning and signal identification, and proficiently handle MAC addresses, hostnames, and IP assignments for designing collaborative electronic systems.	3	PO2, PO3, PSO2

Syllabus

Microcontroller Development Board: CPU clock speed, External Interrupt, Timers & Timer Interrupt, Power Consumption in Each Mode & Sleep Modes

Communication Protocols: UART, I2C protocol: Set Pins, Multi Devices, I2C Scanner, I2S protocol, SPI Protocol, CAN Protocol

Memory & Interfaces: ADC, DAC with Audio Analog Output, EEPROM and its library, Flash Memory, Connectivity: Bluetooth, Wi-Fi

Networking: Network Scanning, Signal Strength Identifier, Connect to Network, Set and Get MAC address, Identification and change of Host name, Static & Dynamic IP assignment, Client-Server configuration and multi-server configuration

Reference Books

- 1 "ESP32 for Busy People", Neil Kolban, 2017, Leanpub.
- 2 "Programming ESP32 with Arduino IDE", Agus Kurniawan, 2018, Independently published.
- 3 "ESP32 Development Workshop", Agus Kurniawan, 2019, Independently published.
- 4 "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black", Donald Norris, 2015, McGraw-Hill Education.
- 5 "ESP32 Projects and Tutorials", Wolfgang Beer, 2018, Independently published.
- 6 "Getting Started with Bluetooth Low Energy: Tools and Techniques for Low- Power Networking", Kevin Townsend, Carles Cufí, Akiba, and Robert Davidson, 2014, O'Reilly Media.
- 7 "Mastering the FreeRTOS Real Time Kernel on the ESP32", Richard Barry, 2016, Real Time Engineers Ltd..
- 8 "ESP32 IoT Development with Zerynth", Ramneek Singh, 2021, Packt Publishing.

- 9 "ESP32 WiFi-BT-BLE MCU Module / ESP-WROOM-32", Espressif Systems, Varies, Espressif Systems.
- 10 "IoT Projects with ESP32: Build exciting and powerful IoT projects using the all-new Espressif ESP32", Agus Kurniawan, 2019, Packt Publishing.
- 11 "Wireless Communication Library for PIC Microcontrollers", Rizwan Waseer, 2015, Apress.

23SDEC02E - EMBEDDED SYSTEM AUTOMATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC02E	EMBEDDED SYSTEM AUTOMATION	ESDA	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply to expertly configure CPU clock speed, implement external interrupts, utilize timers for precise control, and optimize energy efficiency through power management modes in microcontroller-based systems.	3	PO2, PO3, PSO1
CO2	Able to apply UART, I2C, I2S, SPI, and CAN protocols, including pin configuration, multi-device communication, I2C scanner usage, and effective implementation in electronic systems.	3	PO2, PO3, PSO1
CO3	Able to apply ADC and DAC interfacing, EEPROM and Flash Memory usage, and master Bluetooth and Wi-Fi integration for wireless communication with reliable data links in electronic systems.	3	PO2, PO3, PSO2
CO4	Able to apply network operations, including scanning and signal identification, and proficiently handle MAC addresses, hostnames, and IP assignments for designing collaborative electronic systems.	3	PO2, PO3, PSO2

Syllabus

Microcontroller Development Board: CPU clock speed, External Interrupt, Timers & Timer Interrupt, Power Consumption in Each Mode & Sleep Modes

Communication Protocols: UART, I2C protocol: Set Pins, Multi Devices, I2C Scanner, I2S protocol, SPI Protocol, CAN Protocol

Memory & Interfaces: ADC, DAC with Audio Analog Output, EEPROM and its library, Flash Memory, Connectivity: Bluetooth, Wi-Fi

Networking: Network Scanning, Signal Strength Identifier, Connect to Network, Set and Get MAC address, Identification and change of Host name, Static & Dynamic IP assignment, Client-Server configuration and multi-server configuration

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- 1 "ESP32 for Busy People", Neil Kolban, 2017, Leanpub.
- 2 "Programming ESP32 with Arduino IDE", Agus Kurniawan, 2018, Independently published.
- 3 "ESP32 Development Workshop", Agus Kurniawan, 2019, Independently published.
- 4 "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black", Donald Norris, 2015, McGraw-Hill Education.
- 5 "ESP32 Projects and Tutorials", Wolfgang Beer, 2018, Independently published.
- 6 "Getting Started with Bluetooth Low Energy: Tools and Techniques for Low- Power Networking", Kevin Townsend, Carles Cufí, Akiba, and Robert Davidson, 2014, O'Reilly Media.
- 7 "Mastering the FreeRTOS Real Time Kernel on the ESP32", Richard Barry, 2016, Real Time Engineers Ltd..
- 8 "ESP32 WiFi-BT-BLE MCU Module / ESP-WROOM-32", Espressif Systems, Varies, Espressif Systems.

23SDEC02R - EMBEDDED SYSTEM AUTOMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC02R	EMBEDDED SYSTEM AUTOMATION	ESDA	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply to expertly configure CPU clock speed, implement external interrupts, utilize timers for precise control, and optimize energy efficiency through power management modes in microcontroller-based systems.	3	PO2, PO3, PSO1
CO2	Able to apply UART, I2C, I2S, SPI, and CAN protocols, including pin configuration, multi-device communication, I2C scanner usage, and effective implementation in electronic systems.	3	PO2, PO3, PSO2
CO3	Able to apply ADC and DAC interfacing, EEPROM and Flash Memory usage, and master Bluetooth and Wi-Fi integration for wireless communication with reliable data links in electronic systems.	3	PO2, PO3, PSO2

Syllabus

Microcontroller Development Board: CPU clock speed, External Interrupt, Timers & Timer Interrupt, Power Consumption in Each Mode & Sleep Modes

Communication Protocols: UART, I2C protocol: Set Pins, Multi Devices, I2C Scanner, I2S protocol, SPI Protocol, CAN Protocol

Memory & Interfaces: ADC, DAC with Audio Analog Output, EEPROM and its library, Flash Memory, Connectivity: Bluetooth, Wi-Fi

Reference Books

- 1 "ESP32 for Busy People", Neil Kolban, 2017, Leanpub.
- 2 "Programming ESP32 with Arduino IDE", Agus Kurniawan, 2018, Independently published.
- 3 "ESP32 Development Workshop", Agus Kurniawan, 2019, Independently published.
- 4 "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black", Donald Norris, 2015, McGraw-Hill Education.
- 5 "ESP32 Projects and Tutorials", Wolfgang Beer, 2018, Independently published.
- 6 "Getting Started with Bluetooth Low Energy: Tools and Techniques for Low- Power Networking", Kevin Townsend, Carles Cuf?, Akiba, and Robert Davidson, 2014, O'Reilly Media.
- 7 "Mastering the FreeRTOS Real Time Kernel on the ESP32", Richard Barry, 2016, Real Time Engineers Ltd..
- 8 "ESP32 IoT Development with Zerynth", Ramneek Singh, 2021, Packt Publishing.
- 9 "ESP32 WiFi-BT-BLE MCU Module / ESP-WROOM-32", Espressif Systems, Varies, Espressif Systems.
- 10 "IoT Projects with ESP32: Build exciting and powerful IoT projects using the all-new Espressif ESP32", Agus Kurniawan, 2019, Packt Publishing.

23SDEC03A - BIOSENSOR SYSTEM DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC03A	BIOSENSOR SYSTEM DESIGN	BSD	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply different biosensor types, electromagnetic theory, and computer-aided design tools like COMSOL, enabling them to analyze electrostatics and design effective biosensor systems.	3	PO5, PO9, PO11, PO12, PSO1
CO2	Analyze the design of electrochemical sensors for bioanalysis. By exploring electrode optimization, sweat and alcohol sensor design, and real-world case studies, students will gain the knowledge to create efficient and practical sensors for medical diagnostics and other applications.	4	PO5, PO9, PO11, PO12, PSO1
CO3	Analyze sensitivity and selectivity analysis to understand sensor response, and explore advanced design techniques for real-time applications. Through a project focused on biosensor design and performance optimization, students will gain the skills to create highly effective biosensors for practical use.	4	PO5, PO9, PO11, PO12, PSO1
CO4	Examine Surface Plasmon Resonance (SPR), Surface-Enhanced Raman Spectroscopy (SERS), and fiber optic sensors, alongside enzymatic sensors and integration of Artificial Intelligence (AI) and Machine Learning (ML) for data analysis. By the end, students will be equipped to design intelligent biosensors for sensitive and specific detection.	4	PO5, PO9, PO11, PO12, PSO1

Syllabus

Overview of Biosensor and Types, Fundamentals of EM theory, Overview of COMSOL Multiphysics/FDTD software, Electrostatics analysis, Sensor design.

Electrodes design and optimization, design of Electrochemical sensor for sweat analysis, design of gas sensor for alcohol sensing, Case studies.

Sensitivity analysis, Selectivity analysis, Advanced sensor design for real time application. Project on design and performance optimization of biosensors.

SPR sensors, SERS, optical fiber sensors, Enzymatic sensors, Integrating AI and ML concepts into sensors

Reference Books

- 1 Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices , David Prutchi, Michael Norris , 2005, Wiley Publisher .
- 2 Medical Instrumentation: Application and Design , Amit J. Nimunkar, John G. Webster , 2020, Wiley Publisher.
- 3 Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation , Robert B. Northrop , 2003, CRC Publisher .
- 4 A Handbook of Internet of Things in Biomedical and Cyber Physical System (Intelligent Systems Reference Library 165) , Valentina E. Balas (Editor), Vijender Kumar Solanki (Editor), Raghvendra Kumar (Editor), Md. Atiqur Rahman Ahad (Editor) , 2020, Springer.

- The Role of The Internet Of Things (IoT) In Biomedical Engineering Present Scenario and Challenges. ,
- 5 Sushree Bibhuprada B. Priyadarshini, Devendra Kumar Sharma, Rohit Sharma, Korhan Cengiz. , 2022, Apple Academic Press exclusively co-publishes with CRC Press, an imprint of Taylor & Francis Group, LLC .

23SDEC03E - BIOSENSOR SYSTEM DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC03E	BIOSENSOR SYSTEM DESIGN	BSD	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply different biosensor types, electromagnetic theory, and computer-aided design tools like COMSOL, enabling them to analyze electrostatics and design effective biosensor systems.	3	PO5, PO9, PO11, PO12, PSO1
CO2	Analyze the design of electrochemical sensors for bioanalysis. By exploring electrode optimization, sweat and alcohol sensor design, and real-world case studies, students will gain the knowledge to create efficient and practical sensors for medical diagnostics and other applications.	4	PO5, PO9, PO11, PO12, PSO1
CO3	Analyze sensitivity and selectivity analysis to understand sensor response, and explore advanced design techniques for real-time applications. Through a project focused on biosensor design and performance optimization, students will gain the skills to create highly effective biosensors for practical use.	4	PO5, PO9, PO11, PO12, PSO1
CO4	Examine Surface Plasmon Resonance (SPR), Surface-Enhanced Raman Spectroscopy (SERS), and fiber optic sensors, alongside enzymatic sensors and integration of Artificial Intelligence (AI) and Machine Learning (ML) for data analysis. By the end, students will be equipped to design intelligent biosensors for sensitive and specific detection.	4	PO5, PO9, PO11, PO12, PSO1

Syllabus

Overview of Biosensor and Types, Fundamentals of EM theory, Overview of COMSOL Multiphysics, Electrostatics analysis, Sensor design.

Electrodes design and optimization, design of Electrochemical sensor for sweat analysis, design of gas sensor for alcohol sensing, Case studies.

Sensitivity analysis, Selectivity analysis, Advanced sensor design for real time application. Project on design and performance optimization of biosensors.

SPR sensors, SERS, optical fiber sensors, Enzymatic sensors, Integrating AI and ML concepts into sensors

Reference Books

- 1 Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices , David Prutchi, Michael Norris , 2004, wiley.
- 2 Medical Instrumentation: Application and Design , Amit J. Nimunkar, John G. Webster , 2020, wiley.
- 3 Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation , Robert B. Northrop , 2003, CRC.
- 4 A Handbook of Internet of Things in Biomedical and Cyber Physical System (Intelligent Systems Reference Library 165) , Valentina E. Balas (Editor), Vijender Kumar Solanki (Editor), Raghvendra Kumar (Editor), Md. Atiqur Rahman Ahad (Editor) , 2020, Springer.

- The Role of The Internet Of Things (IoT) In Biomedical Engineering Present Scenario and Challenges. ,
- 5 Sushree Bibhuprada B. Priyadarshini, Devendra Kumar Sharma, Rohit Sharma, Korhan Cengiz. , 2022, Apple Academic Press exclusively co-publishes with CRC Press, an imprint of Taylor & Francis Group, LLC .

23SDEC03R - BIOSENSOR SYSTEM DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC03R	BIOSENSOR SYSTEM DESIGN	BSD	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply different biosensor types, electromagnetic theory, and computer-aided design tools like COMSOL, enabling them to analyze electrostatics and design effective biosensor systems.	3	PO5, PO9, PO11, PO12, PSO1
CO2	Analyze the design of electrochemical sensors for bioanalysis. By exploring electrode optimization, sweat and alcohol sensor design, and real-world case studies, students will gain the knowledge to create efficient and practical sensors for medical diagnostics and other applications.	4	PO5, PO9, PO11, PO12, PSO1
CO3	Analyze sensitivity and selectivity analysis to understand sensor response, and explore advanced design techniques for real-time applications. Through a project focused on biosensor design and performance optimization, students will gain the skills to create highly effective biosensors for practical use.	4	PO5, PO9, PO11, PO12, PSO1
CO4	Examine Surface Plasmon Resonance (SPR), Surface-Enhanced Raman Spectroscopy (SERS), and fiber optic sensors, alongside enzymatic sensors and integration of Artificial Intelligence (AI) and Machine Learning (ML) for data analysis. By the end, students will be equipped to design intelligent biosensors for sensitive and specific detection.	4	PO5, PO9, PO11, PO12, PSO1

Syllabus

Overview of Biosensor and Types, Fundamentals of EM theory, Overview of COMSOL Multiphysics/FDTD software, Electrostatics analysis, Sensor design.

Electrodes design and optimization, design of Electrochemical sensor for sweat analysis, design of gas sensor for alcohol sensing, Case studies.

Sensitivity analysis, Selectivity analysis, Advanced sensor design for real time application. Project on design and performance optimization of biosensors.

SPR sensors, SERS, optical fiber sensors, Enzymatic sensors, Integrating AI and ML concepts into sensors

Reference Books

- 1 Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices , David Prutchi, Michael Norris , 2004, Wiley Publisher .
- 2 Medical Instrumentation: Application and Design , Amit J. Nimunkar, John G. Webster , 2020, Wiley Publisher.
- 3 Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation , Robert B. Northrop , 2003, CRC.
- 4 Smart Biosensor Technology , G.K. Knoff, A.S. Bassi , 2006, CRC.

23SDEC04A - DESIGN OF NETWORKS USING NS-3 (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC04A	DESIGN OF NETWORKS USING NS-3	DNN	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate and simulate Simple Topology Creation, TCP/IP Performance Analysis, Routing Protocols Evaluation, Traffic Modeling, Quality of Service (QoS) Analysis, Using NS-3	2	PO1, PO2, PSO2
CO2	Construct and simulate Congestion Control Algorithms, Network Security Analysis, Network Protocol Development, Wireless Network Simulation, Peer-to-Peer (P2P) Networks, MPLS, IoT, SDN Using NS-3	3	PO1, PO2, PO3, PSO2
CO3	Analyse and simulate Wireless Network Simulation, Peer-to-Peer (P2P) Networks, MPLS, IoT, SDN Using NS-3	4	PO1, PO2, PO4, PSO2
CO4	Classify and validate custom network models in NS-3, demonstrating the ability to extend existing modules and adapt the simulator to address specific research or industry-related networking challenges.	4	PO2, PO4, PSO2

Syllabus

Simple Topology Creation, TCP/IP Performance Analysis, Routing Protocols Evaluation, Traffic Modeling, Quality of Service (QoS) Analysis

Congestion Control Algorithms, Network Security Analysis, Network Protocol Development, Wireless Network Simulation, Peer-to-Peer (P2P) Networks

Network Protocol Performance Comparison, Network Simulation with Real Traffic Traces, Network Protocol Testing, Multi-Protocol Label Switching (MPLS), Internet of Things (IoT) Communication:, Software-Defined Networking (SDN)

Transport Layer Protocols: Implementation of TCP and UDP protocols in NS-3, Performance comparison and analysis, Routing Protocols: Overview of routing protocols (e.g., OLSR, AODV), Implementing and evaluating routing protocols in NS-3, Traffic Models: Creating and using traffic models, CBR, VBR, and other traffic generation models, Wireless Networks: Simulating wireless networks and WiFi, Mobile nodes and mobility models

Reference Books

- 1 Network Simulation Experiments Manual, Emad Aboelela, 2003, Morgan Kaufmann Publishers.
- 2 NS-3 Manual, NS-3 Consortium, 2024, Online Resource.
- 3 Wireless Communications & Networks, William Stallings, 2007, Pearson.
- 4 Data Communication and Networking , Behrouz A. Forouzan , 2012, TMH.
- 5 Computer Networks -- A Systems Approach , Peterson, LL and Davie BS , 2015, Morgan Kaufmann, Elsevier .
- 6 Computer Networks , A.S.Tanenbaum, David J. Weteral , 2012, Pearson Education .

23SDEC04E - DESIGN OF NETWORKS USING NS-3 (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC04E	DESIGN OF NETWORKS USING NS-3	DNN	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate and simulate Simple Topology Creation, TCP/IP Performance Analysis, Routing Protocols Evaluation, Traffic Modeling, Quality of Service (QoS) Analysis, Using NS-3	2	PO1, PO2, PO5, PSO2
CO2	Construct and simulate Congestion Control Algorithms, Network Security Analysis, Network Protocol Development, Wireless Network Simulation, Peer-to-Peer (P2P) Networks, MPLS, IoT, SDN Using NS-3	3	PO2, PO3, PO5, PSO2
CO3	Analyse and simulate Wireless Network Simulation, Peer-to-Peer (P2P) Networks, MPLS, IoT, SDN Using NS-3	4	PO2, PO3, PO5, PSO2
CO4	Classify and validate custom network models in NS-3, demonstrating the ability to extend existing modules and adapt the simulator to address specific research or industry-related networking challenges.	4	PO2, PSO2

Syllabus

Simple Topology Creation, TCP/IP Performance Analysis, Routing Protocols Evaluation, Traffic Modeling, Quality of Service (QoS) Analysis

Congestion Control Algorithms, Network Security Analysis, Network Protocol Development, Wireless Network Simulation, Peer-to-Peer (P2P) Networks,

Network Protocol Performance Comparison, Network Simulation with Real Traffic Traces, Network Protocol Testing, Multi-Protocol Label Switching (MPLS), Internet of Things (IoT) Communication:, Software-Defined Networking (SDN)

Transport Layer Protocols: Implementation of TCP and UDP protocols in NS-3, Performance comparison and analysis, Routing Protocols: Overview of routing protocols (e.g., OLSR, AODV), Implementing and evaluating routing protocols in NS-3, Traffic Models: Creating and using traffic models, CBR, VBR, and other traffic generation models, Wireless Networks: Simulating wireless networks and WiFi, Mobile nodes and mobility models

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- 1 Network Simulation Experiments Manual, Emad Aboelela , 2003, Morgan Kaufmann Publishers .
- 2 NS-3 Manual , NS-3 Consortium , 2024, Online Resource .
- 3 Wireless Communications & Networks , William Stallings , 2017, Pearson .
- 4 Data Communication and Networking, Behrouz A. Forouzan, 2012, TMH.
- 5 Computer Networks -- A Systems Approach, Peterson, LL and Davie BS, 2015, Morgan Kaufmann, Elsevier.

23SDEC04R - DESIGN OF NETWORKS USING NS-3 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC04R	DESIGN OF NETWORKS USING NS-3	DNN	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate proficiency in designing and simulating complex network topologies using NS-3, showcasing an understanding of network elements and their interactions.	2	PO1, PO2, PO5, PSO2
CO2	Implement and evaluate various network protocols in NS-3, illustrating competency in protocol design principles and their practical application.	3	PO2, PO3, PO5, PSO2
CO3	Analyze network performance metrics collected from NS-3 simulations, enabling identification and troubleshooting of performance issues in simulated networks.	4	PO2, PO3, PO5, PSO2

Syllabus

Introduction to NS-3: Overview of network simulation and its importance, Introduction to NS-3 framework and its features, Installation and setup of NS-3 environment. Basic Network Elements in NS-3: Understanding network nodes, links, and devices in NS-3, Creating simple network topologies using NS-3, Simulation scripting with NS-3: Basic Layered Architecture of Network Protocols: Understanding OSI and TCP/IP models, Design considerations for network protocols, Transport Layer Protocols, Designing and implementing TCP and UDP protocols in NS-3, Hands-on exercises on configuring and testing transport layer protocols.

Performance Metrics for Networks: Introduction to performance metrics: Throughput, latency, packet loss, etc. Collecting and analyzing simulation data in NS-3, Simulation Experiments in NS-3, Designing simulation scenarios for performance evaluation, Conducting experiments and interpreting results.

Wireless Network Modeling: Introduction to wireless network simulation in NS-3, Modeling wireless communication channels and devices Week 8: Mobility and Security Simulation, Implementing mobility models in NS-3, Introduction to network security simulations in NS-3

Reference Books

- 1 Network Simulation Experiments Manual, Emad Aboelela, 2011, Morgan Kaufmann Publishers.
- 2 Computer Networking: A Top-Down Approach, James F. Kurose, Keith W. Ross, 2017, Pearson.
- 3 NS-3 Manual, NS-3 Consortium, 2024, Online Resource.
- 4 Wireless Communications & Networks, William Stallings, 2009, Pearson.

23SDEC05A - 4G - LTE COMMUNICATION SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC05A	4G - LTE COMMUNICATION SYSTEMS	LCS	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their understanding of 4G architecture, interfaces, user equipment categories, and core functionalities like Quality-of-Service (QoS), security, and mobility within the 3GPP standards framework.	3	PO3, PO4, PO5
CO2	Analyze and evaluate the technical aspects of LTE communication, including frame structure, spectrum management, channel behavior, resource allocation strategies, user-perceived quality of service, and performance analysis techniques for troubleshooting purposes.	4	PO3, PO4, PO5
CO3	Analyze and evaluate advanced techniques for improving user experience in 4G networks, including advanced antenna systems, security measures to mitigate risks, and multi-factor authentication protocols for stronger user verification.	4	PO3, PO4, PO5
CO4	Analyze and evaluate advanced techniques for improving performance and efficiency in 4G LTE-Advanced networks.	4	PO3, PO4, PO5

Syllabus

4G Architecture and Call Process with 3GPP Standards, EPS Reference Points and Interfaces, E-UTRAN Interfaces, User Equipment, LTE UE Category, QoS in LTE, LTE Security, LTE Mobility.

LTE Frame Structure, Dynamic Spectrum Management Techniques, Channel Estimation and Equalization, Resource Allocation, Quality of Service at the User End, Performance Analysis and Troubleshooting Techniques

Advanced Antenna Systems for Improved User Experience in 4G Networks, Security and Privacy at the 4G User End: Mitigating Risks and Ensuring User Protection, 4G Authentication Protocols: A Comprehensive Overview and Analysis, Multi-Factor Authentication in 4G Networks: Strengthening User Verification Processes

Performance estimation of LTE-A downlink adopting higher modulation in Small cells Functional models and 4G LTE architecture of VoLTE services and also Video streaming Threshold based multi traffic load balancing scheme also for LTE-Advanced Networks Coverage enhancement of PBCH in LTE-A Networks also using reduced search viterbi Experimental analysis of energy saving scheme also for enodeB on/off in LTE Networks Spectrum sharing system[for 4G and also 5G] Measurement Peak data rate over 4G network Measurement of Peak spectrum efficiency Mobility analysis across the cellular network for various mobile speeds up to 350 km/h

Reference Books

- 1 LTE and the Evolution to 4G Wireless Design and Measurement Challenges , Moray Rumney , 2013, Wiley.
- 2 4G: LTE/LTE-Advanced for Mobile Broadband, Erik Dahlman, Stefan Parkvall, Johan Skold, 2013, Elsevier Science.
- 3 Advanced Wireless Networks 4G Technologies, Savo G. Glisic, 2006, Wiley.
- 4 Design, Deployment and Performance of 4G-LTE Networks, Ayman ElNashar, Mohamed A. El-Saidny, Mahmoud R. Sherif, 2014, John Wiley & Sons.
- 5 4G, LTE-Advanced Pro and The Road to 5G, Erik Dahlman, Stefan Parkvall, Johan Skold, 2016, Elsevier Science.

23SDEC05E - 4G - LTE COMMUNICATION SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC05E	4G - LTE COMMUNICATION SYSTEMS	LCS	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their understanding of 4G architecture, interfaces, user equipment categories, and core functionalities like Quality-of-Service (QoS), security, and mobility within the 3GPP standards framework.	3	PO3, PO4, PO5
CO2	Analyze and evaluate the technical aspects of LTE communication, including frame structure, spectrum management, channel behavior, resource allocation strategies, user-perceived quality of service, and performance analysis techniques for troubleshooting purposes.	4	PO3, PO4, PO5
CO3	Analyze and evaluate advanced techniques for improving user experience in 4G networks, including advanced antenna systems, security measures to mitigate risks, and multi-factor authentication protocols for stronger user verification.	4	PO3, PO4, PO5
CO4	Analyze and evaluate advanced techniques for improving performance and efficiency in 4G LTE-Advanced networks.	4	PO3, PO4, PO5

Syllabus

4G Architecture and Call Process with 3GPP Standards, EPS Reference Points and Interfaces, E-UTRAN Interfaces, User Equipment, LTE UE Category, QoS in LTE, LTE Security, LTE Mobility.

LTE Frame Structure, Dynamic Spectrum Management Techniques, Channel Estimation and Equalization, Resource Allocation, Quality of Service at the User End, Performance Analysis and Troubleshooting Techniques

Advanced Antenna Systems for Improved User Experience in 4G Networks, Security and Privacy at the 4G User End: Mitigating Risks and Ensuring User Protection, 4G Authentication Protocols: A Comprehensive Overview and Analysis, Multi-Factor Authentication in 4G Networks: Strengthening User Verification Processes

Performance estimation of LTE-A downlink adopting higher modulation in Small cells Functional models and 4G LTE architecture of VoLTE services and also Video streaming Threshold based multi traffic load balancing scheme also for LTE-Advanced Networks Coverage enhancement of PBCH in LTE-A Networks also using reduced search viterbi Experimental analysis of energy saving scheme also for enodeB on/off in LTE Networks Spectrum sharing system[for 4G and also 5G] Measurement Peak data rate over 4G network Measurement of Peak spectrum efficiency Mobility analysis across the cellular network for various mobile speeds up to 350 km/h

Reference Books

- 1 LTE and the Evolution to 4G Wireless Design and Measurement Challenges , Moray Rumney , 2013, Wiley.
- 2 4G: LTE/LTE-Advanced for Mobile Broadband , Erik Dahlman, Stefan Parkvall, Johan Skold , 2013, Elsevier Science.
- 3 LTE and the Evolution to 4G Wireless Design and Measurement Challenges , Moray Rumney , 2013, Wiley.
- 4 Design, Deployment and Performance of 4G-LTE Networks, Ayman ElNashar, Mohamed A. El-Saidny, Mahmoud R. Sherif, 2014, John Wiley & Sons.
- 5 4G, LTE-Advanced Pro and The Road to 5G, Erik Dahlman, Stefan Parkvall, Johan Skold, 2016, Elsevier Science.

23SDEC05R - 4G - LTE COMMUNICATION SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC05R	4G - LTE COMMUNICATION SYSTEMS	LCS	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their understanding of 4G architecture, interfaces, user equipment categories, and core functionalities like Quality-of-Service (QoS), security, and mobility within the 3GPP standards framework.	3	PO3, PO4, PO5
CO2	Analyze and evaluate the technical aspects of LTE communication, including frame structure, spectrum management, channel behavior, resource allocation strategies, user-perceived quality of service, and performance analysis techniques for troubleshooting purposes.	4	PO3, PO4, PO5
CO3	Analyze and evaluate advanced techniques for improving user experience in 4G networks, including advanced antenna systems, security measures to mitigate risks, and multi-factor authentication protocols for user verification.	4	PO3, PO4, PO5

Syllabus

4G Architecture and Call Process with 3GPP Standards, EPS Reference Points and Interfaces, E-UTRAN Interfaces, User Equipment, LTE UE Category, QoS in LTE, LTE Security, LTE Mobility.

LTE Frame Structure, Dynamic Spectrum Management Techniques, Channel Estimation and Equalization, Resource Allocation, Quality of Service at the User End, Performance Analysis and Troubleshooting Techniques

Advanced Antenna Systems for Improved User Experience in 4G Networks, Security and Privacy at the 4G User End: Mitigating Risks and Ensuring User Protection, 4G Authentication Protocols: A Comprehensive Overview and Analysis, Multi-Factor Authentication in 4G Networks: Strengthening User Verification Processes

Reference Books

- 1 LTE and the Evolution to 4G Wireless Design and Measurement Challenges, Moray Rumney , 2013, Wiley .
- 2 4G: LTE/LTE-Advanced for Mobile Broadband , Erik Dahlman, Stefan Parkvall, Johan Skold , 2013, Elsevier Science .
- 3 Advanced Wireless Networks 4G Technologies , Savo G. Glisic , 2006, Wiley.
- 4 Design, Deployment and Performance of 4G-LTE Networks, Ayman ElNashar, Mohamed A. El-Saidny, Mahmoud R. Sherif, 2014, John Wiley & Sons.
- 5 4G, LTE-Advanced Pro and The Road to 5G, Erik Dahlman, Stefan Parkvall, Johan Skold, 2016, Elsevier Science.

23SDEC06A - EMBEDDED DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC06A	EMBEDDED DESIGN	EBD	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply the concept of ARM-Cortex M3 & M4 Architecture	3	PO1, PO2, PO11, PSO1
CO2	Able to apply the STM32 microcontroller concepts & programming language	3	PO1, PO2, PO3, PSO1
CO3	Able to apply the various interfacing concepts of STM32 microcontroller.	3	PO2, PO3, PO5, PSO1
CO4	Able to apply interfacing of actuators and implement data communication using standard protocols	3	PO2, PO3, PO5, PSO1

Syllabus

ARM Cortex M3 and M4: The Internals of STM32 Microcontroller Hardware, Interface Various Peripherals Inside OF STM32 Microcontrollers, Develop Reconfigurable Reusable Firmware (Embedded Software Components) In C-Programming Language Based on ST HAL & LL Drivers

Get Familiar with Interrupts, NVIC, EXTI and Inter-Module Signalling, DMA. STM 32 Concepts: STM32 Interrupts, external interrupt pins & interrupt latency, STM 32 serial print Debug, STM 32 Timers, Timer Module, Timer Mode, counter Mode and Input Capture Mode (ICU), Encoder mode STM 32, PWM

STM 32 INTERFACING: Interface Various Peripherals Inside OF STM32 Microcontrollers, Interface Various Display Units (7-Segments, Alphanumeric LCD, OLED, TFT, etc) Interface Various Input Units (Buttons, Rotary Encoders, Keypad, HMI TouchPADs, etc).

Control Several Types OF Actuators (DC Motors, Servo Motors, Stepper Motors, etc), Serial Communication Via USART, SPI, I2C & Develop USB Applications (CDC, HID, Mass Storage, etc)

Reference Books

- 1 ARM Cortex M4 Cookbook , Mark fisher, 2010, Cambridge University Press.
- 2 Mastering STM32, Carmine Noviello, 2012, Lean Publishing.
- 3 Advanced Programming with STM32 Microcontrollers, Majid Pakdel, 2005, Lean Publishing.
- 4 ARM Cortex-M3 and Cortex-M4 Processors, Joseph Yiu, 2007, Elsevier.

23SDEC06E - EMBEDDED DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC06E	EMBEDDED DESIGN	EBD	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply the concept of ARM-Cortex M3 & M4 Architecture.	3	PO1, PO2, PO11, PSO1
CO2	Able to apply the STM32 microcontroller concepts & programming language	3	PO1, PO2, PO3, PSO1
CO3	Able to apply the various interfacing concepts of STM32 microcontroller.	3	PO2, PO3, PO5, PSO1
CO4	Able to apply interfacing of actuators and implement data communication using standard protocols	3	PO2, PO3, PO5, PSO1

Syllabus

ARM Cortex M3 and M4: The Internals of STM32 Microcontroller Hardware, Interface Various Peripherals Inside OF STM32 Microcontrollers, Develop Reconfigurable Reusable Firmware (Embedded Software Components) In C-Programming Language Based on ST HAL & LL Drivers.

Get Familiar with Interrupts, NVIC, EXTI and Inter-Module Signalling, DMA. STM 32 Concepts: STM32 Interrupts, external interrupt pins & interrupt latency, STM 32 serial print Debug, STM 32 Timers, Timer Module, Timer Mode, counter Mode and Input Capture Mode (ICU), Encoder mode STM 32, PWM

STM 32 INTERFACING: Interface Various Peripherals Inside OF STM32 Microcontrollers, Interface Various Display Units (7-Segments, Alphanumeric LCD, OLED, TFT, etc) Interface Various Input Units (Buttons, Rotary Encoders, Keypad, HMI TouchPADs, etc).

Control Several Types OF Actuators (DC Motors, Servo Motors, Stepper Motors, etc), Serial Communication Via USART, SPI, I2C & Develop USB Applications (CDC, HID, Mass Storage, etc)

Reference Books

- 1 ARM Cortex M4 Cookbook , Mark fisher, 1, Cambridge University Press.
- 2 Mastering STM32, Carmine Noviello, 2, Lean Publishing.
- 3 Advanced Programming with STM32 Microcontrollers, Majid Pakdel, 1, Lean Publishing.
- 4 ARM Cortex-M3 and Cortex-M4 Processors, Joseph Yiu, 3, Elsevier.

23SDEC06R - EMBEDDED DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC06R	EMBEDDED DESIGN	EBD	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply the concept of ARM-Cortex M3 & M4 Architecture	3	PO1, PO2, PO11, PSO1
CO2	Able to apply the STM32 microcontroller concepts & programming language	3	PO1, PO2, PO3, PSO1
CO3	Able to apply the various interfacing concepts of STM32 microcontroller.	3	PO2, PO3, PSO1
CO4	Able to apply interfacing of actuators and implement data communication using standard protocols.	3	PO2, PO3, PSO1

Syllabus

ARM Cortex M3 and M4: The Internals of STM32 Microcontroller Hardware, Interface Various Peripherals Inside OF STM32 Microcontrollers, Develop Reconfigurable Reusable Firmware (Embedded Software Components) In C-Programming Language Based on ST HAL & LL Drivers

Get Familiar with Interrupts, NVIC, EXTI and Inter-Module Signalling, DMA. STM 32 Concepts: STM32 Interrupts, external interrupt pins & interrupt latency, STM 32 serial print Debug, STM 32 Timers, Timer Module, Timer Mode, counter Mode and Input Capture Mode (ICU), Encoder mode STM 32, PWM

STM 32 INTERFACING: Interface Various Peripherals Inside OF STM32 Microcontrollers, Interface Various Display Units (7-Segments, Alphanumeric LCD, OLED, TFT, etc) Interface Various Input Units (Buttons, Rotary Encoders, Keypad, HMI TouchPADs, etc).

Control Several Types OF Actuators (DC Motors, Servo Motors, Stepper Motors, etc), Serial Communication Via USART, SPI, I2C & Develop USB Applications (CDC, HID, Mass Storage, etc)

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- 2 Mastering STM32, Carmine Noviello, 2, Lean Publishing.
- 3 Advanced Programming with STM32 Microcontrollers, Majid Pakdel, 1, Lean Publishing.
- 4 ARM Cortex-M3 and Cortex-M4 Processors, Joseph Yiu, 3, Elsevier.

23SDEC07A - DEEP LEARNING WITH TENSORFLOW FRAMEWORK (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC07A	DEEP LEARNING WITH TENSORFLOW FRAMEWORK	DLTF	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Tensorflow framework for deep neural network construction and evaluate the models.	3	PO1, PO5, PSO2
CO2	Apply Tensorflow and keras APIs to develop deep convolutional neural networks for classification.	3	PO2, PO5, PSO2
CO3	Apply deep networks for sequence modelling applications using Tensorflow framework.	3	PO2, PO5, PSO2
CO4	Develop and deploy practical applications of deep learning models to solve real-world problems	3	PO1, PO5, PSO2

Syllabus

Understanding Objective Function of ML Algorithms, Metrics, Evaluation Methods and Optimizers, Popular Metrics in Detail: R2 Score, RMSE, Cross Entropy, Precision, Recall, F1 Score, ROC-AUC, SGD, ADAM. PySpark functions for importing data from various sources and other big data frameworks, Machine Learning with PySpark, Implementing scalable ML models with PySpark

TENSORFLOW 2.0 AND KERAS FOR DEEP LEARNING: TensorFlow core concepts, Tensors, core APIs, Concrete Functions, Datatypes, Control Statements, Polymorphic Functions, Concrete Functions, Datatypes, Control Statements, NumPy, Pandas. Autograph eager execution, tf.function autograph implementation, Keras (TensorFlow 2.0 Built-in API) Overview, Building Neural Networks in Keras.

DEEP LEARNING FOUNDATION: Deep Dive into Activation Functions: Relu, Sigmoid, Tanh, SoftMax, Linear. Building simple Deep Learning Network, Visualizing Training using TensorBoard, Implementing RNN, CNN in Keras, Building Recurrent Neural Networks for sequence data and Convolution Neural Networks for Image Classification. Advanced Deep Learning - CNN, RNN, LSTM RNN with TensorFlow 2.0 (Keras).

Model Deployment: Saving and Loading Models, Serving TensorFlow Models, Model Optimization. Real-World Applications and Projects: Image Classification, Text Generation, Time Series Forecasting. Advanced Topics and Future Trends: Explainable AI (XAI), Reinforcement Learning Basics

Reference Books

- 1 TensorFlow for Deep Learning, Bharath Ramsundar, Reza Bosagh Zadeh, 2021, O'REILLY.
- 2 Deep Learning with TensorFlow and Keras: Build and deploy supervised, unsupervised, deep, and reinforcement learning models, Amita Kapoor, Antonio Gulli, Sujit Pal, Francois Chollet, 2018, PACKT.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Geron, 2019, O'Reilly Media.
- 4 TensorFlow for Deep Learning: From Linear Regression to Reinforcement Learning, Tom Hope, Yehezkel S. Resheff, and Itay Lieder, 2017, O'Reilly Media.
- 5 Deep Learning with Python, Francois Chollet, 2021, Manning Publications.

23SDEC07E - DEEP LEARNING WITH TENSORFLOW FRAMEWORK (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC07E	DEEP LEARNING WITH TENSORFLOW FRAMEWORK	DLTF	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Tensorflow framework for deep neural network construction and evaluate the models.	3	PO1, PO5, PSO2
CO2	Apply Tensorflow and keras APIs to develop deep convolutional neural networks for classification.	3	PO2, PO5, PSO2
CO3	Apply deep networks for sequence modelling applications using Tensorflow framework.	3	PO2, PO5, PSO2
CO4	Develop and deploy practical applications of deep learning models to solve real-world problems	3	PO1, PO5, PSO2

Syllabus

Understanding Objective Function of ML Algorithms, Metrics, Evaluation Methods and Optimizers, Popular Metrics in Detail: R2 Score, RMSE, Cross Entropy, Precision, Recall, F1 Score, ROC-AUC, SGD, ADAM. PySpark functions for importing data from various sources and other big data frameworks, Machine Learning with PySpark, Implementing scalable ML models with PySpark

TENSORFLOW 2.0 AND KERAS FOR DEEP LEARNING: TensorFlow core concepts, Tensors, core APIs, Concrete Functions, Datatypes, Control Statements, Polymorphic Functions, Concrete Functions, Datatypes, Control Statements, NumPy, Pandas. Autograph eager execution, tf.function autograph implementation, Keras (TensorFlow 2.0 Built-in API) Overview, Building Neural Networks in Keras.

DEEP LEARNING FOUNDATION: Deep Dive into Activation Functions: Relu, Sigmoid, Tanh, SoftMax, Linear. Building simple Deep Learning Network, Visualizing Training using TensorBoard, Implementing RNN, CNN in Keras, Building Recurrent Neural Networks for sequence data and Convolution Neural Networks for Image Classification. Advanced Deep Learning - CNN, RNN, LSTM RNN with TensorFlow 2.0 (Keras).

Model Deployment: Saving and Loading Models, Serving TensorFlow Models, Model Optimization. Real-World Applications and Projects: Image Classification, Text Generation, Time Series Forecasting. Advanced Topics and Future Trends: Explainable AI (XAI), Reinforcement Learning Basics

Reference Books

- 1 TensorFlow for Deep Learning, Bharath Ramsundar, Reza Bosagh Zadeh, 2021, O'REILLY.
- 2 Deep Learning with TensorFlow and Keras: Build and deploy supervised, unsupervised, deep, and reinforcement learning models, Amita Kapoor, Antonio Gulli, Sujit Pal, Francois Chollet, 2018, PACKT.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurlien Gron, 2nd Edition (2019), O'Reilly Media.
- 4 TensorFlow for Deep Learning: From Linear Regression to Reinforcement Learning, Tom Hope, Yehezkel S. Resheff, and Itay Lieder, 1st Edition (2017), O'Reilly Media.
- 5 Deep Learning with Python, Francois Chollet, 2nd Edition (2021), Manning Publications.

23SDEC07R - DEEP LEARNING WITH TENSORFLOW FRAMEWORK (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC07R	DEEP LEARNING WITH TENSORFLOW FRAMEWORK	DLTF	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Tensorflow framework for deep neural network construction and evaluate the models.	3	PO1, PO5, PSO2
CO2	Apply Tensorflow and keras APIs to develop deep convolutional neural networks for classification.	3	PO2, PO5, PSO2
CO3	Apply deep networks for sequence modelling applications using Tensorflow framework.	3	PO1, PO2, PO5, PSO2

Syllabus

Understanding Objective Function of ML Algorithms, Metrics, Evaluation Methods and Optimizers, Popular Metrics in Detail: R2 Score, RMSE, Cross Entropy, Precision, Recall, F1 Score, ROC-AUC, SGD, ADAM. PySpark functions for importing data from various sources and other big data frameworks, Machine Learning with PySpark, Implementing scalable ML models with PySpark

TENSORFLOW 2.0 AND KERAS FOR DEEP LEARNING: TensorFlow core concepts, Tensors, core APIs, Concrete Functions, Datatypes, Control Statements, Polymorphic Functions, Concrete Functions, Datatypes, Control Statements, NumPy, Pandas. Autograph eager execution, tf.function autograph implementation, Keras (TensorFlow 2.0 Built-in API) Overview, Building Neural Networks in Keras.

DEEP LEARNING FOUNDATION: Deep Dive into Activation Functions: Relu, Sigmoid, Tanh, SoftMax, Linear. Building simple Deep Learning Network, Visualizing Training using TensorBoard, Implementing RNN, CNN in Keras, Building Recurrent Neural Networks for sequence data and Convolution Neural Networks for Image Classification. Advanced Deep Learning - CNN, RNN, LSTM RNN with TensorFlow 2.0 (Keras).

Reference Books

- 1 TensorFlow for Deep Learning, Bharath Ramsundar, Reza Bosagh Zadeh, 2021, O'REILLY.
- 2 Deep Learning with TensorFlow and Keras: Build and deploy supervised, unsupervised, deep, and reinforcement learning models, Amita Kapoor, Antonio Gulli, Sujit Pal, Francois Chollet, 2018, PACKT.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurlien Gron, 2nd Edition (2019), O'Reilly Media.
- 4 TensorFlow for Deep Learning: From Linear Regression to Reinforcement Learning, Tom Hope, Yehezkel S. Resheff, and Itay Lieder, 1st Edition (2017), O'Reilly Media.
- 5 Deep Learning with Python, Francois Chollet, 2nd Edition (2021), Manning Publications.

23SDEC08A - PLANAR ANTENNA DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC08A	PLANAR ANTENNA DESIGN	PAD	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse the concept of feeding techniques for MSA application	4	PO2, PO5, PO11, PSO2
CO2	Analyse the various Parameters of MSA	4	PO2, PO5, PSO2
CO3	Design and analyse the Slot mechanism for Microstrip Patch to enhance bandwidth	4	PO2, PO3, PO5, PSO2

Syllabus

Introduction to MSA and feeding techniques: Characteristics of Microstrip Patch Antenna, Advantages, Applications of MSA, Different Feed Technique: Co axial, Inset, Aperture/Slot Coupled, Proximity coupled.

Design steps of Microstrip Patch Antenna: Types of Patch antennas, Microstrip rectangular and circular Patch Antenna: Design equations, Design using different Substrate with different resonant frequencies, Result Analysis of MSA, S parameters, Gain, Directivity, Efficiency and Power radiated plot.

Microstrip Slot Antennas: Radiation mechanism, Micro strip slot antennas, Introduction to rectangular slot antennas, narrow, wide, tapered and circularly polarized slot antennas, Annular slot antennas, Comparison of microstrip slot antennas with patch antennas

Reference Books

1. Antenna Theory Analysis and Design, 1. Constantine Balanis, 3rd, John Wiley.
2. Microstrip Antennas, 2. Bahl IJ, and P. Bhartia, 3rd, Artech House.
3. Microstrip Antenna Design Handbook, 1. Ramesh Garg, Prakash Bhatia, 3rd, Artech House Inc.
4. Microwave Antenna Theory and design, 2. Samuel Silver, 3rd, Peter Peregrinus.

23SDEC08E - PLANAR ANTENNA DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC08E	PLANAR ANTENNA DESIGN	PAD	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse the concept of feeding techniques for MSA application	4	PO2, PO5, PO11, PSO2
CO2	Analyse the various Parameters of MSA	4	PO2, PO5, PSO2
CO3	Design and analyse the Slot mechanism for Microstrip Patch to enhance bandwidth	4	PO2, PO3, PO5, PSO2

Syllabus

Introduction to MSA and feeding techniques: Characteristics of Microstrip Patch Antenna, Advantages, Applications of MSA, Different Feed Technique: Co axial, Inset, Aperture/Slot Coupled, Proximity coupled.

Design steps of Microstrip Patch Antenna: Types of Patch antennas, Microstrip rectangular and circular Patch Antenna: Design equations, Design using different Substrate with different resonant frequencies, Result Analysis of MSA, S parameters, Gain, Directivity, Efficiency and Power radiated plot.

Different feed techniques can be employed to optimize the performance of MSAs. The coaxial probe feed is simple to implement and provides good impedance matching, although it may introduce spurious radiation. The inset feed improves impedance matching and reduces spurious radiation, enhancing overall performance. The aperture/slot coupled feed offers high isolation between the feed n

Microstrip Slot Antennas: Radiation mechanism, Micro strip slot antennas, Introduction to rectangular slot antennas, narrow, wide, tapered and circularly polarized slot antennas, Annular slot antennas, Comparison of microstrip slot antennas with patch antennas

Reference Books

- 1 Antenna Theory Analysis and Design, Constantine Balanis, 3rd, John Wiley.
- 2 Microstrip Antennas, Bahl IJ, and P. Bhartia, 3rd, Artech House.
- 3 Microstrip Antenna Design Handbook, Ramesh Garg, Prakash Bhatia, 3rd, Artech House Inc.
- 4 Microwave Antenna Theory and design, .Samuel Silver, 3rd, Peter Peregrinus.

23SDEC08R - PLANAR ANTENNA DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC08R	PLANAR ANTENNA DESIGN	PAD	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse the concept of feeding techniques for MSA application	4	PO2, PO5, PO11, PSO2
CO2	Analyse the various Parameters of MSA	4	PO2, PO5, PSO2
CO3	Design and analyse the Slot mechanism for Microstrip Patch to enhance bandwidth	4	PO2, PO3, PO5, PSO2

Syllabus

Introduction to MSA and feeding techniques: Characteristics of Microstrip Patch Antenna, Advantages, Applications of MSA, Different Feed Technique: Co axial, Inset, Aperture/Slot Coupled, Proximity coupled.

Design steps of Microstrip Patch Antenna: Types of Patch antennas, Microstrip rectangular and circular Patch Antenna: Design equations, Design using different Substrate with different resonant frequencies, Result Analysis of MSA, S parameters, Gain, Directivity, Efficiency and Power radiated plot.

Microstrip Slot Antennas: Radiation mechanism, Micro strip slot antennas, Introduction to rectangular slot antennas, narrow, wide, tapered and circularly polarized slot antennas, Annular slot antennas, Comparison of microstrip slot antennas with patch antennas

Different feed techniques can be employed to optimize the performance of MSAs. The coaxial probe feed is simple to implement and provides good impedance matching, although it may introduce spurious radiation. The inset feed improves impedance matching and reduces spurious radiation, enhancing overall performance. The aperture/slot coupled feed offers high isolation between the feed n

Reference Books

- 1 Antenna Theory Analysis and Design, Constantine Balanis, 3rd, John Wiley.
- 2 Microstrip Antennas, Bahl IJ, and P. Bhartia, 3rd, Artech House.
- 3 Microstrip Antenna Design Handbook, Ramesh Garg, Prakash Bhatia, 3rd, Artech House Inc.
- 4 Microwave Antenna Theory and design, Samuel Silver, 3rd, Peter Peregrinus.

23SDEC09A - ROBOTICS AND AUTOMATION WITH WEBOTS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC09A	ROBOTICS AND AUTOMATION WITH WEBOTS	RAW	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental concepts of robotics in various terrain using webot tool	3	PO5, PO7, PSO1
CO2	Analyze the planned trajectory using Webots involves utilizing its simulation environment and programming tools to define and execute paths for robotic motion	4	PO5, PO9, PSO1
CO3	Analyzing a wheeled mobile robot in Webots involves creating a virtual environment, configuring the robot's behavior and sensors, and applying navigation algorithms. This facilitates effective obstacle navigation.	4	PO5, PO11, PSO1
CO4	Analyze the autonomous navigation involves designing and implementing algorithms that enable a robot to move independently within a simulated environment.	4	PO5, PO11, PSO1

Syllabus

Devices: Webot Stereoscopic camera, anachrome red/cyan filters, Gantry robot, gripper, Hanoi towers, linear motors, recursive algorithm, Legged robot, alternating tripod gait, linear motor, Differential wheels, Koala, keyboard, texture, Soccer, supervisor, differential wheels, label, Stewart platform, linear motion, physics plugin, ball joint, universal joint

Environment: Apartment, domestic environment, furniture, Break room, domestic environment, furniture, Apartment, household environment, furniture, Factory, workbench, tools, industrial pipes, industrial stairs, hall, workbench, tools, industrial pipes, industrial stairs, kitchen, utensil.

Direct and inverse kinematics problems and workspace, Kinematics. Motions and dimensions, Velocity Analysis and Statics of Manipulators, Trajectory Planning and Generation, Configuration Space, State Space, Geometric Planning, Sampling-based Planning ,Optimization-based Planning.

Designing and testing algorithms for autonomous navigation, path planning, obstacle avoidance usingf Webots includes Designing the Simulation Environment, Programming the Robot Controller, Multi-Sensor Fusion and Real-time Optimization

Reference Books

- 1 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala, 2016, 1st Edition, Butterworth-Heinemann.
- 2 Probabilistic Robotics , Thrun, S., Burgard,W., and Fox, D , 2005, 2nd Edition, MIT Press.
- 3 Planning Algorithms , S M. LaValle , 2006, 2nd Edition, Cambridge University Press.
- 4 Autonomous Vehicles Volume 1: Using Machine Intelligence , Romil Rawat , 2022, 1st Edition, Wiley Publisher.
- 5 Introduction to Mobile Robot Control , SG Tzafestas , 2014,1st Edition , Elsevier.
- 6 Introduction to Autonomous Mobile Robots , R. Siegwart, I. R. Nourbakhsh , 2011, 1st Edition, MIT Press.

23SDEC09E - ROBOTICS AND AUTOMATION WITH WEBOTS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC09E	ROBOTICS AND AUTOMATION WITH WEBOTS	RAW	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental concepts of robotics in various terrain using webot tool	3	PO5, PO7, PSO1
CO2	Analyze the planned trajectory using Webots involves utilizing its simulation environment and programming tools to define and execute paths for robotic motion	4	PO5, PO9, PSO1
CO3	Analyzing a wheeled mobile robot in Webots involves creating a virtual environment, configuring the robot's behavior and sensors, and applying navigation algorithms. This facilitates effective obstacle navigation.	4	PO5, PO11, PSO1
CO4	Analyze the autonomous navigation involves designing and implementing algorithms that enable a robot to move independently within a simulated environment.	4	PO5, PO11, PSO1

Syllabus

Devices: Webot Stereoscopic camera, anachrome red/cyan filters, Gantry robot, gripper, Hanoi towers, linear motors, recursive algorithm, Legged robot, alternating tripod gait, linear motor, Differential wheels, Koala, keyboard, texture, Soccer, supervisor, differential wheels, label, Stewart platform, linear motion, physics plugin, ball joint, universal joint

Environment: Apartment, domestic environment, furniture, Break room, domestic environment, furniture, Apartment, household environment, furniture, Factory, workbench, tools, industrial pipes, industrial stairs, hall, workbench, tools, industrial pipes, industrial stairs, kitchen, utensil.

Direct and inverse kinematics problems and workspace, Kinematics. Motions and dimensions, Velocity Analysis and Statics of Manipulators, Trajectory Planning and Generation, Configuration Space, State Space, Geometric Planning, Sampling-based Planning ,Optimization-based Planning.

Designing and testing algorithms for autonomous navigation, path planning, obstacle avoidance usingf Webots includes Designing the Simulation Environment, Programming the Robot Controller, Multi-Sensor Fusion and Real-time Optimization

Reference Books

- 1 Autonomous Vehicles Volume 1: Using Machine Intelligence , Romil Rawat , 2022, 1st Edition, Wiley.
- 2 Introduction to Mobile Robot Control , SG Tzafestas , 2014, 2nd Edition, Elsevier.
- 3 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala , 2016,2nd Edition, Butterworth-Heinemann.
- 4 Probabilistic Robotics , Thrun, S., Burgard,W., and Fox, D , 2005, 1st Edition, MIT Press.
- 5 Planning Algorithms, S. M. LaValle , 2006, 1st Edition, Cambridge University Press.
- 6 Introduction to Autonomous Mobile Robots , R. Siegwart, I. R. Nourbakhsh , 2011, 1st Edition, MIT Press.

23SDEC09R - ROBOTICS AND AUTOMATION WITH WEBOTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC09R	ROBOTICS AND AUTOMATION WITH WEBOTS	RAW	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental concepts of robotics in various terrain using webot tool	3	PO5, PO7, PSO1
CO2	Analyze the planned trajectory using Webots involves utilizing its simulation environment and programming tools to define and execute paths for robotic motion	4	PO5, PO9, PSO1
CO3	Analyzing a wheeled mobile robot in Webots involves creating a virtual environment, configuring the robot's behavior and sensors, and applying navigation algorithms. This facilitates effective obstacle navigation.	4	PO5, PO11, PSO1

Syllabus

Devices: Webot Stereoscopic camera, anachrome red/cyan filters, Gantry robot, gripper, Hanoi towers, linear motors, recursive algorithm, Legged robot, alternating tripod gait, linear motor, Differential wheels, Koala, keyboard, texture, Soccer, supervisor, differential wheels, label, Stewart platform, linear motion, physics plugin, ball joint, universal joint

Environment: Apartment, domestic environment, furniture, Break room, domestic environment, furniture, Apartment, household environment, furniture, Factory, workbench, tools, industrial pipes, industrial stairs, hall, workbench, tools, industrial pipes, industrial stairs, kitchen, utensil.

Direct and inverse kinematics problems and workspace, Kinematics. Motions and dimensions, Velocity Analysis and Statics of Manipulators, Trajectory Planning and Generation, Configuration Space, State Space, Geometric Planning, Sampling-based Planning ,Optimization-based Planning.

Reference Books

- 1 Autonomous Vehicles Volume 1: Using Machine Intelligence , Romil Rawat , 2022, 1st Edition, Wiley.
- 2 Introduction to Mobile Robot Control , SG Tzafestas , 2014, 1st Edition, Elsevier.
- 3 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala , 2016, 1st Edition, Butterworth-Heinemann.
- 4 Probabilistic Robotics , Thrun, S., Burgard,W., and Fox, D , 2005, 2nd Edition, MIT Press.
- 5 Planning Algorithms , S. M. LaValle , 2006, 2nd Edition, Cambridge University Press.
- 6 Introduction to Autonomous Mobile Robots , R. Siegwart, I. R. Nourbakhsh 2011 , 2011, 1st Edition, MIT Press.

23SDEC10A - INTEGRATED SYSTEM DESIGN AUTOMATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC10A	INTEGRATED SYSTEM DESIGN AUTOMATION	ISDA	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Employ VLSI full custom design to develop a functional module upto backend for backannotation and tapeout	4	PO5, PO7, PO11, PSO2
CO2	Analyze high level description languages from frond end to back end for realization of functional digital module	4	PO2, PO5, PO11, PSO2
CO3	Implement peripheral modules in FPGA for hardware realization of developed digital functional modules	4	PO2, PO5, PO11, PSO2
CO4	Analyze spice models for realizing functional analog VLSI circuits	4	PO2, PO5, PO11, PSO1, PSO2

Syllabus

Project-Based Schematic Capture, Functional simulation, Layout, Post Layout Simulation, GDS-II (Using Cadence)

Verilog constructs, Tasks and Functions, Modelling memories and FSMs, Verilog timing regions, Inferring combinational and sequential logic, Pipelining, compiler directives

FPGA Design Flow, Peripheral module interface, Design of communication protocols, Design of intellectual property (IP) core, Software application on FPGA

Spice Constructs, Functional simulation of spice models, embedding spice/spectre models with technology instances in cadence

Reference Books

- 1 Verilog HDL: A guide to digital design and synthesis, Samir Palnitkar, 2nd, SunSoft Press .
- 2 Semi-custom IC Design and VLSI (Computing and Networks) , P.J. Hicks, 2nd, Institution of Engineering and Technology.
- 3 FPGA Design, Philip Andrew Simpson , 1st, Springer.
- 4 Layout Optimization in VLSI Design (Network Theory and Applications, Bing Lu, 7th, Springer.

23SDEC10E - INTEGRATED SYSTEM DESIGN AUTOMATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC10E	INTEGRATED SYSTEM DESIGN AUTOMATION	ISDA	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Employ VLSI full custom design to develop a functional module upto backend for backannotation and tapeout	4	PO1, PO5, PO9, PSO2
CO2	Analyze high level description languages from frond end to back end for realization of functional digital module	4	PO1, PO5, PO9, PSO2
CO3	Implement peripheral modules in FPGA for hardware realization of developed digital functional modules	4	PO1, PO5, PO9, PSO2
CO4	Analyze spice models for realizing functional analog VLSI circuits	4	PO1, PO5, PO9, PSO2

Syllabus

Project-Based Schematic Capture, Functional simulation, Layout, Post Layout Simulation, GDS-II (Using Cadence)

Verilog constructs, Tasks and Functions, Modelling memories and FSMs, Verilog timing regions, Inferring combinational and sequential logic, Pipelining, compiler directives

FPGA Design Flow, Peripheral module interface, Design of communication protocols, Design of intellectual property (IP) core, Software application on FPGA

Spice Constructs, Functional simulation of spice models, embedding spice/spectre models with technology instances in cadence

Reference Books

- 1 Verilog HDL: A guide to digital design and synthesis, Samir Palnitkar, 2nd, SunSoft Press.
- 2 Design and VLSI (Computing and Networks), P.J. Hicks, 2nd, Institution of Engineering and Technology.
- 3 FPGA Design, Philip Andrew Simpson, 1st, Springer.
- 4 Layout Optimization in VLSI Design (Network Theory and Applications, Bing Lu, 7th, Springer.

23SDEC10R - INTEGRATED SYSTEM DESIGN AUTOMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC10R	INTEGRATED SYSTEM DESIGN AUTOMATION	ISDA	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Employ VLSI full custom design to develop a functional module upto backend for backannotation and tapeout	4	PO1, PO5, PO9, PSO1, PSO2
CO2	Analyze high level description languages from frond end to back end for realization of functional digital module	4	PO1, PO5, PO9, PSO1, PSO2
CO3	Implement peripheral modules in FPGA for hardware realization of developed digital functional modules	4	PO1, PO5, PO9, PSO1, PSO2

Syllabus

Project-Based Schematic Capture, Functional simulation, Layout, Post Layout Simulation, GDS-II (Using Cadence)

Verilog constructs, Tasks and Functions, Modelling memories and FSMs, Verilog timing regions, Inferring combinational and sequential logic, Pipelining, compiler directives

FPGA Design Flow, Peripheral module interface, Design of communication protocols, Design of intellectual property (IP) core, Software application on FPGA

Reference Books

- 1 Verilog HDL: A guide to digital design and synthesis, Samir Palnitkar, 2nd, SunSoft Press.
- 2 Semi-custom IC Design and VLSI (Computing and Networks), P.J. Hicks, 2nd, Institution of Engineering and Technology.
- 3 FPGA Design, Philip Andrew Simpson, Philip Andrew Simpson, Philip Andrew Simpson.
- 4 Layout Optimization in VLSI Design (Network Theory and Applications, Bing Lu, 7th, Springer.

23SDEC11A - BIOMEDICAL SYSTEM INTERFACING AND SIGNAL ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC11A	BIOMEDICAL SYSTEM INTERFACING AND SIGNAL ANALYSIS	BSIS	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Build bio-amplifiers, exploring their role in amplifying weak electrical signals from the body (ECG, EEG, EMG), and examines various bio-amplifier circuits along with design principles for instrumentation amplifiers, a key component. In two sentences, you'll gain the knowledge to build circuits that process biological data.	3	PO5, PO9, PO11, PO12, PSO1
CO2	Examine biosignals (ECG, EMG, EEG) using bioinstrumentation amplifiers and popular software like MATLAB or Multisim. signal processing techniques for raw ECG data, including pre-processing, noise reduction, feature extraction, and classification.	4	PO5, PO9, PO11, PO12, PSO1
CO3	Analyze lab-on-a-chip (LOC) technology, covering biosensor design basics, integration strategies, microfluidics, and data acquisition systems. Build your skills with a hands-on biosensor design project.	4	PO5, PO9, PO11, PO12, PSO1
CO4	Inspect wearable health tech, remote patient monitoring, and imaging techniques like MRI and CT. biofeedback and neurofeedback, then peer into the future of brain-computer interfaces and other emerging trends.	4	PO5, PO9, PO11, PO12, PSO1

Syllabus

Overview of Bio-Amplifier and Types of Bio-Amplifiers, Bio-Amplifier Circuit of ECG, Datasheet of AD624, Bio-Amplifier Circuit for EEG, Bio-Amplifier Circuit for EMG. Design of Instrumentation Amplifier Circuit.

"Instrumentation amplifier signal acquisition for ECG, EMG and EEG using any standalone board, biophysiological instrument. Analysis of ECG signal RAW signal, Preprocessing, Denoise, Features Extraction and Classification using MATLAB/Multisim programming. "

"Lab-On-chip: Basics of Bio-Chemical Sensor design, Integrated Sensor design with example, Electrostatics analysis for sensor design, Micro-Fluid Analysis for LOC, Demo of Biosensor Design. Project on data acquisition system."

Wearable biomedical devices and their applications Remote patient monitoring systems Biomedical imaging techniques (e.g., MRI, CT) Biofeedback systems and neurofeedback applications Emerging trends and future directions in biomedical interfacing

Reference Books

- 1 Practical Guide for Biomedical Signals Analysis Using Machine Learning Techniques, A MATLAB Based Approach , Abdulhamit Subasi , 2019, Elsevier Science Publisher. .
- 2 Biomedical Signal Analysis , Rangaraj M. Rangayyan , 2005, Wiley Publisher .
- 3 Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices , David Prutchi, Michael Norris , 2004, Wiley Publisher .
- 4 Biomedical Instrumentation and Measurements , Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer , 1990, Prentice Hall Inc, New Jersey. .
- 5 Handbook of Biomedical Instrumentation-Technology & Applications , R.S. Khandpur , 2014, Tata McGraw-Hill .

23SDEC11E - BIOMEDICAL SYSTEM INTERFACING AND SIGNAL ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC11E	BIOMEDICAL SYSTEM INTERFACING AND SIGNAL ANALYSIS	BSIS	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Build bio-amplifiers, exploring their role in amplifying weak electrical signals from the body (ECG, EEG, EMG), and examines various bio-amplifier circuits along with design principles for instrumentation amplifiers, a key component. In two sentences, you'll gain the knowledge to build circuits that process biological data.	3	PO5, PO9, PO11, PO12, PSO1
CO2	Examine biosignals (ECG, EMG, EEG) using bioinstrumentation amplifiers and popular software like MATLAB or Multisim. signal processing techniques for raw ECG data, including pre-processing, noise reduction, feature extraction, and classification.	4	PO5, PO9, PO11, PO12, PSO1
CO3	Analyze lab-on-a-chip (LOC) technology, covering biosensor design basics, integration strategies, microfluidics, and data acquisition systems. Build your skills with a hands-on biosensor design project.	4	PO5, PO9, PO11, PO12, PSO1
CO4	Inspect wearable health tech, remote patient monitoring, and imaging techniques like MRI and CT. biofeedback and neurofeedback, then peer into the future of brain-computer interfaces and other emerging trends.	4	PO5, PO9, PO11, PO12, PSO1

Syllabus

Overview of Bio-Amplifier and Types of Bio-Amplifiers, Bio-Amplifier Circuit of ECG, Datasheet of AD624, Bio-Amplifier Circuit for EEG, Bio-Amplifier Circuit for EMG. Design of Instrumentation Amplifier Circuit.

"Instrumentation amplifier signal acquisition for ECG, EMG and EEG using any standalone board, biophysiological instrument. Analysis of ECG signal RAW signal, Preprocessing, Denoise, Features Extraction and Classification using MATLAB/Multisim programming. "

"Lab-On-chip: Basics of Bio-Chemical Sensor design, Integrated Sensor design with example, Electrostatics analysis for sensor design, Micro-Fluid Analysis for LOC, Demo of Biosensor Design. Project on data acquisition system."

Wearable biomedical devices and their applications Remote patient monitoring systems Biomedical imaging techniques (e.g., MRI, CT) Biofeedback systems and neurofeedback applications Emerging trends and future directions in biomedical interfacing

Reference Books

- 1 Practical Guide for Biomedical Signals Analysis Using Machine Learning Techniques, A MATLAB Based Approach , Abdulhamit Subasi , 2019, Elsevier Science Publisher. .
- 2 Biomedical Signal Analysis , Rangaraj M. Rangayyan , 2005, Wiley Publisher .
- 3 Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices , David Prutchi, Michael Norris , 2004, Wiley Publisher .
- 4 Biomedical Instrumentation and Measurements , Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer , 1990, Prentice Hall Inc, New Jersey. .
- 5 Handbook of Biomedical Instrumentation-Technology & Applications , R.S. Khandpur , 2014, Tata McGraw-Hill .

23SDEC11R - BIOMEDICAL SYSTEM INTERFACING AND SIGNAL ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC11R	BIOMEDICAL SYSTEM INTERFACING AND SIGNAL ANALYSIS	BSIS	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Build bio-amplifiers, exploring their role in amplifying weak electrical signals from the body (ECG, EEG, EMG), and examines various bio-amplifier circuits along with design principles for instrumentation amplifiers, a key component. In two sentences, you'll gain the knowledge to build circuits that process biological data.	3	PO5, PO9, PO11, PO12, PSO1
CO2	Examine biosignals (ECG, EMG, EEG) using bioinstrumentation amplifiers and popular software like MATLAB or Multisim. signal processing techniques for raw ECG data, including pre-processing, noise reduction, feature extraction, and classification.	4	PO5, PO9, PO11, PO12, PSO1
CO3	Analyze lab-on-a-chip (LOC) technology, covering biosensor design basics, integration strategies, microfluidics, and data acquisition systems. Build your skills with a hands-on biosensor design project.	4	PO5, PO9, PO11, PO12, PSO1
CO4	Inspect wearable health tech, remote patient monitoring, and imaging techniques like MRI and CT. biofeedback and neurofeedback, then peer into the future of brain-computer interfaces and other emerging trends.	4	PO5, PO9, PO11, PO12, PSO1

Syllabus

Overview of Bio-Amplifier and Types of Bio-Amplifiers, Bio-Amplifier Circuit of ECG, Datasheet of AD624, Bio-Amplifier Circuit for EEG, Bio-Amplifier Circuit for EMG. Design of Instrumentation Amplifier Circuit in CADENCE.

"Instrumentation amplifier signal acquisition for ECG, EMG and EEG using any standalone board, biophysiological instrument. Analysis of ECG signal RAW signal, Preprocessing, Denoise, Features Extraction and Classification using MATLAB/ PYTHON programming. "

"Lab-On-chip: Basics of Bio-Chemical Sensor design, Integrated Sensor design with example, Electrostatics analysis for sensor design, Micro-Fluid Analysis for LOC, Demo of Biosensor Design. Project on data acquisition system."

Wearable biomedical devices and their applications Remote patient monitoring systems Biomedical imaging techniques (e.g., MRI, CT) Biofeedback systems and neurofeedback applications Emerging trends and future directions in biomedical interfacing

Reference Books

- 1 Practical Guide for Biomedical Signals Analysis Using Machine Learning Techniques, A MATLAB Based Approach , Abdulhamit Subasi , 2019, Elsevier Science Publisher. .
- 2 Biomedical Signal Analysis , Rangaraj M. Rangayyan , 2005, Wiley Publisher .
- 3 Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices , David Prutchi, Michael Norris , 2004, Wiley Publisher.
- 4 Biomedical Instrumentation and Measurements , Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer , 1990, Prentice Hall Inc, New Jersey. .
- 5 Handbook of Biomedical Instrumentation-Technology & Applications , R.S. Khandpur , 2014, Tata McGraw-Hill .

23SDEC12A - NETWORK PROGRAMMABILITY AND AUTOMATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC12A	NETWORK PROGRAMMABILITY AND AUTOMATION	NPA	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understanding the principles of network programmability and its significance in modern networking. .	2	PO1, PO2, PSO2
CO2	Apply scripting languages such as Python or Bash to automate repetitive networking tasks .	3	PO2, PO3, PSO2
CO3	Implement basic network automation scripts to perform common tasks like configuration management and device provisioning.	3	PO2, PO3, PSO2
CO4	Implement Security Best Practices in Network Automation:	2	PO3
CO5	Evaluate Emerging Trends and Technologies in Network Automation	3	

Syllabus

Introduction to Network Programmability Overview of network programmability concepts and benefits Introduction to APIs and data models (REST, JSON, XML) Hands-on: Setting up development environment

Scripting for Network Automation Introduction to scripting languages (Python, Bash) Basic scripting concepts (variables, loops, conditionals) Hands-on: Writing scripts to automate network tasks

Interacting with Network Devices Overview of network device APIs (REST, NETCONF, RESTCONF) Using libraries like Paramiko and Netmiko for SSH-based automation Hands-on: Interacting with switches and routers using Python scripts

Understand the security implications of network automation and programmability. Apply best practices to ensure secure automation processes and manage risks effectively.

Stay updated with the latest developments and trends in network automation. Assess how new technologies and methodologies could be integrated into existing network automation strategies.

Reference Books

- 1 Network Programmability and Automation, Matt oswalt, August 2023, O'Reilly Media, Inc..
- 2 Network Programmability and Automation Fundamentals, Jeff Doyle, May 2021, Cisco Press.
- 3 Programming and Automating Cisco Networks, Ryan Tischer and Jason Gooley, 1st Edition, Cisco Press,.
- 4 Python Network Programming Cookbook, Dr. M. O. Faruque Sarker, 9 August 2017, Packt.

23SDEC12E - NETWORK PROGRAMMABILITY AND AUTOMATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC12E	NETWORK PROGRAMMABILITY AND AUTOMATION	NPA	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understaing the role of APIs in network automation and their importance in facilitating communication between devices..	2	PO1, PO2, PSO2
CO2	Apply the basic network automation scripts to perform common tasks like configuration management and device provisioning.	3	PO2, PO3, PSO2
CO3	Analyze network infrastructure requirements and determine which tasks can be automated for efficiency. .	3	PO2, PO3, PSO2
CO4	Implement Security Best Practices in Network Automation:	2	PO3
CO5	Evaluate Emerging Trends and Technologies in Network Automation	3	

Syllabus

Introduction to Network Programmability Overview of network programmability concepts and benefits Introduction to APIs and data models (REST, JSON, XML) Hands-on: Setting up development environment

Scripting for Network Automation Introduction to scripting languages (Python, Bash) Basic scripting concepts (variables, loops, conditionals) Hands-on: Writing scripts to automate network tasks

Interacting with Network Devices Overview of network device APIs (REST, NETCONF, RESTCONF) Using libraries like Paramiko and Netmiko for SSH-based automation Hands-on: Interacting with switches and routers using Python scripts

Understand the security implications of network automation and programmability. Apply best practices to ensure secure automation processes and manage risks effectively.

Stay updated with the latest developments and trends in network automation. Assess how new technologies and methodologies could be integrated into existing network automation strategies.

Reference Books

- 1 Network Automation and Programmability: Automating Network Devices using Python 3" by Abhishek Ratan, Abhishek Ratan: , 3, Packt Publishing .
- 2 Network Programmability and Automation , Matt oswalt , August 2023 , O'Reilly Media, Inc..
- 3 Python Network Programming Cookbook, Dr. M. O. Faruque Sarker, 9 August 2017, Packt.
- 4 Programming and Automating Cisco Networks , Ryan Tischer and Jason Gooley , 1st Edition, Cisco Press,.

23SDEC12R - NETWORK PROGRAMMABILITY AND AUTOMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC12R	NETWORK PROGRAMMABILITY AND AUTOMATION	NPA	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the role of APIs in network automation and their importance in facilitating communication between devices..	1	PO1, PO2, PSO2
CO2	Applying basic network automation scripts to perform common tasks like configuration management and device provisioning.	3	PO2, PO3, PSO2
CO3	Analyze network infrastructure requirements and determine which tasks can be automated for efficiency. .	4	PO2, PO3, PSO2
CO4	Implement Security Best Practices in Network Automation:	2	PO3

Syllabus

Introduction to Network Programmability 1. Overview of network programmability concepts and benefits 2. Introduction to APIs and data models (REST, JSON, XML) 3. Hands-on: Setting up development environment

Scripting for Network Automation 1. Introduction to scripting languages (Python, Bash) 2. Basic scripting concepts (variables, loops, conditionals) 3. Hands-on: Writing scripts to automate network tasks

Interacting with Network Devices 1. Overview of network device APIs (REST, NETCONF, RESTCONF) 2. Using libraries like Paramiko and Netmiko for SSH-based automation 3. Hands-on: Interacting with switches and routers using Python scripts

Understand the security implications of network automation and programmability. Apply best practices to ensure secure automation processes and manage risks effectively.

Reference Books

- 1 Network Automation and Programmability: Automating Network Devices using Python , Abhishek Ratan, 3, Packt Publishing .
- 2 Network Programmability and Automation , Matt oswalt, August 2023, O'Reilly Media, Inc.
- 3 Programming and Automating Cisco Networks, Ryan Tischer and Jason Gooley, 1st Edition, Cisco PRESS.
- 4 Python Network Programming Cookbook , Dr. M. O. Faruque Sarker, 9 August 2017 , Packt.

23SDEC13A - 5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC13A	5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS	5PIA	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their understanding of 5G architecture, call processes defined by 3GPP standards, and core functionalities like eMBB, mMTC, and URLLC to analyze and differentiate use cases for the 5G network.	3	PO3, PO4, PO5
CO2	Analyze and evaluate critical aspects of 5G physical layer design.	4	PO3, PO4, PO5
CO3	Compare and contrast private wireless network architectures and assess their effectiveness	4	PO3, PO4, PO5
CO4	Analyze and assess the potential of 5G technology to address emerging challenges and opportunities across different industries.	4	PO3, PO4, PO5

Syllabus

5G architecture and call process with 3GPP standards, 5G use cases - eMBB, mMTC, URLLC

Transceivers, Channel estimation, OFDM issues, Peak to Average Power ratio (PAPR), Carrier frequency Offset (CFO) and carrier timing offset, Synchronization, PAPR reduction techniques.

Architectures for Private Wireless, Case Studies - Uncovering 5G potential for real-time control in manufacturing, Industrial-grade Private Wireless.

5G use cases - Industrial, Healthcare, Smart cities, Energy and utilities, Autonomous vehicles, Sports broadcasting, Gaming, Agriculture, Hyper express trains.

Reference Books

- 1 5G NR: The Next Generation Wireless Access Technology. , Dahlman, E., Parkvall, S., Skold, J. , 2018, Elsevier Science .
- 2 5G Core Networks: Powering Digitalization. , Rommer, S., Hedman, P., Olsson, M., Frid, L., Sultana, S., Mulligan, C. , 2019, Elsevier Science .
- 3 5G/5G-Advanced The New Generation Wireless Access Technology , Erik Dahlman, Stefan Parkvall, Johan Skold , 2023, Elsevier Science .
- 4 Fundamentals of 5G Mobile Networks , Jonathan Rodriguez , 2015, Wiley.
- 5 Multiple Access Techniques for 5G Wireless Networks and Beyond , Mojtaba Vaezi, Zhiguo Ding, Vincent Poor , 2018, Springer International Publishing .

23SDEC13E - 5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC13E	5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS	5PIA	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their understanding of 5G architecture, call processes defined by 3GPP standards, and core functionalities like eMBB, mMTC, and URLLC to analyze and differentiate use cases for the 5G network.	3	PO3, PO4, PO5
CO2	Analyze and evaluate critical aspects of 5G physical layer design.	4	PO3, PO4, PO5
CO3	Compare and contrast private wireless network architectures and assess their effectiveness	4	PO3, PO4, PO5
CO4	Analyze and assess the potential of 5G technology to address emerging challenges and opportunities across different industries.	4	PO3, PO4, PO5

Syllabus

5G architecture and call process with 3GPP standards, 5G use cases - eMBB, mMTC, URLLC

Transceivers, Channel estimation, OFDM issues, Peak to Average Power ratio (PAPR), Carrier frequency Offset (CFO) and carrier timing offset, Synchronization, PAPR reduction techniques.

Architectures for Private Wireless, Case Studies - Uncovering 5G potential for real-time control in manufacturing, Industrial-grade Private Wireless.

5G use cases - Industrial, Healthcare, Smart cities, Energy and utilities, Autonomous vehicles, Sports broadcasting, Gaming, Agriculture, Hyper express trains.

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- 1 5G NR: The Next Generation Wireless Access Technology. , Dahlman, E., Parkvall, S., Skold, J. , 2018, Elsevier Science .
- 2 5G Core Networks: Powering Digitalization. , Rommer, S., Hedman, P., Olsson, M., Frid, L., Sultana, S., Mulligan, C. , 2019, Elsevier Science .
- 3 5G/5G-Advanced The New Generation Wireless Access Technology , Erik Dahlman, Stefan Parkvall, Johan Skold , 2023, Elsevier Science .
- 4 Fundamentals of 5G Mobile Networks , Jonathan Rodriguez , 2015, Wiley.
- 5 Multiple Access Techniques for 5G Wireless Networks and Beyond , Mojtaba Vaezi, Zhiguo Ding, Vincent Poor , 2018, Springer International Publishing .

23SDEC13R - 5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC13R	5G PRIVATE AND INDUSTRIAL AUTOMATION NETWORKS	5PIA	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their understanding of 5G architecture, call processes defined by 3GPP standards, and core functionalities like eMBB, mMTC, and URLLC to analyze and differentiate use cases for the 5G network.	3	PO3, PO4, PO5
CO2	Analyze and evaluate critical aspects of 5G physical layer design.	4	PO3, PO4, PO5
CO3	Compare and contrast private wireless network architectures and assess their effectiveness	4	PO3, PO4, PO5

Syllabus

5G architecture and call process with 3GPP standards, 5G use cases - eMBB, mMTC, URLLC

Transceivers, Channel estimation, OFDM issues, Peak to Average Power ratio (PAPR), Carrier frequency Offset (CFO) and carrier timing offset, Synchronization, PAPR reduction techniques.

Architectures for Private Wireless, Case Studies - Uncovering 5G potential for real-time control in manufacturing, Industrial-grade Private Wireless.

Reference Books

- 1 5G NR: The Next Generation Wireless Access Technology. , Dahlman, E., Parkvall, S., Skold, J. , 2018, Elsevier Science .
- 2 5G Core Networks: Powering Digitalization. , Rommer, S., Hedman, P., Olsson, M., Frid, L., Sultana, S., Mulligan, C. , 2019, Elsevier Science .
- 3 5G/5G-Advanced The New Generation Wireless Access Technology , Erik Dahlman, Stefan Parkvall, Johan Skold , 2023, Elsevier Science .
- 4 Fundamentals of 5G Mobile Networks , Jonathan Rodriguez , 2015, Wiley.
- 5 Multiple Access Techniques for 5G Wireless Networks and Beyond , Mojtaba Vaezi, Zhiguo Ding, Vincent Poor , 2018, Springer International Publishing .

23SDEC14A - EMBEDDED PROTOTYPE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC14A	EMBEDDED PROTOTYPE	EPT	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concept of Embedded Systems.	3	PO1, PO11, PSO1
CO2	Apply the programming language concepts for Real-time Applications	3	PO1, PO11, PSO1
CO3	Design the interfacing concepts for different development boards	3	PO2, PO11, PSO1
CO4	Implement the concepts for IoT Applications	3	PO2, PO11, PSO1

Syllabus

Embedded C: Introduction to C programming, Storage Classes, Data Types, Controlling program flow, bitwise operations Arrays, Functions, Memory Management, Pointers, Variable arguments in Functions, Arrays and Pointers, Pointer to Functions and advanced topics on Pointers, Structures

Software Development Cycle: ?Vision IDE, C/C++ Compiler & Macro Assembler, Library Manager, Linker/Locator, ?Vision Debugger. Folder structure: Generic ?Vision files, C166 Development tools, C51 Development tools, C251 Development tools, Proteus Design Suite: Schematic Design and Simulation

Microcontroller boards: Arduino Uno, Raspberry Pi, Wireless Module: ESP8266, NRF24L01, Sensor: DHT22, MPU-6050

IoT Applications: Actuator-Servo Motor, Relay Module, Display: OLED Display, TFT, LCD Display, Communication Interface: Bluetooth Module - GSM Module.

Reference Books

- 1 C and the 8051: Programming and Multitasking, SchultzP T R, 1, SchultzP T R Prentice-Hall.
- 2 C: A Reference Manual, Second Edition, Harbison & Steel , 2, Prentice-Hall Software Series.
- 3 Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, 2, Wiley.
- 4 Internet of Things: A hands-on Approach, A.Bahga and V.Madisetti, 2, Universities Press.

23SDEC14E - EMBEDDED PROTOTYPE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC14E	EMBEDDED PROTOTYPE	EPT	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concept of Embedded Systems.	3	PO1, PO11, PSO1
CO2	Apply the programming language concepts for Real-time Applications	3	PO1, PO11, PSO1
CO3	Design the interfacing concepts for different development boards	3	PO2, PO11, PSO1
CO4	Implement the concepts for IoT Applications	3	PO2, PO11, PSO1

Syllabus

Embedded C: Introduction to C programming, Storage Classes, Data Types, Controlling program flow, bitwise operations Arrays, Functions, Memory Management, Pointers, Variable arguments in Functions, Arrays and Pointers, Pointer to Functions and advanced topics on Pointers, Structures

Software Development Cycle: ?Vision IDE, C/C++ Compiler & Macro Assembler, Library Manager, Linker/Locator, ?Vision Debugger. Folder structure: Generic ?Vision files, C166 Development tools, C51 Development tools, C251 Development tools, Proteus Design Suite: Schematic Design and Simulation

Microcontroller boards: Arduino Uno, Raspberry Pi, Wireless Module: ESP8266, NRF24L01, Sensor: DHT22, MPU-6050

IoT Applications: Actuator-Servo Motor, Relay Module, Display: OLED Display, TFT, LCD Display, Communication Interface: Bluetooth Module - GSM Module.

Reference Books

- 1 C and the 8051: Programming and Multitasking, SchultzP T R, 1, Prentice-Hall.
- 2 C: A Reference Manual, Second Edition, Harbison & Steel , 1, Prentice-Hall Software Series.
- 3 Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, 2, Wiley.
- 4 Internet of Things: A hands-on Approach, A.Bahga and V.Madisetti, 2, University Press.

23SDEC14R - EMBEDDED PROTOTYPE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC14R	EMBEDDED PROTOTYPE	EPT	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	ELECTRONIC SYSTEM DESIGN	ESD	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concept of Embedded Systems.	3	PO1, PO11, PSO1
CO2	Apply the programming language concepts for Real-time Applications	3	PO1, PO11, PSO1
CO3	Design the interfacing concepts for different development boards	3	PO2, PO11, PSO1
CO4	Implement the concepts for IoT Applications	3	PO2, PO11, PSO1

Syllabus

Embedded C: Introduction to C programming, Storage Classes, Data Types, Controlling program flow, bitwise operations Arrays, Functions, Memory Management, Pointers, Variable arguments in Functions, Arrays and Pointers, Pointer to Functions and advanced topics on Pointers, Structures

Software Development Cycle: ?Vision IDE, C/C++ Compiler & Macro Assembler, Library Manager, Linker/Locator, ?Vision Debugger. Folder structure: Generic ?Vision files, C166 Development tools, C51 Development tools, C251 Development tools, Proteus Design Suite: Schematic Design and Simulation

Microcontroller boards: Arduino Uno, Raspberry Pi, Wireless Module: ESP8266, NRF24L01, Sensor: DHT22, MPU-6050

IoT Applications: Actuator-Servo Motor, Relay Module, Display: OLED Display, TFT, LCD Display, Communication Interface: Bluetooth Module - GSM Module.

Reference Books

- 1 C and the 8051: Programming and Multitasking, SchultzP T R, 1, Prentice-Hall.
- 2 C: A Reference Manual, Second Edition, Harbison & Steel , 1, Prentice-Hall Software Series.
- 3 Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, 2, Wiley.
- 4 Internet of Things: A hands-on Approach, A.Bahga and V.Madisetti, 2, University Press.

23SDEC15A - NATURAL LANGUAGE PROCESSING USING TENSOR FLOW (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC15A	NATURAL LANGUAGE PROCESSING USING TENSOR FLOW	NLPTF	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various algorithms to convert text into numbers	3	PO1, PO2, PSO1, PSO2
CO2	Modelling the language using various statistical and deep learning models	3	PO1, PO2, PO4, PO5, PSO1
CO3	Apply recurrent neural networks to complex language modelling	2	PO1, PO2, PSO1
CO4	Apply NLP for Sentiment Analysis in Social Media	3	PO1, PO2, PSO1

Syllabus

A Chatbot NLP pipeline. Word tokenization, Building vocabulary with tokenizer and sentiment. Challenges in NLP. Approaches in NLP using NLTK and TensorFlow frameworks.

NTF IDF vectors, Bag of words, Bag of N Grams, One-Hot Encoding, Vectorizing, Zipf's Law, Topic modeling. Word Embeddings, Principal component analysis, Word2Vec, Convolutional neural nets, RNNs, LSTMs, and Language Models for Text processing and Text Classification

Architecture, Datasets, and Performance. Translate complete English sentences into German using an encoder-decoder attention model, Build a Transformer model to summarize text, Use T5 and BERT models to perform question-answering, and Build a chatbot using a Reformer model.

Sentiment Analysis in Social Media: Understanding sentiment analysis techniques for analyzing opinions, emotions, and attitudes expressed in social media text data. Techniques for preprocessing social media text, feature extraction, and sentiment classification using machine learning and deep learning models.

Reference Books

- 1 Natural Language Processing using Python , Steven Bird, Ewan Klein and Edward Loper , 2011, O reilly .
- 2 Foundations of Statistical Natural Language Processing , Christopher Manning and Hinrich Sch?tze. , NA, MIT Press .
- 3 Deep Learning for Natural Language Processing, Palash Goyal, Sumit Pandey, Karan Jain, Ankit Bhatia, 1st Edition, Packt Publishing.
- 4 Applied Text Analysis with Python Enabling Language Aware Data Products with Machine Learning, Benjamin Bengfort, Rebecca Bilbro, Tony Ojeda, Tony Ojeda 1st, O reilly media.

23SDEC15E - NATURAL LANGUAGE PROCESSING USING TENSOR FLOW (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC15E	NATURAL LANGUAGE PROCESSING USING TENSOR FLOW	NLPTF	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various algorithms to convert text into numbers	3	PO1, PO2, PO11, PSO1
CO2	Modelling the language using various statistical and deep learning models	4	PO1, PO2, PO3, PSO1
CO3	Apply recurrent neural networks to complex language modelling	3	PO2, PO3, PO5, PSO1
CO4	Apply NLP for Sentiment Analysis in Social Media	3	PO3, PSO1

Syllabus

A Chatbot NLP pipeline. Word tokenization, Building vocabulary with tokenizer and sentiment. Challenges in NLP. Approaches in NLP using NLTK and TensorFlow frameworks.

NTF IDF vectors, Bag of words, Bag of N-Grams, One Hot Encoding, Vectorizing, Zipf's Law, Topic modeling. Word Embeddings, Principal component analysis, Word2Vec, Convolutional neural nets, RNNs, LSTMs, and Language Models for Text processing and Text Classification

Architecture, Datasets, and Performance. Translate complete English sentences into German using an encoder decoder attention model, Build a Transformer model to summarize text, Use T5 and BERT models to perform question answering, and Build a chatbot using a Reformer model.

Sentiment Analysis in Social Media: Understanding sentiment analysis techniques for analyzing opinions, emotions, and attitudes expressed in social media text data. Techniques for preprocessing social media text, feature extraction, and sentiment classification using machine learning and deep learning models.

Reference Books

- 1 Natural Language Processing using Python , Steven Bird, Ewan Klein and Edward Loper , 2nd edition , O reilly .
- 2 Foundations of Statistical Natural Language Processing , Christopher Manning and Hinrich Schütze. , NA, MIT Press .
- 3 Deep Learning for Natural Language Processing, Palash Goyal, Sumit Pandey, Karan Jain, Ankit Bhatia, 1st , O reilly media.
- 4 Applied Text Analysis with Python Enabling Language Aware Data Products with Machine Learning, Benjamin Bengfort, Rebecca Bilbro, Tony Ojeda, 1st Edition, O reilly media.

23SDEC15R - NATURAL LANGUAGE PROCESSING USING TENSOR FLOW (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC15R	NATURAL LANGUAGE PROCESSING USING TENSOR FLOW	NLPTF	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	EMBEDDED SYSTEM AUTOMATION	ESDA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various algorithms to convert text into numbers	3	PO1, PO2, PO11, PSO1
CO2	Modelling the language using various statistical and deep learning models	3	PO1, PO2, PO3, PSO1
CO3	Apply recurrent neural networks to complex language modelling	3	PO2, PO3, PO5, PSO1

Syllabus

A Chatbot NLP pipeline. Word tokenization, Building vocabulary with tokenizer and sentiment. Challenges in NLP. Approaches in NLP using NLTK and TensorFlow frameworks.

NTF IDF vectors, Bag of words, Bag of N-Grams, One Hot Encoding, Vectorizing, Zipf's Law, Topic modeling. Word Embeddings, Principal component analysis, Word2Vec, Convolutional neural nets, RNNs, LSTMs, and Language Models for Text processing and Text Classification

Architecture, Datasets, and Performance. Translate complete English sentences into German using an encoder decoder attention model, Build a Transformer model to summarize text, Use T5 and BERT models to perform question answering, and Build a chatbot using a Reformer model.

Reference Books

- 1 Natural Language Processing using Python , Steven Bird, Ewan Klein and Edward Loper , 2nd edition , O reilly .
- 2 Foundations of Statistical Natural Language Processing , Christopher Manning and Hinrich Schütze. , NA, MIT Press .
- 3 Deep Learning for Natural Language Processing, Palash Goyal, Sumit Pandey, Karan Jain, Ankit Bhatia, 1st Edition, Packt Publishing.
- 4 Applied Text Analysis with Python Enabling Language Aware Data Products with Machine Learning, Benjamin Bengfort, Rebecca Bilbro, Tony Ojeda, 1st, O reilly media.

23SDEC16A - ADVANCED RADIATING SYSTEM MODELING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC16A	ADVANCED RADIATING SYSTEM MODELING	ARSM	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Intreprete Antenna design for wireless and 5G Applications	3	PO1
CO2	Understand and intreprete the basic Concepts for 5G FR1 Single Band and Multi-Band Mobile Antenna Design	3	PO1
CO3	Apply the concept of the different MIMO-Based 5G FR1 Band Mobile Antennas for 5G and Wireless Apllication	3	PO2
CO4	Analyze the different Antenna-in-Package for 5G and Mobile Antennas	4	PO2
CO5	Design of different patch antennas using EM tools and verify the characteristics	5	PO3

Syllabus

Frequency Characteristics and Channel Models, 5G Network Architecture, Evolution of Mobile Devices, Antenna Materials for 5G smart phone.

Smartphone Components and Their Effects, Antenna Element Design and Topologies, Slot Antenna Design, Monopole Antenna Design, Loop Antenna, Inverted F Antenna, Planar Antenna Design Topologies, Hybrid Antenna Design Topologies.

Motivation and Requirements, Channel Capacity, Envelope Correlation Coefficient, Diversity Gain, Mean Effective Gain, Total Active Reflection Coefficient, Channel Capacity Loss, Antenna Isolation Techniques, Spatial and Polarization Diversity.

Miniaturized Antenna in Package Technology, Background and Challenges, Planar Folded Slot Antenna with Electrically Small and Low Profile, Low Loss Interconnect Technology, Flip Chip Based Packaging of mmWave AiP, Multi Modal AiP Technology, Block Cell Antennas, Modular, Controllable Block Cell Arrays.

Reference Books

- 1 Microwave and Millimeter-wave Antenna Design for 5G Smartphone Applications , Wonbin Hong,?Chow Yen Desmond Sim , 2022, Wiley IEEE Press.
- 2 MIMO Antennas for Wireless Communication: Theory and design , L malviya, RK Panigrahi, MV Kartikeya , 2022, CRC Press.
- 3 Antenna Theory, C.A Balanis, 2001, John Wiley Sons.
- 4 Wireless Communication Electronics Introduction to RF Circuits and Design Techniques, Robert Sobot, 2021, Springer .

23SDEC16E - ADVANCED RADIATING SYSTEM MODELING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC16E	ADVANCED RADIATING SYSTEM MODELING	ARSM	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Intreprete Antenna design for wireless and 5G Applications	3	PO1
CO2	Understand and intreprete the basic Concepts for 5G FR1 Single Band and Multi-Band Mobile Antenna Design	3	PO1
CO3	Apply the concept of the different MIMO-Based 5G FR1 Band Mobile Antennas for 5G and Wireless Apllication	3	PO1
CO4	Analyze the different Antenna-in-Package for 5G and Mobile Antennas	4	PO2
CO5	Design of different patch antennas using EM tools and verify the characteristics	5	PO2

Syllabus

Frequency Characteristics and Channel Models, 5G Network Architecture, Evolution of Mobile Devices, Antenna Materials for 5G smart phone.

Smartphone Components and Their Effects, Antenna Element Design and Topologies, Slot Antenna Design, Monopole Antenna Design, Loop Antenna, Inverted F Antenna, Planar Antenna Design Topologies, Hybrid Antenna Design Topologies.

Motivation and Requirements, Channel Capacity, Envelope Correlation Coefficient, Diversity Gain, Mean Effective Gain, Total Active Reflection Coefficient, Channel Capacity Loss, Antenna Isolation Techniques, Spatial and Polarization Diversity.

Miniaturized Antenna in Package Technology, Background and Challenges, Planar Folded Slot Antenna with Electrically Small and Low Profile, Low Loss Interconnect Technology, Flip Chip Based Packaging of mmWave AiP, Multi Modal AiP Technology, Block Cell Antennas, Modular, Controllable Block Cell Arrays.

Reference Books

- 1 Microwave and Millimeter-wave Antenna Design for 5G Smartphone Applications , Wonbin Hong,?Chow Yen Desmond Sim , 2022, Wiley IEEE Press.
- 2 MIMO Antennas for Wireless Communication: Theory and design , L malviya, RK Panigrahi, MV Kartikeya , 2022, CRC Press.
- 3 Antenna Theory, C.A Balanis, 2001, John Wiley Sons.
- 4 Wireless Communication Electronics Introduction to RF Circuits and Design Techniques, Robert Sobot, 2021, Springer .

23SDEC16R - ADVANCED RADIATING SYSTEM MODELING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC16R	ADVANCED RADIATING SYSTEM MODELING	ARSM	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Intreprete Antenna design for wireless and 5G Applications	3	PO1
CO2	Understand and intreprete the basic Concepts for 5G FR1 Single Band and Multi-Band Mobile Antenna Design	3	PO1
CO3	Apply the concept of the different MIMO-Based 5G FR1 Band Mobile Antennas for 5G and Wireless Apllication	3	PO2
CO4	Analyze the different Antenna-in-Package for 5G and Mobile Antennas	3	PO2

Syllabus

Frequency Characteristics and Channel Models, 5G Network Architecture, Evolution of Mobile Devices, Antenna Materials for 5G smart phone.

Smartphone Components and Their Effects, Antenna Element Design and Topologies, Slot Antenna Design, Monopole Antenna Design, Loop Antenna, Inverted F Antenna, Planar Antenna Design Topologies, Hybrid Antenna Design Topologies.

Motivation and Requirements, Channel Capacity, Envelope Correlation Coefficient, Diversity Gain, Mean Effective Gain, Total Active Reflection Coefficient, Channel Capacity Loss, Antenna Isolation Techniques, Spatial and Polarization Diversity.

Miniaturized Antenna in Package Technology, Background and Challenges, Planar Folded Slot Antenna with Electrically Small and Low Profile, Low Loss Interconnect Technology, Flip Chip Based Packaging of mmWave AiP, Multi Modal AiP Technology, Block Cell Antennas, Modular, Controllable Block Cell Arrays.

Reference Books

- 1 Microwave and Millimeter-wave Antenna Design for 5G Smartphone Applications , Wonbin Hong,?Chow Yen Desmond Sim , 2022, Wiley IEEE Press.
- 2 MIMO Antennas for Wireless Communication: Theory and design , L malviya, RK Panigrahi, MV Kartikeya , 2022, CRC Press.
- 3 Antenna Theory, C.A Balanis, 2001, John Wiley Sons.
- 4 Wireless Communication Electronics Introduction to RF Circuits and Design Techniques, Robert Sobot, 2021, Springer .

23SDEC17A - ROBOT DESIGN AND ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC17A	ROBOT DESIGN AND ANALYSIS	RDA	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Robots kinematics & Dynamics includes designing, controlling, and optimizing their movements and behaviors	2	PO5, PO11, PSO1
CO2	Apply the concepts of robotics sensors necessary for the specified model and verify their functionality.	3	PO5, PO11, PSO1
CO3	Analyzing the swarm for multi-robot systems which can collaborate and coordinate autonomously to achieve complex task	4	PO5, PO11, PSO1
CO4	Analyze the fetch and freight robot which provides autonomous mobile manipulation solutions for industrial and logistics applications	4	PO5, PO11, PSO1

Syllabus

Introduction, RobotStudio- terms and concepts, RobotWare, RAPID concepts, Effects of P, PI, PD & PID Controller of 2nd order System. Stability Analysis of Control system using Root Locus method using MATLAB. Programming concepts, Paths and targets, Coordinate systems, Tool Centre Point Coordinate system, World Coordinate system, Base Frame (BF), Task Frame (TF), Stations with multiple robot systems

Integration and testing of Hybrid UAV. Application of UAV in Remote sensing. Application of UAV in Disaster management. Image processing using Raspberry Pi for agricultural applications. Study About Post Processing Softwares in Drone Surveying. Calculate Aerial Mapping using Drones and Evaluate Contour Map

Swarms: Collective Transport by Ants and Robots, Task Allocation in Bees and Bee-inspired Robot Swarms, Ant-inspired Network Routing and Optimization, Swarms: Ant Colony Foraging and Stigmergy

Design principles and interfaces for kinematic control, grasping strategies, object recognition, and manipulation planning, Sensors and Perception, Object Segmentation and Classification, Localization and Pose Estimation and Integration with Robot Perception Pipeline.

Reference Books

- 1 MODERN ROBOTICS MECHANICS, PLANNING, AND CONTROL, Kevin M. Lynch and Frank C. Park, 2017, 1st Edition, Cambridge.
- 2 Introduction to Autonomous Mobile Robots, Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, 2011, 1st Edition, MIT Press.
- 3 Planning Algorithms, S. M. LaValle, 2006, 2nd Edition, Cambridge University Press.
- 4 Principles of Robot Motion Theory, Algorithms and Implementations, H. Choset, K. M. Lynch, S. Hutchinson, , 2005, 2nd Edition, PHI.

23SDEC17E - ROBOT DESIGN AND ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC17E	ROBOT DESIGN AND ANALYSIS	RDA	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Robots kinematics & Dynamics includes designing, controlling, and optimizing their movements and behaviors	2	PO5, PO11, PSO1
CO2	Apply the concepts of robotics sensors necessary for the specified model and verify their functionality.	3	PO5, PO11, PSO1
CO3	Analyzing the swarm for multi-robot systems which can collaborate and coordinate autonomously to achieve complex task	4	PO5, PO11, PSO1
CO4	Analyze the fetch and freight robot which provides autonomous mobile manipulation solutions for industrial and logistics applications	4	PO5, PO11, PSO1

Syllabus

Introduction, RobotStudio? - terms and concepts, RobotWare, RAPID concepts, Effects of P, PI, PD & PID Controller of 2nd order System. Stability Analysis of Control system using Root Locus method using MATLAB. Programming concepts, Paths and targets, Coordinate systems, Tool Centre Point Coordinate system, World Coordinate system, Base Frame (BF), Task Frame (TF), Stations with multiple robot systems

Integration and testing of Hybrid UAV. Application of UAV in Remote sensing. Application of UAV in Disaster management. Image processing using Raspberry Pi for agricultural applications. Study About Post Processing Softwares in Drone Surveying. Calculate Aerial Mapping using Drones and Evaluate Contour Map.

Swarms: Collective Transport by Ants and Robots, Task Allocation in Bees and Bee-inspired Robot Swarms, Ant-inspired Network Routing and Optimization, Swarms: Ant Colony Foraging and Stigmergy

Design principles and interfaces for kinematic control, grasping strategies, object recognition, and manipulation planning, Sensors and Perception, Object Segmentation and Classification, Localization and Pose Estimation and Integration with Robot Perception Pipeline.

Reference Books

- 1 MODERN ROBOTICS MECHANICS, PLANNING, AND CONTROL, Kevin M. Lynch and Frank C. Park, 2017, 1st Edition, Camebridge.
- 2 Introduction to Autonomous Mobile Robots, Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, 2011, 1st Edition, MIT Press.
- 3 Planning Algorithms, S. M. LaValle, 2006, 2nd Edition, Cambridge University Press.
- 4 Principles of Robot Motion Theory, Algorithms and Implementations, H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, 2003, 2nd Edition, PHI.

23SDEC17R - ROBOT DESIGN AND ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC17R	ROBOT DESIGN AND ANALYSIS	RDA	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Robots kinematics & Dynamics includes designing, controlling, and optimizing their movements and behaviors	3	PO5, PO11, PSO1
CO2	Apply the concepts of robotics sensors necessary for the specified model and verify their functionality.	3	PO5, PO11, PSO1
CO3	Analyzing the swarm for multi-robot systems which can collaborate and coordinate autonomously to achieve complex task	4	PO5, PO11, PSO1

Syllabus

Introduction, RobotStudio - terms and concepts, RobotWare, RAPID concepts, Effects of P, PI, PD & PID Controller of 2nd order System. Stability Analysis of Control system using Root Locus method using MATLAB. Programming concepts, Paths and targets, Coordinate systems, Tool Centre Point Coordinate system, World Coordinate system, Base Frame (BF), Task Frame (TF), Stations with multiple robot systems

Integration and testing of Hybrid UAV. Application of UAV in Remote sensing. Application of UAV in Disaster management. Image processing using Raspberry Pi for agricultural applications. Study About Post Processing Softwares in Drone Surveying. Calculate Aerial Mapping using Drones and Evaluate Contour Map.

Swarms: Collective Transport by Ants and Robots, Task Allocation in Bees and Bee-inspired Robot Swarms, Ant-inspired Network Routing and Optimization, Swarms: Ant Colony Foraging and Stigmergy

Reference Books

- 1 MODERN ROBOTICS MECHANICS, PLANNING, AND CONTROL, Kevin M. Lynch and Frank C. Park, 2017, 1st Edition, Cambridge.
- 2 Introduction to Autonomous Mobile Robots, Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, 2011, 1st Edition, MIT Press.
- 3 Planning Algorithms, S. M. LaValle, 2006, 2nd Edition, Cambridge University Press,.
- 4 Principles of Robot Motion Theory, Algorithms and Implementations, . Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, 2005, 2nd Edition, PHI.

23SDEC18A - VLSI SUBMICRON DESIGN AND VERIFICATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC18A	VLSI SUBMICRON DESIGN AND VERIFICATION	VSDV	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply VLSI Full Custom Submicron Design	3	PO1, PSO1
CO2	Apply VLSI Semicustom Submicron Design	3	PO1, PSO1
CO3	Analyze VLSI Submicron Verification	4	PO1, PO3, PSO1
CO4	Analyze VLSI Submicron Digital IC Testing	4	PO1, PSO1

Syllabus

VLSI Full Custom Submicron Design: Technology dependent analog circuit design; Verilog-A sub-micron module integration; Periodic Steady State Analysis of Amplifiers; Frequency analysis of Amplifiers; DC/Transient (Parametric) response of analog circuits; Layout integration of submodules for full module back annotation process; Layout optimization techniques for parasitic effect reduction; Post layout IP Integration process; Spice Modeling of analog circuits; GDS II generation.

VLSI Semicustom Submicron Design: Verilog constructs: Behavioral modeling of Modules for IC design; Synthesis Process: Translation/Mapping/Optimization ; Power, Area and Timing analysis (Post Synthesis) ; Layout Design of Synthesized design: Floorplanning Process ; Power Planning Process ; Setup/Hold violation check ; Clock Tree Synthesis (CTS) ; Violation check post CTS ; GDS II generation

VLSI Submicron Verification and testing: FPGA Implementation of Digital ICs; Peripheral interfacing of FPGA; Test-bench verification using nc-verilog in cadence; Vector based testing of analog circuits.

Design of Mixed Signal VLSI Circuits, Verification of Mixed signal designs, Layout of Mixed signal designs, Backannotation of mixed signal designs, TEMPUS tool analysis for mixed signal timing analysis, MODUS tools for verification of Mixed signal designs. Hrdware dumping of Mixed signal circuits

Reference Books

- 1 CMOS VLSI Design: ACircuits and Systems Perspective, N. H. E. Weste and D. Harris,Addison Wesley, 2nd , Wiley.
- 2 Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, M. Bushnell and V. Agrawal, 2nd , Wiley.
- 3 Essentials of Electronic Testing, for Digital, Memory and Mixed-Signal VLSI Circuit, Michael L. Bushnell and Vishwani D. Agrawal,, 3nd, Kluwer Academic Publishers.
- 4 Principles of Testing Electronic System, Samiha Mourad and Yervant Zorian , 2nd, Wiley.

23SDEC18E - VLSI SUBMICRON DESIGN AND VERIFICATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC18E	VLSI SUBMICRON DESIGN AND VERIFICATION	VSDV	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply VLSI Full Custom Submicron Design	3	PO1, PSO1
CO2	Apply VLSI Semicustom Submicron Design	3	PO1, PSO1
CO3	Analyze VLSI Submicron Verification	4	PO1, PO3, PSO1
CO4	Analyze VLSI Submicron Digital IC Testing	4	PO1, PSO1

Syllabus

VLSI Full Custom Submicron Design: Technology dependent analog circuit design; Verilog-A sub-micron module integration; Periodic Steady State Analysis of Amplifiers; Frequency analysis of Amplifiers; DC/Transient (Parametric) response of analog circuits; Layout integration of submodules for full module back annotation process; Layout optimization techniques for parasitic effect reduction; Post layout IP Integration process; Spice Modeling of analog circuits; GDS II generation.

VLSI Semicustom Submicron Design: Verilog constructs: Behavioral modeling of Modules for IC design; Synthesis Process: Translation/Mapping/Optimization ; Power, Area and Timing analysis (Post Synthesis) ; Layout Design of Synthesized design: Floorplanning Process ; Power Planning Process ; Setup/Hold violation check ; Clock Tree Synthesis (CTS) ; Violation check post CTS ; GDS II generation

VLSI Submicron Verification and testing: FPGA Implementation of Digital ICs; Peripheral interfacing of FPGA; Test-bench verification using nc-verilog in cadence; Vector based testing of analog circuits.

Design of Mixed Signal VLSI Circuits, Verification of Mixed signal designs, Layout of Mixed signal designs, Backannotation of mixed signal designs, TEMPUS tool analysis for mixed signal timing analysis, MODUS tools for verification of Mixed signal designs. Hrdware dumping of Mixed signal circuits

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- 1 CMOS VLSI Design: ACircuits and Systems Perspective, N. H. E. Weste and D. Harris, Addison Wesley, 2nd , Wiley.
- 2 Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, M. Bushnell and V. Agrawal, 2nd , Wiley.
- 3 Essentials of Electronic Testing, for Digital, Memory and Mixed-Signal VLSI Circuit, Michael L. Bushnell and Vishwani D. Agrawal,, 3nd, Kluwer Academic Publishers.
- 4 Principles of Testing Electronic System, Samiha Mourad and Yervant Zorian, 2nd, Wiley.

23SDEC18R - VLSI SUBMICRON DESIGN AND VERIFICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEC18R	VLSI SUBMICRON DESIGN AND VERIFICATION	VSDV	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply VLSI Full Custom Submicron Design	3	PO1, PSO1
CO2	Apply VLSI Semicustom Submicron Design	3	PO1, PSO1
CO3	Analyze VLSI Submicron Verification and testing	4	PO1, PO3, PSO1

Syllabus

VLSI Full Custom Submicron Design: Technology dependent analog circuit design; Verilog-A sub-micron module integration; Periodic Steady State Analysis of Amplifiers; Frequency analysis of Amplifiers; DC/Transient (Parametric) response of analog circuits; Layout integration of submodules for full module back annotation process; Layout optimization techniques for parasitic effect reduction; Post layout IP Integration process; Spice Modeling of analog circuits; GDS II generation.

VLSI Semicustom Submicron Design: Verilog constructs: Behavioral modeling of Modules for IC design; Synthesis Process: Translation/Mapping/Optimization ; Power, Area and Timing analysis (Post Synthesis) ; Layout Design of Synthesized design: Floorplanning Process ; Power Planning Process ; Setup/Hold violation check ; Clock Tree Synthesis (CTS) ; Violation check post CTS ; GDS II generation

VLSI Submicron Verification and testing: FPGA Implementation of Digital ICs; Peripheral interfacing of FPGA; Test-bench verification using nc-verilog in cadence; Vector based testing of analog circuits.

Reference Books

- 1 CMOS VLSI Design: ACircuits and Systems Perspective, N. H. E. Weste and D. Harris, Addison Wesley, 2nd , Wiley.
- 2 Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, M. Bushnell and V. Agrawal, 2nd, Wiley.
- 3 Essentials of Electronic Testing, for Digital, Memory and Mixed-Signal VLSI Circuit, Michael L. Bushnell and Vishwani D. Agrawal,, 3nd, Kluwer Academic Publishers .
- 4 Principles of Testing Electronic System, Samiha Mourad and Yervant Zorian,, 2nd, Wiley.

23SDEE01A - VISUALIZATION AND MODELING OF CIRCUITS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE01A	VISUALIZATION AND MODELING OF CIRCUITS	VAMC	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the use of symbols,wires, components, in Auto cad Electrical drawing and perform project management	3	PO1, PO5
CO2	Analyze the workflow in Autocad Electrical with ladder diagrams and PLCs	4	PO1, PO5
CO3	Analyze Panel Layout from Electrical drawing schematics.	4	PO1, PO5
CO4	Analyze report generation from panel layouts.Draw 3D models.	4	PO1, PO5

Syllabus

AutoCAD Electrical: Basics of Electrical Drawings, Introduction to AutoCAD Electrical and Interface, project manager, Basics of Electrical Drawings- Common Symbols in Electrical Drawings, Wire and its Types, Labelling - Install and configure AutoCAD Electrical Start AutoCAD, understand components of the initial AutoCAD Electrical screen, commands, various commands to save a file, Exit AutoCAD, Create and manage workspaces, Using various options in AutoCAD help.

Workflow in AutoCAD Electrical, Starting a New Project, Changing Properties of a project, Adding drawings in the project, Inserting Components using Icon menu, Catalog Browser, User Defined list, Equipment list, Panel list, Terminal (Panel list) components. Inserting Wires, applying wire numbers, inserting user defined circuits , ladders , Cable Markers and Circuit Builders. Inserting Parametric PLCs, connectors and terminals.

Panel Layout- Create panel layouts from schematic list, create panel layouts from schematic list, Annotate and edit a footprint, insert footprints from icon menu, add a new record of footprint to the footprint lookup table.

Reports- Generate schematic and panel reports, Change the report format, Place reports in a drawing, Save reports to external files, Plot reports; AutoCAD Electrical with Inventor. Draw 3D models.

Reference Books

- 1 AUTOCAD ELECTRICAL 2022 BLACK BOOK, Gaurav Verma, Matt Weber , 2021, Independent Publishing Platform.
- 2 AutoCAD Electrical 2023 for electrical control designers , Sham Tickoo , 2022, Cadcim Technologies .
- 3 AutoCAD Electrical 2021 : A tutorial approach , Sham Tickoo, 2020, Cadcim Technologies .
- 4 AutoCAD Electrical 2021 : Fundamentals with NFPA standards: Autodesk authourized publisher, Ascent , 2020, Ascent -Center for technical knowledge .
- 5 Electrical Engineering Drawing , S.K. Bhattacharya , 2022, New age international publishers .
- 6 Computer Aided Electrical Drawing Electrical Engineering Drawing , M Yogesh BS Nagaraja N Nandan , 2014, PHI Learning Private Limited.

23SDEE01E - VISUALIZATION AND MODELING OF CIRCUITS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE01E	VISUALIZATION AND MODELING OF CIRCUITS	VAMC	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the use of symbols,wires, components, in Auto cad Electrical drawing and perform project management	3	PO1, PO5
CO2	Analyze the workflow in Autocad Electrical with ladder diagrams and PLCs	4	PO1, PO5
CO3	Analyze Panel Layout from Electrical drawing schematics.	4	PO1, PO5
CO4	Analyze report generation from panel layouts.Draw 3D models.	4	PO1, PO5

Syllabus

AutoCAD Electrical: Basics of Electrical Drawings, Introduction to AutoCAD Electrical and Interface, project manager, Basics of Electrical Drawings- Common Symbols in Electrical Drawings, Wire and its Types, Labelling - Install and configure AutoCAD Electrical Start AutoCAD, understand components of the initial AutoCAD Electrical screen, commands, various commands to save a file, Exit AutoCAD, Create and manage workspaces, Using various options in AutoCAD help.

Workflow in AutoCAD Electrical, Starting a New Project, Changing Properties of a project, Adding drawings in the project, Inserting Components using Icon menu, Catalog Browser, User Defined list, Equipment list, Panel list, Terminal (Panel list) components. Inserting Wires, applying wire numbers, inserting user defined circuits , ladders , Cable Markers and Circuit Builders. Inserting Parametric PLCs, connectors and terminals.

Panel Layout- Create panel layouts from schematic list, create panel layouts from schematic list, Annotate and edit a footprint, insert footprints from icon menu, add a new record of footprint to the footprint lookup table.

Reports- Generate schematic and panel reports, Change the report format, Place reports in a drawing, Save reports to external files, Plot reports; AutoCAD Electrical with Inventor. Draw 3D models.

Reference Books

- 1 AUTOCAD ELECTRICAL 2022 BLACK BOOK , Gaurav Verma, Matt Weber , 2021, Independent Publishing Platform.
- 2 AutoCAD Electrical 2023 for electrical control designers , Sham Tickoo , 2022, Cadcim Technologies .
- 3 AutoCAD Electrical 2021 : A tutorial approach , Sham Tickoo , 2020, Cadcim Technologies .
- 4 AutoCAD Electrical 2021 : Fundamentals with NFPA standards: Autodesk authorized publisher , Ascent , 2020, Ascent -Center for technical knowledge .
- 5 Electrical Engineering Drawing , S.K. Bhattacharya , 2022, New age international publishers .
- 6 Computer Aided Electrical Drawing Electrical Engineering Drawing , M Yogesh BS Nagaraja N Nandan , 2014, PHIndia Publications .

23SDEE01R - VISUALIZATION AND MODELING OF CIRCUITS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE01R	VISUALIZATION AND MODELING OF CIRCUITS	VAMC	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the use of symbols,wires, components, in Auto cad Electrical drawing and perform project management	3	PO1, PO5
CO2	Analyze the workflow in Autocad Electrical with ladder diagrams and PLCs	4	PO1, PO5
CO3	Analyze Panel Layout from Electrical drawing schematics.	4	PO1, PO5

Syllabus

AutoCAD Electrical: Basics of Electrical Drawings, Introduction to AutoCAD Electrical and Interface, project manager, Basics of Electrical Drawings- Common Symbols in Electrical Drawings, Wire and its Types, Labelling - Install and configure AutoCAD Electrical Start AutoCAD, understand components of the initial AutoCAD Electrical screen, commands, various commands to save a file, Exit AutoCAD, Create and manage workspaces, Using various options in AutoCAD help.

Workflow in AutoCAD Electrical, Starting a New Project, Changing Properties of a project, Adding drawings in the project, Inserting Components using Icon menu, Catalog Browser, User Defined list, Equipment list, Panel list, Terminal (Panel list) components. Inserting Wires, applying wire numbers, inserting user defined circuits , ladders , Cable Markers and Circuit Builders. Inserting Parametric PLCs, connectors and terminals.

Panel Layout- Create panel layouts from schematic list, create panel layouts from schematic list, Annotate and edit a footprint, insert footprints from icon menu, add a new record of footprint to the footprint lookup table.

Reference Books

- 1 AUTOCAD ELECTRICAL 2022 BLACK BOOK, Gaurav Verma, Matt Weber , 2021, Independent Publishing platform.
- 2 AutoCAD Electrical 2023 for electrical control designers , Sham Tickoo , 2022, Cadcam Technologies .
- 3 AutoCAD Electrical 2021 : A tutorial approach , Sham Tickoo , 2020, Cadcam Technologies .
- 4 AutoCAD Electrical 2021 : Fundamentals with NFPA standards: Autodesk authorised publisher , Ascent , 2020, Ascent -Center for technical knowledge .
- 5 Electrical Engineering Drawing , S.K. Bhattacharya , 2022, New age international publishers .
- 6 Computer Aided Electrical Drawing Electrical Engineering Drawing, M Yogesh BS Nagaraja N Nandan , 2014, PHIndia Publications .

23SDEE02A - EMBEDDED SYSTEM DESIGN WITH ARM (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE02A	EMBEDDED SYSTEM DESIGN WITH ARM	ESDA	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Assembly Language Programming for Arithmetic and logical problems with the ARM Cortex-M Microcontrollers	3	PO1, PO5
CO2	Apply Embed C programming for STM32F401 board to perform I/O operations, interfacing seven segment and LCD.	3	PO1, PO5
CO3	Apply Embed C Programming for sensors, actuator and communication device interfacing with STM32F401 board	3	PO1, PO5
CO4	Apply the Embed C programming to Internet of Things like Home automation system.	3	PO1, PO5

Syllabus

Introduction to embedded systems, microprocessors and microcontrollers, Architecture of ARM microcontroller, ARM instruction set.

About STM32F401 nucleo board, Embed C programming environment, Interfacing with STM32F401 board, interfacing with seven segment LED, LCD and serial port terminal application.

Interfacing STM32F401 with temperature sensor, LDR, speaker, microphone, relay, speed control of DC motor.

Introduction to IoT, GSM, Bluetooth and design of a Home Automation system.

Reference Books

- 1 Embedded System Design with Arm Cortex-M Microcontrollers Applications with C, C++ and MicroPython, Cem unsalan, Huseyin Deniz Gurhan, Mehmet Erkin Yucel, 2022, Springer .
- 2 Embedded System Design: A Unified Hardware/Software Introduction, F. Vahid and T. Givargis, 2002, Wiley India Pvt. Ltd. .
- 3 ARM System Developer s Guide: Design and Optimizing System Software, A.N. Sloss, D. Symes and C. Wright, 2004, Morgan Kaufman Publishers.
- 4 Computers as Components: Principles of Embedded Computing System Design, W. Wolf, 2008, Morgan Kaufman Publishers.

23SDEE02E - EMBEDDED SYSTEM DESIGN WITH ARM (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE02E	EMBEDDED SYSTEM DESIGN WITH ARM	ESDA	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Assembly Language Programming for Arithmetic and logical problems with the ARM Cortex-M Microcontrollers	3	PO1, PO5
CO2	Apply Embed C programming for STM32F401 board to perform I/O operations, interfacing seven segment and LCD.	3	PO1, PO5
CO3	Apply Embed C Programming for sensors, actuator and communication device interfacing with STM32F401 board	3	PO1, PO5
CO4	Apply the Embed C programming to Internet of Things like Home automation system.	3	PO1, PO5

Syllabus

Introduction to embedded systems, microprocessors and microcontrollers, Architecture of ARM microcontroller, ARM instruction set

About STM32F401 nucleo board, Embed C programming environment, Interfacing with STM32F401 board, interfacing with seven segment LED, LCD and serial port terminal application.

Interfacing STM32F401 with temperature sensor, LDR, speaker, microphone, relay, speed control of DC motor.

Introduction to IoT, GSM, Bluetooth and design of a Home Automation system.

Reference Books

- 1 Embedded System Design with Arm Cortex-M Microcontrollers Applications with C, C++ and MicroPython, Cem Unsalan, Huseyin Deniz Gurhan, Mehmet Erkin Yucel, 2022, Springer.
- 2 Embedded System Design: A Unified Hardware/Software Introduction, F. Vahid and T. Givargis, 2002, Wiley India Pvt. Ltd. .
- 3 ARM System Developer s Guide: Design and Optimizing System Software, A.N. Sloss, D. Symes and C. Wright, 2004, Morgan Kaufman Publishers.
- 4 Computers as Components: Principles of Embedded Computing System Design, W. Wolf, 2008, Morgan Kaufman Publishers.

23SDEE02R - EMBEDDED SYSTEM DESIGN WITH ARM (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE02R	EMBEDDED SYSTEM DESIGN WITH ARM	ESDA	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	DIGITAL DESIGN & COMPUTER ARCHITECTURE	DDCA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Assembly Language Programming for Arithmetic and logical problems with the ARM Cortex-M Microcontrollers	3	PO1, PO5
CO2	Apply Embed C programming for STM32F401 board to perform I/O operations, interfacing seven segment and LCD.	3	PO1, PO5
CO3	Apply Embed C Programming for sensors, actuator and communication device interfacing with STM32F401 board	3	PO1, PO5

Syllabus

Introduction to embedded systems, microprocessors and microcontrollers, Architecture of ARM microcontroller, ARM instruction set

About STM32F401 nucleo board, Embed C programming environment, Interfacing with STM32F401 board, interfacing with seven segment LED, LCD and serial port terminal application.

Interfacing STM32F401 with temperature sensor, LDR, speaker, microphone, relay, speed control of DC motor.

Reference Books

- 1 Embedded System Design with Arm Cortex-M Microcontrollers Applications with C, C++ and MicroPython, Cem Unsalan, Huseyin Deniz Gurhan, Mehmet Erkin Yucel, 2022, Springer.
- 2 Embedded System Design: A Unified Hardware/Software Introduction, F. Vahid and T. Givargis, 2002, Wiley India Pvt. Ltd. .
- 3 ARM System Developer s Guide: Design and Optimizing System Software, A.N. Sloss, D. Symes and C. Wright, 2004, Morgan Kaufman Publishers.
- 4 Computers as Components: Principles of Embedded Computing System Design, W. Wolf, 2008, Morgan Kaufman Publishers.

23SDEE03A - AI TECHNIQUES FOR ELECTRICAL ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE03A	AI TECHNIQUES FOR ELECTRICAL ENGINEERING	AITFEE	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Artificial neural networks, their models, architectures, and learning paradigms (Hebbian, supervised, unsupervised, reinforcement) for pattern recognition and decision-making applications.	3	PO1
CO2	Develop the architecture and functionality of multilayer perceptrons (MLP) and implement the backpropagation algorithm, Radial Basis Function Network , Hopfield Network for training MLPs.	3	PO5
CO3	Apply basics of fuzzy logic, including the distinction between fuzzy and crisp sets, and the concept of membership functions and gain skills in designing fuzzy inference systems, including defining fuzzy rules and using inference mechanisms for decision-making.	3	PO5
CO4	Identify the principles of neuro-fuzzy systems, combining the learning capabilities of ANN with the reasoning capabilities of fuzzy logic, implement and train ANFIS for solving complex engineering problems, leveraging both neural network learning and fuzzy inference.	3	PO5

Syllabus

Artificial Neural Networks: Definition and scope of artificial neural networks. Historical background and development of ANNs. Comparison with biological neural networks. Neurons, weights, biases, activation functions. Types of activation functions: linear, sigmoid, tanh, ReLU., ANN Architecture, Hebbian Learning Introduction to Hebbian learning. Mathematical formulation and implementation. Applications and limitations. Supervised Learning Overview of supervised learning. Training and testing datasets. Error backpropagation algorithm. Gradient descent and its variants. Practical implementation of supervised learning in MLPs. Unsupervised Learning Introduction to unsupervised learning. Reinforcement Learning

ANN Paradigms: Clustering techniques: k-means, hierarchical clustering. Self-Organizing Maps (SOM). Principal Component Analysis (PCA), Multilayer Perceptron and Backpropagation Algorithm, Implementation and Application of Radial Basis Function Networks, Utilization of Hopfield Networks for Pattern Storage and Retrieval, Case studies

Fuzzy Logic: Introduction, Fuzzy versus crisp, Fuzzy sets , Membership function, Basic Fuzzy set operations, Fuzzy Inference , Fuzzy Rule based system, De-fuzzification methods, Application to Load Frequency Control.

Apply Integration of ANN and Fuzzy Logic in Neuro-Fuzzy Model, Implementation of Adaptive Neuro-Fuzzy Inference Systems (ANFIS), Application of Neuro-Fuzzy Models to Electrical Engineering Problems

Reference Books

- 1 Principles of Artificial Neural Networks , Daniel Graupe , 2013, World Scientific.
- 2 Neural Networks, Fuzzy Logic & Genetic Algorithms , S.Rajasekaran and G.A.V.Pai , 2003, PHI, New Delhi..
- 3 Fuzzy Logic with Engineering Applications, Timothy J. Ross , 2011, Wiley.

- 4 Neural Network , James A freeman, David M Skapura , 1991, Addison Wesley, an imprint of Pearson Education, .

23SDEE03E - AI TECHNIQUES FOR ELECTRICAL ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE03E	AI TECHNIQUES FOR ELECTRICAL ENGINEERING	AITFEE	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Artificial neural networks, their models, architectures, and learning paradigms (Hebbian, supervised, unsupervised, reinforcement) for pattern recognition and decision-making applications.	3	PO1
CO2	Develop the architecture and functionality of multilayer perceptrons (MLP) and implement the backpropagation algorithm, Radial Basis Function Network , Hopfield Network for training MLPs.	3	PO5
CO3	Apply basics of fuzzy logic, including the distinction between fuzzy and crisp sets, and the concept of membership functions and gain skills in designing fuzzy inference systems, including defining fuzzy rules and using inference mechanisms for decision-making.	3	PO5
CO4	Identify the principles of neuro-fuzzy systems, combining the learning capabilities of ANN with the reasoning capabilities of fuzzy logic, implement and train ANFIS for solving complex engineering problems, leveraging both neural network learning and fuzzy inference.	3	PO5

Syllabus

Artificial Neural Networks: Definition and scope of artificial neural networks. Historical background and development of ANNs. Comparison with biological neural networks. Neurons, weights, biases, activation functions. Types of activation functions: linear, sigmoid, tanh, ReLU., ANN Architecture, Hebbian Learning Introduction to Hebbian learning. Mathematical formulation and implementation. Applications and limitations. Supervised Learning Overview of supervised learning. Training and testing datasets. Error backpropagation algorithm. Gradient descent and its variants. Practical implementation of supervised learning in MLPs. Unsupervised Learning Introduction to unsupervised learning. Reinforcement Learning

ANN Paradigms: Clustering techniques: k-means, hierarchical clustering. Self-Organizing Maps (SOM). Principal Component Analysis (PCA), Multilayer Perceptron and Backpropagation Algorithm, Implementation and Application of Radial Basis Function Networks, Utilization of Hopfield Networks for Pattern Storage and Retrieval, Case studies

Fuzzy Logic: Introduction, Fuzzy versus crisp, Fuzzy sets , Membership function, Basic Fuzzy set operations, Fuzzy Inference , Fuzzy Rule based system, De-fuzzification methods, Application to Load Frequency Control.

Apply Integration of ANN and Fuzzy Logic in Neuro-Fuzzy Model, Implementation of Adaptive Neuro-Fuzzy Inference Systems (ANFIS), Application of Neuro-Fuzzy Models to Electrical Engineering Problems

Reference Books

- 1 Principles of Artificial Neural Networks, Daniel Graupe, 2013, World Scientific.
- 2 Neural Networks, Fuzzy Logic & Genetic Algorithms , S.Rajasekaran and G.A.V.Pai , 2003, PHI, New Delhi..
- 3 Fuzzy Logic with Engineering Applications , Timothy J. Ross , 2011, Wiley..

- 4 Neural Network , James A freeman, David M Skapura , 1991, Addison Wesley, an imprint of Pearson Education, .

23SDEE03R - AI TECHNIQUES FOR ELECTRICAL ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE03R	AI TECHNIQUES FOR ELECTRICAL ENGINEERING	AITFEE	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Artificial neural networks, their models, architectures, and learning paradigms (Hebbian, supervised, unsupervised, reinforcement) for pattern recognition and decision-making applications.	3	PO1
CO2	Develop the architecture and functionality of multilayer perceptrons (MLP) and implement the backpropagation algorithm, Radial Basis Function Network , Hopfield Network for training MLPs.	3	PO5
CO3	Apply basics of fuzzy logic, including the distinction between fuzzy and crisp sets, and the concept of membership functions and gain skills in designing fuzzy inference systems, including defining fuzzy rules and using inference mechanisms for decision-making.	3	PO5

Syllabus

Artificial Neural Networks: Definition and scope of artificial neural networks. Historical background and development of ANNs. Comparison with biological neural networks. Neurons, weights, biases, activation functions. Types of activation functions: linear, sigmoid, tanh, ReLU., ANN Architecture, Hebbian Learning Introduction to Hebbian learning. Mathematical formulation and implementation. Applications and limitations. Supervised Learning Overview of supervised learning. Training and testing datasets. Error backpropagation algorithm. Gradient descent and its variants. Practical implementation of supervised learning in MLPs. Unsupervised Learning Introduction to unsupervised learning. Reinforcement Learning

ANN Paradigms: Clustering techniques: k-means, hierarchical clustering. Self-Organizing Maps (SOM). Principal Component Analysis (PCA), Multilayer Perceptron and Backpropagation Algorithm, Implementation and Application of Radial Basis Function Networks, Utilization of Hopfield Networks for Pattern Storage and Retrieval, Case studies

Fuzzy Logic: Introduction, Fuzzy versus crisp, Fuzzy sets , Membership function, Basic Fuzzy set operations, Fuzzy Inference , Fuzzy Rule based system, De-fuzzification methods, Application to Load Frequency Control.

Reference Books

- 1 Principles of Artificial Neural Networks , Daniel Graupe, 2013, World Scientific.
- 2 Neural Networks, Fuzzy Logic & Genetic Algorithms . , S.Rajasekaran and G.A.V.Pai , 2003, PHI, New Delhi..
- 3 Fuzzy Logic with Engineering Applications , Timothy J. Ross , 2011, Wiley..
- 4 Neural Network , James A freeman, David M Skapura , 1991, Addison Wesley, an imprint of Pearson Education.

23SDEE04A - AI & ML FOR SMART GRIDS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE04A	AI & ML FOR SMART GRIDS	AIMLSG	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize AI tools to optimize smart grids by enhancing real-time energy distribution, minimizing outages, forecasting demand, and improving resilience with predictive analytics and machine learning.	3	PO2, PO5
CO2	Analyze Neural Network tools for designing and evaluating solutions, ensuring optimized performance and accuracy in complex simulations. Analyze Neural Network tools for designing and evaluating solutions, ensuring optimized performance and accuracy .	4	PO5
CO3	Analyze smart grid efficiency with simulation tools to identify improvements in energy distribution and performance. Ensure optimal operation and sustainability.	4	PO5
CO4	Analyze and evaluate AI and ML algorithms for anomaly detection and fault diagnosis in smart grids. Ensure precise identification and quick resolution for enhanced reliability and efficiency	4	PO5, PSO2

Syllabus

Introduction to Smart Grid Technology, Overview of smart grid components and architecture, Smart Grid Components and Subsystems, Energy storage systems

Energy storage systems for renewable energy integration, Microgrids and their role in renewable energy integration, Data mining and machine learning techniques for smart grid data analysis, AI-based control and optimization techniques for smart grid management

AI and ML applications in renewable energy integration, Cybersecurity and ethical considerations related to AI and ML in the smart grid

Anomaly Detection Techniques: Statistical methods, machine learning algorithms, and ensemble methods. Fault Diagnosis: Pattern recognition, fault localization, and decision support systems.

Reference Books

- 1 Artificial Intelligence-based Smart Power Systems, Sanjeevikumar Padmanaban, Sivaraman Palanisamy, Sharmeela Chenniappan, Jens Bo Holm-Nielsen, 2022, Wiley.
- 2 Applications of Artificial Intelligence in Planning and Operation of Smart Grids, Mehdi Rahmani-Andebili , 2022, Springer International Publishing.
- 3 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, John Wiley & Sons .
- 4 Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, and Kithsiri Liyanage, 2012, Wiley-IEEE Press.
- 5 Machine Learning for Smart Grids: Algorithms, Methodologies, and Applications, Chen-Ching Liu, Wade D. Smith, and Steven W. Su, 2017, CRC Press.
- 6 Artificial Intelligence Techniques for Smart Grids, Hongjian Sun, Yuguang Fang, and Huan Zhao, 2021, Springer.
- 7 Deep Learning Applications in Smart Grids, Siddhartha Kumar Khaitan, Jianhui Wang, and Bikash C. Pal, 2019, CRC Press.

23SDEE04E - AI & ML FOR SMART GRIDS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE04E	AI & ML FOR SMART GRIDS	AIMLSG	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Artificial Intelligence tools tailored for optimizing the smart grid to enhance real time energy distribution and minimize power outages, predictive analytics and machine learning algorithms to forecast energy demand and improve grid resilience.	3	PO2, PO5
CO2	Analyze the capabilities of Neural Network tools for designing and evaluating solutions tailored to specific applications, ensuring optimized performance and accuracy in complex system simulations.	4	PO5
CO3	Analyze the efficiency of the smart grid using simulation tools to identify potential improvements in energy distribution, reliability, and overall performance, ensuring optimal operation and sustainability.	4	PO5
CO4	Analyze and evaluate various AI and ML algorithms to obtain customized solutions for anomaly detection and fault diagnosis in smart grids, ensuring precise identification and swift resolution of issues for enhanced grid reliability and efficiency.	4	PO5, PSO2

Syllabus

Introduction to Smart Grid Technology, Overview of smart grid components and architecture, Smart Grid Components and Subsystems, Energy storage systems

Energy storage systems for renewable energy integration, Microgrids and their role in renewable energy integration, Data mining and machine learning techniques for smart grid data analysis, AI-based control and optimization techniques for smart grid management

AI and ML applications in renewable energy integration, Cybersecurity and ethical considerations related to AI and ML in the smart grid

Anomaly Detection Techniques: Statistical methods, machine learning algorithms, and ensemble methods. Fault Diagnosis: Pattern recognition, fault localization, and decision support systems.

Reference Books

- 1 Artificial Intelligence-based Smart Power Systems, Sanjeevikumar Padmanaban, Sivaraman Palanisamy, Sharmeela Chenniappan, Jens Bo Holm-Nielsen, 2022, Wiley.
- 2 Applications of Artificial Intelligence in Planning and Operation of Smart Grids, Mehdi Rahmani-Andebili, 2022, Springer International Publishing.
- 3 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, John Wiley & Sons.
- 4 Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, and Kithsiri Liyanage, 2012, Wiley-IEEE Press.
- 5 Machine Learning for Smart Grids: Algorithms, Methodologies, and Applications, Chen-Ching Liu, Wade D. Smith, and Steven W. Su, 2017, CRC Press.
- 6 Artificial Intelligence Techniques for Smart Grids, Hongjian Sun, Yuguang Fang, and Huan Zhao, 2021, Springer.
- 7 Deep Learning Applications in Smart Grids, Siddhartha Kumar Khaitan, Jianhui Wang, and Bikash C. Pal, 2019, CRC Press.

23SDEE04R - AI & ML FOR SMART GRIDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE04R	AI & ML FOR SMART GRIDS	AIMLSG	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Artificial Intelligence tools tailored for optimizing the smart grid to enhance real time energy distribution and minimize power outages, predictive analytics and machine learning algorithms to forecast energy demand and improve grid resilience.	3	PO2, PO5
CO2	Analyze the capabilities of Neural Network tools for designing and evaluating solutions tailored to specific applications, ensuring optimized performance and accuracy in complex system simulations.	4	PO5
CO3	Analyze the efficiency of the smart grid using simulation tools to identify potential improvements in energy distribution, reliability, and overall performance, ensuring optimal operation and sustainability.	4	PO5

Syllabus

Introduction to Smart Grid Technology, Overview of smart grid components and architecture, Smart Grid Components and Subsystems, Energy storage systems

Energy storage systems for renewable energy integration, Microgrids and their role in renewable energy integration, Data mining and machine learning techniques for smart grid data analysis, AI-based control and optimization techniques for smart grid management

AI and ML applications in renewable energy integration, Cybersecurity and ethical considerations related to AI and ML in the smart grid

Reference Books

- 1 Artificial Intelligence-based Smart Power Systems , Sanjeevikumar Padmanaban, Sivaraman Palanisamy, Sharmeela Chenniappan, Jens Bo Holm-Nielsen , 2022, Wiley .
- 2 Applications of Artificial Intelligence in Planning and Operation of Smart Grids , Mehdi Rahmani-Andebili , 2022, Springer International Publishing .
- 3 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, John Wiley & Sons.
- 4 Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, and Kithsiri Liyanage, 2012, Wiley-IEEE Press.
- 5 Machine Learning for Smart Grids: Algorithms, Methodologies, and Applications, Chen-Ching Liu, Wade D. Smith, and Steven W. Su, 2017, CRC Press.
- 6 Artificial Intelligence Techniques for Smart Grids, Hongjian Sun, Yuguang Fang, and Huan Zhao, 2021, Springer.

23SDEE05A - MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE05A	MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS	GML	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of MATLAB to renewable energy sources	3	PO1, PO5
CO2	Analyze the characteristics of solar PV system using MATLAB.	4	PO1, PO5
CO3	Analyze the characteristics of wind energy conversion system using MATLAB.	4	PO1, PO5
CO4	Analyze the characteristics of wind and solar hybrid system system using MATLAB.	4	PO1, PO5

Syllabus

Overview of MATLAB simulation, fundamentals of solar PV and wind energy conversion system. Measurement and analysis of current-voltage (IV) characteristics of a solar PV cell. Determination of fill factor and efficiency of a solar PV cell. Effect of temperature on the output characteristics of a solar PV cell.

Solar PV System: V-I characteristics, effect of temperature, shading effect, fill factor, efficiency, irradiance impact, series and parallel connection of solar cells.

Wind Energy Conversion Systems: Power curve, effect of varying wind speeds, tip-speed ratio, impact of blade pitch angle. Determination of the tip-speed ratio of a wind turbine using MATLAB simulation and experimental validation. Study of the impact of blade pitch angle on the performance of a wind turbine.

Hybrid Energy: Simulation using MATLAB, Characteristics analysis. performance and efficiency of a hybrid energy system that combines solar PV and wind energy sources. impact of grid integration on the stability of the hybrid system, including the effects of grid faults, voltage fluctuations, and frequency deviations.

Reference Books

- 1 Wind Energy Explained: Theory, Design and Application, James F. Manwell, Jon G. Mnd edition (2010)cGowan, and Anthony L. Rogers., 2010, John Wiley & Sons..
- 2 Solar Energy Engineering: Processes and Systems, Soteris A. Kalogirou, 2013, Academic Press.
- 3 Wind Energy Handbook, Tony Burton, Nick Jenkins, David Sharpe, and Ervin Bossanyi, 2011, John Wiley & Sons.
- 4 Renewable Energy Sources, John Twidell & Toney Weir: E&F.N. Spon., 2010, Taylor & Francis New York .

23SDEE05E - MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE05E	MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS	GML	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of MATLAB to renewable energy sources	3	PO1, PO5
CO2	Analyze the characteristics of solar PV system using MATLAB.	4	PO1, PO5
CO3	Analyze the characteristics of wind energy conversion system using MATLAB.	4	PO1, PO5
CO4	Analyze the characteristics of wind and solar hybrid system system using MATLAB.	4	PO1, PO5

Syllabus

Overview of MATLAB simulation, fundamentals of solar PV and wind energy conversion system.

Solar PV System: V-I characteristics, effect of temperature, shading effect, fill factor, efficiency, irradiance impact, series and parallel connection of solar cells.

Wind Energy Conversion Systems: Power curve, effect of varying wind speeds, tip-speed ratio, impact of blade pitch angle.

Analyze the characteristics of wind and solar hybrid system using MATLAB.

Reference Books

- 1 Wind Energy Explained: Theory, Design and Application, James F. Manwell, Jon G. McGowan, and Anthony L. Rogers., 2010, John Wiley & Sons..
- 2 Solar Energy Engineering: Processes and Systems, Soteris A. Kalogirou, 2013, Academic Press.
- 3 Wind Energy Handbook, Tony Burton, Nick Jenkins, David Sharpe, and Ervin Bossanyi, 2011, John Wiley & Sons.
- 4 Renewable Energy Sources, John Twidell & Toney Weir: E&F.N. Spon., 2010, Taylor & Francis New York .

23SDEE05R - MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE05R	MODELING AND SIMULATION OF GREEN ENERGY SYSTEMS	GML	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of MATLAB to renewable energy sources	3	PO1, PO5
CO2	Analyze the characteristics of solar PV system using MATLAB.	4	PO1, PO5
CO3	Analyze the characteristics of wind energy conversion system using MATLAB.	4	PO1, PO5

Syllabus

Overview of MATLAB simulation, fundamentals of solar PV and wind energy conversion system.

Solar PV System: V-I characteristics, effect of temperature, shading effect, fill factor, efficiency, irradiance impact, series and parallel connection of solar cells.

Wind Energy Conversion Systems: Power curve, effect of varying wind speeds, tip-speed ratio, impact of blade pitch angle.

Reference Books

- 1 Wind Energy Explained: Theory, Design and Application, James F. Manwell, Jon G. McGowan, and Anthony L. Rogers., 2010, John Wiley & Sons..
- 2 Solar Energy Engineering: Processes and Systems, Soteris A. Kalogirou, 2013, Academic Press.
- 3 Wind Energy Handbook, Tony Burton, Nick Jenkins, David Sharpe, and Ervin Bossanyi, 2011, John Wiley & Sons.
- 4 Renewable Energy Sources, John Twidell & Toney Weir: E&F.N. Spon., 2010, Taylor & Francis New York .

23SDEE06A - EVT HARDWARE PROTOTYPING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE06A	EVT HARDWARE PROTOTYPING	EVTHP	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply PCB design tools for circuit design of electric vehicle hardware	3	PO1, PO5, PSO1
CO2	Apply prototyping principles to construct electric vehicle power circuits	3	PO1, PO5, PSO1
CO3	Apply prototyping principles to construct electric vehicle control circuits	3	PO1, PO5, PSO1
CO4	Apply embedded battery management systems for electric vehicle power and control circuits	3	PO1, PO5, PSO1

Syllabus

Ultiboard tool, design setup, part placement, traces and copper design, PCB calculators, auto-routing and auto-placement, preparing for assembly- gerber files-drill, cut, solder layers, PCB layout design for power circuits and control circuits.

Prototyping Power circuits - Front-end converter, Power converter, Braking, Battery power converter - PCB design, assembling, testing and calibration.

Prototyping Control circuits - Driver boards, BMS controller, Protection circuits, Display units-PCB design, assembling, testing and calibration.

Embedded BMS: Charge controller, equalizer, dynamic charge controller, cooling, monitoring IoT systems prototyping

Reference Books

- 1 Electric Vehicle Design and Prototyping, JJames E. Van Tassel, 2015, CRC Press.
- 2 Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussain, 2018, Pearson education.
- 3 Hybrid Electric Vehicles: Principles and Applications with Practical Perspective, chris Mi, 2018, Springer.
- 4 Electric Vehicle Machines and Drives: Design, Analysis and Application, K. T. Chau, 2019, Wiley-IEEE Press.

23SDEE06E - EVT HARDWARE PROTOTYPING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE06E	EVT HARDWARE PROTOTYPING	EVTHP	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply PCB design tools for circuit design of electric vehicle hardware	3	PO1, PO5, PSO1
CO2	Apply prototyping principles to construct electric vehicle power circuits	3	PO1, PO5, PSO1
CO3	Apply prototyping principles to construct electric vehicle control circuits	3	PO1, PO5, PSO1
CO4	Apply embedded battery management systems for electric vehicle power and control circuits	3	PO1, PO5, PSO1

Syllabus

Ultiboard tool, design setup, part placement, traces and copper design, PCB calculators, auto-routing and auto-placement, preparing for assembly- gerber files-drill, cut, solder layers, PCB layout design for power circuits and control circuits.

Prototyping Power circuits - Front-end converter, Power converter, Braking, Battery power converter - PCB design, assembling, testing and calibration.

Prototyping Control circuits - Driver boards, BMS controller, Protection circuits, Display units-PCB design, assembling, testing and calibration.

Embedded BMS: Charge controller, equalizer, dynamic charge controller, cooling, monitoring IoT systems prototyping

Reference Books

- 1 Electric Vehicle Design and Prototyping, JJames E. Van Tassel, 2015, CRC Press.
- 2 Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussain, 2018, Pearson education.
- 3 Hybrid Electric Vehicles: Principles and Applications with Practical Perspective, chris Mi, 2018, Springer.
- 4 Electric Vehicle Machines and Drives: Design, Analysis and Application, K. T. Chau, 2019, Wiley-IEEE Press.

23SDEE06R - EVT HARDWARE PROTOTYPING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE06R	EVT HARDWARE PROTOTYPING	EVTHP	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply PCB design tools for circuit design of electric vehicle hardware	3	PO1, PO5, PSO1
CO2	Apply prototyping principles to construct electric vehicle power circuits	3	PO1, PO5, PSO1
CO3	Apply prototyping principles to construct electric vehicle control circuits	3	PO1, PO5, PSO1

Syllabus

Ultiboard tool, design setup, part placement, traces and copper design, PCB calculators, auto-routing and auto-placement, preparing for assembly- gerber files-drill, cut, solder layers, PCB layout design for power circuits and control circuits.

Prototyping Power circuits - Front-end converter, Power converter, Braking, Battery power converter - PCB design, assembling, testing and calibration.

Prototyping Control circuits - Driver boards, BMS controller, Protection circuits, Display units-PCB design, assembling, testing and calibration.

Reference Books

- 1 Electric Vehicle Design and Prototyping, JJames E. Van Tassel, 2015, CRC Press.
- 2 Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussain, 2018, Pearson education.
- 3 Hybrid Electric Vehicles: Principles and Applications with Practical Perspective, chris Mi, 2018, Springer.
- 4 Electric Vehicle Machines and Drives: Design, Analysis and Application, K. T. Chau, 2019, Wiley-IEEE Press.

23SDEE07A - IA HARDWARE PROTOTYPING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE07A	IA HARDWARE PROTOTYPING	IAHP	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply signal conditioning circuit design for IoT systems	3	PO1, PO5, PSO1
CO2	Apply embedded Systems Programming for cloud and mobile application connectivity	3	PO1, PO5, PSO1
CO3	Apply PCB design practices to design Embedded Systems Layouts	3	PO1, PO5, PSO1
CO4	Develop embedded automation prototypes	3	PO1, PO5, PSO1

Syllabus

Sensors and Signal Conditioning Circuits : classification , principles, protocols ESP 32 /Node MCU features and board comparison and handling Integrating Sensors to esp32 -serial object, Magnetic Switch Module 4: Integrating Sensors to esp32- Relay, Moisture sensor

Implementation Wifi Connectivity to Google Firebase Console and functionalities, Kodular mobile application development, Integrating Embedded Board and Cloud for data visualization and analytics ,Cloud to Mobile application Data trans receiving . END to END application development Project assignment

Ultiboard tool- design setup, part placement, traces and copper design, PCB calculators, auto-routing and auto-placement, preparing for assembly- gerber files-drill, cut, solder layers, PCB layout design for power circuits and IOT modules

Prototypes: Bio-medical instruments, Energy monitoring IoT systems, drive systems, multistage systems

Reference Books

- 1 Embedded System Design with Arm Cortex-M Microcontrollers Applications with C, C++ and MicroPython, Cemnsalan, Hseyin Deniz Grhan, Mehmet Erkin Y?cel, 2022, Springer.
- 2 From Machine- to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence, Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,Stamatiskarnouskos, David Boyle, 2015, Academic Press.
- 3 Arm Cortex-M Microcontrollers Applications, Mehmet Erkin, 2022, Springer.
- 4 Industrial Automation: Hands On, Frank Lamb, 2022, McGraw-Hill Education.

23SDEE07E - IA HARDWARE PROTOTYPING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE07E	IA HARDWARE PROTOTYPING	IAHP	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply signal conditioning circuit design for IoT systems	3	PO1, PO5, PSO1
CO2	Apply embedded Systems Programming for cloud and mobile application connectivity	3	PO1, PO5, PSO1
CO3	Apply PCB design practices to design Embedded Systems Layouts	3	PO1, PO5, PSO1
CO4	Develop embedded automation prototypes	3	PO1, PO5, PSO1

Syllabus

Sensors and Signal Conditioning Circuits : classification , principles, protocols ESP 32 /Node MCU features and board comparison and handling Integrating Sensors to esp32 -serial object, Magnetic Switch Module 4: Integrating Sensors to esp32- Relay, Moisture sensor

Implementation Wifi Connectivity to Google Firebase Console and functionalities, Kodular mobile application development, Integrating Embedded Board and Cloud for data visualization and analytics ,Cloud to Mobile application Data trans receiving . END to END application development Project assignment

Ultiboard tool- design setup, part placement, traces and copper design, PCB calculators, auto-routing and auto-placement, preparing for assembly- gerber files-drill, cut, solder layers, PCB layout design for power circuits and IOT modules

Prototypes: Bio-medical instruments, Energy monitoring IoT systems, drive systems, multistage systems

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- 1 Embedded System Design with Arm Cortex-M Microcontrollers Applications with C, C++ and MicroPython, Cem ?nsalan, H?seyin Deniz G?rhan, Mehmet Erkin Y?cel, 2022, Springer.
- 2 From Machine- to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence, Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, 2015, Academic Press.
- 3 Arm Cortex-M Microcontrollers Applications, Mehmet Erkin, 2022, Springer.
- 4 Industrial Automation: Hands On, Frank Lamb, 2022, McGraw-Hill Education.

23SDEE07R - IA HARDWARE PROTOTYPING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDEE07R	IA HARDWARE PROTOTYPING	IAHP	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply signal conditioning circuit design for IoT systems	3	PO1, PO5, PSO1
CO2	Apply embedded Systems Programming for cloud and mobile application connectivity	3	PO1, PO5, PSO1
CO3	Apply PCB design practices to design Embedded Systems Layouts	3	PO1, PO5, PSO1

Syllabus

Sensors and Signal Conditioning Circuits : classification , principles, protocols ESP 32 /Node MCU features and board comparison and handling Integrating Sensors to esp32 -serial object, Magnetic Switch Module 4: Integrating Sensors to esp32- Relay, Moisture sensor

Implementation Wifi Connectivity to Google Firebase Console and functionalities, Kodular mobile application development, Integrating Embedded Board and Cloud for data visualization and analytics ,Cloud to Mobile application Data trans receiving . END to END application development Project assignment

Ultiboard tool- design setup, part placement, traces and copper design, PCB calculators, auto-routing and auto-placement, preparing for assembly- gerber files-drill, cut, solder layers, PCB layout design for power circuits and IOT modules

Reference Books

- 1 Embedded System Design with Arm Cortex-M Microcontrollers Applications with C, C++ and MicroPython , Cem ?nsalan, H?seyin Deniz G?rhan, Mehmet Erkin Y?cel , 2022, Springer .
- 2 From Machine- to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence , Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,Stamatiskarnouskos, David Boyle , 2015, Academic Press .
- 3 Arm Cortex-M Microcontrollers Applications , Mehmet Erkin Y?cel, 2022, Springer.
- 4 Industrial Automation: Hands On, Frank Lamb, 2022, McGraw-Hill Education.

23SDIN01A - IOT HARDWARE PROGRAMMING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN01A	IOT HARDWARE PROGRAMMING	IOTHP	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to access and implement the preliminary softwares for ESP 32 Development board	3	PO1, PO2, PSO1
CO2	Able to apply the basic concepts using raspberry Pi	3	PO1, PO2, PSO1
CO3	Able to apply the communication Protocols using Raspberry Pi	3	PO1, PO2, PSO1
CO4	Able to access the cloud database for data posting and monitoring using raspberry Pi	4	PO2, PSO2

Syllabus

ESP 32 Introduction, Pin Configuration, Features, Applications, Software and Driver Tools, Arduino IDE installation, ESP32 Boards manager package installation, GPIO, SERIAL COMMUNICATION, Posting data to cloud database

Raspberry pi Introduction, Pin Configuration, Features, Applications, Software and Driver Tools, raspberry pi OS installation, GPIO, control LEDs, Switches, motors, Actuators.

Raspberry pi Communication Protocol, Connecting Raspberry Pi to cloud platforms, uploading sensor data to the cloud, Implementing cloud-based dashboards and remote control of devices.

IoT Project Development: Designing and implementing IoT projects using Raspberry Pi, integrating sensors, actuators, and communication protocols, Testing, debugging, and deploying IoT applications. Home Automation using Raspberry Pi, Distributed Computing Cluster

Reference Books

- 1 Getting Started With Raspberry Pi - Getting to Know the Inexpensive ARM-Powered Linux Computer, Matt Richardson, Shawn Wallace, and Wolfram Donat, 4(Grayscale Indian Edition), Shroff Publishers.
- 2 Raspberry Pi Cookbook, Simon Monk, 1, O'Reilly Media.
- 3 Exploring Raspberry Pi, Derek Molloy, 2, Wiley.
- 4 Internet of Things: A hands-on Approach, A.Bahga and V.Madisetti, 2, University Press.

23SDIN01E - IOT HARDWARE PROGRAMMING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN01E	IOT HARDWARE PROGRAMMING	IOTHP	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to access and implement the preliminary softwares for ESP 32 Development board	3	PO1, PO2, PSO1
CO2	Able to apply the basic concepts using raspberry Pi	3	PO1, PO2, PSO1
CO3	Able to apply the communication Protocols using Raspberry Pi	3	PO1, PO2, PSO1
CO4	Able to access the cloud database for data posting and monitoring using raspberry Pi	4	PO2, PSO2

Syllabus

ESP 32 Introduction, Pin Configuration, Features, Applications, Software and Driver Tools, Arduino IDE installation, ESP32 Boards manager package installation, GPIO, SERIAL COMMUNICATION, Posting data to cloud database

Raspberry pi Introduction, Pin Configuration, Features, Applications, Software and Driver Tools, raspberry pi OS installation, GPIO, control LEDs, Switches, motors, Actuators.

Raspberry pi Communication Protocol, Connecting Raspberry Pi to cloud platforms, uploading sensor data to the cloud, Implementing cloud-based dashboards and remote control of devices.

IoT Project Development: Designing and implementing IoT projects using Raspberry Pi, integrating sensors, actuators, and communication protocols, Testing, debugging, and deploying IoT applications. Home Automation using Raspberry Pi, Distributed Computing Cluster

Reference Books

- 1 Getting Started With Raspberry Pi - Getting to Know the Inexpensive ARM-Powered Linux Computer, Matt Richardson, Shawn Wallace, and Wolfram Donat, 4(Grayscale Indian Edition), Shroff Publishers.
- 2 Raspberry Pi Cookbook, Simon Monk, 1, O'Reilly Media.
- 3 Exploring Raspberry Pi, Derek Molloy, 2, Wiley.
- 4 Internet of Things: A hands-on Approach, A.Bahga and V.Madisetti, 2, University Press.

23SDIN01R - IOT HARDWARE PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN01R	IOT HARDWARE PROGRAMMING	IOTHP	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to access and implement the preliminary softwares for ESP 32 Development board	3	PO1, PO2, PSO1
CO2	Able to apply the basic concepts using raspberry Pi	3	PO1, PO2, PSO1
CO3	Able to apply the communication Protocols using Raspberry Pi	3	PO1, PO2, PSO1
CO4	Able to access the cloud database for data posting and monitoring using raspberry Pi	4	PO2, PSO2

Syllabus

ESP 32 Introduction, Pin Configuration, Features, Applications, Software and Driver Tools, Arduino IDE installation, ESP32 Boards manager package installation, GPIO, SERIAL COMMUNICATION, Posting data to cloud database

Raspberry pi Introduction, Pin Configuration, Features, Applications, Software and Driver Tools, raspberry pi OS installation, GPIO, control LEDs, Switches, motors, Actuators.

Raspberry pi Communication Protocol, Connecting Raspberry Pi to cloud platforms, uploading sensor data to the cloud, Implementing cloud-based dashboards and remote control of devices.

IoT Project Development: Designing and implementing IoT projects using Raspberry Pi, integrating sensors, actuators, and communication protocols, Testing, debugging, and deploying IoT applications. Home Automation using Raspberry Pi, Distributed Computing Cluster

Reference Books

- 1 Getting Started With Raspberry Pi - Getting to Know the Inexpensive ARM-Powered Linux Computer, Matt Richardson, Shawn Wallace, and Wolfram Donat, 4(Grayscale Indian Edition), Shroff Publishers.
- 2 Raspberry Pi Cookbook, Simon Monk, 1, O'Reilly Media.
- 3 Exploring Raspberry Pi, Derek Molloy, 2, Wiley.
- 4 Internet of Things: A hands-on Approach, A.Bahga and V.Madisetti, 2, University Press.

23SDIN03A - IOT FULL STACK DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN03A	IOT FULL STACK DEVELOPMENT	IOTSDF	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	IOT HARDWARE PROGRAMMING	IOTHP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply foundational Node-Red concepts to create structured and semantic front-end elements for IoT applications.	3	PO1, PO5
CO2	Apply HTML and CSS styling techniques to design visually appealing and responsive user interfaces for IoT-based interfaces.	3	PO1, PO5
CO3	Develop scripts and applications to collect and process data from IoT sensors and devices, providing real-time updates to the front-end.	3	PO1, PO5
CO4	Apply API Integration and NPM (Node Package Manager) libraries for IOT Applications	3	PO1, PO5, PO9, PSO1

Syllabus

:Node Red: Introduction, Structure, Objectives, Technical Requirements, Operating System, Cloning the code, Node, Node Red in brief, Installation in the Host OS, Node Architecture in brief. HTML: Introduction to HTML, HTML Documents, Basic structure of an HTML document, Creating an HTML document, Mark up Tags, Heading-Paragraphs, Line Breaks, HTML Tags. Introduction to elements of HTML, Working with Text, Working with Lists, Tables and Frames, Working with Hyperlinks, Images and Multimedia,

Working with Forms and controls, Concept of CSS, Creating Style Sheet, CSS Properties. Javascript: Introduction to Javascript, Objects, Primitives Operations and Expressions, Control Statements, Arrays, Functions, Constructors, Pattern Matching using Regular Expressions.

React Js: Introduction to React Js, Node, Node Package Manager (NPM), installation of React Js,

Comparision between HTML, CSS, Javascript with React Js, Components ,Variables and properties of React Js.Hooks: Introduction to Hooks , Importance of Hooks,Rules of Hooks,Concepts of Hooks. Node Js: Introduction Node Js, how to use js, API Integration and NPM (Node Package Manager) libraries, .Introduction MySQL.

Reference Books

- 1 Web Technologies: Concepts, Methodologies, Tools, and Applications , Arthur Tatnall , 4th,2010, Information Science Reference .
- 2 "Building Internet of Things with the Arduino" , Charalampos Doukas, Manolis Tsamardinos , 1st Edition,2012, Apress.
- 3 "Internet of Things: Principles and Paradigms", Rajkumar Buyya, Amir Vahid Dastjerdi , 1st,2016, Morgan Kaufmann .
- 4 The Internet of Things: Key Applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi , 2nd,2012, wiley.

23SDIN03E - IOT FULL STACK DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN03E	IOT FULL STACK DEVELOPMENT	IOTSDF	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	IOT HARDWARE PROGRAMMING	IOTHP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply foundational Node-Red concepts to create structured and semantic front-end elements for IoT applications.	3	PO1, PO5
CO2	Apply HTML and CSS styling techniques to design visually appealing and responsive user interfaces for IoT-based interfaces.	3	PO1, PO5
CO3	Develop scripts and applications to collect and process data from IoT sensors and devices, providing real-time updates to the front-end.	3	PO1, PO5
CO4	Apply API Integration and NPM (Node Package Manager) libraries for IOT Applications	3	PO1, PO5, PO9, PSO1

Syllabus

:Node Red: Introduction, Structure, Objectives, Technical Requirements, Operating System, Cloning the code, Node, Node Red in brief, Installation in the Host OS, Node Architecture in brief. HTML: Introduction to HTML, HTML Documents, Basic structure of an HTML document, Creating an HTML document, Mark up Tags, Heading-Paragraphs, Line Breaks, HTML Tags. Introduction to elements of HTML, Working with Text, Working with Lists, Tables and Frames, Working with Hyperlinks, Images and Multimedia,

Working with Forms and controls, Concept of CSS, Creating Style Sheet, CSS Properties. Javascript: Introduction to Javascript, Objects, Primitives Operations and Expressions, Control Statements, Arrays, Functions, Constructors, Pattern Matching using Regular Expressions.

React Js: Introduction to React Js, Node, Node Package Manager (NPM), installation of React Js,

Comparision between HTML, CSS, Javascript with React Js, Components ,Variables and properties of React Js.Hooks: Introduction to Hooks , Importance of Hooks,Rules of Hooks,Concepts of Hooks. Node Js: Introduction Node Js, how to use js, API Integration and NPM (Node Package Manager) libraries, .Introduction MySQL.

Reference Books

- 1 Web Technologies: Concepts, Methodologies, Tools, and Applications , Arthur Tatnall , 4th,2010, Information science references.
- 2 "Building Internet of Things with the Arduino" , Charalampos Doukas, Manolis Tsamardinos , 1st Edition ,2012, Apress .
- 3 "Internet of Things: Principles and Paradigms" , Rajkumar Buyya, Amir Vahid Dastjerdi , 1st,2016, Morgan Kaufmann .
- 4 The Internet of Things: Key Applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi , 2nd,2012, wiley .

23SDIN03R - IOT FULL STACK DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN03R	IOT FULL STACK DEVELOPMENT	IOTSDF	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	IOT HARDWARE PROGRAMMING	IOTHP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply foundational Node-Red concepts to create structured and semantic front-end elements for IoT applications.	3	PO1, PO5, PSO1
CO2	Apply HTML and CSS styling techniques to design visually appealing and responsive user interfaces for IoT-based interfaces.	3	PO1, PO5, PSO1
CO3	Develop scripts and applications to collect and process data from IoT sensors and devices, providing real-time updates to the front-end.	3	PO1, PO5, PO9

Syllabus

:Node Red: Introduction, Structure, Objectives, Technical Requirements, Operating System, Cloning the code, Node, Node Red in brief, Installation in the Host OS, Node Architecture in brief. HTML: Introduction to HTML, HTML Documents, Basic structure of an HTML document, Creating an HTML document, Mark up Tags, Heading-Paragraphs, Line Breaks, HTML Tags. Introduction to elements of HTML, Working with Text, Working with Lists, Tables and Frames, Working with Hyperlinks, Images and Multimedia,

Working with Forms and controls, Concept of CSS, Creating Style Sheet, CSS Properties. Javascript: Introduction to Javascript, Objects, Primitives Operations and Expressions, Control Statements, Arrays, Functions, Constructors, Pattern Matching using Regular Expressions.

React Js: Introduction to React Js, Node, Node Package Manager (NPM), installation of React Js, Comparision between HTML, CSS, Javascript with React Js, Components ,Variables and properties of React Js.Hooks: Introduction to Hooks , Importance of Hooks,Rules of Hooks,Concepts of Hooks. Node Js: Introduction Node Js, how to use js, API Integration

Reference Books

- 1 Web Technologies: Concepts, Methodologies, Tools, and Applications, Arthur Tatnall , 4th edition,2010 , Information scienc refernces.
- 2 "Building Internet of Things with the Arduino" , Charalampos Doukas, Manolis Tsamardinos , 1st Edition ,2012, Apress.
- 3 "Internet of Things: Principles and Paradigms" , Rajkumar Buyya, Amir Vahid Dastjerdi , 1st,2016, Morgan Kaufmann.
- 4 The Internet of Things: Key Applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi, 2nd,2012, Wiley.

23SDIN04A - CLOUD COMPUTING FOR IOT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN04A	CLOUD COMPUTING FOR IOT	IOTPD	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	IOT SYSTEM DESIGN	IOTPA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of cloud computing services , deployment models, enabling technology ,Cloud-based IoT platforms	3	PO1, PO2, PSO1
CO2	Apply different cloud infrastructures virtualization and storage in different virtualization	3	PO1, PO2, PSO1
CO3	Analyze the different case studies on healthcare, agriculture and parking system	3	PO1, PO2, PO3, PSO1
CO4	Recognize emerging trends in IoT and cloud computing, including the impact of 5G technology.	4	PO1, PO4, PO5, PSO1

Syllabus

Introduction to cloud computing: Responsibility models, Characteristics, cloud model, consumption-based models, deployment models, benefits of cloud services, Cloud service types: IaaS, PaaS, SaaS Cloud Deployment models, Cloud enabling Technology, Cloud Architectures. Role of cloud computing in IoT, Cloud-based IoT platforms and frameworks.

Overview of ARM and RISC Design Philosophy, concept of ARM cortex M-series Microcontroller, Advanced Microcontroller Bus Architecture, Understanding the concept of HAL library and its role in embedded c programming, GPIO programming with external devices (LED, 1 Switch, Motor control) using HAL, Configuring ADC registers,

Security and Privacy in Cloud-based IoT: Security considerations for Raspberry Pi and cloud integration, Authentication and encryption techniques, Privacy concerns and data protection in cloud environments. Scalability and Performance Optimization: Scaling Raspberry Pi-based IoT applications in the cloud, Load balancing and resource allocation, Performance monitoring and optimization techniques improving performance through load balancing, system and storage redundancy. Intergrace between IoT Devices and IoT-based Clouds.

Trends in IoT and Cloud Computing Impact of 5G on IoT and Cloud Future Research Directions and Innovations

Reference Books

- 1 "Cloud Computing A Practical Approach for Learning and Implementation", A Srinivasan, J Suresh, 2014, Pearson.
- 2 "Cloud Computing, A Practical Approach", Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, 2009, Tata-McGraw-Hill Osborne Media.
- 3 "Cloud computing: Data intensive computing and scheduling", Magoules, Frederic, 2019, Chapman & Hall.
- 4 Integration of Cloud Computing with Internet of Things: Foundations, Analytics and Applications (Advances in Learning Analytics for Intelligent Cloud-IoT Systems) , Monika Mangla, Suneeta Satpathy, Bhagirathi Nayak, Sachi Nandan Mohanty , 2021, wiley.

23SDIN04E - CLOUD COMPUTING FOR IOT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN04E	CLOUD COMPUTING FOR IOT	IOTPD	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	IOT SYSTEM DESIGN	IOTPA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of cloud computing services , deployment models, enabling technology ,Cloud-based IoT platforms	3	PO1, PO2, PSO1
CO2	Apply different cloud infrastructures virtualization and storage in different virtualization	3	PO1, PO2, PSO1
CO3	Analyze the different case studies on healthcare, agriculture and parking system	3	PO1, PO2, PO3, PSO1
CO4	Recognize emerging trends in IoT and cloud computing, including the impact of 5G technology.	4	PO1, PSO1

Syllabus

Introduction to cloud computing: Responsibility models, Characteristics, cloud model, consumption-based models, deployment models, benefits of cloud services, Cloud service types: IaaS, PaaS, SaaS Cloud Deployment models, Cloud enabling Technology, Cloud Architectures. Role of cloud computing in IoT, Cloud-based IoT platforms and frameworks.

Overview of ARM and RISC Design Philosophy, concept of ARM cortex M-series Microcontroller, Advanced Microcontroller Bus Architecture, Understanding the concept of HAL library and its role in embedded c programming, GPIO programming with external devices (LED, 1 Switch, Motor control) using HAL, Configuring ADC registers,

Security and Privacy in Cloud-based IoT: Security considerations for Raspberry Pi and cloud integration, Authentication and encryption techniques, Privacy concerns and data protection in cloud environments. Scalability and Performance Optimization: Scaling Raspberry Pi-based IoT applications in the cloud, Load balancing and resource allocation, Performance monitoring and optimization techniques improving performance through load balancing, system and storage redundancy. Intergrace between IoT Devices and IoT-based Clouds.

Trends in IoT and Cloud Computing Impact of 5G on IoT and Cloud Future Research Directions and Innovations

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- 1 "Cloud Computing A Practical Approach for Learning and Implementation", A Srinivasan, J Suresh, 2014, Pearson.
- 2 "Cloud Computing, A Practical Approach", Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, 2009, Tata-McGraw-Hill Osborne Media.
- 3 "Cloud computing: Data intensive computing and scheduling", Magoules, Frederic, 2019, Chapman & Hall.
- 4 Integration of Cloud Computing with Internet of Things: Foundations, Analytics and Applications (Advances in Learning Analytics for Intelligent Cloud-IoT Systems) , Monika Mangla, Suneeta Satpathy, Bhagirathi Nayak, Sachi Nandan Mohanty , 2021, wiley.

23SDIN04R - CLOUD COMPUTING FOR IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN04R	CLOUD COMPUTING FOR IOT	IOTPD	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	IOT SYSTEM DESIGN	IOTPA	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of cloud computing services , deployment models, enabling technology ,Cloud-based IoT platforms	2	PO1, PO2, PSO1
CO2	Apply different cloud infrastructures virtualization and storage in different virtualization	2	PO1, PO2, PSO1
CO3	Analyze the different case studies on healthcare, agriculture and parking system	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to cloud computing: Responsibility models, Characteristics, cloud model, consumption-based models, deployment models, benefits of cloud services, Cloud service types: IaaS, PaaS, SaaS Cloud Deployment models, Cloud enabling Technology, Cloud Architectures. Role of cloud computing in IoT, Cloud-based IoT platforms and frameworks.

Overview of ARM and RISC Design Philosophy, concept of ARM cortex M-series Microcontroller, Advanced Microcontroller Bus Architecture, Understanding the concept of HAL library and its role in embedded c programming, GPIO programming with external devices (LED, 1 Switch, Motor control) using HAL, Configuring ADC registers,

Security and Privacy in Cloud-based IoT: Security considerations for Raspberry Pi and cloud integration, Authentication and encryption techniques, Privacy concerns and data protection in cloud environments. Scalability and Performance Optimization: Scaling Raspberry Pi-based IoT applications in the cloud, Load balancing and resource allocation, Performance monitoring and optimization techniques improving performance through load balancing, system and storage redundancy. Interpace between IoT Devices and IoT-based Clouds.

Reference Books

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- 2 "Cloud Computing, A Practical Approach", Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, 2009, Tata-McGraw-Hill Osborne Media.
- 3 "Cloud computing: Data intensive computing and scheduling", Magoules, Frederic, 2019, Chapman & Hall.
- 4 Integration of Cloud Computing with Internet of Things: Foundations, Analytics and Applications (Advances in Learning Analytics for Intelligent Cloud-IoT Systems) , Monika Mangla, Suneeta Satpathy, Bhagirathi Nayak, Sachi Nandan Mohanty, 2021, wiley.

23SDIN05A - IOT ANALYTICS FOR THE CLOUD (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN05A	IOT ANALYTICS FOR THE CLOUD	IOTAC	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CLOUD COMPUTING FOR IOT	CCIoT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying IoT principles with cloud computing technologies.	3	PO2, PO3, PO5, PSO1
CO2	Explore various IoT data sources and formats	4	PO2, PO3, PO5, PSO1
CO3	Analyze data pre processing techniques for IoT data	4	PO2, PO3, PO5, PSO1
CO4	Evaluate cloud-based analytics tools and platforms for IoT data analysis.	5	PO2, PO3, PO5, PSO1
CO5	Evaluate real-time and batch analytics on IoT data streams.	5	PO2, PO3, PO5, PSO1
CO6	Evaluate machine learning and AI techniques for predictive analytics in IoT	5	PO2, PO3, PO5, PSO1

Syllabus

Introduction to IoT Analytics and Cloud Computing Overview of IoT and its applications Introduction to cloud computing and its role in IoT analytics Challenges and opportunities in IoT data analytics

IoT Data Sources and Formats Types of IoT data sources (sensors, devices, etc.) Understanding IoT data formats (structured, semi-structured, unstructured) Data acquisition and ingestion strategies

Data Preprocessing for IoT Data Data cleaning, filtering, and normalization techniques Handling missing data and outliers Feature engineering for IoT analytics

Cloud-based Analytics Tools and Platforms Overview of cloud-based analytics services (AWS IoT Analytics, Azure IoT Hub, Google Cloud IoT Core) Hands-on exploration of IoT analytics platforms

Real-time Analytics on IoT Data Streams Introduction to stream processing frameworks (Apache Kafka, Apache Flink) Building real-time analytics pipelines for IoT data

Batch Analytics on Historical IoT Data Introduction to big data processing frameworks (Apache Hadoop, Apache Spark) Performing batch analytics on historical IoT data

IoT Security Best Practices Security challenges in IoT Implementing secure communication (e.g., TLS/SSL) Device authentication and authorization

Designing End-to-End IoT Solutions Architecture design considerations Integrating multiple cloud services Best practices for deployment

Reference Books

- 1 Analytics for the Internet of Things (IoT), Andrew Minter, July 2017, Packt Publishing.
- 2 AN INTRODUCTION TO IOT ANALYTICS, Harry G. Perros, March 2021, Chapman and Hall/CRC.

- 3 IoT Data Analytics using Python: Learn how to use Python to collect, analyze, and visualize IoT data , M S Hariharan , 22 October 2023, BPB.
- 4 Hands-On Edge Analytics with Azure IoT: Design and develop IoT applications with edge analytical solutions including Azure IoT Edge, Colin Dow, 1st Edition, Microsoft.

23SDIN05E - IOT ANALYTICS FOR THE CLOUD (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN05E	IOT ANALYTICS FOR THE CLOUD	IOTAC	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	CLOUD COMPUTING FOR IOT	CCIoT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying IoT principles with cloud computing technologies.	3	PO2, PO3, PO5, PSO1
CO2	Explore various IoT data sources and formats	4	PO2, PO3, PO5, PSO1
CO3	Analyze data pre processing techniques for IoT data	4	PO2, PO3, PO5, PSO1
CO4	Evaluate cloud-based analytics tools and platforms for IoT data analysis.	5	PO2, PO3, PO5, PSO1
CO5	Evaluate real-time and batch analytics on IoT data streams.	5	PO2, PO3, PO5, PSO1

Syllabus

Introduction to IoT Analytics and Cloud Computing Overview of IoT and its applications Introduction to cloud computing and its role in IoT analytics Challenges and opportunities in IoT data analytics

IoT Data Sources and Formats Types of IoT data sources (sensors, devices, etc.) Understanding IoT data formats (structured, semi-structured, unstructured) Data acquisition and ingestion strategies

Data Preprocessing for IoT Data Data cleaning, filtering, and normalization techniques Handling missing data and outliers Feature engineering for IoT analytics

Cloud-based Analytics Tools and Platforms Overview of cloud-based analytics services (AWS IoT Analytics, Azure IoT Hub, Google Cloud IoT Core) Hands-on exploration of IoT analytics platforms

Real-time Analytics on IoT Data Streams Introduction to stream processing frameworks (Apache Kafka, Apache Flink) Building real-time analytics pipelines for IoT data

Batch Analytics on Historical IoT Data Introduction to big data processing frameworks (Apache Hadoop, Apache Spark) Performing batch analytics on historical IoT data

IoT Security Best Practices Security challenges in IoT Implementing secure communication (e.g., TLS/SSL) Device authentication and authorization

Designing End-to-End IoT Solutions Architecture design considerations Integrating multiple cloud services Best practices for deployment

Reference Books

- 1 Analytics for the Internet of Things (IoT), Andrew Minter, July 2017, Packt Publishing.
- 2 AN INTRODUCTION TO IOT ANALYTICS, Harry G. Perros, March 2021, Chapman and Hall/CRC.
- 3 IoT Data Analytics using Python: Learn how to use Python to collect, analyze, and visualize IoT data, M S Hariharan, 22 October 2023, BPB.

- 4 Hands-On Edge Analytics with Azure IoT: Design and develop IoT applications with edge analytical solutions including Azure IoT Edge, Colin Dow, 2015, Microsoft.

23SDIN05R - IOT ANALYTICS FOR THE CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN05R	IOT ANALYTICS FOR THE CLOUD	IOTAC	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	CLOUD COMPUTING FOR IOT	CCIoT	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying IoT principles with cloud computing technologies.	3	PO2, PO3, PO5, PSO1
CO2	Explore various IoT data sources and formats	4	PO2, PO3, PO5, PSO1
CO3	Analyze data pre processing techniques for IoT data	4	PO2, PO3, PO5, PSO1
CO4	Analyse cloud-based analytics tools and platforms for IoT data analysis.	4	PO2, PO3, PO5, PSO1
CO5	Evaluate real-time and batch analytics on IoT data streams	5	PO2, PO3, PO5, PSO1

Syllabus

Introduction to IoT Analytics and Cloud Computing Overview of IoT and its applications Introduction to cloud computing and its role in IoT analytics Challenges and opportunities in IoT data analytics

IoT Data Sources and Formats Types of IoT data sources (sensors, devices, etc.) Understanding IoT data formats (structured, semi-structured, unstructured) Data acquisition and ingestion strategies

Data Preprocessing for IoT Data Data cleaning, filtering, and normalization techniques Handling missing data and outliers Feature engineering for IoT analytics

Cloud-based Analytics Tools and Platforms Overview of cloud-based analytics services (AWS IoT Analytics, Azure IoT Hub, Google Cloud IoT Core) Hands-on exploration of IoT analytics platforms

Cloud-based Analytics Tools and Platforms Overview of cloud-based analytics services (AWS IoT Analytics, Azure IoT Hub, Google Cloud IoT Core) Hands-on exploration of IoT analytics platforms

Real-time Analytics on IoT Data Streams Introduction to stream processing frameworks (Apache Kafka, Apache Flink) Building real-time analytics pipelines for IoT data

IoT Security Best Practices Security challenges in IoT Implementing secure communication (e.g., TLS/SSL) Device authentication and authorization

Designing End-to-End IoT Solutions Architecture design considerations Integrating multiple cloud services Best practices for deployment

Reference Books

- 1 Analytics for the Internet of Things (IoT), Andrew Minter, July 2017, Packt Publishing.
- 2 AN INTRODUCTION TO IOT ANALYTICS, Harry G. Perros, March 2021, Chapman and Hall/CRC.
- 3 IoT Data Analytics using Python: Learn how to use Python to collect, analyze, and visualize IoT data, M S Hariharan, 22 October 2023, BPB.

- 4 Hands-On Edge Analytics with Azure IoT: Design and develop IoT applications with edge analytical solutions including Azure IoT Edge, Colin Dow, 1st Edition, Microsoft.

23SDIN06A - EMBEDDED AND IOT ROGRAMMING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN06A	EMBEDDED AND IOT ROGRAMMING	IOTHP	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Development of Embedded applications using Embedded C	2	PO2, PO3, PSO1
CO2	Interfacing of sensors for with microcontrollers that facilitates Embedded applications development.	3	PO2, PO3, PO5, PSO1
CO3	Internet of Things (IoT) fundamentals , IoT and embedded system architectures	3	PO2, PO3, PO5, PSO1
CO4	Embedded System/ Product Design with ARM Microcontrollers/ARM SoCs, IoT Application Development etc.	3	PO2, PO3, PO5, PSO1

Syllabus

Introduction to embedded systems, Application areas and categories of embedded systems, Overview of embedded system architecture, Specialties and trends in embedded systems, Development and debugging Tools.

Introduction to Embedded protocols - USART/I2C/SPI and USB. Comparison of these protocols.

Overview of IoT hardware platforms, Introduction to various IoT Standards, Peripheral Programming with Arduino/NODEMCU. Python programming for Raspberry Pi and interfaces.

A real world Industry problem involving Embedded or IoT System Design using state of the art industry standard tools and practices.

Reference Books

- 1 Embedded C, Pont, Michael J, 2002, Addison-Wesley.
- 2 Embedded Systems Architecture Programming and Design:, Raj Kamal, 2002, Tata McGraw Hill.
- 3 Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Ovidiu Vermesan, SINTEF, Norway & Peter Friess, EU, Belgium, 2008, River Publishers.
- 4 Internet of Things (A Hands-on-Approach), Vijay Madiseti , ArshdeepBahga, 2015, Vijay Madiseti , ArshdeepBahga.

23SDIN06E - EMBEDDED AND IOT ROGRAMMING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN06E	EMBEDDED AND IOT ROGRAMMING	IOTHP	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Development of Embedded applications using Embedded C	3	PO2, PO3, PSO1
CO2	Interfacing of sensors for with microcontrollers that facilitates Embedded applications development.	3	PO2, PO3, PO5, PSO1
CO3	Internet of Things (IoT) fundamentals , IoT and embedded system architectures	3	PO2, PO3, PO5, PSO1
CO4	Embedded System/ Product Design with ARM Microcontrollers/ARM SoCs, IoT Application Development etc.	3	PO2, PO3, PO5, PSO1

Syllabus

Introduction to embedded systems, Application areas and categories of embedded systems, Overview of embedded system architecture, Specialties and trends in embedded systems, Development and debugging Tools.

Introduction to Embedded protocols - USART/I2C/SPI and USB. Comparison of these protocols.

Overview of IoT hardware platforms, Introduction to various IoT Standards, Peripheral Programming with Arduino/NODEMCU. Python programming for Raspberry Pi and interfaces.

A real world Industry problem involving Embedded or IoT System Design using state of the art industry standard tools and practices.

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- 2 Embedded Systems Architecture Programming and Design: , Raj Kamal , 2002, Tata McGraw Hill .
- 3 Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems , Ovidiu Vermesan, SINTEF, Norway & Peter Friess, EU, Belgium , 2008, River Publishers .
- 4 Internet of Things (A Hands-on-Approach) , Vijay Madiseti , ArshdeepBahga , 2015, Vijay Madiseti , ArshdeepBahga .

23SDIN06R - EMBEDDED AND IOT ROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDIN06R	EMBEDDED AND IOT ROGRAMMING	IOTHP	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	FUNDAMENTALS OF IOT AND SENSORS	FITS	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Development of Embedded applications using Embedded C	3	PO2, PO3, PSO1
CO2	Interfacing of sensors for with microcontrollers that facilitates Embedded applications development.	3	PO2, PO3, PO5, PSO1
CO3	Embedded System/ Product Design with ARM Microcontrollers/ARM SoCs, IoT Application Development etc.	3	PO2, PO3, PO5, PSO1

Syllabus

Introduction to embedded systems, Application areas and categories of embedded systems, Overview of embedded system architecture, Specialties and trends in embedded systems, Development and debugging Tools.

Introduction to Embedded protocols - USART/I2C/SPI and USB. Comparison of these protocols.

A real world Industry problem involving Embedded or IoT System Design using state of the art industry standard tools and practices.

Reference Books

- 1 Embedded C , Pont, Michael J , 2002, Addison-Wesley .
- 2 Embedded Systems Architecture Programming and Design: , Raj Kamal , 2002, Tata McGraw Hill .
- 3 Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems , Ovidiu Vermesan, SINTEF, Norway & Peter Friess, EU, Belgium , 2008, River Publishers .
- 4 Internet of Things (A Hands-on-Approach) , Vijay Madisetti , ArshdeepBahga , 2015, Vijay Madisetti , ArshdeepBahga .

23SDME01A - VISUALIZATION AND MODELLING FOR ENGINEERING DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME01A	VISUALIZATION AND MODELLING FOR ENGINEERING DESIGN	VMED	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING GRAPHICS	EG	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of Orthographic projection to Generate the views and sectioning.	3	PO1, PO5, PSO1
CO2	Prepare the assembly drawing of engine parts, machine Components both in conventional form and then by using software.	3	PO1, PO5, PSO1
CO3	Generate detail drawings of individual parts of an assembled machine Component both in conventional form and then by using software.	3	PO1, PO5, PSO1
CO4	Generate Production Drawings by considering Limits, tolerances and fits, Surface roughness .	3	PO1, PO5, PSO1

Syllabus

Review: Orthographic projection, missing lines, Interpolation of views and sectioning Specification of materials: Engineering materials, code designation of steels, copper, and aluminium and its alloys.

ASSEMBLY DRAWINGS: Introduction, stuffing box, screw jack, Lathe tailstock, gate valve, steam engine cross head.

PART DRAWINGS: I C Engine connecting rod, Single Tool Post, spark plug, safety Valves etc Production drawing: Introduction to developing and reading of production drawing of simple machine elements like helical gear, bevel gear, flange, pinion shaft, connecting rod, crank shaft, belt pulley, piston details etc, idea about tool drawing.

Limits, tolerances and fits: Introduction, limit systems, tolerance, fits drawing exercises. Surface roughness: Introduction, surface roughness, machining symbols, identification of surface roughness drawing exercises. Computer aided drawing: Introduction, input, output devices, introduction to drafting software like Creo/ Solidworks, basic commands and development of simple 2D and 3D drawings.

Reference Books

- 1 Machine Drawing , K L Narayana, P Kannaiah & K Venkat Reddy , 3rd Edition June 2009, New Age .
- 2 Machine Drawing , N D Bhatt , 51th Edition 2023, Charotar .
- 3 Production Drawing , K L Narayana, P Kannaiah & K Venkat Reddy , 3rd Edition 2014, New Age.
- 4 Machine Drawing , Siddeswar, Kannaiah and V V S Sastry , 1st Edition 2017, TMH.
- 5 Autodesk Fusion 360: A Power Guide for Beginners and Intermediate Users, John Willis (Author), Sandeep Dogra (Author), Cadartifex (Author), 1st Edition 2018, CAD Arti flex.

23SDME01E - VISUALIZATION AND MODELLING FOR ENGINEERING DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME01E	VISUALIZATION AND MODELLING FOR ENGINEERING DESIGN	VMED	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING GRAPHICS	EG	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of Orthographic projection to Generate the views and sectioning.	3	PO1, PO5, PSO1
CO2	Prepare the assembly drawing of engine parts, machine Components both in conventional form and then by using software.	3	PO1, PO5, PSO1
CO3	Generate detail drawings of individual parts of an assembled machine Component both in conventional form and then by using software.	3	PO1, PO5, PSO1
CO4	Generate Production Drawings by considering Limits, tolerances and fits, Surface roughness	3	PO1, PO5, PSO1

Syllabus

Review: Orthographic projection, missing lines, Interpolation of views and sectioning Specification of materials: Engineering materials, code designation of steels, copper, and aluminium and its alloys.

ASSEMBLY DRAWINGS: Introduction, stuffing box, screw jack, Lathe tailstock, gate valve, steam engine cross head etc

PART DRAWINGS: I C Engine connecting rod, Single Tool Post, spark plug, safety Valves etc. Production drawing: Introduction to developing and reading of production drawing of simple machine elements like helical gear, bevel gear, flange, pinion shaft, connecting rod, crank shaft, belt pulley, piston details etc, idea about tool drawing.

Limits, tolerances and fits: Introduction, limit systems, tolerance, fits drawing exercises. Surface roughness: Introduction, surface roughness, machining symbols, identification of surface roughness drawing exercises. Computer aided drawing: Introduction, input, output devices, introduction to drafting software like Creo/ Solidworks, basic commands and development of simple 2D and 3D drawings.

Reference Books

- 1 Machine Drawing , K L Narayana, P Kannaiah & K Venkat Reddy , 3rd Edition June 2009, New Age .
- 2 Machine Drawing , N D Bhatt , 51th Edition 2023, Charotar .
- 3 Production Drawing , K L Narayana, P Kannaiah & K Venkat Reddy , 3rd Edition 2014, New Age .
- 4 Machine Drawing , Siddeswar, Kannaiah and V V S Sastry , 1st Edition 2017, TMH.
- 5 Autodesk Fusion 360: A Power Guide for Beginners and Intermediate Users, John Willis (Author), Sandeep Dogra (Author), Cadartifex (Author), 1st Edition 2018, CAD Arti flex.

23SDME01R - VISUALIZATION AND MODELLING FOR ENGINEERING DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME01R	VISUALIZATION AND MODELLING FOR ENGINEERING DESIGN	VMED	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING GRAPHICS	EG	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of Orthographic projection to Generate the views and sectioning.	3	PO1, PO5, PSO1
CO2	Prepare the assembly drawing of engine parts, machine Components both in conventional form and then by using software.	3	PO1, PO5, PSO1
CO3	Generate detail drawings of individual parts of an assembled machine Component both in conventional form and then by using software	3	PO1, PO5, PSO1
CO4	Generate Production Drawings by considering Limits, tolerances and fits, Surface roughness	3	PO1, PO5, PSO1

Syllabus

Review: Orthographic projection, missing lines, Interpolation of views and sectioning Specification of materials: Engineering materials, code designation of steels, copper, and aluminium and its alloys.

ASSEMBLY DRAWINGS: Introduction, stuffing box, screw jack, Lathe tailstock, gate valve, steam engine cross head etc

PART DRAWINGS: I C Engine connecting rod, Single Tool Post, spark plug, safety Valves etc Production drawing: Introduction to developing and reading of production drawing of simple machine elements like helical gear, bevel gear, flange, pinion shaft, connecting rod, crank shaft, belt pulley, piston details etc, idea about tool drawing.

Limits, tolerances and fits: Introduction, limit systems, tolerance, fits drawing exercises. Surface roughness: Introduction, surface roughness, machining symbols, identification of surface roughness drawing exercises. Computer aided drawing: Introduction, input, output devices, introduction to drafting software like Creo/ Solidworks, basic commands and development of simple 2D and 3D drawings.

Reference Books

- 1 Machine Drawing , K L Narayana, P Kannaiah & K Venkat Reddy , 3rd Edition June 2009, New Age .
- 2 Machine Drawing , N D Bhatt , 51th Edition 2023, Charotar .
- 3 Production Drawing , K L Narayana, P Kannaiah & K Venkat Reddy , 3rd Edition 2014, New Age.
- 4 Machine Drawing , Siddeswar, Kannaiah and V V S Sastry, 1st Edition 2017, TMH.
- 5 Autodesk Fusion 360: A Power Guide for Beginners and Intermediate Users, John Willis (Author), Sandeep Dogra (Author), Cadartifex (Author), 1st Edition 2018, CAD Arti flex.

23SDME02A - COMPUTER INTEGRATED MANUFACTURING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME02A	COMPUTER INTEGRATED MANUFACTURING	CIDM	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	MANUFACTURING PROCESSES	MP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Model pathways using CAD, manufacturing fundamentals, and integration tools/software.	3	PO1, PO2, PSO2
CO2	Develop CNC part programs demonstrating knowledge of NC machines, CNC principles, and basic concepts.	3	PO1, PO2, PSO2
CO3	Apply NC part programming for turning, milling, and drilling with CNC Train Software simulations.	3	PO1, PO4, PSO2
CO4	Execute CNC experiments using CAM software for hands-on path generation and program creation.	4	PO1, PO2, PSO2

Syllabus

Basic concepts of CAD / CAM and their integration tools/software

Basic concepts concepts and working principles of NC Machines and CNC Programming in machining

CNC Part programming for Turning, Milling and Drilling operations and simulation on CNC Train Software

Path generation and building of part programs using CAM Softwares, Hands on training on CNC machines

Reference Books

- 1 Automation Production Systems & Computer Integrated manufacturing , Mikell P. Groover , 3rd, 2008, Prentice Hall of India, New Delhi .
- 2 CNC Programming Basics & Tutorial Textbook , Michael J. Peterson , 2nd, 2014, CreateSpace Independent Publishing Platform .
- 3 CNC Programming for Machining , Kaushik kumar, Chikesh Ranjan, J Paulo Davim , 2nd, 2022, Springer .
- 4 Qualification for Computer Integrated Manufacturing , Felix Rauner , 3rd, 2001, Springer .
- 5 Computer Integrated Manufacturing , A. Alavudeen, N. Venkateshwaran , 2nd, 2011, PHI Learning .

23SDME02E - COMPUTER INTEGRATED MANUFACTURING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME02E	COMPUTER INTEGRATED MANUFACTURING	CIDM	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	MANUFACTURING PROCESSES	MP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply CAD and manufacturing fundamentals to model pathways using integration tools/software.	3	PO1, PO2, PSO2
CO2	Develop CNC part programs demonstrating knowledge of NC machines, CNC principles, and basic concepts.	3	PO1, PO2, PSO2
CO3	Apply NC part programming for turning, milling, and drilling with CNC Train Software simulations.	3	PO1, PO4, PSO2
CO4	Execute CNC experiments using CAM software for hands-on path generation and program creation.	4	PO1, PO2, PSO2

Syllabus

Basic concepts of CAD / CAM and their integration tools/software

Basic concepts concepts and working principles of NC Machines and CNC Programming in machining

CNC Part programming for Turning, Milling and Drilling operations and simulation on CNC Train Software

Path generation and building of part programs using CAM Softwares, Hands on training on CNC machines

Reference Books

- 1 Automation Production Systems & Computer Integrated manufacturing , Mikell P. Groover , 2nd, 2008, Prentice Hall of India, New Delhi .
- 2 CNC Programming Basics & Tutorial Textbook , Michael J. Peterson , 3rd, 2014, CreateSpace Independent Publishing Platform .
- 3 CNC Programming for Machining , Kaushik kumar, Chikesh Ranjan, J Paulo Davim , 1st, 2022, Springer .
- 4 Qualification for Computer Integrated Manufacturing , Felix Rauner , 3rd, 2001, Springer .

23SDME02R - COMPUTER INTEGRATED MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME02R	COMPUTER INTEGRATED MANUFACTURING	CIDM	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	MANUFACTURING PROCESSES	MP	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Model paths with basic fundamentals of computer aided design and manufacturing	3	PO1, PO2, PSO2
CO2	Prepare CNC Part Programs for machining	3	PO1, PO2, PSO2
CO3	Implement NC Part Programming in Part Production	3	PO1, PO4, PSO2

Syllabus

Basic concepts of CAD / CAM and their integration tools/software

Basic concepts concepts and working principles of NC Machines and CNC Programming in machining

CNC Part programming for Turning, Milling and Drilling operations and simulation on CNC Train Software

Reference Books

- 1 Automation Production Systems & Computer Integrated manufacturing , Mikell P. Groover , 3rd, Prentice Hall of India, New Delhi .
- 2 CNC Programming Basics & Tutorial Textbook , Michael J. Peterson , 2nd, CreateSpace Independent Publishing Platform .
- 3 CNC Programming for Machining , Kaushik kumar, Chikesh Ranjan, J Paulo Davim , 1st, Springer .
- 4 Computer Integrated Manufacturing, A. Alavudeen, N. Venkateshwaran, 2nd , PHI Learning.
- 5 Qualification for Computer Integrated Manufacturing, Felix Rauner, 4th , Springer.

23SDME03A - FINITE ELEMENT ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME03A	FINITE ELEMENT ANALYSIS	FEA	A	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ADVANCED STRENGTH OF MATERIALS	ASM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform basic and advanced structural analysis of engineering components	4	PO2, PO5
CO2	Explore advanced analysis methods in engineering design.	4	PO2, PO5
CO3	Create and improve models for design optimization.	4	PO2, PO5
CO4	Design a finite element analysis project demonstrating advanced mechanical engineering skills	5	PO2, PO5

Syllabus

Introduction to Ansys workbench, Adding material properties, meshing methods and mesh controls, basic analysis procedure, Structural analysis of a block, Linear and Non linear Structural analysis

parameter management for efficient design exploration, applying remote boundary conditions to simulate real-world scenarios, and performing dynamic analyses such as modal, harmonic, and fatigue analysis.

Hypermesh overview: Generating mid surface and analysing, To prepare a model from concept and analyse further to improve the design, Develop a functional prototype

Introduction to CFD, cell zone & Boundary conditions, solver settings, turbulence modelling, Fluid flow in Mixing chamber

Reference Books

- 1 Building better products with FEA, Vince Adams and Abraham, 1st Edition, Onword press.
- 2 Finite Element Analysis, S S Bhavikatti, 3rd Edition, New Age International.
- 3 Machine Design, Robert L. Norton, 4th Edition, Pearson.
- 4 Mechanical Engineering Design, Richard G Budynas; J Keith Nisbett, 9th Edition, McGraw-Hill International.
- 5 Introduction to Computational Fluid Dynamics, Pradip Niyogi, S.K.Chakrabarthy, M.K.Laha, 1st Edition, Pearson.

23SDME03E - FINITE ELEMENT ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME03E	FINITE ELEMENT ANALYSIS	FEA	E	0	0	6	4	4

Prerequisite

S#	Course Title	Acronym	Rule
1	ADVANCED STRENGTH OF MATERIALS	ASM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform basic and advanced structural analysis of engineering components	4	PO2, PO5
CO2	Explore advanced analysis methods in engineering design.	4	PO2, PO5
CO3	Create and improve models for design optimization.	4	PO2, PO5
CO4	Design a finite element analysis project demonstrating advanced mechanical engineering skills	5	PO2, PO5

Syllabus

Introduction to Ansys workbench, Adding material properties, meshing methods and mesh controls, basic analysis procedure, Structural analysis of a block, Linear and Non linear Structural analysis

parameter management for efficient design exploration, applying remote boundary conditions to simulate real-world scenarios, and performing dynamic analyses such as modal, harmonic, and fatigue analysis.

Hypermesh overview: Generating mid surface and analysing, To prepare a model from concept and analyse further to improve the design, Develop a functional prototype

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- 3 Machine Design, Robert L. Norton, 4th Edition, Pearson.
- 4 Mechanical Engineering Design, Richard G Budynas; J Keith Nisbett, 9th Edition, McGraw-Hill International.
- 5 Introduction to Computational Fluid Dynamics, Pradip Niyogi, S.K.Chakrabarthy, M.K.Laha, 1st Edition, Pearson.

23SDME03R - FINITE ELEMENT ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME03R	FINITE ELEMENT ANALYSIS	FEA	R	0	0	2	4	2

Prerequisite

S#	Course Title	Acronym	Rule
1	ADVANCED STRENGTH OF MATERIALS	ASM	-

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform basic and advanced structural analysis of engineering components	4	PO2, PO5
CO2	Explore advanced analysis methods in engineering design.	4	PO2, PO5
CO3	Design a finite element analysis project demonstrating advanced mechanical engineering skills	5	PO2, PO5

Syllabus

Introduction to Ansys workbench, Adding material properties, meshing methods and mesh controls, basic analysis procedure, Structural analysis of a block, Linear and Non linear Structural analysis ANSYS Workbench is a comprehensive simulation platform for engineering analysis. It integrates various modules for structural, thermal, and fluid dynamics simulations. Users can create models, define material properties, set up boundary conditions, and run simulations within a unified environment. The platform supports linear and nonlinear analysis, dynamic simulations, and design optimization. The intuitive interface simplifies model setup and result interpretation.

parameter management for efficient design exploration, applying remote boundary conditions to simulate real-world scenarios, and performing dynamic analyses such as modal, harmonic, and fatigue analysis.

Hypermesh overview: Generating mid surface and analysing, To prepare a model from concept and analyse further to improve the design

Reference Books

- 1 Building better products with FEA , Vince Adams and Abraham , 1st Edition, Onword press .
- 2 Finite Element Analysis , S S Bhavikatti , 3rd Edition, New Age International .
- 3 Machine Design , Robert L. Norton , 4th Edition, Pearson.
- 4 Mechanical Engineering Design , Richard G Budynas; J Keith Nisbett , 9th Edition, McGraw-Hill International .

23SDME04A - ANALYSIS OF ENERGY SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME04A	ANALYSIS OF ENERGY SYSTEMS	AES	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Simulate and Analyze the performance of various types of heat exchangers	4	PO1, PO5
CO2	Analyze the performance of various thermal energy storage devices	4	PO1, PO5
CO3	Model and simulation of thermal management of electronic components	4	PO1, PO5
CO4	Simulate multi-phase flows	4	PO1, PO5
CO5	Analysis of combustion process in IC engines	4	PO1, PO5

Syllabus

Tube in Tube, Shell and tube, Plate type heat exchangers. Nano fluids, heat transfer enhancement mechanisms in heat exchangers

Sensible heat storage, Latent heat storage devices. Simulation of melting and solidification of PCMs

Battery cooling techniques: Air cooling, liquid cooling and cooling through phase change

Liquid liquid, Gas- liquid, liquid-solid flows

Simulation of combustion process, optimization of various design parameters on combustion in IC engines

Reference Books

- 1 Numerical Heat Transfer and Fluid Flow , S. V. Patankar , 4,2018, Hemisphere .
- 2 Thermal Energy Storage Systems and Applications, Ibrahim Dincer and Mark A. Rosen, 1, 2022, John Wiley & Sons.
- 3 Energy Storage Systems: Fundamentals, Classification and a Technical Comparative, Jos? Manuel And?jar M?rquez , Francisca Segura Manzano , Jes?s Rey Luengo, 1,2023, Springer.
- 4 Energy Storage Systems: An Introduction, Satyender Singh , 2, 2021, Nova Science Publishers Inc.

23SDME04E - ANALYSIS OF ENERGY SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME04E	ANALYSIS OF ENERGY SYSTEMS	AES	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Simulate and Analyze the performance of various types of heat exchangers	4	PO1, PO5
CO2	Analyze the performance of various thermal energy storage devices	4	PO1, PO5
CO3	Model and simulation of thermal management of electronic components	4	PO1, PO5
CO4	Simulate multi-phase flows	4	PO1, PO5

Syllabus

Tube in Tube, Shell and tube, Plate type heat exchangers. Nano fluids, heat transfer enhancement mechanisms in heat exchangers

Sensible heat storage, Latent heat storage devices. Simulation of melting and solidification of PCMs

Battery cooling techniques: Air cooling, liquid cooling and cooling through phase change

Liquid liquid, Gas- liquid, liquid-solid flows

Reference Books

- 1 Numerical Heat Transfer and Fluid Flow, S. V. Patankar, 4,2018 , Hemisphere.
- 2 Thermal Energy Storage Systems and Applications , Ibrahim Dincer and Mark A. Rosen , 1,2022 , John Wiley & Sons.
- 3 Energy Storage Systems: Fundamentals, Classification and a Technical Comparative, Jos? Manuel And?jar M?rquez , Francisca Segura Manzano , Jes?s Rey Luengo , 1, 2023 , Springer.
- 4 Energy Storage Systems: An Introduction , Satyender Singh , 2, 2021 , Nova Science Publishers Inc.

23SDME04R - ANALYSIS OF ENERGY SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME04R	ANALYSIS OF ENERGY SYSTEMS	AES	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Simulate and Analyze the performance of various types of heat exchangers	4	PO1, PO5
CO2	Analyze the performance of various thermal energy storage devices	4	PO1, PO5
CO3	Model and simulation of thermal management of electronic components	4	PO1, PO5
CO4	Simulate multi-phase flows	4	PO1, PO5

Syllabus

Tube in Tube, Shell and tube, Plate type heat exchangers. Nano fluids, heat transfer enhancement mechanisms in heat exchangers

Sensible heat storage, Latent heat storage devices. Simulation of melting and solidification of PCMs

Battery cooling techniques: Air cooling, liquid cooling and cooling through phase change

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- 1 Numerical Heat Transfer and Fluid Flow, S. V. Patankar, 4,2018, Hemisphere.
- 2 Thermal Energy Storage Systems and Applications , Ibrahim Dincer and Mark A. Rosen, 1, 2022 , John Wiley & Sons.
- 3 Energy Storage Systems: Fundamentals, Classification and a Technical Comparative, Jos? Manuel And?jar M?rquez , Francisca Segura Manzano , Jes?s Rey Luengo , 1,2023, Springer.
- 4 Energy Storage Systems: An Introduction , Satyender Singh , 2,2021 , Nova Science Publishers Inc.

23SDME05A - 3D MODELLING AND DIGITAL PROTOTYPING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME05A	3D MODELLING AND DIGITAL PROTOTYPING	3DMDP	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform 3D modelling of engineering components	4	PO1, PO5, PSO1
CO2	Perform analysis and simulation of a finite element model	4	PO1, PO5, PSO1
CO3	Design and execute a fully functional prototype	5	PO1, PO5, PSO1
CO4	Analysis of Engineering problems using Hypermesh optistruct solver	4	PO1, PO5, PSO1

Syllabus

3D modelling of engineering components To perform 3D modeling of engineering components, start by creating a detailed CAD model using software like SolidWorks or AutoCAD. Define the component's geometry, including all critical features and dimensions. Apply appropriate material properties and assign specific attributes to each part. Use meshing tools to create a finite element mesh, refining areas that require higher accuracy. Implement boundary conditions and loads to simulate real-world operating conditions. Finally, run simulations and analyze the results to optimize the design for performance and manufacturability.

Conversion of geometric model to finite element model, analysis and simulation of a finite element model To perform analysis and simulation of a finite element model, import the CAD geometry into FEA software and generate a finite element mesh. Assign material properties and define boundary conditions and loads to represent real-world scenarios. Solve the model using the appropriate solver to compute displacements, stresses, and strains. Analyze the results to identify critical areas and potential failure points. Refine the mesh and iterate the analysis as needed for improved accuracy. Finally, validate the results with experimental data or theoretical predictions to ensure reliability.

To prepare a model from concept and analyse further to improve the design, Develop a functional prototype To design and execute a fully functional prototype, start with conceptual design by creating initial sketches and CAD models. Develop detailed 3D models and select appropriate materials and manufacturing processes. Create the prototype using rapid prototyping techniques like 3D printing or CNC machining. Conduct functional tests to validate performance and gather data. Refine the design based on test results, iterating the prototyping and testing as needed. Perform final validation with comprehensive testing to ensure the prototype meets all requirements and document the process.

1D beam analysis and 2D plate with hole analysis in Hypermesh Optistruct solver Prepare the Model: Import or create the geometry and clean it up in Hypermesh. Mesh the Geometry: Generate a finite element mesh with appropriate elements and density. Define Materials: Assign material properties to the model components. Apply Conditions: Set boundary conditions and loads to simulate real-world scenarios. Run Analysis: Use OptiStruct to solve for displacements, stresses, and other parameters. Review Results: Analyze the results in HyperView and make necessary optimizations.

Reference Books

- 1 ANSYS Tutorial Release 2022 , Kent L. Lawrence , First -2022 edition, SDC publications .
- 2 Design Workbook Using SOLIDWORKS 2021 , Ronald E. Barr, Davor Juricic, Thomas J. Krueger, Alejandro Reyes , 2021, SDC publications.
- 3 Building better products with FEA , Vince Adams and Abraham , 1999, Onword press .
- 4 Finite Element Analysis , S S Bhavikatti , 2005, New Age International .

- 5 Introduction to finite element Engineering , Chandraputla, 3rd Edition 2015, Pearson.

23SDME05E - 3D MODELLING AND DIGITAL PROTOTYPING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME05E	3D MODELLING AND DIGITAL PROTOTYPING	3DMDP	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform 3D modelling of engineering components	3	PO1, PO5, PSO1
CO2	Perform analysis and simulation of a finite element model	3	PO1, PO5, PSO1
CO3	Design and execute a fully functional prototype	3	PO1, PO5, PSO1
CO4	Analysis of Engineering problems using Hypermesh optistruct solver	3	PO1, PO5, PSO1

Syllabus

3D modeling of engineering components involves creating a digital representation of physical objects using three-dimensional geometry. This process is essential for designing, analyzing, and manufacturing components across various industries, including automotive, aerospace, civil engineering, and consumer products. 3D models provide a detailed and accurate depiction of components, facilitating simulations, prototyping, and production.

The conversion of a geometric model to a finite element model, followed by analysis and simulation, is a systematic and iterative process. Each stage requires careful consideration to ensure accurate and reliable results. By combining advanced computational techniques with engineering judgment, FEM enables the design and analysis of complex structures, leading to safer and more efficient engineering solutions.

Developing a functional prototype from a conceptual model involves a thorough process of design, analysis, optimization, and testing. By following a structured approach, you ensure that the prototype not only meets its functional requirements but is also optimized for performance and manufacturability. This iterative process is crucial for creating a successful product that can be efficiently brought to market.

Performing a 1D beam analysis and a 2D plate with a hole analysis using Hypermesh and OptiStruct involves several steps.

Reference Books

- 1 ANSYS Tutorial Release 2022 , Kent L. Lawrence , 1st release 2022, SDC publications .
- 2 Design Workbook Using SOLIDWORKS 2021 , Ronald E. Barr, Davor Juricic, Thomas J. Krueger, Alejandro Reyes , 1st edition 2021, SDC publications .
- 3 Building better products with FEA , Vince Adams and Abraham , 1 St edition 1998, Onword press .
- 4 Finite Element Analysis , S S Bhavikatti , 1st Edition January 2015, New Age International .
- 5 Introduction to Finite Elements in Engineering, CHANDRUPATLA, 3rd edition 2015, PEARSON.

23SDME05R - 3D MODELLING AND DIGITAL PROTOTYPING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME05R	3D MODELLING AND DIGITAL PROTOTYPING	3DMDP	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform 3D modelling of engineering components	4	PO1, PO5, PSO1
CO2	Perform analysis and simulation of a finite element model	4	PO1, PO5, PSO1
CO3	Design and execute a fully functional prototype	5	PO1, PO5, PSO1

Syllabus

3D modeling of engineering components involves creating a digital representation of physical objects using three-dimensional geometry. This process is essential for designing, analyzing, and manufacturing components across various industries, including automotive, aerospace, civil engineering, and consumer products. 3D models provide a detailed and accurate depiction of components, facilitating simulations, prototyping, and production.

Converting a geometric model to a finite element model (FEM) involves several steps to prepare the model for numerical analysis. The finite element method (FEM) is used to analyze complex structures by dividing them into smaller, simpler elements.

Preparing a model from concept, analyzing it to improve the design, and developing a functional prototype involves a systematic approach that includes conceptual design, geometry preparation, finite element modeling, simulation, and prototype development. By iterating through design and analysis, engineers can refine their models, address issues, and optimize performance. Developing a functional prototype provides a tangible representation of the design, allowing for real-world testing and validation before full-scale production.

Reference Books

- 1 ANSYS Tutorial Release 2022 , Kent L. Lawrence , 2022, SDC publications .
- 2 Design Workbook Using SOLIDWORKS 2021 , Ronald E. Barr, Davor Juricic, Thomas J. Krueger, Alejandro Reyes , 2021, SDC publications .
- 3 Building better products with FEA , Vince Adams and Abraham , 1999, Onword press .
- 4 Finite Element Analysis , S S Bhavikatti , 2005, New Age International .

23SDME06A - GEOMETRIC DIMENSIONING AND TOLERANCING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME06A	GEOMETRIC DIMENSIONING AND TOLERANCING	GDAT	A	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand GD&T applications, benefits, key terms, and practical advantages in engineering and manufacturing.	2	PO1, PO3, PSO1
CO2	Practice creating industrial drawings to develop skills for interpreting technical specifications in manufacturing and design.	3	PO1, PO3, PSO1
CO3	Calculating tolerance values ensures precision in generating industrial drawings for manufacturing and design.	3	PO1, PO3, PSO1
CO4	Case studies on industrial drawings with GD&T symbols offer practical insights into design and manufacturing standards.	2	PO1, PO3, PSO1

Syllabus

Calculation involves determining the limits and fits of tolerances specified in standards, ensuring components fit and function correctly within defined parameters.

Interpretation involves understanding and applying GD&T symbols within industrial drawings, ensuring precise communication of design requirements for manufacturing and assembly processes.

Calculation involves deriving various tolerance values from GD&T drawings and using specialized software to create industrial drawings incorporating GD&T symbols accurately.

Study involves examining the interpretation and practical application of GD&T symbols within industrial drawings for precise engineering specifications and manufacturing processes.

Reference Books

- 1 Geometric Dimensioning and Tolerancing: Applications, Analysis & Measurement , James D Meadows , 2004 , ASME Press .
- 2 Dimensioning and Tolerancing Handbook , Paul J. Drake , 1999 , New York: McGraw-Hill .
- 3 Geometric Dimensioning and Tolerancing: Workbook and Answer Book , Alex Krulikowski , 2017 , Effective Training Inc .
- 4 GD&T: Application and Interpretation , Bruce A. Wilson , 2011 , Delmar Cengage Learning .
- 5 Geometric Dimensioning and Tolerancing for Mechanical Design , Gene R. Cogorno , 2010 , McGraw-Hill Education .

23SDME06E - GEOMETRIC DIMENSIONING AND TOLERANCING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME06E	GEOMETRIC DIMENSIONING AND TOLERANCING	GDAT	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand GD&T applications, benefits, key terms, and practical advantages in engineering and manufacturing.	2	PO1, PO3, PSO1
CO2	Practice creating industrial drawings to develop skills for interpreting technical specifications in manufacturing and design.	3	PO1, PO3, PSO1
CO3	Calculating tolerance values ensures precision in generating industrial drawings for manufacturing and design.	3	PO1, PO3, PSO1
CO4	Case studies on industrial drawings with GD&T symbols offer practical insights into design and manufacturing standards.	2	PO1, PO3, PSO1

Syllabus

Calculation involves determining the limits and fits of tolerances specified in standards, ensuring components fit and function correctly within defined parameters.

Interpretation involves understanding and applying GD&T symbols within industrial drawings, ensuring precise communication of design requirements for manufacturing and assembly processes.

Calculation involves deriving various tolerance values from GD&T drawings and using specialized software to create industrial drawings incorporating GD&T symbols accurately.

Study involves examining the interpretation and practical application of GD&T symbols within industrial drawings for precise engineering specifications and manufacturing processes.

Reference Books

- 1 Geometric Dimensioning and Tolerancing: Applications, Analysis & Measurement , James D Meadows , 2004 , ASME Press .
- 2 Dimensioning and Tolerancing Handbook , Paul J. Drake , 1999 , New York: McGraw-Hill .
- 3 Geometric Dimensioning and Tolerancing: Workbook and Answer Book , Alex Krulikowski , 2017 , Effective Training Inc .
- 4 GD&T: Application and Interpretation , Bruce A. Wilson , 2011 , Delmar Cengage Learning .
- 5 Geometric Dimensioning and Tolerancing for Mechanical Design , Gene R. Cogorno , 2010, McGraw-Hill Education .

23SDME06R - GEOMETRIC DIMENSIONING AND TOLERANCING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDME06R	GEOMETRIC DIMENSIONING AND TOLERANCING	GDAT	R	0	0	2	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand GD&T applications, benefits, key terms, and practical advantages in engineering and manufacturing.	2	PO1, PO3, PSO1
CO2	Practice creating industrial drawings to develop skills for interpreting technical specifications in manufacturing and design.	3	PO1, PO3, PSO1
CO3	Calculating tolerance values ensures precision in generating industrial drawings for manufacturing and design.	3	PO1, PO3, PSO1

Syllabus

Calculation involves determining the limits and fits of tolerances specified in standards, ensuring components fit and function correctly within defined parameters.

Interpretation involves understanding and applying GD&T symbols within industrial drawings, ensuring precise communication of design requirements for manufacturing and assembly processes.

Calculation involves deriving various tolerance values from GD&T drawings and using specialized software to create industrial drawings incorporating GD&T symbols accurately.

Reference Books

- 1 Geometric Dimensioning and Tolerancing: Applications, Analysis & Measurement , James D Meadows , 2004 , ASME Press .
- 2 Dimensioning and Tolerancing Handbook , Paul J. Drake , 1999 , New York: McGraw-Hill .
- 3 Geometric Dimensioning and Tolerancing: Workbook and Answer Book , Alex Krulikowski , 2017 , Effective Training Inc .
- 4 GD&T: Application and Interpretation , Bruce A. Wilson , 2011 , Delmar Cengage Learning .
- 5 Geometric Dimensioning and Tolerancing for Mechanical Design , Gene R. Cogorno , 2010 , McGraw-Hill Education .



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Professional Elective Courses (PEC)

23ABT3101A - BIOSENSORS AND BIOELECTRONICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3101A	BIOSENSORS AND BIOELECTRONICS	BSBE	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the fundamental principles of electrochemistry, biophysics, and materials science to the design and operation of biosensors involves leveraging the unique aspects of these disciplines to create devices that can detect biological molecules with high sensitivity and specificity.	3	PO1
CO2	Analyzing the performance characteristics of biosensors is essential to understanding their effectiveness and applicability in various fields, such as medical diagnostics, environmental monitoring, and food safety.	4	PO2
CO3	Designing and fabricating simple biosensors for the detection of specific biomolecules involves several steps, including choosing the right materials, developing a detection mechanism, and ensuring the system's sensitivity and specificity.	6	PO1
CO4	Critically evaluating biosensing techniques reveals their unique strengths and limitations, impacting their effectiveness in medical diagnostics, environmental monitoring, food safety, and biotechnology.	4	PO1
CO5	Applying biosensors in healthcare, environmental monitoring, and food safety represents a shift towards proactive, precision-driven approaches that enhance efficiency, decision-making, and outcomes in these critical areas.	3	PO2
CO6	Effectively communicating the principles and applications of biosensors in both written and oral formats requires a comprehensive understanding of the technology along with the ability to convey complex scientific concepts clearly and succinctly to diverse audiences.	5	PO2
CO7	Demonstrating an understanding of the ethical considerations associated with biosensor development and deployment involves recognizing the complex interplay between technological advancements, societal impact, and ethical responsibilities.	4	PO5

Syllabus

Definition and Classification: Overview of biosensors, types based on biorecognition elements and transduction principles. Historical Development and Milestones: Evolution of biosensor technology and key advancements. Applications: Diverse applications in healthcare, environmental monitoring, food safety, and biotechnology. Ethical and Regulatory Considerations: Privacy, data security, informed consent, and regulatory frameworks.

Basic Biochemical Principles: Redox reactions, enzyme kinetics, and biomolecular interactions relevant to biosensor operation. Electrochemical Techniques: Principles of potentiometry, amperometry, and impedance spectroscopy. Optical Techniques: Introduction to fluorescence, absorption spectroscopy, and surface plasmon resonance (SPR). Piezoelectric and Magnetic Techniques: Basics of piezoelectricity and magnetic sensors in biosensing.

Antibodies: Structure, function, and applications in immunosensors. Enzymes: Types, mechanisms, immobilization techniques, and enzymatic biosensor applications. Aptamers: Selection, properties, and aptasensor applications in diagnostics and therapeutics. Nucleic Acids: DNA/RNA biosensors, PCR-based biosensing, and applications in genetic analysis.

Electrochemical Transducers: Working principles, electrode materials, and applications in glucose monitoring, pH sensing, and environmental monitoring. Optical Transducers: SPR, fluorescence-based sensors, and colorimetric assays in biosensing applications. Piezoelectric Transducers: Principles, materials, and applications in biosensors and bioelectronics. Integration of Transducers: Multimodal biosensing approaches and sensor arrays.

Nanotechnology in Biosensors: Nanomaterials (nanoparticles, nanotubes) and their applications in enhancing sensor performance. Microfluidics and Lab-on-a-Chip: Integration of biosensors with microfluidic devices for miniaturization and point-of-care applications. Wireless Biosensors: IoT integration, wearable biosensors, and real-time data transmission in healthcare monitoring.

Clinical Diagnostics: Disease biomarkers, point-of-care testing, and biosensor technologies in clinical laboratories.

Therapeutic Monitoring: Drug monitoring, personalized medicine, and biosensors in therapeutic drug management.

Implantable Biosensors: Bioelectronics for continuous monitoring of physiological parameters and feedback systems.

Environmental Monitoring: Detection of pollutants, pathogens, and toxins using biosensors in air, water, and soil.

Food Safety: Detection of contaminants, allergens, and pathogens in food products using biosensors.

Bioprocess Monitoring: Biosensors in biotechnology and industrial processes for process control and quality assurance.

Reference Books

- 1 Nanobiosensors: From Design to Applications, Kenneth A. Janes, 5(2005), Springer.
- 2 Handbook of Biosensors and Bioelectronic Devices, Richard F. Turner, Ajit P. Kumar, and Ian S. McKnight, 7(2002), Willey.
- 3 Fundamentals of Bioelectronics: Fabrication, Devices, and Applications, John G. Burke, 8(2006), Willey.
- 4 Biosensors: Principles and Applications, Elisabete A. Ferreira and Luis M. P. Flix, 6(2009), Springer.

23ABT3101E - BIOSENSORS AND BIOELECTRONICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3101E	BIOSENSORS AND BIOELECTRONICS	BSBE	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the fundamental principles of electrochemistry, biophysics, and materials science to the design and operation of biosensors involves leveraging the unique aspects of these disciplines to create devices that can detect biological molecules with high sensitivity and specificity.	3	PO1
CO2	Analyzing the performance characteristics of biosensors is essential to understanding their effectiveness and applicability in various fields, such as medical diagnostics, environmental monitoring, and food safety.	4	PO2
CO3	Designing and fabricating simple biosensors for the detection of specific biomolecules involves several steps, including choosing the right materials, developing a detection mechanism, and ensuring the system's sensitivity and specificity.	6	PO1
CO4	Critically evaluating biosensing techniques reveals their unique strengths and limitations, impacting their effectiveness in medical diagnostics, environmental monitoring, food safety, and biotechnology.	4	PO1
CO5	Applying biosensors in healthcare, environmental monitoring, and food safety represents a shift towards proactive, precision-driven approaches that enhance efficiency, decision-making, and outcomes in these critical areas.	3	PO2
CO6	Effectively communicating the principles and applications of biosensors in both written and oral formats requires a comprehensive understanding of the technology along with the ability to convey complex scientific concepts clearly and succinctly to diverse audiences.	5	PO2
CO7	Demonstrating an understanding of the ethical considerations associated with biosensor development and deployment involves recognizing the complex interplay between technological advancements, societal impact, and ethical responsibilities.	4	PO5

Syllabus

Definition and Classification: Overview of biosensors, types based on biorecognition elements and transduction principles. Historical Development and Milestones: Evolution of biosensor technology and key advancements. Applications: Diverse applications in healthcare, environmental monitoring, food safety, and biotechnology. Ethical and Regulatory Considerations: Privacy, data security, informed consent, and regulatory frameworks., enzymes, aptamers, nucleic acids Transducers: Electrochemical, optical, piezoelectric

Basic Biochemical Principles: Redox reactions, enzyme kinetics, and biomolecular interactions relevant to biosensor operation. Electrochemical Techniques: Principles of potentiometry, amperometry, and impedance spectroscopy. Optical Techniques: Introduction to fluorescence, absorption spectroscopy, and surface plasmon resonance (SPR). Piezoelectric and Magnetic Techniques: Basics of piezoelectricity and magnetic sensors in biosensing.

Antibodies: Structure, function, and applications in immunosensors. Enzymes: Types, mechanisms, immobilization techniques, and enzymatic biosensor applications. Aptamers: Selection, properties, and aptasensor applications in diagnostics and therapeutics. Nucleic Acids: DNA/RNA biosensors, PCR-based biosensing, and applications in genetic analysis.

Electrochemical Transducers: Working principles, electrode materials, and applications in glucose monitoring, pH sensing, and environmental monitoring. Optical Transducers: SPR, fluorescence-based sensors, and colorimetric assays in biosensing applications. Piezoelectric Transducers: Principles, materials, and applications in biosensors and bioelectronics. Integration of Transducers: Multimodal biosensing approaches and sensor arrays.

Nanotechnology in Biosensors: Nanomaterials (nanoparticles, nanotubes) and their applications in enhancing sensor performance. Microfluidics and Lab-on-a-Chip: Integration of biosensors with microfluidic devices for miniaturization and point-of-care applications. Wireless Biosensors: IoT integration, wearable biosensors, and real-time data transmission in healthcare monitoring.

Clinical Diagnostics: Disease biomarkers, point-of-care testing, and biosensor technologies in clinical laboratories.

Therapeutic Monitoring: Drug monitoring, personalized medicine, and biosensors in therapeutic drug management.

Implantable Biosensors: Bioelectronics for continuous monitoring of physiological parameters and feedback systems.

Environmental Monitoring: Detection of pollutants, pathogens, and toxins using biosensors in air, water, and soil.

Food Safety: Detection of contaminants, allergens, and pathogens in food products using biosensors.

Bioprocess Monitoring: Biosensors in biotechnology and industrial processes for process control and quality assurance.

Reference Books

- 1 Nanobiosensors: From Design to Applications, Kenneth A. Janes, 5(2005), Springer.
- 2 Handbook of Biosensors and Bioelectronic Devices, Richard F. Turner, Ajit P. Kumar, and Ian S. McKnight , 7(2002), Wiley.
- 3 Fundamentals of Bioelectronics: Fabrication, Devices, and Applications, John G. Burke, 8(2006), Wiley.
- 4 Biosensors: Principles and Applications, Elisabete A. Ferreira and Lu?s M. P. Flix, 6(2009), Springer.

23ABT3101R - BIOSENSORS AND BIOELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3101R	BIOSENSORS AND BIOELECTRONICS	BSBE	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the fundamental principles of electrochemistry, biophysics, and materials science to the design and operation of biosensors involves leveraging the unique aspects of these disciplines to create devices that can detect biological molecules with high sensitivity and specificity.	3	PO1
CO2	Analyzing the performance characteristics of biosensors is essential to understanding their effectiveness and applicability in various fields, such as medical diagnostics, environmental monitoring, and food safety.	4	PO2
CO3	Designing and fabricating simple biosensors for the detection of specific biomolecules involves several steps, including choosing the right materials, developing a detection mechanism, and ensuring the system's sensitivity and specificity.	6	PO1
CO4	Critically evaluating biosensing techniques reveals their unique strengths and limitations, impacting their effectiveness in medical diagnostics, environmental monitoring, food safety, and biotechnology.	4	PO1
CO5	Applying biosensors in healthcare, environmental monitoring, and food safety represents a shift towards proactive, precision-driven approaches that enhance efficiency, decision-making, and outcomes in these critical areas.	3	PO2
CO6	Demonstrating an understanding of the ethical considerations associated with biosensor development and deployment involves recognizing the complex interplay between technological advancements, societal impact, and ethical responsibilities.	4	PO2

Syllabus

Definition and Classification: Overview of biosensors, types based on biorecognition elements and transduction principles. Historical Development and Milestones: Evolution of biosensor technology and key advancements. Applications: Diverse applications in healthcare, environmental monitoring, food safety, and biotechnology. Ethical and Regulatory Considerations: Privacy, data security, informed consent, and regulatory frameworks., enzymes, aptamers, nucleic acids Transducers: Electrochemical, optical, piezoelectric

BioBasic Biochemical Principles: Redox reactions, enzyme kinetics, and biomolecular interactions relevant to biosensor operation. Electrochemical Techniques: Principles of potentiometry, amperometry, and impedance spectroscopy. Optical Techniques: Introduction to fluorescence, absorption spectroscopy, and surface plasmon resonance (SPR). Piezoelectric and Magnetic Techniques: Basics of piezoelectricity and magnetic sensors in biosensing.

Electrochemical biosensors: EnzymAntibodies: Structure, function, and applications in immunosensors. Enzymes: Types, mechanisms, immobilization techniques, and enzymatic biosensor applications. Aptamers: Selection, properties, and aptasensor applications in diagnostics and therapeutics. Nucleic Acids: DNA/RNA biosensors, PCR-based biosensing, and applications in genetic analysis.

Biocompatible materials for biosensorElectrochemical Transducers: Working principles, electrode materials, and applications in glucose monitoring, pH sensing, and environmental monitoring. Optical Transducers: SPR, fluorescence-based sensors, and colorimetric assays in biosensing applications. Piezoelectric Transducers: Principles, materials, and applications in biosensors and bioelectronics. Integration of Transducers: Multimodal biosensing approaches and sensor arrays.

Biosensors in Nanotechnology in Biosensors: Nanomaterials (nanoparticles, nanotubes) and their applications in enhancing sensor performance. Microfluidics and Lab-on-a-Chip: Integration of biosensors with microfluidic devices for miniaturization and point-of-care applications. Wireless Biosensors: IoT integration, wearable biosensors, and real-time data transmission in healthcare monitoring.

Clinical Diagnostics: Disease biomarkers, point-of-care testing, and biosensor technologies in clinical laboratories.

Therapeutic Monitoring: Drug monitoring, personalized medicine, and biosensors in therapeutic drug management.

Implantable Biosensors: Bioelectronics for continuous monitoring of physiological parameters and feedback systems.

Reference Books

- 1 Nanobiosensors: From Design to Applications, Kenneth A. Janes, 5 (2005), Springer.
- 2 Handbook of Biosensors and Bioelectronic Devices, Richard F. Turner, Ajit P. Kumar, and Ian S. McKnight , 7(2002), Willey.
- 3 Fundamentals of Bioelectronics: Fabrication, Devices, and Applications, John G. Burke, 8 (2006), Wiley.
- 4 Biosensors: Principles and Applications, Elisabete A. Ferreira and Luis M. P. Flix, 6 (2009), Springer.

23ABT3202A - IOT APPLICATIONS IN PRECISION AGRICULTURE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3202A	IOT APPLICATIONS IN PRECISION AGRICULTURE	IOTAPA	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the fundamental concepts of IoT (Internet of Things) and its applications in precision agriculture involves exploring how interconnected devices and sensors can revolutionize farming practices.	2	PO1
CO2	Analyzing various IoT sensors and data acquisition systems relevant to agriculture involves understanding the diverse range of sensors used to collect data from fields, crops, livestock, and environmental conditions.	4	PO3
CO3	Applying the principles of the Internet of Things (IoT) to precision agriculture involves creating sophisticated sensor networks and developing effective data management strategies.	3	PO3
CO4	Evaluate the impact of IoT on agricultural data collection, analysis, and decision-making is profound. By enabling precise data collection, sophisticated analysis, and informed decision-making, IoT technologies are transforming agriculture into a more efficient, productive, and sustainable industry	5	PO3
CO5	Developing a deployment strategy for an Internet of Things (IoT) system aimed at addressing plant disease in precision agriculture involves a comprehensive approach that integrates advanced technology, robust data analysis, and effective implementation practices.	6	PO3

Syllabus

Introduction to IoT and Precision Agriculture: Fundamentals of IoT (Internet of Things), sensors, actuators, and communication protocols, Introduction to precision agriculture and its goals, Applications of IoT in various aspects of precision agriculture (e. g., soil monitoring, irrigation management, crop health)

IoT Sensors for Precision Agriculture: Sensors for measuring environmental parameters (temperature, humidity, light) relevant to agriculture, Soil sensors for moisture, nutrient content, and pH monitoring, Plant sensors for monitoring growth, stress, and health, Communication technologies for IoT in agriculture (e.g., Bluetooth, Wi-Fi, cellular). Network reliability and data integrity. Techniques for reducing data transmission power consumption.

Introduction to IoT in Agriculture Overview of IoT and its significance in agriculture. Current trends and future prospects of IoT in the agricultural sector. Case studies of IoT applications in various agricultural practices. Fundamentals of IoT Sensor Networks Types of sensors used in agriculture (e.g., soil moisture, temperature, humidity, pH). Basics of wireless sensor networks (WSNs). Sensor network topologies and communication protocols. Designing Scalable IoT Sensor Networks, Principles of scalability in IoT networks. Designing network architecture for large-scale agricultural deployments. Challenges and solutions in scaling IoT networks. Power Management in IoT Sensor Networks Importance of power management in IoT devices. Low-power communication protocols and technologies (e.g., Zigbee, LoRa, NB-IoT). Energy harvesting techniques and power optimization strategies.

Overview of precision agriculture and its benefits. Role of IoT in precision agriculture. Types of IoT devices and sensors used in agriculture, Types of sensors used in agriculture (e.g., soil moisture, temperature, humidity, pH). Basics of wireless sensor networks (WSNs). Sensor network topologies and communication protocols, Principles of scalability in IoT networks. Designing network architecture for large-scale agricultural deployments. Challenges and solutions in scaling IoT networks, Importance of power management in IoT devices. Low-power communication protocols and technologies (e.g., Zigbee, LoRa, NB-IoT). Energy harvesting techniques and power optimization strategies, Methods of data acquisition from IoT sensors. Real-time vs. periodic data collection. Handling and preprocessing of sensor data, Communication technologies for IoT in agriculture (e.g., Bluetooth, Wi-Fi, cellular). Network reliability and data integrity. Techniques for reducing data transmission power consumption, Data storage solutions (e.g., cloud storage, edge computing). Data management platforms and software. Ensuring data security and privacy in IoT networks, Techniques for analyzing IoT sensor data (e.g., statistical analysis, machine learning). Using data analytics to support agricultural decision-making. Visualization tools and dashboards for presenting data insights.

Advanced Topics in IoT for Precision Agriculture: Emerging trends in IoT technologies for agriculture (e.g., artificial intelligence, drones), In-depth analysis of successful IoT implementations in agriculture. Hands-on project: Design and deploy a small-scale IoT sensor network for a specific agricultural application, Challenges in IoT deployment in agriculture (e.g., connectivity, cost, environmental factors). Emerging technologies and future trends in IoT for agriculture. Ethical and environmental considerations in IoT deployment, Methods of data acquisition from IoT sensors. Real-time vs. periodic data collection. Handling and preprocessing of sensor data.

Reference Books

- 1 Precision Agriculture Technologies for Food Security and Sustainability, Jhuberli Pereira de Souza, 1(2003), Springer.
- 2 Agricultural Internet of Things: Technologies and Applications (Agriculture Automation and Control), Daniele Marin, Daniele Bottazzi, Andrea Conti, and Pietro Sanga, 1(2006), Springer.
- 3 Internet of Things (IoT) for Precision Agriculture Application, Manishkumar Dholu, Y. S. Reddy, and N. H. Rao, 2(2008), CRC Press.
- 4 Big Data in Agriculture: A Challenge for Computer Science, Ioana Cristina Mirea - Muntean, Vasile Cristea, and Jo?o Manuel R. S. Tavares, 1(2011), Springer.

23ABT3202E - IOT APPLICATIONS IN PRECISION AGRICULTURE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3202E	IOT APPLICATIONS IN PRECISION AGRICULTURE	IOTAPA	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the fundamental concepts of IoT (Internet of Things) and its applications in precision agriculture involves exploring how interconnected devices and sensors can revolutionize farming practices.	2	PO1
CO2	Analyzing various IoT sensors and data acquisition systems relevant to agriculture involves understanding the diverse range of sensors used to collect data from fields, crops, livestock, and environmental conditions.	4	PO3
CO3	Applying the principles of the Internet of Things (IoT) to precision agriculture involves creating sophisticated sensor networks and developing effective data management strategies.	3	PO3
CO4	Evaluate the impact of IoT on agricultural data collection, analysis, and decision-making is profound. By enabling precise data collection, sophisticated analysis, and informed decision-making, IoT technologies are transforming agriculture into a more efficient, productive, and sustainable industry	5	PO3
CO5	Developing a deployment strategy for an Internet of Things (IoT) system aimed at addressing plant disease in precision agriculture involves a comprehensive approach that integrates advanced technology, robust data analysis, and effective implementation practices.	6	PO3

Syllabus

Introduction to IoT and Precision Agriculture: Fundamentals of IoT (Internet of Things), sensors, actuators, and communication protocols, Introduction to precision agriculture and its goals, Applications of IoT in various aspects of precision agriculture (e. g., soil monitoring, irrigation management, crop health)

IoT Sensors for Precision Agriculture: Sensors for measuring environmental parameters (temperature, humidity, light) relevant to agriculture, Soil sensors for moisture, nutrient content, and pH monitoring, Plant sensors for monitoring growth, stress, and health, Communication technologies for IoT in agriculture (e.g., Bluetooth, Wi-Fi, cellular). Network reliability and data integrity. Techniques for reducing data transmission power consumption.

Introduction to IoT in Agriculture Overview of IoT and its significance in agriculture. Current trends and future prospects of IoT in the agricultural sector. Case studies of IoT applications in various agricultural practices. Fundamentals of IoT Sensor Networks Types of sensors used in agriculture (e.g., soil moisture, temperature, humidity, pH). Basics of wireless sensor networks (WSNs). Sensor network topologies and communication protocols. Designing Scalable IoT Sensor Networks, Principles of scalability in IoT networks. Designing network architecture for large-scale agricultural deployments. Challenges and solutions in scaling IoT networks. Power Management in IoT Sensor Networks Importance of power management in IoT devices. Low-power communication protocols and technologies (e.g., Zigbee, LoRa, NB-IoT). Energy harvesting techniques and power optimization strategies.

Overview of precision agriculture and its benefits. Role of IoT in precision agriculture. Types of IoT devices and sensors used in agriculture, Types of sensors used in agriculture (e.g., soil moisture, temperature, humidity, pH). Basics of wireless sensor networks (WSNs). Sensor network topologies and communication protocols, Principles of scalability in IoT networks. Designing network architecture for large-scale agricultural deployments. Challenges and solutions in scaling IoT networks, Importance of power management in IoT devices. Low-power communication protocols and technologies (e.g., Zigbee, LoRa, NB-IoT). Energy harvesting techniques and power optimization strategies, Methods of data acquisition from IoT sensors. Real-time vs. periodic data collection. Handling and preprocessing of sensor data, Communication technologies for IoT in agriculture (e.g., Bluetooth, Wi-Fi, cellular). Network reliability and data integrity. Techniques for reducing data transmission power consumption, Data storage solutions (e.g., cloud storage, edge computing). Data management platforms and software. Ensuring data security and privacy in IoT networks, Techniques for analyzing IoT sensor data (e.g., statistical analysis, machine learning). Using data analytics to support agricultural decision-making. Visualization tools and dashboards for presenting data insights.

Advanced Topics in IoT for Precision Agriculture: Emerging trends in IoT technologies for agriculture (e.g., artificial intelligence, drones), In-depth analysis of successful IoT implementations in agriculture. Hands-on project: Design and deploy a small-scale IoT sensor network for a specific agricultural application, Challenges in IoT deployment in agriculture (e.g., connectivity, cost, environmental factors). Emerging technologies and future trends in IoT for agriculture. Ethical and environmental considerations in IoT deployment, Methods of data acquisition from IoT sensors. Real-time vs. periodic data collection. Handling and preprocessing of sensor data.

Reference Books

- 1 Precision Agriculture Technologies for Food Security and Sustainability, Jhuberli Pereira de Souza, 1(2003), Springer.
- 2 Agricultural Internet of Things: Technologies and Applications (Agriculture Automation and Control), Daniele Marin, Daniele Bottazzi, Andrea Conti, and Pietro Sanga, 1(2006), Springer.
- 3 Internet of Things (IoT) for Precision Agriculture Application, Manishkumar Dholu, Y. S. Reddy, and N. H. Rao, 2(2008), CRC Press.
- 4 Big Data in Agriculture: A Challenge for Computer Science, Ioana Cristina Mirea - Muntean, Vasile Cristea, and Jo?o Manuel R. S. Tavares, 1(2011), Springer.

23ABT3202R - IOT APPLICATIONS IN PRECISION AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3202R	IOT APPLICATIONS IN PRECISION AGRICULTURE	IOTAPA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the fundamental concepts of IoT (Internet of Things) and its applications in precision agriculture involves exploring how interconnected devices and sensors can revolutionize farming practices.	2	PO1
CO2	Analyzing various IoT sensors and data acquisition systems relevant to agriculture involves understanding the diverse range of sensors used to collect data from fields, crops, livestock, and environmental conditions.	4	PO3
CO3	Applying the principles of the Internet of Things (IoT) to precision agriculture involves creating sophisticated sensor networks and developing effective data management strategies.	3	PO3
CO4	Evaluate the impact of IoT on agricultural data collection, analysis, and decision-making is profound. By enabling precise data collection, sophisticated analysis, and informed decision-making, IoT technologies are transforming agriculture into a more efficient, productive, and sustainable industry	5	PO3

Syllabus

Introduction to IoT and Precision Agriculture: Fundamentals of IoT (Internet of Things), sensors, actuators, and communication protocols, Introduction to precision agriculture and its goals, Applications of IoT in various aspects of precision agriculture (e. g., soil monitoring, irrigation management, crop health)

IoT Sensors for Precision Agriculture: Sensors for measuring environmental parameters (temperature, humidity, light) relevant to agriculture, Soil sensors for moisture, nutrient content, and pH monitoring, Plant sensors for monitoring growth, stress, and health, Communication technologies for IoT in agriculture (e.g., Bluetooth, Wi-Fi, cellular). Network reliability and data integrity. Techniques for reducing data transmission power consumption.

Introduction to IoT in Agriculture Overview of IoT and its significance in agriculture. Current trends and future prospects of IoT in the agricultural sector. Case studies of IoT applications in various agricultural practices. Fundamentals of IoT Sensor Networks Types of sensors used in agriculture (e.g., soil moisture, temperature, humidity, pH). Basics of wireless sensor networks (WSNs). Sensor network topologies and communication protocols. Designing Scalable IoT Sensor Networks, Principles of scalability in IoT networks. Designing network architecture for large-scale agricultural deployments. Challenges and solutions in scaling IoT networks. Power Management in IoT Sensor Networks Importance of power management in IoT devices. Low-power communication protocols and technologies (e.g., Zigbee, LoRa, NB-IoT). Energy harvesting techniques and power optimization strategies.

Overview of precision agriculture and its benefits. Role of IoT in precision agriculture. Types of IoT devices and sensors used in agriculture, Types of sensors used in agriculture (e.g., soil moisture, temperature, humidity, pH). Basics of wireless sensor networks (WSNs). Sensor network topologies and communication protocols, Principles of scalability in IoT networks. Designing network architecture for large-scale agricultural deployments. Challenges and solutions in scaling IoT networks, Importance of power management in IoT devices. Low-power communication protocols and technologies (e.g., Zigbee, LoRa, NB-IoT). Energy harvesting techniques and power optimization strategies, Methods of data acquisition from IoT sensors. Real-time vs. periodic data collection. Handling and preprocessing of sensor data, Communication technologies for IoT in agriculture (e.g., Bluetooth, Wi-Fi, cellular). Network reliability and data integrity. Techniques for reducing data transmission power consumption, Data storage solutions (e.g., cloud storage, edge computing). Data management platforms and software. Ensuring data security and privacy in IoT networks, Techniques for analyzing IoT sensor data (e.g., statistical analysis, machine learning). Using data analytics to support agricultural decision-making. Visualization tools and dashboards for presenting data insights.

Reference Books

- 1 Precision Agriculture Technologies for Food Security and Sustainability , Precision Agriculture Technologies for Food Security and Sustainability , 1(2003), Springer.
- 2 Agricultural Internet of Things: Technologies and Applications (Agriculture Automation and Control), Daniele Marin, Daniele Bottazzi, Andrea Conti, and Pietro Sanga, 1(2006), Springer.
- 3 Internet of Things (IoT) for Precision Agriculture Application, Manishkumar Dholu, Y. S. Reddy, and N. H. Rao, 2(2008), CRC Press.
- 4 Big Data in Agriculture: A Challenge for Computer Science, Ioana Cristina Mirea - Muntean, Vasile Cristea, and Jo?o Manuel R. S. Tavares, 1(2011), Springer.

23ABT3203A - MACHINE LEARNING FOR PRECISION AGRICULTURE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3203A	MACHINE LEARNING FOR PRECISION AGRICULTURE	MLPA	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of machine learning and their specific applications in precision agriculture, emphasizing the practical benefits and real-world impact of these technologies.	2	PO2
CO2	Analyze the various machine learning algorithms relevant to agricultural data analysis	4	PO2
CO3	Apply the machine learning techniques for tasks like yield prediction, disease detection, and stress monitoring in agricultural data	3	PO3
CO4	Evaluate the performance of machine learning models for precision agriculture applications	5	PO3
CO5	Create a machine learning model to address a specific challenge in precision agriculture	6	PO5

Syllabus

Introduction to Machine Learning and Precision Agriculture: Fundamentals of machine learning, supervised and unsupervised learning algorithms, Introduction to precision agriculture and its data-driven approach, Applications of machine learning in various aspects of precision agriculture (e. g., yield prediction, soil fertility analysis, crop health monitoring)

Machine Learning Algorithms for Agricultural Data: Regression analysis for yield prediction and crop growth modeling, Classification algorithms for disease detection, weed identification, and crop type classification, Introduction to cloud services (AWS, Google Cloud, Azure) Using cloud-based tools for model training and deployment, Integrating machine learning models with IoT systems Real-time data analysis and decision-making, Data privacy and security in agriculture Ethical implications of machine learning in farming Future trends and emerging technologies

Data Preprocessing and Model Building for Agriculture: Data acquisition methods and agricultural data formats (e. g., sensor data, satellite imagery), Data preprocessing techniques for agricultural data (cleaning, handling missing values, feature engineering), Data cleaning and handling missing values Data normalization and standardization Feature selection and engineering, Data visualization techniques (histograms, scatter plots, box plots) Identifying patterns and trends in agricultural data Statistical summaries and insights

Advanced Machine Learning Techniques for Agriculture: Deep learning models for image analysis in agriculture (e. g., disease detection using convolutional neural networks), Basic concepts and terminology Types of machine learning (supervised, unsupervised, reinforcement), Applications and case studies Impact on productivity and sustainability, Types of agricultural data (sensor data, weather data, satellite imagery) Data collection methods, Data cleaning and handling missing values Data normalization and standardization Feature selection and engineering, Data visualization techniques (histograms, scatter plots, box plots) Identifying patterns and trends in agricultural data Statistical summaries and insights

Machine Learning Integration for Precision Agriculture Solutions : Integration of machine learning models with IoT and agricultural decision support systems (DSS), Introduction to Python libraries (Pandas, NumPy, Matplotlib, Seaborn) Hands-on exercises with real agricultural datasets, Logistic regression Support Vector Machines (SVM) Naive Bayes, Yield prediction Disease detection and classification Soil health monitoring, Performance metrics (RMSE, MAE, accuracy, precision, recall) Cross-validation and model tuning

Reference Books

- 1 Machine Learning for Precision Agriculture: Methods and Applications, Fuhua Li, Lei Wang, and Kenneth H. Schellnhuber, 1(2008), CRC Press.

- 2 Deep Learning for Agricultural Applications , Muhammad Awais Khan, Abdul Salam, Muhammad Younis Javed, and Shahzad Sharif, 1(2010), Springer.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow , Aurélien Geron, 1(2012), O'Reilly Media.
- 4 Precision Agriculture Technologies for Food Security and Sustainability , Jhuberli Pereira de Souza, 1(2014), Springer.

23ABT3203E - MACHINE LEARNING FOR PRECISION AGRICULTURE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3203E	MACHINE LEARNING FOR PRECISION AGRICULTURE	MLPA	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of machine learning and its potential applications in precision agriculture	2	PO2
CO2	Analyze the various machine learning algorithms relevant to agricultural data analysis	4	PO2
CO3	Apply the machine learning techniques for tasks like yield prediction, disease detection, and stress monitoring in agricultural data	3	PO3
CO4	Evaluate the performance of machine learning models for precision agriculture applications	5	PO3
CO5	Create a machine learning model to address a specific challenge in precision agriculture	6	PO5

Syllabus

Introduction to Machine Learning and Precision Agriculture: Fundamentals of machine learning, supervised and unsupervised learning algorithms, Introduction to precision agriculture and its data-driven approach, Applications of machine learning in various aspects of precision agriculture (e. g., yield prediction, soil fertility analysis, crop health monitoring)

Machine Learning Algorithms for Agricultural Data: Regression analysis for yield prediction and crop growth modeling, Classification algorithms for disease detection, weed identification, and crop type classification, Introduction to cloud services (AWS, Google Cloud, Azure) Using cloud-based tools for model training and deployment, Integrating machine learning models with IoT systems Real-time data analysis and decision-making, Data privacy and security in agriculture Ethical implications of machine learning in farming Future trends and emerging technologies

Data Preprocessing and Model Building for Agriculture: Data acquisition methods and agricultural data formats (e. g., sensor data, satellite imagery), Data preprocessing techniques for agricultural data (cleaning, handling missing values, feature engineering), Data cleaning and handling missing values Data normalization and standardization Feature selection and engineering, Data visualization techniques (histograms, scatter plots, box plots) Identifying patterns and trends in agricultural data Statistical summaries and insights

Advanced Machine Learning Techniques for Agriculture: Deep learning models for image analysis in agriculture (e. g., disease detection using convolutional neural networks), Basic concepts and terminology Types of machine learning (supervised, unsupervised, reinforcement), Applications and case studies Impact on productivity and sustainability, Types of agricultural data (sensor data, weather data, satellite imagery) Data collection methods, Data cleaning and handling missing values Data normalization and standardization Feature selection and engineering, Data visualization techniques (histograms, scatter plots, box plots) Identifying patterns and trends in agricultural data Statistical summaries and insights

Machine Learning Integration for Precision Agriculture Solutions : Integration of machine learning models with IoT and agricultural decision support systems (DSS), Introduction to Python libraries (Pandas, NumPy, Matplotlib, Seaborn) Hands-on exercises with real agricultural datasets, Logistic regression Support Vector Machines (SVM) Naive Bayes, Yield prediction Disease detection and classification Soil health monitoring, Performance metrics (RMSE, MAE, accuracy, precision, recall) Cross-validation and model tuning

Reference Books

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- 2 Deep Learning for Agricultural Applications , Muhammad Awais Khan, Abdul Salam, Muhammad Younis Javed, and Shahzad Sharif, 1(2010), Springer.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow , Aurlien Giron, 1(2012), O'Reilly Media.
- 4 Precision Agriculture Technologies for Food Security and Sustainability , Jhuberli Pereira de Souza, 1(2014), Springer.

23ABT3203R - MACHINE LEARNING FOR PRECISION AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3203R	MACHINE LEARNING FOR PRECISION AGRICULTURE	MLPA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of machine learning and its potential applications in precision agriculture	2	PO3
CO2	Analyze the various machine learning algorithms relevant to agricultural data analysis	4	PO3
CO3	Apply the machine learning techniques for tasks like yield prediction, disease detection, and stress monitoring in agricultural data	3	PO4
CO4	Evaluate the performance of machine learning models for precision agriculture applications	5	PO4

Syllabus

Introduction to Machine Learning and Precision Agriculture: Fundamentals of machine learning, supervised and unsupervised learning algorithms, Introduction to precision agriculture and its data-driven approach, Applications of machine learning in various aspects of precision agriculture (e. g., yield prediction, soil fertility analysis, crop health monitoring)

Machine Learning Algorithms for Agricultural Data: Regression analysis for yield prediction and crop growth modeling, Classification algorithms for disease detection, weed identification, and crop type classification, Introduction to cloud services (AWS, Google Cloud, Azure) Using cloud-based tools for model training and deployment, Integrating machine learning models with IoT systems Real-time data analysis and decision-making, Data privacy and security in agriculture Ethical implications of machine learning in farming Future trends and emerging technologies

Data Preprocessing and Model Building for Agriculture: Data acquisition methods and agricultural data formats (e. g., sensor data, satellite imagery), Data preprocessing techniques for agricultural data (cleaning, handling missing values, feature engineering), Data cleaning and handling missing values Data normalization and standardization Feature selection and engineering, Data visualization techniques (histograms, scatter plots, box plots) Identifying patterns and trends in agricultural data Statistical summaries and insights

Advanced Machine Learning Techniques for Agriculture: Deep learning models for image analysis in agriculture (e. g., disease detection using convolutional neural networks), Basic concepts and terminology Types of machine learning (supervised, unsupervised, reinforcement), Applications and case studies Impact on productivity and sustainability, Types of agricultural data (sensor data, weather data, satellite imagery) Data collection methods, Data cleaning and handling missing values Data normalization and standardization Feature selection and engineering, Data visualization techniques (histograms, scatter plots, box plots) Identifying patterns and trends in agricultural data Statistical summaries and insights

Reference Books

- 1 Machine Learning for Precision Agriculture: Methods and Applications, Fuhua Li, Lei Wang, and Kenneth H. Schellnhuber, 1(2008), CRC Press.
- 2 Deep Learning for Agricultural Applications , Muhammad Awais Khan, Abdul Salam, Muhammad Younis Javed, and Shahzad Sharif, 1(2010), Springer.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow , Aurlien Giron, 1(2012), O'Reilly Media.
- 4 Precision Agriculture Technologies for Food Security and Sustainability , Jhuberli Pereira de Souza, 1(2014), Springer.

23ABT3304A - IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3304A	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	IPAA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of digital image processing and its applications in agriculture	2	PO2
CO2	Analyze the various image processing techniques for tasks like segmentation, feature extraction, and classification in agricultural images	4	PO2
CO3	Apply the image processing techniques to analyze agricultural images for tasks like crop health monitoring, weed detection, and yield estimation	3	PO2
CO4	Evaluate the performance of image processing algorithms for specific agricultural applications	5	PO5
CO5	Develop an image processing solution to overcome the hurdle of plant growth in agricultural image analysis	6	PO5
CO6	Communicate the results of image processing analysis effectively, using visualizations and technical reports, for agricultural stakeholders	4	PO5
CO7	Design and execute image processing projects for agricultural applications	6	PO5

Syllabus

Introduction to Digital Image Processing and Agriculture: Fundamentals of digital image processing (DIP) concepts (pixels, color models, image representation), Overview of Image Processing Definition and key concepts Importance of image processing in various fields Fundamentals of Digital Images Image formation and representation Pixels, resolution, and color spaces (RGB, HSV, grayscale) Applications in Agriculture Importance and benefits of image processing in agriculture Case studies and examples (e.g., crop monitoring, disease detection, yield estimation) Tools and Software Introduction to image processing libraries (OpenCV, PIL, Scikit-image) Setting up the development environment

Image Preprocessing for Agricultural Applications: Image segmentation techniques for separating objects of interest (crops, weeds) from background, Image Acquisition Techniques Types of imaging devices (cameras, drones, satellites) Factors affecting image quality (lighting, angle, resolution) Image Preprocessing Image enhancement techniques (histogram equalization, contrast adjustment) Noise reduction (filtering, smoothing) Image transformation (scaling, rotation, cropping) Color and Intensity Transformations Color space conversions (RGB to grayscale, HSV) Thresholding and binarization Hands-on Exercises Acquiring images using different devices Preprocessing images for further analysis

Feature Extraction and Classification in Agricultural Images: Feature extraction techniques for capturing relevant information from agricultural images (color features, texture features), Feature Extraction Key concepts and importance of feature extraction Techniques for feature extraction (edges, corners, textures) Using feature descriptors (SIFT, SURF, ORB) Image Segmentation Importance of segmentation in image analysis Threshold-based segmentation Region-based segmentation (region growing, watershed) Edge-based segmentation (Canny edge detection, Hough transform) Advanced segmentation techniques (semantic segmentation, U-Net) Applications in Agriculture Segmentation for crop and weed identification Feature extraction for disease detection and classification Hands-on Exercises Extracting features from agricultural images Implementing segmentation algorithms on real datasets

Advanced Image Processing Techniques for Agriculture: Deep learning for object detection and segmentation in agricultural images (e. g., You Only Look Once - YOLO), Image Classification Basic concepts and importance of image classification Classical methods (KNN, SVM) and deep learning methods (CNN) Training and evaluating image classification models Object Detection Introduction to object detection and its importance Techniques for object detection (sliding window, region proposals) Deep learning methods for object detection (YOLO, SSD, Faster R-CNN) Applications in Agriculture Classification of crop types and diseases Object detection for pest identification and monitoring Hands-on Exercises Building and training image classification models Implementing object detection algorithms on agricultural datasets

Image Processing Applications in Precision Agriculture: Integration of image processing with other precision agriculture technologies (e. g., IoT sensors, UAVs) , Challenges and considerations for deploying image processing solutions in real-world agriculture (e. g., data storage, computational resources), Integrating Image Processing with IoT Combining image processing with sensor data for precision agriculture Real-time image analysis using IoT devices Advanced Applications Remote sensing and satellite image analysis for large-scale agriculture UAVs and drones for crop monitoring and management Building Decision Support Systems Using image processing for real-time decision making in agriculture Developing dashboards and visualization tools Ethical and Practical Considerations Data privacy and security in image processing Ethical implications of using image processing in agriculture Future Trends and Emerging Technologies Innovations in image processing and their potential impact on agriculture Exploring AI and machine learning advancements in image processing

Design and execute image processing projects for agricultural applications, Overview of Image Processing Definition and key concepts Importance of image processing in various fields Fundamentals of Digital Images Image formation and representation Pixels, resolution, and color spaces (RGB, HSV, grayscale) Applications in Agriculture Importance and benefits of image processing in agriculture Case studies and examples (e.g., crop monitoring, disease detection, yield estimation) Tools and Software Introduction to image processing libraries (OpenCV, PIL, Scikit-image) Setting up the development environment

Image Classification for Crop Identification: Principles of image classification, Supervised and unsupervised classification algorithms, Hands-on session: Implementing crop identification using machine learning classifiers, Integration of Remote Sensing Data, Utilizing remote sensing data (e.g., satellite imagery, multispectral data) in agricultural image processing, Hands-on session: Integrating remote sensing data with image processing techniques

Reference Books

- 1 Digital Image Processing for Agriculture and Forestry, Richard S. Nixon, Faez uhdavasibi, and Steven S. Webb, 2(2000), Academic Press.
- 2 Computer Vision Applications in Agriculture, Yu Jiang, Feng Ma, and Jinwen Guo, 1(2002), Springer.
- 3 Deep Learning for Image Processing, Jason Brownlee, 1(2004), Machine Learning Mastery.
- 4 Precision Agriculture Technologies for Food Security and Sustainability , Jhuberli Pereira de Souza, 1(2006), Springer.

23ABT3304E - IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3304E	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	IPAA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of digital image processing and its applications in agriculture	2	PO2
CO2	Analyze the various image processing techniques for tasks like segmentation, feature extraction, and classification in agricultural images	4	PO2
CO3	Apply image processing techniques to analyze agricultural images for tasks like crop health monitoring, weed detection, and yield estimation	3	PO2
CO4	Evaluate the performance of image processing algorithms for specific agricultural applications	5	PO5
CO5	Develop an image processing solution to overcome the hurdle of plant growth in agricultural image analysis	6	PO5
CO6	Communicate the results of image processing analysis effectively, using visualizations and technical reports, for agricultural stakeholders	4	PO5
CO7	Design and execute image processing projects for agricultural applications	6	PO5

Syllabus

Introduction to Digital Image Processing and Agriculture: Fundamentals of digital image processing (DIP) concepts (pixels, color models, image representation), Overview of Image Processing Definition and key concepts Importance of image processing in various fields Fundamentals of Digital Images Image formation and representation Pixels, resolution, and color spaces (RGB, HSV, grayscale) Applications in Agriculture Importance and benefits of image processing in agriculture Case studies and examples (e.g., crop monitoring, disease detection, yield estimation) Tools and Software Introduction to image processing libraries (OpenCV, PIL, Scikit-image) Setting up the development environment

Image Preprocessing for Agricultural Applications: Image segmentation techniques for separating objects of interest (crops, weeds) from background, Image Acquisition Techniques Types of imaging devices (cameras, drones, satellites) Factors affecting image quality (lighting, angle, resolution) Image Preprocessing Image enhancement techniques (histogram equalization, contrast adjustment) Noise reduction (filtering, smoothing) Image transformation (scaling, rotation, cropping) Color and Intensity Transformations Color space conversions (RGB to grayscale, HSV) Thresholding and binarization Hands-on Exercises Acquiring images using different devices Preprocessing images for further analysis

Feature Extraction and Classification in Agricultural Images: Feature extraction techniques for capturing relevant information from agricultural images (color features, texture features), Feature Extraction Key concepts and importance of feature extraction Techniques for feature extraction (edges, corners, textures) Using feature descriptors (SIFT, SURF, ORB) Image Segmentation Importance of segmentation in image analysis Threshold-based segmentation Region-based segmentation (region growing, watershed) Edge-based segmentation (Canny edge detection, Hough transform) Advanced segmentation techniques (semantic segmentation, U-Net) Applications in Agriculture Segmentation for crop and weed identification Feature extraction for disease detection and classification Hands-on Exercises Extracting features from agricultural images Implementing segmentation algorithms on real datasets

Advanced Image Processing Techniques for Agriculture: Deep learning for object detection and segmentation in agricultural images (e. g., You Only Look Once - YOLO), Image Classification Basic concepts and importance of image classification Classical methods (KNN, SVM) and deep learning methods (CNN) Training and evaluating image classification models Object Detection Introduction to object detection and its importance Techniques for object detection (sliding window, region proposals) Deep learning methods for object detection (YOLO, SSD, Faster R-CNN) Applications in Agriculture Classification of crop types and diseases Object detection for pest identification and monitoring Hands-on Exercises Building and training image classification models Implementing object detection algorithms on agricultural datasets

Image Processing Applications in Precision Agriculture: Integration of image processing with other precision agriculture technologies (e. g., IoT sensors, UAVs) , Challenges and considerations for deploying image processing solutions in real-world agriculture (e. g., data storage, computational resources), Integrating Image Processing with IoT Combining image processing with sensor data for precision agriculture Real-time image analysis using IoT devices Advanced Applications Remote sensing and satellite image analysis for large-scale agriculture UAVs and drones for crop monitoring and management Building Decision Support Systems Using image processing for real-time decision making in agriculture Developing dashboards and visualization tools Ethical and Practical Considerations Data privacy and security in image processing Ethical implications of using image processing in agriculture Future Trends and Emerging Technologies Innovations in image processing and their potential impact on agriculture Exploring AI and machine learning advancements in image processing

Design and execute image processing projects for agricultural applications, Overview of Image Processing Definition and key concepts Importance of image processing in various fields Fundamentals of Digital Images Image formation and representation Pixels, resolution, and color spaces (RGB, HSV, grayscale) Applications in Agriculture Importance and benefits of image processing in agriculture Case studies and examples (e.g., crop monitoring, disease detection, yield estimation) Tools and Software Introduction to image processing libraries (OpenCV, PIL, Scikit-image) Setting up the development environment

Image Classification for Crop Identification: Principles of image classification, Supervised and unsupervised classification algorithms, Hands-on session: Implementing crop identification using machine learning classifiers, Integration of Remote Sensing Data, Utilizing remote sensing data (e.g., satellite imagery, multispectral data) in agricultural image processing, Hands-on session: Integrating remote sensing data with image processing techniques

Reference Books

- 1 Digital Image Processing for Agriculture and Forestry, Richard S. Nixon, Faez uhdavasibi, and Steven S. Webb, 2(2000), Academic Press.
- 2 Computer Vision Applications in Agriculture, Yu Jiang, Feng Ma, and Jinwen Guo, 1(2002), Springer.
- 3 Deep Learning for Image Processing, Jason Brownlee, 1(2004), Machine Learning Mastery.
- 4 Precision Agriculture Technologies for Food Security and Sustainability , Jhuberli Pereira de Souza, 1(2006), Springer.

23ABT3304R - IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3304R	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	IPAA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of digital image processing and its applications in agriculture	2	PO2
CO2	Analyze the various image processing techniques for tasks like segmentation, feature extraction, and classification in agricultural images	4	PO2
CO3	Apply image processing techniques to analyze agricultural images for tasks like crop health monitoring, weed detection, and yield estimation	3	PO2
CO4	Evaluate the performance of image processing algorithms for specific agricultural applications	5	PO5
CO5	Develop an image processing solution to overcome the hurdle of plant growth in agricultural image analysis	6	PO5
CO6	Communicate the results of image processing analysis effectively, using visualizations and technical reports, for agricultural stakeholders	4	PO5

Syllabus

Introduction to IoT and Precision Agriculture: Fundamentals of IoT (Internet of Things), sensors, actuators, and communication protocols, Introduction to precision agriculture and its goals, Applications of IoT in various aspects of precision agriculture (e. g., soil monitoring, irrigation management, crop health)

IoT Sensors for Precision Agriculture: Sensors for measuring environmental parameters (temperature, humidity, light) relevant to agriculture, Soil sensors for moisture, nutrient content, and pH monitoring, Plant sensors for monitoring growth, stress, and health, Communication technologies for IoT in agriculture (e.g., Bluetooth, Wi-Fi, cellular). Network reliability and data integrity. Techniques for reducing data transmission power consumption.

Introduction to IoT in Agriculture Overview of IoT and its significance in agriculture. Current trends and future prospects of IoT in the agricultural sector. Case studies of IoT applications in various agricultural practices. Fundamentals of IoT Sensor Networks Types of sensors used in agriculture (e.g., soil moisture, temperature, humidity, pH). Basics of wireless sensor networks (WSNs). Sensor network topologies and communication protocols. Designing Scalable IoT Sensor Networks, Principles of scalability in IoT networks. Designing network architecture for large-scale agricultural deployments. Challenges and solutions in scaling IoT networks. Power Management in IoT Sensor Networks Importance of power management in IoT devices. Low-power communication protocols and technologies (e.g., Zigbee, LoRa, NB-IoT). Energy harvesting techniques and power optimization strategies.

Overview of precision agriculture and its benefits. Role of IoT in precision agriculture. Types of IoT devices and sensors used in agriculture, Types of sensors used in agriculture (e.g., soil moisture, temperature, humidity, pH). Basics of wireless sensor networks (WSNs). Sensor network topologies and communication protocols, Principles of scalability in IoT networks. Designing network architecture for large-scale agricultural deployments. Challenges and solutions in scaling IoT networks, Importance of power management in IoT devices. Low-power communication protocols and technologies (e.g., Zigbee, LoRa, NB-IoT). Energy harvesting techniques and power optimization strategies, Methods of data acquisition from IoT sensors. Real-time vs. periodic data collection. Handling and preprocessing of sensor data, Communication technologies for IoT in agriculture (e.g., Bluetooth, Wi-Fi, cellular). Network reliability and data integrity. Techniques for reducing data transmission power consumption, Data storage solutions (e.g., cloud storage, edge computing). Data management platforms and software. Ensuring data security and privacy in IoT networks, Techniques for analyzing IoT sensor data (e.g., statistical analysis, machine learning). Using data analytics to support agricultural decision-making. Visualization tools and dashboards for presenting data insights.

Advanced Topics in IoT for Precision Agriculture: Emerging trends in IoT technologies for agriculture (e. g., artificial intelligence, drones), In-depth analysis of successful IoT implementations in agriculture. Hands-on project: Design and deploy a small-scale IoT sensor network for a specific agricultural application, Challenges in IoT deployment in agriculture (e.g., connectivity, cost, environmental factors). Emerging technologies and future trends in IoT for agriculture. Ethical and environmental considerations in IoT deployment, Methods of data acquisition from IoT sensors. Real-time vs. periodic data collection. Handling and preprocessing of sensor data.

Interpret the results of their image processing analysis (e.g., disease detection rates, yield estimates) Visualize their findings using appropriate charts, graphs, and image overlays Write technical reports that explain the methodology, results, and implications of their image processing work for agricultural stakeholders who may not have a strong technical background (e.g., farmers, agricultural extension agents)

Reference Books

- 1 Digital Image Processing for Agriculture and Forestry, Richard S. Nixon, Faez uhdavasibi, and Steven S. Webb, 1(2000), Academic Press.
- 2 Computer Vision Applications in Agriculture, Yu Jiang, Feng Ma, and Jinwen Guo, 1(2002), Springer.
- 3 Deep Learning for Image Processing, Jason Brownlee, 1(2004), Machine Learning Mastery.
- 4 Precision Agriculture Technologies for Food Security and Sustainability , Jhuberli Pereira de Souza, 1(2006), Springer.

23ABT3405M - BIOINSTRUMENTATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3405M	BIOINSTRUMENTATION	BIM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles of various bioinstrumentation techniques and their applications in biological research	2	PO2
CO2	Analyze the operational characteristics and limitations of common bioinstrumentation tools	4	PO2
CO3	Apply the bioinstrumentation techniques for sample preparation, data acquisition, and analysis in biological experiments	3	PO3
CO4	Evaluate the suitability of different bioinstrumentation methods for specific biological research questions	5	PO3
CO5	Design a protocol for resolving frequent bioinstrumentation problems.	6	PO5

Syllabus

Introduction to Bioinstrumentation: Fundamentals of bioinstrumentation and its role in biological research, Different categories of bioinstruments based on function (microscopy, spectroscopy, etc.), Introduction to biosensors and their applications in biodetection, Bioinstrumentation safety practices and regulations

Microscopic Techniques in Bioinstrumentation: Principles of light microscopy, brightfield, darkfield, and fluorescence microscopy, Electron microscopy (SEM, TEM) for high-resolution imaging of biological structures. Advanced microscopy techniques (confocal microscopy, super-resolution microscopy)

Spectroscopic Techniques in Bioinstrumentation: Principles of UV-visible spectroscopy and its applications in biomolecule quantification, Fluorescence spectroscopy and its applications in studying biomolecular interactions, Introduction to mass spectrometry for protein and biomolecule identification

Bioinstrumentation for Physiological Measurements: Electrocardiogram (ECG) and electroencephalogram (EEG) for recording electrical activity, Biosensors for measuring biomolecules like glucose and electrolytes, Bioinstrumentation for studying biomolecular interactions (e. g., surface plasmon resonance)

Advanced Bioinstrumentation Techniques: Introduction to flow cytometry for cell analysis and sorting, Principles of DNA sequencing and its applications in genomics, Emerging trends in bioinstrumentation

Reference Books

- 1 Bioinstrumentation: Principles and Applications, John G. Webster, Gary A. MacKenzie, and Elizabeth A. Carr, 6, Taylor & Francis.
- 2 Principles of Biomedical Engineering, Donald L. Barr, 6, Academic Press.
- 3 Flow Cytometry and Cell Sorting, Andreas Radbruch, Jochen G. Hengartner, Philipp Miltenyi, and Andreas Radbruch, 3, Academic Press.
- 4 Next-Generation Sequencing Technologies, Lincoln C. Tai, David Ruan, Zhaohui Cheng, Yuanfang Li, and Chanfeng Lin, 4, Springer.

23ABT3406M - DATA ACQUISITION AND COMMUNICATION SYSTEMS FOR AGRICULTURE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3406M	DATA ACQUISITION AND COMMUNICATION SYSTEMS FOR AGRICULTURE	DACSA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles of data acquisition systems and their applications in agriculture	2	PO2
CO2	Analyze sensor technologies for collecting agricultural data (environmental, soil, plant)	4	PO2
CO3	Apply data acquisition systems and communication protocols for agricultural monitoring and automation	3	PO3
CO4	Evaluate the performance and limitations of data acquisition systems for agricultural applications	5	PO3

Syllabus

Introduction to Data Acquisition Systems: Fundamentals of data acquisition systems (DAQ) and their components (sensors, transducers, data loggers), Applications of DAQ systems in precision agriculture, environmental monitoring, and resource management

Sensor Technologies for Agricultural Data Collection: Sensors for measuring environmental parameters (temperature, humidity, light) , Soil sensors for moisture, nutrient content, and pH monitoring, Plant sensors for monitoring growth, stress, and health

Data Acquisition System Design and Implementation: Designing DAQ systems for different agricultural applications (considering sensor types, power requirements), Data acquisition software and configuration for agricultural monitoring , Communication protocols for data transmission (wireless, internet of things - IoT)

Data Management and Analysis for Agriculture: Data storage and management for agricultural data collected from DAQ systems , Data visualization and analysis techniques for agricultural applications, Integration of DAQ systems with agricultural decision-support systems (DSS)

Reference Books

- 1 Precision Agriculture Technologies for Food Security and Sustainability, Jhuberli Pereira de Souza, 1, Springer.
- 2 Wireless Sensor Networks for Agriculture and Environmental Monitoring , Gast?n Ch?vez-Garc?a and Luis Humberto Guti?rrez-N?poles, 1, Springer.
- 3 Data Acquisition and Processing for Sensor Networks: Irrigation and Greenhouse Automation, Leo Kluth and Michael O'Connell, 1, Springer.
- 4 Big Data in Agriculture: A Challenge for Computer Science, Ioana Cristina Mirea - Muntean, Vasile Cristea, and Jo?o Manuel R. S. Tavares, 1, Springer.

23ABT3507 - MICROFLUIDICS FOR AGRICULTURAL APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3507	MICROFLUIDICS FOR AGRICULTURAL APPLICATIONS	MAP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles of microfluidics and its advantages for agricultural applications	2	PO2
CO2	Analyze the design and operation of microfluidic devices for specific agricultural applications	4	PO2
CO3	Apply microfluidic techniques for plant and soil analysis, pathogen detection, and precision agriculture	3	PO3, PO4
CO4	Evaluate the potential and limitations of microfluidics for agricultural research and development	5	PO3, PO4

Syllabus

Introduction to Microfluidics and its Applications: Fundamentals of microfluidics, miniaturization, and lab-on-a-chip (LOC) concepts, Introduction to different microfluidic components and fabrication methods

Microfluidic Devices for Plant and Soil Analysis: Microfluidic devices for plant disease diagnosis, pathogen detection, Biosensing applications in microfluidics for measuring plant nutrients and metabolites

Microfluidics for Precision Agriculture: Microfluidic-based controlled environment agriculture (CEA) systems, Applications in precision irrigation and fertilizer delivery using microfluidics, Microfluidic devices for high-throughput plant phenotyping and stress monitoring

Advanced Microfluidic Techniques and Applications: Integration of microfluidics with other technologies (e. g., microarrays, PCR), Microfluidic platforms for single-cell analysis and manipulation in plant science, Emerging trends and future directions of microfluidics in agricultural research

Reference Books

- 1 Microfluidics for Food, Agriculture and Biosystems Industries, Suresh Kumar and Satyender Kumar, 1, Elsevier.
- 2 Lab-on-a-Chip for Food Science and Technology, Patrick Wen-hwa Chung and Wen-fang Dong, 1, Academic Press.
- 3 Microfluidics and Nanofluidics: Theory and Applications, Richard B. Fair and Aaron D. Stroock, 1, Cambridge University Press.
- 4 Precision Agriculture Technologies for Food Security and Sustainability, Jhuberli Pereira de Souza, 1, Springer.

23ABT3508 - BIOINFORMATICS FOR AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ABT3508	BIOINFORMATICS FOR AGRICULTURE	BIA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of bioinformatics and their applications in agriculture	2	PO2, PO5
CO2	Analyze the biological data relevant to agriculture using bioinformatics tools	4	PO2, PO3, PO5
CO3	Apply bioinformatics techniques for crop improvement, disease resistance analysis, and marker-assisted selection	3	PO2, PO3, PO5
CO4	Evaluate the potential and limitations of bioinformatics approaches in agricultural research	5	PO5

Syllabus

Introduction to Bioinformatics and Agriculture: Overview of bioinformatics and its role in agriculture Introduction to biological databases relevant to agriculture (e.g., genomic databases, protein databases) Basics of sequence analysis and genome annotation techniques Applications of bioinformatics in crop improvement, pest management, and agricultural sustainability

Biological Data Analysis with Bioinformatics Tools: Sequence analysis tools for DNA, RNA, and protein sequences (e.g., BLAST, gene prediction), Principles of genome sequencing technologies (e.g., next-generation sequencing, nanopore sequencing) Genome assembly algorithms and techniques Genome annotation methods for identifying genes, regulatory elements, and functional elements in agricultural species Case studies on genome sequencing and assembly in crop plants and livestock

Bioinformatics for Crop Improvement: Marker-assisted selection (MAS) and applications in breeding programs, Introduction to transcriptomics and gene expression analysis RNA sequencing (RNA-seq) techniques and data analysis workflows Differential gene expression analysis in response to abiotic and biotic stresses Functional annotation of transcripts and identification of key regulatory pathways in agricultural species

Advanced Bioinformatics Applications in Agriculture: Gene editing techniques (CRISPR) and their potential for crop improvement, Comparative genomics approaches for studying genetic variation and evolution in agricultural species Phylogenetic analysis and molecular evolution techniques Identification of conserved genomic regions and gene families relevant to agriculture Applications of comparative genomics in crop breeding, conservation biology, and evolutionary studies

Reference Books

- 1 Bioinformatics for Agriculture: Principles and Applications , R. Keshavachandran, 1, IK International Publishing House.
- 2 Introduction to Bioinformatics, Arthur Lesk , 4, Oxford University Press.
- 3 Plant Bioinformatics , David J. Mackill and Robert N. Bennett , 2, Springer.
- 4 Next-Generation Sequencing Data Analysis: A Practical Guide, Illumina , 2, Self-Published.

23ACI3101A - GENERATIVE ADVERSARIAL NETWORKS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3101A	GENERATIVE ADVERSARIAL NETWORKS	GANS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the theoretical foundations of Generative Adversarial Networks (GANs).	2	PO1, PO2, PSO2
CO2	Implement basic and advanced GAN architectures.	3	PO1, PO3, PSO1
CO3	Apply appropriate training techniques to train GAN models effectively.	3	PO2, PO3, PSO1
CO4	Examine the performance of GAN models using appropriate metrics	4	PO2, PSO2
CO5	Classify applications of GANs in image generation, data augmentation, and domain adaptation.	2	PO1, PSO2
CO6	Examine the implementation of GAN technology.	4	PO1, PSO2
CO7	Develop the GAN model using appropriate frameworks and libraries.	5	PO11, PSO1

Syllabus

Introduction to Generative Adversarial Networks - Overview of GANs; Historical context and development: Early Development, Evolution and Advancements; Basic architecture and components: Generator, Discriminator, Training Process

GAN Training Techniques - Adversarial training process; Loss functions in GANs: Original GAN Loss, Non-Saturating GAN Loss, Least Squares GAN (LSGAN) Loss, Wasserstein GAN (WGAN) Loss, Wasserstein GAN with Gradient Penalty (WGAN-GP) Loss; Regularization techniques: Gradient Penalty, Spectral Normalization, Batch Normalization, Dropout, Label Smoothing, Feature Matching, Noise Injection, Instance Noise

Advanced GAN Architectures - Conditional GANs: Conditioning Information, Architecture, Loss Functions, Applications; Wasserstein GANs: Wasserstein Distance, Loss Functions, Weight Clipping, Wasserstein GAN with Gradient Penalty (WGAN-GP); Self-Attention GANs: Self-Attention Mechanism, Attention Layers, Architecture, Applications; Progressive GANs: Progressive Growing, Training Process, Architecture, Benefits, Applications

Evaluation of GAN Models - Performance metrics: Purpose, Common Metrics, Inception Score: Definition, Computation, Interpretation, Limitations; Frechet Inception Distance: Definition, Computation, Interpretation, Advantages; Perceptual Path Length: Definition, Computation, Interpretation, Applications

Applications of GANs - Image generation: Unconditional Image Generation, Conditional Image Generation, High-Resolution Image Generation; Data augmentation: Enhancing Training Datasets, Domain-Specific Augmentation; Style transfer: Artistic Style Transfer, Real-Time Style Transfer, Semantic Style Transfer; Domain adaptation: Unsupervised Domain Adaptation, Image-to-Image Translation, Multi-Domain Adaptation

Reference Books

- 1 GANs in Action: Deep learning with Generative Adversarial Networks, Jakub Langr and Vladimir Bok, 2019, Manning.
- 2 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 3 Hands-On Generative Adversarial Networks with PyTorch 1.x, John Hany and Greg Walters, 2019, Packt.
- 4 Generative Deep Learning: Teaching Machines to Paint, Write, Compose and Play, David Foster, 2019, O'Reilly.

- 5 Deep Learning for Computer Vision: Expert techniques to train advanced neural networks using TensorFlow and Keras, Rajalingappaa Shanmugamani, 2018, Packt.
- 6 Generative Adversarial Networks Cookbook, Josh Kalin , 2018, Packt.

23ACI3101E - GENERATIVE ADVERSARIAL NETWORKS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3101E	GENERATIVE ADVERSARIAL NETWORKS	GANS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the theoretical foundations of Generative Adversarial Networks (GANs).	2	PO1, PO2, PSO2
CO2	Implement basic and advanced GAN architectures.	3	PO1, PO3, PSO1
CO3	Apply appropriate training techniques to train GAN models effectively.	3	PO2, PO3, PSO1
CO4	Examine the performance of GAN models using appropriate metrics	4	PO2, PSO2
CO5	Classify applications of GANs in image generation, data augmentation, and domain adaptation.	2	PO1, PSO2
CO6	Examine the implementation of GAN technology.	4	PO1, PSO2
CO7	Develop the GAN model using appropriate frameworks and libraries.	5	PO11, PSO1

Syllabus

Introduction to Generative Adversarial Networks - Overview of GANs; Historical context and development: Early Development, Evolution and Advancements; Basic architecture and components: Generator, Discriminator, Training Process

GAN Training Techniques - Adversarial training process; Loss functions in GANs: Original GAN Loss, Non-Saturating GAN Loss, Least Squares GAN (LSGAN) Loss, Wasserstein GAN (WGAN) Loss, Wasserstein GAN with Gradient Penalty (WGAN-GP) Loss; Regularization techniques: Gradient Penalty, Spectral Normalization, Batch Normalization, Dropout, Label Smoothing, Feature Matching, Noise Injection, Instance Noise

Advanced GAN Architectures - Conditional GANs: Conditioning Information, Architecture, Loss Functions, Applications; Wasserstein GANs: Wasserstein Distance, Loss Functions, Weight Clipping, Wasserstein GAN with Gradient Penalty (WGAN-GP); Self-Attention GANs: Self-Attention Mechanism, Attention Layers, Architecture, Applications; Progressive GANs: Progressive Growing, Training Process, Architecture, Benefits, Applications

Evaluation of GAN Models - Performance metrics: Purpose, Common Metrics, Inception Score: Definition, Computation, Interpretation, Limitations; Frechet Inception Distance: Definition, Computation, Interpretation, Advantages; Perceptual Path Length: Definition, Computation, Interpretation, Applications

Applications of GANs - Image generation: Unconditional Image Generation, Conditional Image Generation, High-Resolution Image Generation; Data augmentation: Enhancing Training Datasets, Domain-Specific Augmentation; Style transfer: Artistic Style Transfer, Real-Time Style Transfer, Semantic Style Transfer; Domain adaptation: Unsupervised Domain Adaptation, Image-to-Image Translation, Multi-Domain Adaptation

Reference Books

- 1 GANs in Action: Deep learning with Generative Adversarial Networks, Jakub Langr and Vladimir Bok, 2019, Manning.
- 2 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 3 Hands-On Generative Adversarial Networks with PyTorch 1.x, John Hany and Greg Walters, 2019, Packt.
- 4 Generative Deep Learning: Teaching Machines to Paint, Write, Compose and Play, David Foster, 2019, O'Reilly.

- 5 Deep Learning for Computer Vision: Expert techniques to train advanced neural networks using TensorFlow and Keras, Rajalingappaa Shanmugamani , 2018, Packt.
- 6 Generative Adversarial Networks Cookbook, Josh Kalin , 2018, Packt.

23ACI3101R - GENERATIVE ADVERSARIAL NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3101R	GENERATIVE ADVERSARIAL NETWORKS	GANS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the theoretical foundations of Generative Adversarial Networks (GANs).	2	PO1, PO2, PSO2
CO2	Implement basic and advanced GAN architectures.	3	PO1, PO3, PSO1
CO3	Apply appropriate training techniques to train GAN models effectively.	3	PO2, PO3, PO5, PSO1
CO4	Examine the performance of GAN models using appropriate metrics.	4	PO2, PSO2
CO5	Examine the implementation of GAN technology.	4	PO1, PSO2
CO6	Develop the GAN model using appropriate frameworks and libraries.	5	PO1, PO5, PSO2

Syllabus

Introduction to Generative Adversarial Networks - Overview of GANs; Historical context and development: Early Development, Evolution and Advancements; Basic architecture and components: Generator, Discriminator, Training Process

GAN Training Techniques - Adversarial training process; Loss functions in GANs: Original GAN Loss, Non-Saturating GAN Loss, Least Squares GAN (LSGAN) Loss, Wasserstein GAN (WGAN) Loss, Wasserstein GAN with Gradient Penalty (WGAN-GP) Loss; Regularization techniques: Gradient Penalty, Spectral Normalization, Batch Normalization, Dropout, Label Smoothing, Feature Matching, Noise Injection, Instance Noise

Advanced GAN Architectures - Conditional GANs: Conditioning Information, Architecture, Loss Functions, Applications; Wasserstein GANs: Wasserstein Distance, Loss Functions, Weight Clipping, Wasserstein GAN with Gradient Penalty (WGAN-GP); Self-Attention GANs: Self-Attention Mechanism, Attention Layers, Architecture, Applications; Progressive GANs: Progressive Growing, Training Process, Architecture, Benefits, Applications

Evaluation of GAN Models - Performance metrics: Purpose, Common Metrics, Inception Score: Definition, Computation, Interpretation, Limitations; Frechet Inception Distance: Definition, Computation, Interpretation, Advantages; Perceptual Path Length: Definition, Computation, Interpretation, Applications

Reference Books

- 1 GANs in Action: Deep learning with Generative Adversarial Networks, Jakub Langr and Vladimir Bok, 2019, Manning.
- 2 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 3 Hands-On Generative Adversarial Networks with PyTorch 1.x, John Hany and Greg Walters, 2019, Packt.
- 4 Generative Deep Learning: Teaching Machines to Paint, Write, Compose and Play, David Foster, 2019, O'Reilly.
- 5 Deep Learning for Computer Vision: Expert techniques to train advanced neural networks using TensorFlow and Keras, Rajalingappaa Shanmugamani, 2018, Packt.
- 6 Generative Adversarial Networks Cookbook, Josh Kalin, 2018, Packt.

23ACI3202A - EXPLAINABLE AI AND COMMUNICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3202A	EXPLAINABLE AI AND COMMUNICATIONS	EAIC	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a comprehensive understanding of the fundamental principles and concepts of explainable AI, including the importance of transparency, interpretability, and trust in AI systems.	2	PO1, PO3, PO4, PSO2
CO2	Identify and apply various techniques and methods for making AI models explainable, such as feature importance, model simplification, visualization methods, and rule-based systems	3	PO1, PO3, PO4, PSO2
CO3	Evaluate Critically evaluate the explainability of different AI models using standard metrics and frameworks.	4	PO1, PO3, PO4, PSO2
CO4	Develop effective communication skills to articulate complex AI concepts and explanations to diverse audiences, including technical and non-technical stakeholders.	3	PO1, PO3, PO4, PSO2
CO5	Analyze the ethical and societal implications of AI systems and the necessity for explainability in promoting ethical AI practices.	4	PO1, PO3, PO4, PSO2

Syllabus

Definition and importance of Explainable AI. - Historical context and evolution of AI explainability. - Key stakeholders and their needs in AI explanations. -Case studies demonstrating the need for XAI.

Definition and importance of Explainable AI. - Historical context and evolution of AI explainability. - Key stakeholders and their needs in AI explanations. - Case studies demonstrating the need for XAI.

Intrinsically interpretable models (decision trees, linear models, rule-based systems). - Advantages and limitations of simple models. - Case studies of intrinsically interpretable models in use.

Model-agnostic explanation methods: LIME, SHAP. - Model-specific explanation methods. - Visualization techniques: heatmaps, partial dependence plots, and feature importance. - Hands-on exercises with LIME and SHAP.

Model-agnostic explanation methods: LIME, SHAP. - Model-specific explanation methods. - Visualization techniques: heatmaps, partial dependence plots, and feature importance. - Hands-on exercises with LIME and SHAP.

Reference Books

- 1 Interpretable Machine Learning, Christoph Molnar, 2, 2022, Shroff.
- 2 Transparent Data Mining for Big and Small Data, Tania Cerquitelli, Daniele Quercia, and Frank Pasquale., 1, 2017, Springer.
- 3 Explainable Artificial Intelligence (XAI): Concepts, enabling tools, technologies and applications, Pethuru Raj and Utku K?se, 1, 2023, IET.
- 4 Explainable AI for Practitioners, Michael Munn, David Pitman, 1, 2022, O'Reilly Media, Inc..
- 5 Explainable AI: Interpreting, Explaining and Visualizing Deep Learning, Wojciech Samek, Gr?goire Montavon, Andrea Vedaldi, 1, 2019, Springer.

23ACI3202E - EXPLAINABLE AI AND COMMUNICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3202E	EXPLAINABLE AI AND COMMUNICATIONS	EAIC	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a comprehensive understanding of the fundamental principles and concepts of explainable AI, including the importance of transparency, interpretability, and trust in AI systems.	2	PO1, PO3, PO4, PSO2
CO2	Identify and apply various techniques and methods for making AI models explainable, such as feature importance, model simplification, visualization methods, and rule-based systems	3	PO1, PO3, PO4, PSO2
CO3	Evaluate Critically evaluate the explainability of different AI models using standard metrics and frameworks	4	PO1, PO3, PO4, PSO2
CO4	Develop effective communication skills to articulate complex AI concepts and explanations to diverse audiences, including technical and non-technical stakeholders.	3	PO1, PO3, PO4, PSO2
CO5	Analyze the ethical and societal implications of AI systems and the necessity for explainability in promoting ethical AI practices.	4	PO1, PO3, PO4, PSO2

Syllabus

Definition and importance of Explainable AI. - Historical context and evolution of AI explainability. - Key stakeholders and their needs in AI explanations. -Case studies demonstrating the need for XAI.

Definition and importance of Explainable AI. - Historical context and evolution of AI explainability. - Key stakeholders and their needs in AI explanations. - Case studies demonstrating the need for XAI.

Intrinsically interpretable models (decision trees, linear models, rule-based systems). - Advantages and limitations of simple models. - Case studies of intrinsically interpretable models in use.

Model-agnostic explanation methods: LIME, SHAP. - Model-specific explanation methods. - Visualization techniques: heatmaps, partial dependence plots, and feature importance. - Hands-on exercises with LIME and SHAP.

Model-agnostic explanation methods: LIME, SHAP. - Model-specific explanation methods. - Visualization techniques: heatmaps, partial dependence plots, and feature importance. - Hands-on exercises with LIME and SHAP.

Reference Books

- 1 Interpretable Machine Learning , Christoph Molnar , 2, 2022, Shroff.
- 2 Transparent Data Mining for Big and Small Data, Tania Cerquitelli, Daniele Quercia, 1,2017, Springer.
- 3 Explainable Artificial Intelligence (XAI): Concepts, enabling tools, technologies and applications, Pethuru Raj and Utku K?se, 1, 2023, IET.
- 4 Explainable AI for Practitioners, Michael Munn, David Pitman, 1, 2022, O'Reilly Media, Inc..
- 5 Explainable AI: Interpreting, Explaining and Visualizing Deep Learning , Wojciech Samek, Gr?goire , 1, 2019, Springer.

23ACI3202R - EXPLAINABLE AI AND COMMUNICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3202R	EXPLAINABLE AI AND COMMUNICATIONS	EAIC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a comprehensive understanding of the fundamental principles and concepts of explainable AI, including the importance of transparency, interpretability, and trust in AI systems	2	PO1, PO3, PO4, PSO2
CO2	Identify and apply various techniques and methods for making AI models explainable, such as feature importance, model simplification, visualization methods, and rule-based systems	3	PO1, PO3, PO4, PSO2
CO3	Evaluate Critically evaluate the explainability of different AI models using standard metrics and frameworks	4	PO1, PO3, PO4, PSO2
CO4	Develop effective communication skills to articulate complex AI concepts and explanations to diverse audiences, including technical and non-technical stakeholders	3	PO1, PO3, PO4, PSO2

Syllabus

Definition and importance of Explainable AI. - Historical context and evolution of AI explainability. - Key stakeholders and their needs in AI explanations. -Case studies demonstrating the need for XAI.

Definition and importance of Explainable AI. - Historical context and evolution of AI explainability. - Key stakeholders and their needs in AI explanations. - Case studies demonstrating the need for XAI.

Intrinsically interpretable models (decision trees, linear models, rule-based systems). - Advantages and limitations of simple models. - Case studies of intrinsically interpretable models in use.

Model-agnostic explanation methods: LIME, SHAP. - Model-specific explanation methods. - Visualization techniques: heatmaps, partial dependence plots, and feature importance. - Hands-on exercises with LIME and SHAP.

Reference Books

- 1 Interpretable Machine Learning , Christoph Molnar , 2, 2022, Shroff.
- 2 Transparent Data Mining for Big and Small Data, Tania Cerquitelli, Daniele Quercia, 1, 2017, Springer.
- 3 Explainable Artificial Intelligence (XAI): Concepts, enabling tools, technologies and applications, Pethuru Raj and Utku K?se , 1, 2023, IET.
- 4 Explainable AI for Practitioners, Michael Munn, David Pitman, 1, 2022, O'Reilly Media, Inc..
- 5 Explainable AI: Interpreting, Explaining and Visualizing Deep Learning , Wojciech Samek, Gr?goire Montavon, 1, 2019, Springer.

23ACI3303A - FUZZY LOGIC WITH SET THEORY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3303A	FUZZY LOGIC WITH SET THEORY	FLST	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basic knowledge of the fuzzy sets, operations and their properties.	2	PO1, PO2, PO8, PSO1
CO2	Understand the fundamental concepts of Fuzzy functions and Fuzzy logic	2	PO1, PO2, PO8, PSO1
CO3	Apply the concepts of Fuzzy sets in image processing, pattern reorganization and decision making.	3	PO1, PO2, PO8, PSO1
CO4	Analyze the concepts of Fuzzy logic in image processing.	4	PO2, PO3, PO8, PSO1
CO5	Explain the applications of fuzzy systems	2	PO2, PO3, PO8, PSO1
CO6	Apply the fuzzy sets and relations logic and systems	3	PO2, PO3, PO8, PSO1
CO7	Apply fuzzy logic with set theory operations	3	PO2, PO3, PO8, PSO1

Syllabus

Basic concepts of fuzzy set t norm t conorms Membership function alpha cut Algebra of fuzzy sets Distance between fuzzy sets Fuzzy relation

Fuzzy numbers Arithmetic operations of fuzzy numbers Extension principle Interval arithmetic Defuzzification

Fuzzy valued functions Fuzzy equations fuzzy inequalities system of fuzzy linear equations Maximum and minimum of fuzzy functions

Classical Logic Multi valued Logics Fuzzy Propositions Fuzzy Quantifiers

Linguistic hedges Inference from conditional Fuzzy proposition

Reference Books

- 1 Fuzzy sets and systems, Didier Buboïs and Henri Prade, 2019, Academic Press.
- 2 An Introduction to Fuzzy logic and Fuzzy sets, James J Buckley Esfandiar Eslami, 2022, Springer.
- 3 Fuzzy set theory and application, H.J.Zimmerman, 2001, Association with KLUWER.
- 4 Fuzzy Logic with Engineering Applications, Timothy J. Ross, 2010, Wiley.

23ACI3303E - FUZZY LOGIC WITH SET THEORY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3303E	FUZZY LOGIC WITH SET THEORY	FLST	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basic knowledge of the fuzzy sets, operations and their properties.	2	PO1, PO2, PO8, PSO1
CO2	Understand the fundamental concepts of Fuzzy functions and Fuzzy logic	2	PO1, PO2, PO8, PSO1
CO3	Apply the concepts of Fuzzy sets in image processing, pattern reorganization and decision making.	3	PO1, PO2, PO8, PSO1
CO4	Analyze the concepts of Fuzzy logic in image processing.	4	PO2, PO3, PO8, PSO1
CO5	Explain the applications of fuzzy systems	2	PO2, PO3, PO8, PSO1
CO6	Apply the fuzzy sets and relations logic and systems	3	PO2, PO3, PO8, PSO1
CO7	Apply fuzzy logic with set theory operations	3	PO2, PO3, PO8, PSO1

Syllabus

Basic concepts of fuzzy set t norm t conorms Membership function alpha cut Algebra of fuzzy sets Distance between fuzzy sets Fuzzy relation

Fuzzy numbers Arithmetic operations of fuzzy numbers Extension principle Interval arithmetic Defuzzification

Fuzzy valued functions Fuzzy equations fuzzy inequalities system of fuzzy linear equations Maximum and minimum of fuzzy functions

Classical Logic Multi valued Logics Fuzzy Propositions Fuzzy Quantifiers

Linguistic hedges Inference from conditional Fuzzy proposition

Reference Books

- 1 Fuzzy sets and systems, Didier Buboïs and Henri Prade, 1, Academic Press.
- 2 An Introduction to Fuzzy logic and Fuzzy sets, James J Buckley Esfandiar Eslami, 1, Springer.
- 3 Fuzzy set theory and application, H.J.Zimmerman, 1, Association with KLUWER.
- 4 Fuzzy Logic with Engineering Applications, Timothy J. Ross, 4, Wiley.

23ACI3303R - FUZZY LOGIC WITH SET THEORY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3303R	FUZZY LOGIC WITH SET THEORY	FLST	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basic knowledge of the fuzzy sets, operations and their properties.	2	PO1, PO2, PO8, PSO1
CO2	Understand the fundamental concepts of Fuzzy functions and Fuzzy logic	2	PO1, PO2, PO8, PSO1
CO3	Apply the concepts of Fuzzy sets in image processing, pattern reorganization and decision making.	3	PO1, PO2, PO8, PSO1
CO4	Analyze the concepts of Fuzzy logic in image processing.	4	PO2, PO3, PO8, PSO1
CO5	Explain the applications of fuzzy systems	4	PO2, PO3, PO8, PSO1
CO6	Construct the fuzzy sets and relations logic and systems	5	PO2, PO3, PO8, PSO1
CO7	Developing the skilling in the concepts of Fuzzy sets and logic systems.	5	PO2, PO3, PO8, PSO1

Syllabus

Basic concepts of fuzzy set t norm t conorms Membership function alpha cut Algebra of fuzzy sets Distance between fuzzy sets Fuzzy relation

Fuzzy numbers Arithmetic operations of fuzzy numbers Extension principle Interval arithmetic Defuzzification

Fuzzy valued functions Fuzzy equations fuzzy inequalities system of fuzzy linear equations Maximum and minimum of fuzzy functions

Classical Logic Multi valued Logics Fuzzy Propositions Fuzzy Quantifiers Linguistic hedges Inference from conditional Fuzzy proposition

Reference Books

- 1 Fuzzy sets and systems, Didier Buboio and Henri Prade, 1, Academic Press.
- 2 An Introduction to Fuzzy logic and Fuzzy sets, James J Buckley Esfandiar Eslami , 1, Springer.
- 3 Fuzzy set theory and application, H.J.Zimmerman, 1, Association with KLUWER.
- 4 Fuzzy Logic with Engineering Applications, Timothy J. Ross, 4, Wiley.

23ACI3404M - HEURISTIC ALGORITHMS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3404M	HEURISTIC ALGORITHMS	HAG	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the Foundations of Heuristic Algorithms the basic characteristics of engineering design optimization models, including the definition of design variables, objectives, and constraints	2	PO1, PO2, PO6, PSO2
CO2	Applying Heuristic Methods to Solve Optimization Problems, mathematical optimization methods for linear and nonlinear functions of several variables with or without constraints determine solutions and whether the global optimum is guaranteed.	3	PO1, PO2, PO6, PSO2
CO3	Analyzing Performance of Heuristic Algorithms n mathematical optimization models (LP, IP, NLP, MILP, and MINLP) for a variety of engineering design problems using the AMPL modeling language.	4	PO1, PO3, PO6, PSO2
CO4	Analyzing Custom Heuristic Solutions for Complex Problems Solve problem models using existing software programs and critique the near-optimal or optimal solution obtained.	4	PO1, PO3, PO6, PSO2

Syllabus

Introduction to Heuristic Algorithms: Understanding what heuristic algorithms are and their role in problem-solving. Differentiating between exact and heuristic algorithms. Solution Initialization Module This module generates initial candidate solutions. These can be random or based on some heuristic. Components: Random Initialization: Generates random solutions within the feasible space. Heuristic Initialization: Uses domain-specific knowledge to create a good starting point. Feasibility Check: Ensures that generated solutions meet the constraints.

Solution Initialization Module This module generates initial candidate solutions. These can be random or based on some heuristic. Components: Random Initialization: Generates random solutions within the feasible space. Heuristic Initialization: Uses domain-specific knowledge to create a good starting point. Feasibility Check: Ensures that generated solutions meet the constraints. Solution Evaluation Module This module assesses the quality of each candidate solution using the objective function. Components: Fitness Function: Calculates how good each solution is based on the objective function. Penalty Function: Applies penalties to solutions that violate constraints. Ranking and Selection: Ranks solutions based on their fitness scores.

Solution Improvement Module This module iteratively improves the candidate solutions. Techniques such as local search, genetic operators, or other heuristic methods are applied. Components: Local Search: Fine-tunes solutions by exploring neighboring solutions. Mutation and Crossover: Used in genetic algorithms to combine and modify solutions. Simulated Annealing: Probabilistic technique to escape local optima by allowing worse solutions temporarily.

Advanced Applications and Case Studies Topics: Real-World Applications Scheduling Problems Network Optimization Machine Learning Feature Selection Case Studies Industry-Specific Applications Performance Analysis and Benchmarking Future Directions Emerging Trends in Heuristics Integration with Machine Learning and AI

Reference Books

- 1 An Introduction to Optimization, Edwin K.P. Chong and Stanislaw H. Zak, 2nd, 2013, Wiley.
- 2 Metaheuristics: From Design to Implementation, El-Ghazali Talbi, 1st, 2009, Wiley.
- 3 Handbook of Heuristics, Rafael Mart?, Panos M. Pardalos, Mauricio G. C. Resende (Editors), 1st, 2008, Springer.
- 4 Optimization by Simulated Annealing, S. Kirkpatrick, C. D. Gelatt, M. P. Vecchi, 1st, 1983, CRC Press.

23ACI3405M - SWARM INTELLIGENCE APPROACHES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3405M	SWARM INTELLIGENCE APPROACHES	SIA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand, formulate and assess problems in evolutionary computation and swarm intelligence.	2	PO1, PO2, PSO1
CO2	Evaluate the strengths and weaknesses of alternative approaches to evolutionary and swarm-based methods.	2	PO1, PO2, PSO2
CO3	Determine and analyze the key commonalities and differences in various evolutionary and swarm-based models.	3	PO1, PO2, PSO2
CO4	Analyse advance techniques in evolutionary computation and swarm intelligence on problems such as optimization, automatic programming, control, machine learning, and modeling. Develop a proposal for an extended research project.	4	PO2, PO3, PO4, PSO2

Syllabus

Evolutionary Algorithms, Different Components of Evolutionary Algorithms. Differences of Swarm intelligence from EAs. Finding problems in which these techniques are needed, say TSP & those where non-machine learning optimization method are enough. How to frame problem with a particular approach in mind.

Comparing the alternative approaches from the computational point, i.e. representation and search. Latter comprises: (a) Size of search space, (b) Feature space. The latter concerns: Curse of dimensionality, constraint of minimum training data size needed.

Factors include rate of convergence, reliability (considering the changing conditions or input variable values), optimality for numerical optimization, time & space complexity based on search space reduction and associated benefits.

Analyse advance techniques in evolutionary computation and swarm intelligence on problems such as optimization, automatic programming, control, machine learning, and modeling.

Reference Books

- 1 An Introduction to Evolutionary Computing, Natural Computing Series, A. E. Eiben, J. E. Smith, 2nd, 2015, Springer.
- 2 Hands-On Genetic Algorithms with Python, Eyal Wiersansky, 1st, 2020, Packt Publishing.
- 3 Hands-on Neuroevolution with Python: Build HighPerforming Artificial Neural Network Architectures using Neuroevolution-based Algorithm, Iaroslav Omelianenko, 2019, Packt Publishing.
- 4 Recent Advances in Evolutionary Multi-objective Optimization, Slim Bechikh, Rituparna Datta, Abhishek Gupta, 1st, 2017, Springer.
- 5 Hyper-Heuristics: Theory and Applications, Nelishia Pillay, Rong Qu, 1st, 2018, Springer.
- 6 Evolutionary Approach to Machine Learning and Deep Neural Networks: Neuro-Evolution and Gene Regulatory Networks, Hitoshi Iba, 1st, 2018, Springer.

23ACI3506 - DATA MANIPULATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3506	DATA MANIPULATION	DMP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret various data manipulation operations such as filtering, sorting, and aggregating to extract meaningful insights from raw datasets	2	PO1, PO2, PSO2
CO2	Apply data manipulation techniques using relevant software tools and programming languages such as Python, R, or SQL to manipulate real-world datasets.	3	PO1, PO2, PSO2
CO3	Evaluate different approaches to data manipulation and select the most appropriate methods based on the characteristics and objectives of the dataset.	3	PO1, PO2, PSO2
CO4	Analyze the impact of data manipulation on the quality, accuracy, and reliability of data for downstream analysis and decision-making processes.	4	PO1, PO2, PSO2

Syllabus

Introduction to data manipulation concepts and importance in data analysis Understanding data types, data structures, and data formats, Basic data cleaning techniques: handling missing values, outliers, and duplicates, Techniques for data transformation: reshaping, merging, and pivoting datasets Introduction to regular expressions for text manipulation Case studies and hands-on exercises using Python pandas library

Filtering datasets based on conditions and criteria Sorting dataframes by column values Advanced filtering techniques: chaining conditions, using boolean indexing, Understanding aggregation functions: sum, mean, median, etc. Grouping data by categories or variables Applying aggregation functions to grouped dataframes

Overview of SQL language and its applications Writing SQL queries to retrieve, filter, and sort data from databases Performing basic data manipulation tasks using SQL: joining tables, subqueries, etc, Aggregating data in SQL: using GROUP BY and aggregate functions Modifying data in SQL: INSERT, UPDATE, DELETE operations Case studies and practical exercises using SQL in real-world scenarios

Understanding the ethical implications of data manipulation Identifying biases and privacy concerns in data manipulation processes Strategies for ensuring fairness, transparency, and accountability in data manipulation, Best practices for data manipulation workflows and documentation Exploring emerging trends and technologies in data manipulation Final project presentations and discussions on the role of data manipulation in data science and analytics

Reference Books

- 1 Data Manipulation with R, Phil Spector, 2nd Edition, 2008, Springer.
- 2 R for Data Science: Import, Tidy, Transform, Visualize, and Model Data, Hadley Wickham and Garrett Grolemund, 2nd Edition, 2016, O'Reilly Media.
- 3 SQL Cookbook: Query Solutions and Techniques for Database Developers, Anthony Molinaro, 2nd Edition, 2006, O'Reilly Media.
- 4 Pandas Cookbook, Theodore Petrou, 1st Edition, 2017, Packt Publishing.
- 5 R for Data Science, Hadley Wickham, 1st Edition, 2023, O'Reilly Media.
- 6 Python for Data Analysis, Wes McKinney, 3rd Edition, 2003, O'Reilly Media.

23ACI3507 - REINFORCEMENT LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3507	REINFORCEMENT LEARNING	RLG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Discuss basic and advanced reinforcement learning techniques.	2	PO1, PO3, PO4, PSO1
CO2	Demonstrate suitable learning tasks to which these learning techniques can be applied.	3	PO1, PO2, PO3, PSO1
CO3	Analyze some of the current limitations of reinforcement learning techniques.	4	PO2, PO3, PO4, PSO2
CO4	Formulate decision problems, set up and run computational experiments, evaluation of results from experiments.	5	PO2, PO3, PO4, PSO2

Syllabus

Reinforcement learning framework, Bandit problems, Advanced Bandit Algorithms, action selection, Policy Gradient Methods

Dynamic programming, Markov Decision Processes (MDPs), Monte Carlo methods, Monte Carlo Control, Temporal-difference learning, Temporal-Difference Control

Planning in RL, Model-Based Planning Methods, Function approximation for generalization, Advanced Function Approximation Techniques, Actor-critic and gradient-based optimization

Multi-agent reinforcement learning, Multi-Agent Learning Paradigms, Value-Based Methods in MARL, Environments with partial observability, Value-Based Methods for POMDPs

Reference Books

- 1 Reinforcement Learning: An Introduction, Richard S. Sutton and Andrew G. Barto, Second Edition, 2018, The MIT Press.
- 2 Algorithms for Reinforcement Learning, Csaba Szepesvári, First Edition, 2010, Morgan & Claypool Publishers.
- 3 Cognitive Analytics and Reinforcement Learning: Theories, Techniques and Applications, Elakkiya R. and Subramaniaswamy V., 1st Edition, 2022, WILEY.
- 4 Deep Reinforcement Learning in Action, Alexander Zai and Brandon Brown, 1st Edition, 2020, Manning Publications..

23ACI3508 - EVOLUTIONARY COMPUTATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACI3508	EVOLUTIONARY COMPUTATION	ECP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the history and fundamental concepts of Evolutionary Computation, including Genetic Algorithms and Evolutionary Strategies, and will be able to apply these techniques to solve real-world problems in engineering, finance, bioinformatics, and robotics through practical assignments and projects.	2	PO1, PO2, PO8, PSO2
CO2	Describe the principles of Genetic Algorithms (GAs), including representation, selection, crossover, mutation, and termination, grasp advanced topics like multi-objective optimization and parallel GAs,	2	PO1, PO2, PO8, PSO2
CO3	Apply Evolutionary Strategies (ES) and Evolutionary Programming (EP), with various Evolutionary Algorithms (EAs) including Genetic Algorithms and Genetic Programming, and apply these techniques to practical problems in diverse fields through project-based learning.	3	PO2, PO4, PO8, PSO2
CO4	Analyze Genetic Programming (GP) and various evolutionary techniques, including representation, initialization, and genetic operators, and apply tree-based GP, grammatical evolution, differential evolution (DE), Particle Swarm Optimization (PSO), and Ant Colony Optimization (ACO) to solve diverse optimization problems	4	PO2, PO4, PO8, PSO2

Syllabus

This module introduces Evolutionary Computation, exploring its history, fundamental concepts, and various types like Genetic Algorithms and Evolutionary Strategies. Students will learn about populations, individuals, and fitness functions, and apply these techniques to real-world problems in engineering, finance, bioinformatics, and robotics through practical assignments and projects.

This module covers Genetic Algorithms (GAs), including representation, initialization, selection, crossover, mutation, and termination. It explores fitness scaling, selection mechanisms like roulette wheel and tournament selection, and parameter tuning. Advanced topics include multi-objective optimization, parallel GAs, and niching techniques, with practical applications and project-based learning.

This module explores Evolutionary Strategies (ES) and Evolutionary Programming (EP), detailing types of Evolutionary Algorithms (EAs) such as Genetic Algorithms and Genetic Programming. It covers applications of Evolutionary Computation, comparing ES and EP with GAs, and their practical uses in various fields through project-based learning.

This module introduces Genetic Programming (GP) and other evolutionary techniques, including representation, initialization, and genetic operators. It covers tree-based GP, grammatical evolution, differential evolution (DE), and swarm intelligence algorithms like Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO), with applications in various optimization problems.

Reference Books

- 1 Introduction to Evolutionary Computing, A.E. Eiben and J.E. Smith, 4th, 2008, Springer.
- 2 Genetic Algorithms in Search, Optimization, and Machine Learning, D.E. Goldberg, 3, 2011, Addison-Wesley Professional.
- 3 Evolutionary Algorithms for Solving Multi-Objective Problems, C.A. Coello Coello, 3, 2009, Springer.
- 4 Evolutionary Computation: A Unified Approach, K. Deb, 2, 2014, Wiley.
- 5 Handbook of Evolutionary Computation, T. Beck, D.B. Fogel, and Z. Michalewicz, 3, 2016, Publisher: Oxford University Press.

6 Bio Computing, Pat cummi, 3, 2018, Wiley.

23ADE3101A - EDGE COMPUTING FUNDAMENTALS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3101A	EDGE COMPUTING FUNDAMENTALS	ECF	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Edge and Fog Computing and infer the opportunities and challenges	2	PO1, PO2, PO8, PSO1
CO2	Examine the Architectural detail of Edge Computing and explore the issues that are being addressed by the industry	4	PO1, PO2, PO8, PSO1
CO3	Interpret the Security Requirements for Edge Computing and its Middleware needed	4	PO1, PO2, PO8, PSO1
CO4	Evaluate the applicability and need for Edge/Fog Computing in various real-time projects	4	PO2, PO3, PO8, PSO1
CO5	Evaluate computing paradigms using various applications in Edge Computing	4	PO2, PO3, PO8, PSO1
CO6	Implementaion of sensor based IOT applications	4	PO2, PO3, PO8, PSO1
CO7	Demonstrate proficiency in connecting edge devices to edge computing platforms.	4	PO2, PO3, PO8, PSO1

Syllabus

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Opportunities and Challenges, Addressing the Challenges in Federating Edge Resources

Architecture: Integrating IoT + Fog + Cloud Infrastructures, System Modeling, and Research Challenges, Network Slicing Management in Edge and Fog, Optimization in Fog Computing, Formal Modeling Framework for Fog Computing,

Middleware for Fog and Edge Computing: Design Issues, State-of-the-Art Middleware Infrastructures, A Lightweight Container Middleware for Edge Cloud Architectures, Security and Data Management

Security Management for Edge Cloud Architectures, Applications, and Issues: Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking, Fog Computing Model for Evolving Smart Transportation Applications

Application of Docker container and cabrnets in edge computing, edge design of IoT storage system like kye value store

Reference Books

- 1 Edge Computing: A Primer , Jie CaoQuan Zhang Weisong Shi , 1st (2018), Springer .
- 2 Fog and Edge Computing-Simply In-depth , Singh Ajit , 2nd Edition, English Paperback .
- 3 Fog and Edge Computing: Principles and Paradigms , Rajkumar Buyya (Editor), Satish Narayana Sri rama , 1st (2019), Wiley Publications .
- 4 IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security , Perry Lea , 2nd Edition, Paperback .

23ADE3101E - EDGE COMPUTING FUNDAMENTALS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3101E	EDGE COMPUTING FUNDAMENTALS	ECF	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Edge and Fog Computing and infer the opportunities and challenges	2	PO1, PO2, PO8, PSO1
CO2	Examine the Architectural detail of Edge Computing and explore the issues that are being addressed by the industry	4	PO1, PO2, PO8, PSO1
CO3	Interpret the Security Requirements for Edge Computing and its Middleware needed	4	PO2, PO3, PO8, PSO1
CO4	Evaluate the applicability and need for Edge/Fog Computing in various real-time projects	4	PO2, PO3, PO8, PSO1
CO5	Applying Edge/Fog Computing in various real-time projects	4	PO2, PO3, PO8, PSO1
CO6	Applying the various models and architectures of Edge Computing	4	PO2, PO3, PO8, PSO1
CO7	Analysing the outcomes of various real time and challenging goals of technology	3	PO2, PO3, PO8, PSO1

Syllabus

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Opportunities and Challenges, Addressing the Challenges in Federating Edge Resources

Architecture: Integrating IoT + Fog + Cloud Infrastructures, System Modeling, and Research Challenges, Network Slicing Management in Edge and Fog, Optimization in Fog Computing, Formal Modeling Framework for Fog Computing,

Middleware for Fog and Edge Computing: Design Issues, State-of-the-Art Middleware Infrastructures, A Lightweight Container Middleware for Edge Cloud Architectures, Security and Data Management

Security Management for Edge Cloud Architectures, Applications, and Issues: Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking

.Fog Computing Model for Evolving Smart Transportation Applications

Reference Books

- 1 Edge Computing: A Primer, Jie Cao, Quan Zhang, Weisong Shi, 1st (2018), Springer.
- 2 Fog and Edge Computing-Simply In-depth, Singh Ajit, 2nd Edition, English Paperback.
- 3 Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya (Editor), Satish Narayana Sri Rama, 1st (2019), Wiley Publications.
- 4 IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, Perry Lea, 2nd Edition, Paperback.

23ADE3101R - EDGE COMPUTING FUNDAMENTALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3101R	EDGE COMPUTING FUNDAMENTALS	ECF	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Edge and Fog Computing and infer the opportunities and challenges	2	PO1, PO2, PO8, PSO1
CO2	Examine the Architectural detail of Edge Computing and explore the issues that are being addressed by the industry	4	PO1, PO2, PO8, PSO1
CO3	Interpret the Security Requirements for Edge Computing and its Middleware needed	4	PO1, PO2, PO8, PSO1
CO4	Evaluate the applicability and need for Edge/Fog Computing in various real-time projects	4	PO2, PO3, PO8, PSO1
CO5	Evaluate computing paradigms using various applications in Edge Computing	4	PO2, PO3, PO8, PSO1
CO6	Design of IoT storage system like key value store	4	PO2, PO3, PO8, PSO1

Syllabus

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Opportunities and Challenges, Addressing the Challenges in Federating Edge Resources

Architecture: Integrating IoT + Fog + Cloud Infrastructures, System Modeling, and Research Challenges, Network Slicing Management in Edge and Fog, Optimization in Fog Computing, Formal Modeling Framework for Fog Computing,

Middleware for Fog and Edge Computing: Design Issues, State-of-the-Art Middleware Infrastructures, A Lightweight Container Middleware for Edge Cloud Architectures, Security and Data Management

Security Management for Edge Cloud Architectures, Applications, and Issues: Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking, Fog Computing Model for Evolving Smart Transportation Applications

Reference Books

- 1 Edge Computing: A Primer , Jie CaoQuan Zhang Weisong Shi , 1st (2018) , Springer.
- 2 Fog and Edge Computing-Simply In-depth , Singh Ajit , 2nd Edition , English Paperback.
- 3 Fog and Edge Computing: Principles and Paradigms , Rajkumar Buyya (Editor), Satish Narayana Sri rama , 1st (2019) , Wiley Publications.
- 4 IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security , Perry Lea , 2nd Edition , Paperback.

23ADE3202A - AI AT THE EDGE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3202A	AI AT THE EDGE	AIAE	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the importance of EDGE computing, ML Ops, and basic technologies in view of IoT using Machine Learning and Deep Learning.	2	PO2, PO4, PSO2
CO2	Practice Hands-on experience to know role of Python packages on data science to interpret the design AI technologies	3	PO1, PO3, PSO2
CO3	Demonstrate Deep learning using classification, Regression, and CNN in view of Natural Language Processing	3	PO2, PSO1
CO4	Practice deploying containers on edge devices using recurrent neural networks, unsupervised learning.	3	PO1, PO3, PSO1
CO5	Devise latest artificial intelligence application technologies pertained to EDGE computing.	4	PO2, PSO2

Syllabus

Importance of Machine Learning principles and Deep Learning principles; Foundations of Edge computing; Full Stack development in context of AI. MLOps -Machine learning and DevOps Cloud-native development Cloud development process flows

Hands-on machine learning development including the main libraries like NumPy, Pandas, Matplotlib, SciKit-Learn

Deep learning development for the main algorithms: Classification using Multi-layer perceptron (MLP) using techniques like dropout, Regression-linear regression, logistic regression, multivariate regression, etc.; Convolutional Neural Networks; Natural Language Processing;

Recurrent Neural Networks; Unsupervised Learning (PCA and K-means); deploy modules using containers on edge devices

Generative Adversarial Networks (GANs), Bayesian approaches to machine learning and deep learning Reinforcement Learning

Reference Books

- 1 "Edge AI: Vision and Voice on TinyML Devices", Pete Warden, Daniel Situnayake, First, O'Reilly .
- 2 "TinyML: Machine Learning with TensorFlow Lite", Pete Warden, Daniel Situnayake, First, O'Reilly.
- 3 AI at the Edge: Solving Real-World Problems with Embedded Machine Learning, Daniel Situnayake (Author), Jenny Plunkett (Author), NA, O'Reilly.
- 4 Artificial Intelligence: A Modern Approach, Russell/Norvig (Author), Fourth, Pearson.
- 5 TinyML Cookbook, Gian Marco Iodice , Second, Pacct Publishing.

23ADE3202E - AI AT THE EDGE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3202E	AI AT THE EDGE	AIAE	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize Deep Learning Techniques using CNN pertained to classification such as image and text analysis.	2	PO2, PO4, PSO2
CO2	Discover deployment of Edge computing applications using predictive analysis techniques such as regression and classification	3	PO1, PO3, PSO2
CO3	Infer problems on generative adversarial networks, reinforcement learning, predictive modelling using AIML techniques	2	PO2, PO4, PSO1
CO4	Predict and classify the differences in real world using regression, time-series and Recurrent Neural Networks.	3	PO1, PO3, PSO1
CO5	Discover to build creative and interactive smart automation applications of generative adversarial networks	4	PO2, PSO2

Syllabus

Image Classification using CNN: Aim to develop an image classification program utilizing Convolutional Neural Networks (CNNs) to classify images into predefined categories, demonstrating understanding of deep learning principles.

Predictive Maintenance for IoT Devices: Develop a predictive maintenance program for IoT devices using machine learning algorithms, such as regression and classification, to predict device failures and optimize maintenance schedules.

Generative Adversarial Network (GAN) for Image Generation: Create a GAN-based program to generate realistic images, demonstrating understanding of generative models and their applications in image synthesis.

Traffic Flow Prediction using Machine Learning: Create a program to predict traffic flow patterns using machine learning algorithms, such as regression and time series analysis, showcasing expertise in transportation analytics.

Chatbot Development for Customer Support: Develop a chatbot program using natural language processing techniques to provide automated responses to customer queries, showcasing proficiency in conversational AI.

Reference Books

- 1 Edge AI: Vision and Voice on TinyML Devices, Pete Warden, Daniel Situnayake, First, O'Reilly.
- 2 TinyML: Machine Learning with TensorFlow Lite, Pete Warden, Daniel Situnayake, First, O'Reilly.
- 3 AI at the Edge: Solving Real-World Problems with Embedded Machine Learning, Daniel Situnayake (Author), Jenny Plunkett (Author), NA, O'Reilly.
- 4 Artificial Intelligence: A Modern Approach, Russell/Norvig, Fourth, Pearson.

23ADE3202R - AI AT THE EDGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3202R	AI AT THE EDGE	AIAE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the importance of EDGE computing, ML Ops, and basic technologies in view of IoT using Machine Learning and Deep Learning	2	PO2, PO3, PSO2
CO2	Demonstrate Deep learning using classification, Regression, and CNN in view of Natural Language Processing	2	PO1, PO4, PSO2
CO3	Practice deploying containers on edge devices using recurrent neural networks, unsupervised learning.	3	PO2, PO3, PSO1
CO4	Relate the AI models with EDGE and devise latest artificial intelligence application technologies pertained to EDGE computing.	3	PO1, PO4, PSO1

Syllabus

Importance of Machine Learning principles and Deep Learning principles Foundations of Edge computing Full Stack development in context of AI. MLOps -Machine learning and DevOps Cloud-native development Cloud development process flows

Hands-on deep learning development for the main algorithms-Classification using Multi-layer perceptron (MLP) by establishing a baseline and improving that baseline using techniques like dropout; Regression -linear regression, logistic regression, multivariate regression, etc.

Convolutional Neural Networks; Natural Language Processing; Recurrent Neural Networks; Autoencoders and Unsupervised Learning (PCA and K-means

Natural Language Processing (NLP), Unsupervised Learning, Learning Generative Adversarial Networks (GANs)

Reference Books

- 1 "Edge AI: Vision and Voice on TinyML Devices, Pete Warden, Daniel Situnayake , First, O'Reilly.
- 2 TinyML: Machine Learning with TensorFlow Lite, Pete Warden, Daniel Situnayake, First, O'Reilly.
- 3 AI at the Edge: Solving Real-World Problems with Embedded Machine Learning, Daniel Situnayake, Jenny Plunkett, NA, O'Reilly.
- 4 Artificial Intelligence: A Modern Approach, Russell, Norvig, Fourth, Pearson.
- 5 TinyML Cookbook, Gian Marco Iodice, Second, Packt Publishing.

23ADE3303A - EDGE AI ARCHITECTURES AND APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3303A	EDGE AI ARCHITECTURES AND APPLICATIONS	EAIAA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of Edge AI, including its principles, advantages, and challenges.	2	PO1, PO6
CO2	Explore various edge AI architectures and their components	2	PO1, PO3
CO3	Learn about AI algorithms optimized for edge deployment.	3	PO1, PO6
CO4	Analyze case studies of real-world edge AI applications across different domains	4	PO3, PO6
CO5	Evaluate the performance and efficiency of Edge AI systems	4	PO4
CO6	Develop and optimize AI algorithms suitable for edge deployment, deploying edge AI solutions on different types of edge devices and platforms	4	PO1, PO3, PS01
CO7	Evaluate the performance and efficiency of edge AI systems through practical experimentation and benchmarking	4	PO4

Syllabus

Introduction to Edge AI, Edge Devices and Platforms: Overview of Edge AI, Principles and Advantages, Challenges and Constraints, Integration of AI with edge computing. Edge Devices and Platforms: Types of edge devices (e.g., IoT devices, smartphones, edge servers), Edge computing platforms and frameworks, Hardware considerations for edge AI

Edge AI Architectures: Centralized vs. decentralized edge architectures, Cloud vs. Edge Computing, Edge Device Characteristics, Edge AI Platform Comparison, Fog computing and cloudlet architectures, Microservices and containerization for edge deployment,

AI Algorithms for Edge Deployment, Optimization Techniques for Edge AI, Optimization Techniques for Edge AI: Model Quantization, Pruning and Compression, Hardware Acceleration

Edge AI Applications, Edge AI Development Tools and Practices: Smart IoT Devices , Autonomous Vehicles, Healthcare Monitoring Systems, Performance metrics and evaluation criteria, Ethical considerations and privacy concerns, Tools for developing and deploying edge AI solutions, Best practices for designing efficient edge architectures, Real-world deployment challenges and mitigation strategies

Privacy and Security in Edge AI, Future Trends in Edge AI: Federated Learning, Secure Model Deployment, Data Privacy Regulations, Edge Computing Paradigms, Edge-to-Cloud Integration, Edge AI in Industry 4.0

Reference Books

- 1 Edge AI: Vision and Challenges. , Lim, Y., Choi, J., & Kim, H. (Eds.), First Edititon, Springer.
- 2 Edge Computing for AIoT: Concepts and Applications., Gupta, G., & Patel, D. , First Edititon, Wiley.
- 3 AI at the Edge, Daniel Situnayake, Jenny Plunkett, Second Edition, O'Reilly Media, Inc.
- 4 Practical Edge AI: Development and Deployment. , Zhang, T., & Lin, J., First Edition, O'Reilly Media.
- 5 Practical Deep Learning for Cloud, Mobile, and Edge, Anirudh Koul, Siddha Ganju, and Meher Kasam, First Edition, O'reilly Media.

23ADE3303E - EDGE AI ARCHITECTURES AND APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3303E	EDGE AI ARCHITECTURES AND APPLICATIONS	EAIAA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of Edge AI, including its principles, advantages, and challenges.	2	PO1, PO6
CO2	Explore various edge AI architectures and their components	2	PO1, PO3
CO3	Learn about AI algorithms optimized for edge deployment.	3	PO1, PO6
CO4	Analyze case studies of real-world edge AI applications across different domains	4	PO3, PO6
CO5	Evaluate the performance and efficiency of Edge AI systems	4	PO4
CO6	Develop and optimize AI algorithms suitable for edge deployment, deploying edge AI solutions on different types of edge devices and platforms	5	PO1, PO3, PS01
CO7	Evaluate the performance and efficiency of edge AI systems through practical experimentation and benchmarking	4	PO4

Syllabus

Introduction to Edge AI, Edge Devices and Platforms: Overview of Edge AI, Principles and Advantages, Challenges and Constraints, Integration of AI with edge computing. Edge Devices and Platforms: Types of edge devices (e.g., IoT devices, smartphones, edge servers), Edge computing platforms and frameworks, Hardware considerations for edge AI

Edge AI Architectures: Centralized vs. decentralized edge architectures, Cloud vs. Edge Computing, Edge Device Characteristics, Edge AI Platform Comparison, Fog computing and cloudlet architectures, Microservices and containerization for edge deployment,

AI Algorithms for Edge Deployment, Optimization Techniques for Edge AI, Optimization Techniques for Edge AI: Model Quantization, Pruning and Compression, Hardware Acceleration

Edge AI Applications, Edge AI Development Tools and Practices: Smart IoT Devices , Autonomous Vehicles, Healthcare Monitoring Systems, Performance metrics and evaluation criteria, Ethical considerations and privacy concerns. Tools for developing and deploying edge AI solutions, Best practices for designing efficient edge architectures, Real-world deployment challenges and mitigation strategies

Privacy and Security in Edge AI, Future Trends in Edge AI: Federated Learning, Secure Model Deployment, Data Privacy Regulations, Edge Computing Paradigms, Edge-to-Cloud Integration, Edge AI in Industry 4.0

Reference Books

- 1 Edge AI: Vision and Challenges., Lim, Y., Choi, J., & Kim, H. (Eds.) , First, Springer .
- 2 Edge Computing for AIoT: Concepts and Applications. , Gupta, G., & Patel, D. , First, Wiley .
- 3 AI at the Edge , Daniel Situnayake, Jenny Plunkett , First , O'Reilly Media, Inc .
- 4 Practical Edge AI: Development and Deployment. , Zhang, T., & Lin, J. , 2022, O'Reilly Media, Inc .
- 5 Practical Deep Learning for Cloud, Mobile, and Edge , Anirudh Koul, Siddha Ganju, and Meher Kasam , 2019, O'Reilly Media.

23ADE3303R - EDGE AI ARCHITECTURES AND APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3303R	EDGE AI ARCHITECTURES AND APPLICATIONS	EAIAA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of Edge AI, including its principles, advantages, and challenges.	2	PO1, PO6
CO2	Explore various edge AI architectures and their components	2	PO1, PO3
CO3	Learn about AI algorithms optimized for edge deployment.	3	PO1, PO6
CO4	Analyze case studies of real-world edge AI applications across different domains	4	PO3, PO6
CO5	Evaluate the performance and efficiency of Edge AI systems	4	PO4
CO6	Develop and optimize AI algorithms suitable for edge deployment, deploying edge AI solutions on different types of edge devices and platforms	5	PO1, PO3, PSO1

Syllabus

Introduction to Edge AI, Edge Devices and Platforms: Overview of Edge AI, Principles and Advantages, Challenges and Constraints, Integration of AI with edge computing. Edge Devices and Platforms: Types of edge devices (e.g., IoT devices, smartphones, edge servers), Edge computing platforms and frameworks, Hardware considerations for edge AI

Edge AI Architectures: Centralized vs. decentralized edge architectures, Cloud vs. Edge Computing, Edge Device Characteristics, Edge AI Platform Comparison, Fog computing and cloudlet architectures, Microservices and containerization for edge deployment,

AI Algorithms for Edge Deployment, Optimization Techniques for Edge AI, Optimization Techniques for Edge AI: Model Quantization, Pruning and Compression, Hardware Acceleration

Edge AI Applications, Edge AI Development Tools and Practices: Smart IoT Devices , Autonomous Vehicles, Healthcare Monitoring Systems, Performance metrics and evaluation criteria, Ethical considerations and privacy concerns, Tools for developing and deploying edge AI solutions, Best practices for designing efficient edge architectures, Real-world deployment challenges and mitigation strategies

Reference Books

- 1 Edge AI: Vision and Challenges., Lim, Y., Choi, J., & Kim, H. (Eds.), 2020, Springer.
- 2 Edge Computing for AIoT: Concepts and Applications., Gupta, G., & Patel, D., 2021, Wiley.
- 3 AI at the Edge, Daniel Situnayake, Jenny Plunkett, first , O'Reilly Media, Inc.
- 4 Practical Edge AI: Development and Deployment., Zhang, T., & Lin, J., First, O'Reilly Media.
- 5 Practical Deep Learning for Cloud, Mobile, and Edge, Anirudh Koul, Siddha Ganju, and Meher Kasam, 2019, O'Reilly Media.

23ADE3404M - EDGE AI AND 5G (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3404M	EDGE AI AND 5G	EAI5G	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the architectural elements, functionality, and operational dynamics of edge computing, AI, and 5G networks.	2	PO1, PO2, PSO1
CO2	Demonstrate and integrate edge computing with AI and 5G technologies for enhanced performance and efficiency	3	PO2, PO3, PSO1
CO3	Implement solutions using EDGE AI and 5G to solve industry-specific problems.	3	PO1, PO4, PSO2
CO4	Evaluate the performance, scalability, and security aspects of EDGE AI systems integrated with 5G	4	PO3, PO5, PSO1

Syllabus

Introduction to Edge Computing,Paradigms of Edge Computing,AI Hardware for Edge Computing,Edge Computing Frameworks,Virtualizing the Edge.Evolution of cellular networks: From 1G to 5G,Key features and architecture of 5G networks,Spectrum considerations and deployment scenarios,3GPP Release Specifications,Network Slicing,Network Function Virtualization,ORAN.Artificial Intelligence Applications on Edge:Real-time Video Analytic,Autonomous Internet of Vehicles (IoVs),Intelligent Manufacturing,Smart Home and City

Artificial Intelligence Inference in Edge Optimization of AI Models. in Edge:General Methods for Model Optimization,Model Optimization for Edge Devices. Segmentation of AI Models,Early Exit of Inference (EEol),Sharing of AI Computation. Artificial Intelligence Training at Edge:Distributed Training at Edge Vanilla Federated Learning at Edge.Resource-Optimized FL,Security-Enhanced FL. A Case Study for Training deep reinforcement learning (DRL) at Edge:Multi-User Edge Computing Scenario,Offloading Strategy for Computing Tasks Based on DRL,Distributed Cooperative Training.

Integration of AI with EDGE and 5G: Deploying AI models at the edge: Benefits and challenges,Hardware and software requirements for Edge AI. Data processing and analytics at the edge.How 5G enables AI at the edge, Real-time data processing with 5G.Use cases: Smart city infrastructure, IoT devices, autonomous vehicles.Integrating AI with IoT and EDGE devices for enhanced decision-making.

Specific AI applications in 5G: network slicing, predictive maintenance, and automated network optimization.Enhanced mobile broadband (eMBB), ultra-reliable low-latency communications (URLLC), and massive machine type communications (mMTC).Machine Learning for Network Optimization:Techniques for traffic prediction, resource allocation, and anomaly detection in 5G network,Application of reinforcement learning for dynamic network optimization.

Reference Books

- 1 Edge AI: Convergence of Edge Computing and Artificial Intelligence , Xiaofei Wang, Yiwen Han, Victor C. M. Leung, Dusit Niyato, Xueqiang Yan, Xu Chen , 2020, Springer.
- 2 5G NR: The next generation wireless access network technology , Erik Dhalman et al., 2018, Academic Press.
- 3 5G Networks: Planning, Design and Optimization , Christofer Larsson , 2018, Academic press.
- 4 AI at the Edge, Daniel Situnayake, Jenny Plunkett, 2023, OREILLY.

23ADE3405M - EDGE AI SECURITY AND PROTECTION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3405M	EDGE AI SECURITY AND PROTECTION	EAISP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts and architecture of edge computing and AI systems	2	PO1
CO2	Apply privacy-preserving techniques and encryption methods to secure data in edge AI applications.	3	PO2, PSO1
CO3	Analyze the effectiveness of different defense mechanisms against adversarial attacks on edge AI systems	4	PO4, PSO2
CO4	Design a secure communication protocol for data transmission in edge AI environments	5	PO3, PSO2

Syllabus

Introduction to Edge Computing, Core Components of Edge Computing Systems, Architecture of Edge Computing Systems, Introduction to Artificial Intelligence, Integration of AI with Edge Computing, Case Studies of Edge Computing and AI Integration, Emerging Trends and Future Directions, Ethical and Legal Considerations.

Data Privacy in Edge AI, Differential Privacy, Homomorphic Encryption, Secure Multiparty Computation (SMPC), Privacy-Preserving Machine Learning Models, Secure Communication Protocols for Edge AI, Case Studies and Practical Applications, Emerging Trends and Future Directions.

Adversarial Attacks, Adversarial Attack Techniques, Defense Mechanisms, Robust Training Methods, Detection and Mitigation Techniques, Cryptographic Approaches, Evaluation of Defense Mechanisms

Secure Communication in Edge AI, Fundamentals of Cryptography, Encryption Techniques for Secure Communication, Authentication and Integrity, Secure Communication Protocols, Network Security in Edge AI, Performance and Scalability, Implementation of Secure Communication.

Reference Books

- 1 Deep Reinforcement Learning: Fundamentals, Research and Applications, Hao Dong, Zihan Ding, and Shanghang Zhang, 2018, Springer Nature Switzerland AG.
- 2 Privacy-Preserving Machine Learning (SpringerBriefs on Cyber Security Systems and Networks), Jin Li, Ping Li, Tong Li, Xiaofeng Chen, Zheli Liu, 2022, Springer Verlag, Singapore.
- 3 Adversarial Machine Learning, Yevgeniy Vorobeychik, Murat Kantarcioglu, 2018, Springer International Publishing AG .
- 4 Cryptography and Network Security Principles and Practice, William Stallings, 2020, Pearson Education.

23ADE3506 - EDGE AI DEVELOPMENT FRAMEWORKS AND TOOLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3506	EDGE AI DEVELOPMENT FRAMEWORKS AND TOOLS	EAIDFT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of edge AI and its significance in distributed computing.	2	PO1, PO2, PO8, PSO1
CO2	Evaluate and select appropriate edge AI development frameworks based on specific use cases and requirements.	3	PO1, PO2, PO8, PSO1
CO3	Develop and deploy AI models on edge devices using leading-edge AI frameworks and tools.	4	PO2, PO3, PO8, PSO1
CO4	Optimize AI models for resource-constrained edge environments, considering factors such as latency, energy efficiency, and model size.	4	PO2, PO3, PO8, PSO1

Syllabus

Introduction to Edge AI Development-Overview of edge computing and its relevance to AI applications.Introduction to edge AI development frameworks and tools.Comparison of cloud-based AI versus edge AI. Hands-on: Setting up development environment and basic edge AI project.

Edge AI Model Development -Techniques for designing lightweight AI models suitable for edge deployment. Transfer learning and model compression for edge devices. Practical considerations for edge AI model development (e.g., latency, power consumption). Hands-on: Developing and training AI models for edge deployment using TensorFlow Lite or similar frameworks

Optimization Techniques for Edge AI-Quantization, pruning, and other optimization techniques to reduce model size and improve performance. Hardware acceleration and inference optimization for edge devices. Benchmarking and performance evaluation of optimized edge AI models. Hands-on: Optimizing AI models for specific edge computing scenarios using optimization tools and techniques.

Edge AI Deployment and Management -Deployment strategies for edge AI models: on-device, edge server, hybrid approaches. Integration of edge AI models with IoT devices and sensors. Managing edge AI deployments: monitoring, updates, and maintenance. Real-world applications and case studies of edge AI deployments across various domains. Hands-on project: Deploying and managing edge AI solutions for specific use cases.

Reference Books

- 1 Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya, Amir Vahid Dastjerdi, and Satish Narayana Srirama, 2019, wiley.
- 2 Edge AI: Vision and Challenges, Amir M. Rahmani, Magdy Bayoumi, and Pasi Liljeberg, 2021, wiley.
- 3 AI at the Edge, Daniel Situnayake, Jenny Plunkett, 2023, O'Reilly Media, Inc..
- 4 Fog and Edge Computing: Simply In-depth, Singh Ajit, 2nd Edition, English PaperBack.

23ADE3507 - EDGE AI ANALYTICS AND DATA MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3507	EDGE AI ANALYTICS AND DATA MANAGEMENT	EAIADM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Fundamentals of AI and Machine Learning Introduction to AI and ML algorithms Supervised, unsupervised, and reinforcement learning Edge-specific ML algorithms and optimizations	2	PO1, PO3, PSO1
CO2	Understand the Edge Data Management Techniques Data collection strategies at the edge Data storage and processing on edge devices Data transmission and synchronization in edge environments	2	PO2, PO4, PSO1
CO3	Apply the Edge Analytics and Insights Introduction to edge analytics Real-time analytics and anomaly detection at the edge Extracting insights from edge data using ML algorithms	3	PO3, PSO2
CO4	Analyse the Deployment Considerations and Performance Optimization for Edge AI	4	PO4, PSO2

Syllabus

Fundamentals of AI and Machine Learning Introduction to AI and ML algorithms Supervised, unsupervised, and reinforcement learning Edge-specific ML algorithms and optimizations

Edge Data Management Techniques Data collection strategies at the edge Data storage and processing on edge devices Data transmission and synchronization in edge environments

Edge Analytics and Insights Introduction to edge analytics Real-time analytics and anomaly detection at the edge Extracting insights from edge data using ML algorithms

Deployment Considerations and Performance Optimization for Edge AI and data management

Reference Books

- 1 Edge Computing for Computer Vision, David V. James, 1, Apress.
- 2 Edge Computing: Models, Technologies, and Applications, Danda B. Rawat, Joel J.P.C. Rodrigues, and Ivan Stojmenovic, 1, CRC Press.
- 3 Edge Analytics in IoT: Data Science at the Edge, Ajit Jaokar, 1, Apress.
- 4 Edge Computing for Internet of Things: A Paradigm for Data Management, Processing and Analytics, K. Raghunandan, Prathima Agrawal, 1, Springer.

23ADE3508 - EDGE AI AND SUSTAINABILITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ADE3508	EDGE AI AND SUSTAINABILITY	EAIAS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of Edge AI and its applications in sustainable development	2	PO1, PO7
CO2	Apply Edge AI algorithms to optimize resource consumption and improve energy efficiency	4	PO3, PO5, PO7
CO3	Critically evaluate the effectiveness of Edge AI solutions in addressing sustainability challenges	5	PO7
CO4	Discuss the ethical considerations associated with the deployment of Edge AI technologies in sustainable development	2	

Syllabus

Introduction to Edge AI and Sustainability: Overview of Edge Computing and Artificial Intelligence, Sustainable Development Goals (SDGs), Challenges in achieving sustainability goals and the role of technology

Edge AI Techniques for Resource Optimization: Edge Computing Architectures, Machine Learning at the Edge, Optimization Algorithms: Overview of optimization techniques for resource-constrained environments, Optimization objectives: latency reduction, energy efficiency, bandwidth conservation, Edge-specific optimization algorithms such as federated learning, reinforcement learning, and evolutionary algorithms

Edge AI Applications in Energy Management: Smart Grids and Energy Distribution, Predictive Maintenance for Renewable Energy Systems, Energy-efficient Edge Computing: Comparison with traditional cloud computing in terms of energy consumption, Energy-aware Edge Device Design, Dynamic Voltage and Frequency Scaling (DVFS), Task Offloading and Load Balancing,

Ethical and Societal Implications of Edge AI in Sustainability: Ethical Frameworks for AI Development, Bias and Fairness in Edge AI Algorithms, Privacy and Data Security Concerns Regulatory and Policy Considerations

Reference Books

- 1 Edge AI: Making Robots Smarter, Howard Dong, Xiaodong Xiong, Zhihua Zhang, 1st Edition, O'Reilly Media.
- 2 Sustainable Development Goals: Their Impact on ICT and the Role of ICT in Achieving Them, Richard Heeks, 1st Edition, Springer.
- 3 Machine Learning for Edge Computing: A Paradigm Shift, Pranshu Pandey, Snehanishu Sengupta, 1st Edition, CRC Press.
- 4 Ethics of Artificial Intelligence and Robotics, Rafael Capurro, Michael Nagenborg, Johannes Holbrook, 1st Edition, Springer.
- 5 Sustainable Edge Computing: Concepts, Challenges, and Applications, Arup Mitra, Kunal Sharma, 1st Edition, Wiley.
- 6 Designing Edge Computing Solutions for Sustainable Development, Lei Wang, Wenjia Huang, 1st Edition, Elsevier.

23AEA3101A - AUTOMOTIVE SENSOR AND APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3101A	AUTOMOTIVE SENSOR AND APPLICATIONS	ASA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the core functionalities of modern automotive systems, including the roles of ECUs, sensor integration, and key subsystems.	3	PO1, PO5, PO11, PSO2
CO2	Analyze the function and application of diverse sensors within engine management systems to achieve optimal engine performance and minimize emissions.	4	PO1, PO5, PO11, PSO2
CO3	Apply how sensor data is utilized to achieve advanced functionalities in powertrain and vehicle motion control systems.	3	PO1, PO5, PO11, PSO2
CO4	Analyze the effectiveness of sensor integration within active and passive safety systems, considering the influence of electronic components and communication protocols.	4	PO1, PO5, PO11, PSO2
CO5	Analyze basic sensor-based systems for automotive applications.	4	PO1, PO5, PO11, PSO2
CO6	Evaluate the applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	6	PO1, PO5, PO11, PSO2
CO7	Develop case studies for applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	6	PO1, PO5, PO11, PSO2

Syllabus

Introduction to Automotive Systems Current trends in automobiles: Electrification, automation, and connectivity. Overview of automotive control systems: Electronic Control Units (ECUs) and sensor integration. Introduction to typical automotive subsystems and components. Introduction to AUTOSAR (Automotive Open System Architecture).

Engine Management Systems Basic sensor arrangement in engine management systems. Types of engine sensors: Oxygen sensors (lambda sensors) Crank angle position sensors Throttle position sensors (TPS) Air mass flow (MAF) sensors Temperature sensors (coolant, intake air) Speed sensors Algorithms for engine control: Open-loop and closed-loop systems. Electronic ignition systems. Exhaust Gas Recirculation (EGR) for emission control.

Vehicle Powertrain and Motion Control Electronic transmission control systems. Adaptive power steering. Adaptive cruise control. Safety and comfort systems: Anti-lock Braking System (ABS) Traction Control System (TCS) Electronic Stability Control (ESC) Active suspension control Sensor applications in powertrain and motion control systems.

Active and Passive Safety Systems Body electronics: Lighting control, remote keyless entry, immobilizers, etc. Electronic instrument clusters and dashboard electronics. Design considerations for automotive electronics: Electromagnetic interference (EMI) suppression Electrostatic compatibility (EMC) Sensor applications in active and passive safety systems, Automotive Standards and Protocols Introduction to automotive communication protocols: CAN (Controller Area Network)

Electrification in Automotive Systems: Proficiency in Electric Vehicle Simulation. **Automation in Automotive Systems:** Mastery in Autonomous Vehicle Control. **Connectivity in Automotive Systems:** Competence in CAN Bus Communication. **Powertrain Demonstration:** Ability to Measure Engine RPM. **Chassis Experiment:** Skill in ABS Sensor Testing. **Body Electronics Experiment:** Capability in Interior Light Control. **Gas Sensor Integration:** Skill in integrating gas sensors with development boards and implementing alert systems. **Lighting System Programming:** Proficiency in programming development boards to control vehicle lighting and automate lighting functions based on environmental and vehicle conditions. **Lighting Control System Testing:** Ability to test and verify the functionality of lighting control systems for various scenarios.

Reference Books

- 1 Automotive Sensors, John Turner, 2009, Momentum Press.
- 2 Sensors and Actuators in Mechatronics Design and Applications, Andrzej M Pawlak, 2006, CRC Press.
- 3 Automotive Electronics Design Fundamentals, Najamuz Zaman, 2015, Springer Cham.
- 4 Automotive Mechatronics: Operational and Practical Issues, Konrad Reif, 2014, Springer.
- 5 Automotive Sensors and Instrumentation, M. P. Gerrard, 1992, SAE International.

23AEA3101E - AUTOMOTIVE SENSOR AND APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3101E	AUTOMOTIVE SENSOR AND APPLICATIONS	ASA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the core functionalities of modern automotive systems, including the roles of ECUs, sensor integration, and key subsystems.	3	PO1, PO5, PO11, PSO2
CO2	Analyze the function and application of diverse sensors within engine management systems to achieve optimal engine performance and minimize emissions.	4	PO1, PO5, PO11, PSO2
CO3	Apply how sensor data is utilized to achieve advanced functionalities in powertrain and vehicle motion control systems.	3	PO1, PO5, PO11, PSO2
CO4	Analyze the effectiveness of sensor integration within active and passive safety systems, considering the influence of electronic components and communication protocols.	4	PO1, PO5, PO11, PSO2
CO5	Analyze basic sensor-based systems for automotive applications.	5	PO1, PO5, PO11, PSO2
CO6	Evaluate the applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	5	PO1, PO5, PO11, PSO2
CO7	Develop Case studies for applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	6	PO1, PO5, PO11, PSO2

Syllabus

Introduction to Automotive Systems Current trends in automobiles: Electrification, automation, and connectivity. Overview of automotive control systems: Electronic Control Units (ECUs) and sensor integration. Introduction to typical automotive subsystems and components. Introduction to AUTOSAR (Automotive Open System Architecture).

Engine Management Systems Basic sensor arrangement in engine management systems. Types of engine sensors: Oxygen sensors (lambda sensors) Crank angle position sensors Throttle position sensors (TPS) Air mass flow (MAF) sensors Temperature sensors (coolant, intake air) Speed sensors Algorithms for engine control: Open-loop and closed-loop systems. Electronic ignition systems. Exhaust Gas Recirculation (EGR) for emission control.

Vehicle Powertrain and Motion Control Electronic transmission control systems. Adaptive power steering. Adaptive cruise control. Safety and comfort systems: Anti-lock Braking System (ABS) Traction Control System (TCS) Electronic Stability Control (ESC) Active suspension control Sensor applications in powertrain and motion control systems.

Active and Passive Safety Systems Body electronics: Lighting control, remote keyless entry, immobilizers, etc. Electronic instrument clusters and dashboard electronics. Design considerations for automotive electronics: Electromagnetic interference (EMI) suppression Electrostatic compatibility (EMC) Sensor applications in active and passive safety systems, Automotive Standards and Protocols Introduction to automotive communication protocols: CAN (Controller Area Network)

Electrification in Automotive Systems: Proficiency in Electric Vehicle Simulation. Automation in Automotive Systems: Mastery in Autonomous Vehicle Control. Connectivity in Automotive Systems: Competence in CAN Bus Communication. Powertrain Demonstration: Ability to Measure Engine RPM. Chassis Experiment: Skill in ABS Sensor Testing. Body Electronics Experiment: Capability in Interior Light Control. Gas Sensor Integration: Skill in integrating gas sensors with development boards and implementing alert systems. Lighting System Programming: Proficiency in programming development boards to control vehicle lighting and automate lighting functions based on environmental and vehicle conditions. Lighting Control System Testing: Ability to test and verify the functionality of lighting control systems for various scenarios.

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- 1 Automotive Sensors, John Turner, 2009, Momentum Press.
- 2 Sensors and Actuators in Mechatronics Design and Applications, Andrzej M Pawlak, 2006, CRC Press.
- 3 Automotive Electronics Design Fundamentals, Najamuz Zaman, 2015, Springer Cham.
- 4 Automotive Mechatronics: Operational and Practical Issues, Konrad Reif, 2014, Springer.
- 5 Automotive Sensors and Instrumentation, M. P. Gerrard, 1992, SAE International.

23AEA3101R - AUTOMOTIVE SENSOR AND APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3101R	AUTOMOTIVE SENSOR AND APPLICATIONS	ASA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the core functionalities of modern automotive systems, including the roles of ECUs, sensor integration, and key subsystems.	3	PO1, PO5, PO11, PSO2
CO2	Analyze the function and application of diverse sensors within engine management systems to achieve optimal engine performance and minimize emissions.	4	PO1, PO5, PO11, PSO2
CO3	Analyze how sensor data is utilized to achieve advanced functionalities in powertrain and vehicle motion control systems.	4	PO1, PO5, PO11, PSO2
CO4	Analyze the effectiveness of sensor integration within active and passive safety systems, considering the influence of electronic components and communication protocols.	4	PO1, PO5, PO11, PSO2
CO5	Evaluate the applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	5	PO1, PO5, PO11, PSO2
CO6	Develop Case studies for applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	6	PO1, PO5, PO11, PSO2

Syllabus

Introduction to Automotive Systems Current trends in automobiles: Electrification, automation, and connectivity. Overview of automotive control systems: Electronic Control Units (ECUs) and sensor integration. Introduction to typical automotive subsystems and components. Introduction to AUTOSAR (Automotive Open System Architecture).

Engine Management Systems Basic sensor arrangement in engine management systems. Types of engine sensors: Oxygen sensors (lambda sensors) Crank angle position sensors Throttle position sensors (TPS) Air mass flow (MAF) sensors Temperature sensors (coolant, intake air) Speed sensors Algorithms for engine control: Open-loop and closed-loop systems. Electronic ignition systems. Exhaust Gas Recirculation (EGR) for emission control.

Vehicle Powertrain and Motion Control Electronic transmission control systems. Adaptive power steering. Adaptive cruise control. Safety and comfort systems: Anti-lock Braking System (ABS) Traction Control System (TCS) Electronic Stability Control (ESC) Active suspension control Sensor applications in powertrain and motion control systems.

Active and Passive Safety Systems Body electronics: Lighting control, remote keyless entry, immobilizers, etc. Electronic instrument clusters and dashboard electronics. Design considerations for automotive electronics: Electromagnetic interference (EMI) suppression Electrostatic compatibility (EMC) Sensor applications in active and passive safety systems, Automotive Standards and Protocols Introduction to automotive communication protocols: CAN (Controller Area Network)

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- 1 Automotive Sensors, John Turner, 2009, Momentum Press.
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- 3 Automotive Electronics Design Fundamentals, Najamuz Zaman, 2015, Springer Cham.
- 4 Automotive Mechatronics: Operational and Practical Issues, Konrad Reif, 2014, Springer.
- 5 Automotive Sensors and Instrumentation, M. P. Gerrard, 1992, SAE International.

23AEA3202A - AUTOTRONICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3202A	AUTOTRONICS	AT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of sensors for engine management	3	PO1, PO2, PO4, PSO1
CO2	Apply the concept of control of fuel systems	3	PO1, PO2, PO3, PSO1
CO3	Apply the concept for Electronically controlled Injection and actuators	3	PO1, PO3, PO4, PSO1
CO4	Analyze and design OBD tools	4	PO1, PO2, PO4, PSO2
CO5	Analyze and apply theoretical concepts to develop mathematical models and simulate	5	PO2, PO3, PO7, PSO2
CO6	Analyze the components of fuel system and compare their performance	5	PO2, PO3, PO7, PSO2

Syllabus

Concept of Sensor Functions: Types of sensors and their principles of operation, Applications of sensors in measurement, monitoring, and control systems. Control Functions: Fundamentals of control systems and feedback mechanisms, Analysis of control algorithms, stability criteria, and system optimization.

Sensors for Fuel Injection Systems: Types of sensors used in fuel injection systems (e.g., mass airflow sensors, oxygen sensors), Role of sensors in monitoring air-fuel ratio and engine load for optimal fuel delivery. Metering Controls: Principles of metering fuel flow and injection timing control, Application of sensors in regulating fuel quantity and timing based on engine operating conditions. Timing Controls: Types of sensors involved in timing control (e.g., crankshaft position sensors, camshaft position sensors), Importance of precise timing for ignition and fuel injection synchronization in engine operation.

Electronic Control Management: Fundamentals of electronic control units (ECUs) in fuel injection systems, Algorithms and strategies for precise control of high-pressure fuel delivery and injection timing.

Analysis of OBD1 and OBD2: Differences in architecture, protocols, and diagnostic capabilities between OBD1 and OBD2 systems, Control strategies and fault detection methods used in OBD1 and OBD2 for vehicle diagnostics and emissions control.

Components of the Fuel System: Examination of key fuel system components such as fuel pumps, injectors, and filters. Performance Comparison: Comparative analysis of performance, efficiency, and reliability of different fuel system components.

Reference Books

- 1 Autotronics, P.N.Sankar, 2015, Geometric Publishers.
- 2 Automotive Electronics, Bosch, 2014, Bosch.
- 3 Auto Electrical and Electronics Equipments (Automotive Electrical Systems and Autotronics), R.B. Gupta, 2021, Satya Prakashan.
- 4 A Textbook of Automobile Engineering, S.K. Gupta, 2020, S. Chand Publishers.

23AEA3202E - AUTOTRONICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3202E	AUTOTRONICS	AT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of sensors for engine management	3	PO1, PO2, PO4, PSO1
CO2	Apply the concept of control of fuel systems	3	PO1, PO2, PO3, PSO1
CO3	Apply the concept for Electronically controlled Injection and actuators	3	PO1, PO3, PO4, PSO1
CO4	Analyze and design OBD tools	4	PO1, PO2, PO4, PSO2
CO5	Analyze and apply theoretical concepts to develop mathematical models and simulate	5	PO2, PO3, PO7, PSO2

Syllabus

Concept of Sensor Functions: Types of sensors and their principles of operation, Applications of sensors in measurement, monitoring, and control systems. Control Functions: Fundamentals of control systems and feedback mechanisms, Analysis of control algorithms, stability criteria, and system optimization.

Sensors for Fuel Injection Systems: Types of sensors used in fuel injection systems (e.g., mass airflow sensors, oxygen sensors), Role of sensors in monitoring air-fuel ratio and engine load for optimal fuel delivery. Metering Controls: Principles of metering fuel flow and injection timing control, Application of sensors in regulating fuel quantity and timing based on engine operating conditions. Timing Controls: Types of sensors involved in timing control (e.g., crankshaft position sensors, camshaft position sensors), Importance of precise timing for ignition and fuel injection synchronization in engine operation.

Electronic Control Management: Fundamentals of electronic control units (ECUs) in fuel injection systems, Algorithms and strategies for precise control of high-pressure fuel delivery and injection timing.

Analysis of OBD1 and OBD2: Differences in architecture, protocols, and diagnostic capabilities between OBD1 and OBD2 systems, Control strategies and fault detection methods used in OBD1 and OBD2 for vehicle diagnostics and emissions control.

Components of the Fuel System: Examination of key fuel system components such as fuel pumps, injectors, and filters. Performance Comparison: Comparative analysis of performance, efficiency, and reliability of different fuel system components.

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- 2 Automotive Electronics, Bosch, 2014, Bosch.
- 3 Auto Electrical and Electronics Equipments (Automotive Electrical Systems and Autotronics), R.B. Gupta, 2021, Satya Prakashan.
- 4 A Textbook of Automobile Engineering, S.K. Gupta, 2020, S. Chand Publishers.

23AEA3202R - AUTOTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3202R	AUTOTRONICS	AT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of sensors for engine management	3	PO1, PO2, PSO1
CO2	Apply the concept of control of fuel systems	3	PO1, PO2, PO3, PSO1
CO3	Apply the concept for Electronically controlled Injection and actuators	3	PO1, PO3, PO4, PSO1
CO4	Analyze and design OBD tools	4	PO1, PO2, PO4, PSO2

Syllabus

Concept of Sensor Functions: Types of sensors and their principles of operation, Applications of sensors in measurement, monitoring, and control systems. Control Functions: Fundamentals of control systems and feedback mechanisms, Analysis of control algorithms, stability criteria, and system optimization.

Sensors for Fuel Injection Systems: Types of sensors used in fuel injection systems (e.g., mass airflow sensors, oxygen sensors), Role of sensors in monitoring air-fuel ratio and engine load for optimal fuel delivery. Metering Controls: Principles of metering fuel flow and injection timing control, Application of sensors in regulating fuel quantity and timing based on engine operating conditions. Timing Controls: Types of sensors involved in timing control (e.g., crankshaft position sensors, camshaft position sensors), Importance of precise timing for ignition and fuel injection synchronization in engine operation.

Electronic Control Management: Fundamentals of electronic control units (ECUs) in fuel injection systems, Algorithms and strategies for precise control of high-pressure fuel delivery and injection timing.

Analysis of OBD1 and OBD2: Differences in architecture, protocols, and diagnostic capabilities between OBD1 and OBD2 systems, Control strategies and fault detection methods used in OBD1 and OBD2 for vehicle diagnostics and emissions control.

Reference Books

- 1 Autotronics, P.N.Sankar, 2015, Geometric publishers.
- 2 Automotive Electronics, Bosch, 2014, Bosch.
- 3 Auto Electrical and Electronics Equipments (Automotive Electrical Systems and Autotronics), R.B. Gupta, 2021, Satya Prakashan.
- 4 A Textbook of Automobile Engineering, S.K. Gupta, 2020, S. Chand Publishers.

23AEA3203A - AUTOMOTIVE POLLUTION AND ITS CONTROL (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3203A	AUTOMOTIVE POLLUTION AND ITS CONTROL	APC	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interprete vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution	3	PO1, PO7
CO2	Illustrate about pollutant formation in SI Engine, mechanism of HC , CO and NO in SI engine, exhaust emission and factors affecting the emission, evaporative emission, crankcase emission, lead emission	3	PO1, PO7
CO3	Illustrate about pollutant formation in CI Engine, mechanism of HC , CO and NO in CI engine, exhaust emission and factors affecting the emission. evaporative emission, crankcase emission, lead emission	3	PO1, PO7
CO4	Analyze about noise, Vibration And Harshness, Sources of Noise, Measurement of Noise -Engine combustion noise, - control of noise, control devices and noise proof materials	4	PO1, PO7
CO5	Demonstrate about the working NDIR, FID, Chemiluminescent analyzers, Gas Chromatograph, smoke meters, emission standards.	3	PO1, PO7

Syllabus

Vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution

Pollutant formation in SI Engine, mechanism of HC , CO and NO in SI engine, exhaust emission and factors affecting the emission, evaporative emission, crankcase emission, lead emission

Design strategies to control emission from engines, effect of design and operating parameters on emission concentrations, modification in the engine design.

Noise, Vibration And Harshness, Sources of Noise, Measurement of Noise -Engine combustion noise, - control of noise, control devices and noise proof materials

Reference Books

- 1 Internal Combustion Engines, V Ganesan, 8, McGraw Hill.
- 2 Internal Combustion Engines, Obert,E.F., 5, New Age International Publishers.
- 3 Environmental Pollution and Control, J. Jeffrey Peirce, P. Aarne Vesilind, Ruth F. Weiner, 4, Elsevier Science & Technology Books.

23AEA3203E - AUTOMOTIVE POLLUTION AND ITS CONTROL (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3203E	AUTOMOTIVE POLLUTION AND ITS CONTROL	APC	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interprete vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution	3	PO1, PO7
CO2	Illustrate about pollutant formation in SI Engine, mechanism of HC , CO and NO in SI engine, exhaust emission and factors affecting the emission, evaporative emission, crankcase emission, lead emission	3	PO1, PO7
CO3	Illustrate about pollutant formation in CI Engine, mechanism of HC , CO and NO in CI engine, exhaust emission and factors affecting the emission. evaporative emission, crankcase emission, lead emission	3	PO1, PO7
CO4	Analyze about noise, Vibration And Harshness, Sources of Noise, Measurement of Noise -Engine combustion noise, - control of noise, control devices and noise proof materials	4	PO1, PO7
CO5	Demonstrate about the working NDIR, FID, Chemiluminescent analyzers, Gas Chromatograph, smoke meters, emission standards.	3	PO1, PO7

Syllabus

Vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution

Pollutant formation in SI Engine, mechanism of HC , CO and NO in SI engine, exhaust emission and factors affecting the emission, evaporative emission, crankcase emission, lead emission

Pollutant formation in CI Engine, mechanism of HC , CO and NO in SI engine, exhaust emission and factors affecting the emission.

Design strategies to control emission from engines, effect of design and operating parameters on emission concentrations, modification in the engine design.

Noise, Vibration And Harshness, Sources of Noise, Measurement of Noise -Engine combustion noise, - control of noise, control devices and noise proof materials

Reference Books

- 1 Internal Combustion Engines, V Ganesan, 1, McGraw Hill..
- 2 Pollutant Formation and Control in Combustion, L. D. Smoot, 1, Springer.
- 3 Environmental Pollution and Control, J. Jeffrey Peirce, P. Aarne Vesilind, Ruth F. Weiner, 4, Elsevier .

23AEA3203R - AUTOMOTIVE POLLUTION AND ITS CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3203R	AUTOMOTIVE POLLUTION AND ITS CONTROL	APC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interprete vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution	3	PO1, PO7
CO2	Illustrate about pollutant formation in SI Engine, mechanism of HC , CO and NO in SI engine, exhaust emission and factors affecting the emission, evaporative emission, crankcase emission, lead emission	3	PO1, PO7
CO3	Design strategies to control emission from engines, effect of design and operating parameters on emission concentrations, modification in the engine design.	3	PO1, PO7
CO4	Analyze about noise, Vibration And Harshness, Sources of Noise, Measurement of Noise -Engine combustion noise, - control of noise, control devices and noise proof materials	4	PO1, PO7

Syllabus

Vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution

Pollutant formation in SI Engine, mechanism of HC , CO and NO in SI engine, exhaust emission and factors affecting the emission, evaporative emission, crankcase emission, lead emission

Design strategies to control emission from engines, effect of design and operating parameters on emission concentrations, modification in the engine design.

Noise, Vibration And Harshness, Sources of Noise, Measurement of Noise -Engine combustion noise, - control of noise, control devices and noise proof materials

Reference Books

- 1 Internal Combustion Engines, V Ganesan, 8, McGraw Hill.
- 2 Internal Combustion Engines, Obert,E.F., 5, New Age International Publishers.
- 3 Environmental Pollution and Control, J. Jeffrey Peirce, P. Aarne Vesilind, Ruth F. Weiner, 4, Elsevier Science & Technology Books.

23AEA3304A - ALTERNATE DRIVES, TRACTION AND CONTROLS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3304A	ALTERNATE DRIVES, TRACTION AND CONTROLS	ADTC	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of alternate technologies	3	PO1, PO2
CO2	Apply the concept of speed and torque for automotive requirements	3	PO1, PO2
CO3	Apply the concept for Hybrid architecture design	3	PO1, PO2
CO4	Analyze the Concept of fuel cells	4	PO1, PO2
CO5	Analyze power electronics dynamics and control	5	PO1, PO2
CO6	Analyze the dynamic stability of the vehicle	6	PO3
CO7	Apply the concept of hybrid vehicles and design drive layouts	6	PO3

Syllabus

Concept of Alternate Technology for Vehicle Drives: Overview of alternative propulsion technologies such as electric, hybrid, hydrogen fuel cells, and compressed air. Comparative analysis of these technologies in terms of efficiency, emissions, and feasibility. Design and Integration: Principles of designing vehicle systems using alternative technologies. Challenges and considerations in integrating alternative drives into existing vehicle platforms. Future Trends and Innovations: Emerging trends and advancements in alternative vehicle drive technologies, Potential impacts on the automotive industry and transportation infrastructure.

Alternate Drive Controls: Implementation of control systems for alternative propulsion technologies (electric, hybrid, hydrogen fuel cells). Strategies for optimizing performance, efficiency, and responsiveness. Traction Requirements: Analysis of traction control requirements for different driving conditions and vehicle types. Integration of traction control systems with alternate drives for improved stability and safety. System Optimization and Testing: Techniques for testing and fine-tuning control systems and traction requirements. Evaluation of system performance under various operational scenarios.

Hybrid Vehicles: Principles and types of hybrid vehicle systems (series, parallel, and plug-in hybrids). Key components and their functions in hybrid powertrains. Design Drive Layouts: Designing drive layouts for optimal performance and efficiency in hybrid vehicles. Integration of electric motors, internal combustion engines, and energy storage systems.

Fuel Cell Vehicles: Principles of fuel cell operation and types of fuel cells used in vehicles. Advantages, challenges, and applications of fuel cell technology in transportation. Drive Trains: Design and components of fuel cell vehicle drive trains. Integration and optimization of fuel cells with electric motors and energy storage systems.

Dynamic Stability of Vehicles: Principles of vehicle dynamics and stability, including roll, pitch, and yaw behavior. Analysis of factors affecting stability, such as suspension design, weight distribution, and electronic stability control systems.

Reference Books

- 1 Modern Electric, Hybrid Electric and Fuel Cell Vehicles, Mehrdad Ehsani, 2015, CRC Press.
- 2 Electric & Hybrid Vehicles, Iqbal Hussein , 2015, CRC Press.
- 3 Fundamentals of Vehicle Dynamics, Thomas gillespie, 1992, SAE International.
- 4 Power Electronics and Electric Drives for Traction Applications, Gonzalo Abad, 2016, Wiley.

23AEA3304E - ALTERNATE DRIVES, TRACTION AND CONTROLS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3304E	ALTERNATE DRIVES, TRACTION AND CONTROLS	ADTC	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of alternate technologies	3	PO1, PO2
CO2	Apply the concept of speed and torque for automotive requirements	3	PO1, PO2
CO3	Apply the concept for Hybrid architecture design	3	PO1, PO2
CO4	Analyze the Concept of fuel cells	4	PO1, PO2
CO5	Analyze power electronics dynamics and control	5	PO1, PO2
CO6	Analyze the dynamic stability of the vehicle	6	PO3
CO7	Apply the concept of hybrid vehicles and design drive layouts	6	PO3

Syllabus

Concept of Alternate Technology for Vehicle Drives: Overview of alternative propulsion technologies such as electric, hybrid, hydrogen fuel cells, and compressed air. Comparative analysis of these technologies in terms of efficiency, emissions, and feasibility. Design and Integration: Principles of designing vehicle systems using alternative technologies. Challenges and considerations in integrating alternative drives into existing vehicle platforms. Future Trends and Innovations: Emerging trends and advancements in alternative vehicle drive technologies, Potential impacts on the automotive industry and transportation infrastructure.

Alternate Drive Controls: Implementation of control systems for alternative propulsion technologies (electric, hybrid, hydrogen fuel cells). Strategies for optimizing performance, efficiency, and responsiveness. Traction Requirements: Analysis of traction control requirements for different driving conditions and vehicle types. Integration of traction control systems with alternate drives for improved stability and safety. System Optimization and Testing: Techniques for testing and fine-tuning control systems and traction requirements. Evaluation of system performance under various operational scenarios.

Hybrid Vehicles: Principles and types of hybrid vehicle systems (series, parallel, and plug-in hybrids). Key components and their functions in hybrid powertrains. Design Drive Layouts: Designing drive layouts for optimal performance and efficiency in hybrid vehicles. Integration of electric motors, internal combustion engines, and energy storage systems.

Fuel Cell Vehicles: Principles of fuel cell operation and types of fuel cells used in vehicles. Advantages, challenges, and applications of fuel cell technology in transportation. Drive Trains: Design and components of fuel cell vehicle drive trains. Integration and optimization of fuel cells with electric motors and energy storage systems.

Dynamic Stability of Vehicles: Principles of vehicle dynamics and stability, including roll, pitch, and yaw behavior. Analysis of factors affecting stability, such as suspension design, weight distribution, and electronic stability control systems.

Reference Books

- 1 Modern Electric, Hybrid Electric and Fuel Cell Vehicles, Mehrdad Ehsani, 2015, CRC publisher.
- 2 Electric & Hybrid Vehicles, Iqbal Hussein, 2018, CRC Publisher.
- 3 Fundamentals of Vehicle Dynamics, Thomas Gillespie, 1992, SAE International.
- 4 Power Electronics and Electric Drives for Traction Applications, Gonzalo Abad, 2016, Wiley.

23AEA3304R - ALTERNATE DRIVES, TRACTION AND CONTROLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3304R	ALTERNATE DRIVES, TRACTION AND CONTROLS	ADTC	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of alternate technologies	3	PO1, PO2
CO2	Apply the concept of speed and torque for automotive requirements	3	PO1, PO2
CO3	Apply the concept for Hybrid architecture design	3	PO1, PO2
CO4	Analyze the Concept of fuel cells	4	PO1, PO2
CO5	Analyze power electronics dynamics and control	5	PO1, PO2
CO6	Analyze various drives and compare their performance	6	PO3

Syllabus

Concept of Alternate Technology for Vehicle Drives: Overview of alternative propulsion technologies such as electric, hybrid, hydrogen fuel cells, and compressed air. Comparative analysis of these technologies in terms of efficiency, emissions, and feasibility. Design and Integration: Principles of designing vehicle systems using alternative technologies. Challenges and considerations in integrating alternative drives into existing vehicle platforms. Future Trends and Innovations: Emerging trends and advancements in alternative vehicle drive technologies, Potential impacts on the automotive industry and transportation infrastructure.

Alternate Drive Controls: Implementation of control systems for alternative propulsion technologies (electric, hybrid, hydrogen fuel cells). Strategies for optimizing performance, efficiency, and responsiveness. Traction Requirements: Analysis of traction control requirements for different driving conditions and vehicle types. Integration of traction control systems with alternate drives for improved stability and safety. System Optimization and Testing: Techniques for testing and fine-tuning control systems and traction requirements. Evaluation of system performance under various operational scenarios.

Hybrid Vehicles: Principles and types of hybrid vehicle systems (series, parallel, and plug-in hybrids). Key components and their functions in hybrid powertrains. Design Drive Layouts: Designing drive layouts for optimal performance and efficiency in hybrid vehicles. Integration of electric motors, internal combustion engines, and energy storage systems.

Fuel Cell Vehicles: Principles of fuel cell operation and types of fuel cells used in vehicles. Advantages, challenges, and applications of fuel cell technology in transportation. Drive Trains: Design and components of fuel cell vehicle drive trains. Integration and optimization of fuel cells with electric motors and energy storage systems.

Dynamic Stability of Vehicles: Principles of vehicle dynamics and stability, including roll, pitch, and yaw behavior. Analysis of factors affecting stability, such as suspension design, weight distribution, and electronic stability control systems.

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- 3 Fundamentals of Vehicle Dynamics, Thomas Gillespie, 1992, SAE International.
- 4 Power Electronics and Electric Drives for Traction Applications, Gonzalo Abad, 2016, Wiley.

23AEA3405M - VEHICLE CONTROL SYSTEMS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3405M	VEHICLE CONTROL SYSTEMS	VCS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Classical Control Techniques for Vehicle Dynamics and Modeling	3	PO1
CO2	Apply, Develop, and Put into Practice Vehicle-Specific Control Systems	3	PO1, PO2
CO3	Applying modelling and simulation tools, apply the development of advanced vehicle control systems	3	PO2, PO3, PO4
CO4	Apply the development of vehicle control in case studies and current research.	3	

Syllabus

Overview of Vehicle Dynamics: Basic concepts of vehicle dynamics, Longitudinal, lateral, and vertical dynamics, Vehicle modeling; Control Systems Fundamentals: Introduction to control theory, Linear systems and control, State-space representation

Classical Control Techniques: PID Control, Proportional-Integral-Derivative control theory, Tuning methods, Implementation in vehicle systems; Frequency Domain Analysis, Bode plots, Nyquist criteria, Stability analysis, Application to vehicle control; Modern Control Techniques: State-Space Control, State-space models, Observability and controllability, Pole placement and state feedback

Optimal Control: Linear Quadratic Regulator (LQR), Application to vehicle stability and control; Adaptive and Robust Control: Concepts of adaptive control, Robust control techniques, Implementation in uncertain environments; Vehicle-Specific Control Systems: Anti-lock Braking System (ABS), ABS fundamentals, Control algorithms, Performance analysis

Traction Control System (TCS): TCS fundamentals, Control strategies, Integration with vehicle dynamics; Electronic Stability Program (ESP): ESP fundamentals, Control logic, Real-world applications; Autonomous Vehicle Control: Sensor fusion, Path planning and control, Autonomous driving architectures; Hybrid and Electric Vehicle Control: Energy management strategies, Control of electric drives, Regenerative braking systems

Reference Books

- 1 Vehicle Dynamics and Control, Rajesh Rajamani, 2nd (2011), Springer.
- 2 Automotive Control Systems: For Engine, Driveline, and Vehicle, Uwe Kiencke and Lars Nielsen, 2nd (2005), Springer.
- 3 Modern Control Engineering, Katsuhiko Ogata, 5th (2010), Prentice Hall.
- 4 The Automotive Chassis: Engineering Principles, Reza N. Jazar, 2nd (2014), Springer.
- 5 Fundamentals of Vehicle Dynamics, Thomas D. Gillespie, 1st (1992), Society of Automotive Engineers (SAE).

23AEA3406M - AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3406M	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	AEES	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of Automotive Electronics	3	PO1, PO2, PO4, PSO1
CO2	Apply the concept of Fuel Ignition Electronics	3	PO1, PO2, PO7, PSO1
CO3	Apply the concept for Fuel Injection Electronics	3	PO1, PO3, PO4, PSO1
CO4	Analyze the Concept of Electronics Accessories	4	PO1, PO2, PO4, PSO2

Syllabus

Electronics for Vehicles: Overview of electronic systems in vehicles, including sensors, actuators, and control units. Applications of automotive electronics in safety, infotainment, and vehicle performance optimization.

Electronic Controls for Fuel Ignition Systems: Principles of electronic ignition systems and components (e.g., ECUs, sensors, actuators). Techniques for optimizing ignition timing and fuel delivery for performance and efficiency.

Electronic Controls for Fuel Systems: Integration of electronic control units (ECUs) for fuel injection, delivery, and pressure regulation. Application of sensors and actuators to optimize fuel efficiency and emissions in various driving conditions. Electronic Controls for Steering Systems: Principles of electronic power steering (EPS) and steer-by-wire systems. Design and implementation of sensors, ECUs, and actuators for precise steering control and driver assistance features.

Electronic Controls for Automotive Accessories: Overview of electronic systems for accessories like HVAC (Heating, Ventilation, and Air Conditioning), infotainment, and lighting. Integration of sensors, ECUs, and actuators to enhance functionality, comfort, and safety features in vehicles.

Reference Books

- 1 Understanding Automotive Electronics: An Engineering Perspective, William Ribbens, 2013, Butterworth.
- 2 Automobile Electrical and Electronics Systems, Tom Denton, 2015, Butterworth.
- 3 Automotive Electrical and Electronics, A.K. Babu, 2018, Khannabooks.com.
- 4 Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive (Bosch Professional Automotive Information), Robert Bosch GmbH, 2014, Springer Vieweg.

23AEA3507 - SOFT COMPUTING TECHNIQUES FOR AUTOMOTIVE APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3507	SOFT COMPUTING TECHNIQUES FOR AUTOMOTIVE APPLICATIONS	SCTAA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Comprehend principles and applications of neural networks, fuzzy logic, and genetic algorithms	3	PO1, PO2, PSO1
CO2	Apply neural networks to address complex automotive challenges	3	PO1, PO2, PSO1
CO3	Design and implement soft computing-based automotive systems	3	PO1, PO2, PSO1
CO4	Evaluate soft computing model performance in automotive contexts	3	PO1, PO2, PSO1

Syllabus

Introduction to Soft Computing Concepts, comparison with conventional computing, automotive applications, Fuzzy Logic Fuzzy sets, operations, inference systems, automotive applications (engine control, brake systems, driver assistance systems)

Neural Networks: Biological inspiration, types, learning algorithms, Single layer and multi layered networks, Feedback neural networks automotive applications (vehicle control, image processing, fault diagnosis)

Genetic Algorithms Principles, applications in automotive design, scheduling, routing5Hybrid Soft Computing Techniques, Neuro-fuzzy systems, genetic-fuzzy systems

Automotive applications (advanced driver assistance systems, autonomous vehicles), Soft Computing for Automotive Applications, Vehicle dynamics and control: Applications of soft computing, Automotive safety systems: Collision avoidance, pedestrian detection, Electric and hybrid vehicles: Battery management, energy management, Automotive comfort and ergonomics.

Reference Books

- 1 Neuro-fuzzy and soft computing A computational approach to learning and machine intelligence, Jang, J.S. R., Sun, C.T., & Mizutani, E, 1997, Prentice-Hall.
- 2 Principles of Soft Computing, S N. Sivanandam, S. N. Deepa, 2011, Wiley India.
- 3 Neural Networks and Fuzzy Systems, Bart Kosko, 2004, PHI.
- 4 Fuzzy Logic with Engineering Applications, Timothy J Ross, 2010, Wiley.

23AEA3508 - AUTOMOTIVE NETWORKING AND PROTOCOLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AEA3508	AUTOMOTIVE NETWORKING AND PROTOCOLS	ANP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basics of networking to automotive vehicular technologies	2	PO1, PO2, PSO2
CO2	Analysis of CAN protocols, bus access and Physical layer standards	3	PO1, PO2, PSO2
CO3	Analyze higher level CAN protocols	3	PO1, PO2, PSO2
CO4	Analysis of LIN protocols and standards	3	PO1, PO2, PSO2

Syllabus

Overview of communication and networking --- need for In-Vehicle networking -- layers of OSI interface model -- Multiplexing and Demultiplexing-- Concepts--vehicle buses

Networks and protocols: CAN protocols: Principles of data exchange--real time data transmission-- message frame formats, bit encoding--bit-timing and synchronization-- data rate and bus length--network topology--bus access- physical layer st

CAN higher layer protocols: Introduction to CAN open--Device net--TTCAN--SAEJ1939-overview CAN open and application , transportation electronics--CAN open standards

LIN: LINstandard overview--applications --LIN communication concept message frame-- development flow. MOST overview--data rates-data types-topology-application areas

Reference Books

- 1 Telematics Communication Technologies and Vehicular Networks: Wireless Architectures and Application,, Chung Ming Huang, YuhShyan Chen, 1st edition, Information Science Reference, United States.
- 2 Distributed Automotive Embedded Systems,, Ronald K Jurgen, 4th , SAE International, United States.
- 3 Industrial Communication Technology Handbook, Richard Zurawski,, 2nd, CRC press.
- 4 Automotive Mechatronics: Automotive Networking, Driving Stability Systems Electronics, Konrad Reif, 2nd, Springer, United States.

23AIP3101A - DEEP LEARNING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3101A	DEEP LEARNING	DL	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand optimization algorithms to solve neural networks	2	PO2, PSO1
CO2	Apply CNN model and its variants like LeNet, AlexNet, VGGNet models to real time data	3	PO2, PSO1
CO3	Apply RNN, Long Short Term Memory (LSTM) and GRU to solve sequential data problems	3	PO3, PSO1
CO4	Apply autoencoders, RBM and Markov models for real time applications	3	PO2, PO3, PSO2
CO5	Apply transfer learning models-, object detection models-deep reinforcement models	3	PO2, PO4, PSO2
CO6	Implement Basic Deep Neural Networks, convolutional neural networks, LSTM, RNN and autoencoders	5	PO3, PO5, PSO2
CO7	Implement Deep learning case studies using keras and pytorch	5	PO3, PO5, PSO2

Syllabus

Introduction to Deep learning, History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron's, Perceptron Learning Algorithm and Convergence, Multilayer Perceptron's (MLPs), Representation Power of MLPs, Sigmoid Neurons, Feedforward Neural Networks, Backpropagation, Challenges in Neural Network Optimization, Gradient Descent (GD), Momentum Based GD, Stochastic GD, Adam, RMSProp

Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Dropout, Greedy Layer wise Pre-training, Better activation functions, better weight initialization methods, Learning Vectorial Representations Of Words Convolutional Neural Networks, LeNet, AlexNet, Z VGGNet,

Visualizing Convolutional Neural Networks, Guided Backpropagation, Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs, Deep Dream, Deep Art,

Encoder Decoder Models: Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Markov Networks. Using joint distributions for classification and sampling, Latent Variables, Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Generative Adversarial Networks

Transfer learning-ZFNet, MobileNet, GoogleNET, Object Detection : ResNet, FastRCNN, YOLO and, Autoregressive Models: NADE, MADE, Deep reinforcement learning

Reference Books

- 1 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, 2016, MIT.
- 2 Grokking Deep Learning, Andrew Trask, 2019, Manning publications, .
- 3 Deep Learning From Scratch: Building with Python from First Principles, Seth Weidman, 2019, oreilly.
- 4 Deep learning in Python/Pytorch, Eli Stevens, 2020, Manning Publications.

23AIP3101E - DEEP LEARNING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3101E	DEEP LEARNING	DL	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand optimization algorithms to solve neural networks	2	PO2, PSO1
CO2	Apply CNN variants like LeNet, AlexNet, VGGNet models on real time data	3	PO2, PSO1
CO3	Apply RNN, Long Short Term Memory (LSTM) and GRU to solve sequential data problems	3	PO3, PSO1
CO4	Apply autoencoders, RBM and Markov models for real time applications	3	PO2, PO3, PSO2
CO5	Apply transfer learning models-, object detection models-deep reinforcement models	3	PO2, PO4, PSO2
CO6	Implement Basic Deep Neural Networks, convolutional neural networks, LSTM, RNN and autoencoders	5	PO3, PO5, PSO2
CO7	Implement Deep learning case studies using keras and pytorch	5	PO3, PO5, PSO2

Syllabus

Introduction to Deep learning, History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron's, Perceptron Learning Algorithm and Convergence, Multilayer Perceptron's (MLPs), Representation Power of MLPs, Sigmoid Neurons, Feedforward Neural Networks, Backpropagation, Challenges in Neural Network Optimization, Gradient Descent (GD), Momentum Based GD, Stochastic GD, Adam, RMSProp

Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Dropout, Greedy Layer wise Pre-training, Better activation functions, better weight initialization methods, Learning Vectorial Representations Of Words Convolutional Neural Networks, LeNet, AlexNet, Z VGGNet,

Visualizing Convolutional Neural Networks, Guided Backpropagation, Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs, Deep Dream, Deep Art

Encoder Decoder Models: Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Markov Networks. Using joint distributions for classification and sampling, Latent Variables, Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Generative Adversarial Networks

Transfer learning-ZFNet, MobileNet, GoogleNET, Object Detection : ResNet, FastRCNN, YOLO and, Autoregressive Models: NADE, MADE, Deep reinforcement learning

Reference Books

- 1 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, 2016, MIT Press.
- 2 Grokking Deep Learning, Andrew Trask, 2019, Manning publications, .
- 3 Deep Learning From Scratch: Building with Python from First Principles, Seth Weidman, 2019, oreilly.
- 4 Deep learning in Python/Pytorch, Eli Stevens, 2020, Manning Publications.

23AIP3101R - DEEP LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3101R	DEEP LEARNING	DL	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand optimization algorithms to solve neural networks	2	PO1, PO2, PSO1
CO2	Apply CNN model and its variants to real time data like LeNet, AlexNet, VGGNet models	3	PO2, PSO1
CO3	Apply sequence models such as RNN, Long Short Term Memory (LSTM), and GRU for real time applications	3	PO3, PSO2
CO4	Apply autoencoders, RBM, Markov models and Deep belief neural networks	3	PO2, PO3, PSO1
CO5	Implement deep learning techniques using keras, pytorch	5	PO3, PO5, PSO2
CO6	Implement basic Neural Networks, convolutional neural networks, various types of auto encoders.	5	PO3, PO5, PSO2

Syllabus

Introduction to Deep learning, History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron's, Perceptron Learning Algorithm and Convergence, Multilayer Perceptron's (MLPs), Representation Power of MLPs, Sigmoid Neurons, Feedforward Neural Networks, Backpropagation, Gradient Descent (GD), Momentum Based GD, Stochastic GD, Adam.

Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Dropout, Greedy Layer wise Pre-training, Better activation functions, better weight initialization methods, Learning Vectorial Representations Of Words Convolutional Neural Networks, LeNet, AlexNet, VGGNet, ResNet Object Detection

Visualizing Convolutional Neural Networks, Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs, Deep Dream, Deep Art,

Encoder Decoder Models, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Markov Networks. Using joint distributions for classification and sampling, Latent Variables, Unsupervised Learning, Markov Chains, Restricted Boltzmann Machines, Deep Belief neural networks

Reference Books

- 1 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, 2016, MIT Press.
- 2 Grokking Deep Learning, Andrew Trask, 2019, Manning publications.
- 3 Deep Learning with PyTorch: A practical approach to building neural network models using PyTorch, Vishnu Bramania, 2018, Packt Publishing Limited.
- 4 Deep learning in Python/Pytorch, Eli Stevens 2020, 2020, Manning Publications.

23AIP3202A - SOFT COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3202A	SOFT COMPUTING	SC	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline soft computing from hard computing, explain fuzzy sets, fuzzy logic operations, generalized operations, fuzziness, fuzzy resolution, fuzzy relations, composition, interface, fuzzy decision-making considerations, and describe fuzzy control basics, architecture, properties, robustness, and stability.	2	PO1, PO2, PO3
CO2	Apply connectionist modeling with multi-layer perceptrons, Hopfield networks, RBF networks, SOMs, and applications of ANNs across diverse domains.	3	PO1, PO2, PO3
CO3	Analyze Genetic algorithms optimization, schema theorem demonstration, and enhanced problem-solving capabilities inference with neural networks and fuzzy logic integration.	4	PO1, PO2, PO3
CO4	Inspect neuro-fuzzy system architecture, optimization techniques with neural networks and fuzzy logic, neuro-evolution in dynamic networks, recent advances in neuro-evolution methodologies for enhanced computational intelligence.	4	PO1, PO2, PO4
CO5	Conclude Markov Decision Processes (MDPs), Dynamic Programming, Monte Carlo Methods, Temporal Difference (TD) Learning, Function Approximation, Deep Reinforcement Learning, Policy Gradient Methods, Exploration and Exploitation, advanced topics, and applications in reinforcement learning.	4	PO1, PO2, PO4

Syllabus

Introduction to computing: Differentiate Soft computing versus hard computing, properties of soft computing, Fundamentals of Fuzzy Logic Systems: Fuzzy sets, Fuzzy logic operations, generalized operations, Fuzziness and fuzzy resolution, fuzzy relations, composition and interface, considerations of fuzzy decision- making. Fuzzy logic control: Basic of fuzzy control, Fuzzy control architecture, Properties of fuzzy control, robustness and stability

Fundamentals of connectionist modeling The multi-layer perceptrons Fundamentals of connectionist modeling , The Hopfield network, RBF, SOM, application of ANN.

Evolutionary computing: Overview of Evolutionary computing, Genetic algorithms and optimization, the schema theorem: the fundamental algorithm of Genetic algorithms, Genetic algorithms - operations, integration of Genetic algorithms with neural networks, integration of Genetic algorithms with fuzzy logic

Dynamic Neural Networks, Neuro Fuzzy Systems: Architecture of neuro fuzzy systems, construction of neuro fuzzy systems. Optimization with neural networks and fuzzy logic, Neuro evolution , Advances in Neuro evolution

Markov Decision Processes (MDPs) -Dynamic Programming and Monte Carlo Methods - Temporal Difference (TD) Learning -Function Approximation and Deep Reinforcement Learning - Policy Gradient Methods -Exploration and Exploitation, Advanced Topics, and Applications

Reference Books

- 1 Neuro-Fuzzy and Soft Computing, J.S.R.Jang, C.T. Sun and E.Mizutani, 1997, Pearson Education.
- 2 Principles of Soft Computing, S N. Sivanandam, S. N. Deepa, 2007, Wiley India.
- 3 Fundamentals of Neural Networks, Laurene Fausett, 2007, Pearson-2004.
- 4 Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications, S. Rajasekaran and G.A. Vijayalakshmi Pai, 2005, PHI Learning.
- 5 Genetic Algorithms in Search, Optimization, and Machine Learning, David E. Goldberg, 1989, Addison-Wesley.

- 6 Evolutionary Algorithms for Solving Multi-Objective Problems, Carlos A. Coello Coello, 2007, Springer.

23AIP3202E - SOFT COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3202E	SOFT COMPUTING	SC	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline soft computing from hard computing, explain fuzzy sets, fuzzy logic operations, generalized operations, fuzziness, fuzzy resolution, fuzzy relations, composition, interface, fuzzy decision-making considerations, and describe fuzzy control basics, architecture, properties, robustness, and stability.	2	PO1, PO2, PO3
CO2	Apply connectionist modeling with multi-layer perceptrons, Hopfield networks, RBF networks, SOMs, and applications of ANNs across diverse domains.	3	PO1, PO2, PO3
CO3	Analyze Genetic algorithms optimization, schema theorem demonstration, and enhanced problem-solving capabilities inference with neural networks and fuzzy logic integration.	4	PO1, PO2, PO3
CO4	Inspect neuro-fuzzy system architecture, optimization techniques with neural networks and fuzzy logic, neuro-evolution in dynamic networks, recent advances in neuro-evolution methodologies for enhanced computational intelligence.	4	PO1, PO2, PO4
CO5	Conclude Markov Decision Processes (MDPs), Dynamic Programming, Monte Carlo Methods, Temporal Difference (TD) Learning, Function Approximation, Deep Reinforcement Learning, Policy Gradient Methods, Exploration and Exploitation, advanced topics, and applications in reinforcement learning.	4	PO1, PO2, PO4

Syllabus

Introduction to computing: Differentiate Soft computing versus hard computing, properties of soft computing, Fundamentals of Fuzzy Logic Systems: Fuzzy sets, Fuzzy logic operations, generalized operations, Fuzziness and fuzzy resolution, fuzzy relations, composition and interface, considerations of fuzzy decision- making. Fuzzy logic control: Basic of fuzzy control, Fuzzy control architecture, Properties of fuzzy control, robustness and stability.

Fundamentals of connectionist modeling The multi-layer perceptrons Fundamentals of connectionist modeling , The Hopfield network, RBF, SOM, application of ANN.

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Dynamic Neural Networks, Neuro Fuzzy Systems: Architecture of neuro fuzzy systems, construction of neuro fuzzy systems. Optimization with neural networks and fuzzy logic, Neuro evolution , Advances in Neuro evolution

Markov Decision Processes (MDPs) -Dynamic Programming and Monte Carlo Methods - Temporal Difference (TD) Learning -Function Approximation and Deep Reinforcement Learning - Policy Gradient Methods -Exploration and Exploitation, Advanced Topics, and Applications

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- 2 Principles of Soft Computing, S N. Sivanandam, S. N. Deepa, 2007, Wiley India.
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- 4 Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications, S. Rajasekaran and G.A. Vijayalakshmi Pai, 2005, PHI Learning.
- 5 Genetic Algorithms in Search, Optimization, and Machine Learning, David E. Goldberg, 1989, Addison-Wesley.

- 6 Evolutionary Algorithms for Solving Multi-Objective Problems, Carlos A. Coello Coello, 2007, Springer.

23AIP3202R - SOFT COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3202R	SOFT COMPUTING	SC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline soft computing from hard computing, explain fuzzy sets, fuzzy logic operations, generalized operations, fuzziness, fuzzy resolution, fuzzy relations, composition, interface, fuzzy decision-making considerations, and describe fuzzy control basics, architecture, properties, robustness, and stability.	2	PO1, PO2, PO3
CO2	Apply connectionist modeling with multi-layer perceptrons, Hopfield networks, RBF networks, SOMs, and applications of ANNs across diverse domains.	3	PO1, PO2, PO3
CO3	Analyze Genetic algorithms optimization, schema theorem demonstration, and enhanced problem-solving capabilities inference with neural networks and fuzzy logic integration.	4	PO1, PO2, PO3
CO4	Inspect neuro-fuzzy system architecture, optimization techniques with neural networks and fuzzy logic, neuro-evolution in dynamic networks, recent advances in neuro-evolution methodologies for enhanced computational intelligence.	4	PO1, PO2, PO4

Syllabus

Introduction to computing: Differentiate Soft computing versus hard computing, properties of soft computing, Fundamentals of Fuzzy Logic Systems: Fuzzy sets, Fuzzy logic operations, generalized operations, Fuzziness and fuzzy resolution, fuzzy relations, composition and interface, considerations of fuzzy decision- making. Fuzzy logic control: Basic of fuzzy control, Fuzzy control architecture, Properties of fuzzy control, robustness and stability.

Fundamentals of connectionist modeling The multi-layer perceptrons Fundamentals of connectionist modeling , The Hopfield network, RBF, SOM, application of ANN.

Evolutionary computing: Overview of Evolutionary computing, Genetic algorithms and optimization, the schema theorem: the fundamental algorithm of Genetic algorithms, Genetic algorithms - operations, integration of Genetic algorithms with neural networks, integration of Genetic algorithms with fuzzy logic.

Dynamic Neural Networks, Neuro Fuzzy Systems: Architecture of neuro fuzzy systems, construction of neuro fuzzy systems. Optimization with neural networks and fuzzy logic, Neuro evolution , Advances in Neuro evolution

Reference Books

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- 2 Principles of Soft Computing , S N. Sivanandam, S. N. Deepa , 2007 , Wiley India.
- 3 Fundamentals of Neural Networks , Laurene Fausett , 2007 , Pearson.
- 4 Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications , Rajasekaran and G.A. Vijayalakshmi Pai , 2005, PHI Learning.
- 5 Genetic Algorithms in Search, Optimization, and Machine Learning , David E. Goldberg , 1989, Addison-Wesley.
- 6 Evolutionary Algorithms for Solving Multi-Objective Problems, Carlos A. Coello Coello , 2007, Springer.

23AIP3203A - MULTI MODAL INFORMATION PROCESSING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3203A	MULTI MODAL INFORMATION PROCESSING	MMIP	A	3	0	4	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize the various types of signals, systems and their frequency domain transformation.	3	PO1, PSO1
CO2	Apply the design methodology of different filters and their realizations.	3	PO1, PO3, PSO1
CO3	Examine signal processing approaches for extraction of information present in the natural signals.	4	PO1, PO2, PSO1
CO4	Discover machine learning approaches for processing of signals.	4	PO1, PO3, PSO1
CO5	Analyze the usefulness of Signals and Systems, Transforms and Filter Design, 1-Dimensional and 2-Dimensional Information Processing, Machine Learning approaches for building Multimodal Information Processing based Intelligent Systems	4	PO1, PO2, PO3, PSO1
CO6	Examine the signal processing approaches related to transformation, filtering, feature extraction, machine learning for signal processing.	4	PO1, PO2, PO3, PSO1

Syllabus

Signals and Systems: Types of Signals: Analog, deterministic, non-deterministic, random signals, periodic, aperiodic signals, discrete time signals, digital signals. Elementary signals: impulse, unit step, ramp, sinusoidal signal, complex exponential. Systems: impulse response, Convolution, Difference Equations for representation of systems, properties of systems, linearity, superposition principle, shift invariance, causality, stability. Fourier series for periodic signals, Fourier transforms, properties of Fourier Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transforms (DFT), Fast Fourier Transforms (FFT), Phase and group delays, Sampling and Quantization.

Transforms and Filter Design: Z-Transforms, Region of convergence (ROC), Properties of Z-Transforms, Causality and stability of filters, Finite Impulse Response (FIR), Infinite Impulse Response (IIR), Pole-Zero representation, Digital filter design: FIR filter design by Fourier Transform, Linear Phase Characteristics, low pass, high pass, band pass and band reject filters, IIR filter design by coefficient calculation, Frequency response of filters, All pass filters, Hilbert Transform, Filter realizations.

1-Dimensional and 2-Dimensional Information Processing: Windowing techniques: Rectangular, Bartlett, Hamming, Hanning, Blackwell, Kaiser. Shorttime analysis: Short Time Fourier Transform (STFT) of Speech signals, Enhancement (denoising) techniques such as Mean, Median, and Moving average filter for images. Feature extraction techniques: MelFrequency Cepstral Coefficients (MFCC), Linear Prediction Coefficients (LPC) for speech, Audio Reconstruction using Analysis by Synthesis approach. Wavelet based image decomposition, Image Reconstruction using Analysis by Synthesis approach.

Machine Learning approaches for building Multimodal Information Processing based Intelligent Systems: Pre-processing, feature extraction and classification using Convolutional Neural Networks (CNN) and Deep Neural Networks (DNN). Data augmentation using Generative Adversarial Networks (GAN), synthesis of signals using Recurrent Neural Network (RNN).

Studies on Advanced topics of Signals and Systems, Transforms and Filter Design, 1-Dimensional and 2-Dimensional Information Processing, Machine Learning approaches for building Multimodal Information Processing based Intelligent Systems

Reference Books

- 1 Discrete Time Signal Processing , Alan V. Oppenheim and R. W. Schaffer, 2nd, Prentice Hall, MIT Press, 1999 .

- 2 Signals and Systems , Simon Haykin and Barry Van Veen, , 2nd, Wiley, 2007 .
- 3 Digital Signal Processing: Fundamentals and Applications , LiTan , 1st , Academic Press, 2008 .
- 4 Deep Learning , Ian Goodfellow, Yoshua Bengio, and Aaron Courville , 1st, MIT Press, 2021 .
- 5 Digital Signal Processing: Principles, Algorithms, and Applications , J. G. Proakis and M G , Monolakis, , 4th, Prentice Hall, 2007 .

23AIP3203E - MULTI MODAL INFORMATION PROCESSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3203E	MULTI MODAL INFORMATION PROCESSING	MMIP	E	3	0	4	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize the various types of signals, systems and their frequency domain transformation.	3	PO1, PSO1
CO2	Apply the design methodology of different filters and their realizations.	3	PO1, PO3, PSO1
CO3	Examine signal processing approaches for extraction of information present in the natural signals.	4	PO1, PO2, PSO1
CO4	Discover machine learning approaches for processing of signals.	4	PO1, PO3, PSO1
CO5	Analyze the usefulness of Signals and Systems, Transforms and Filter Design, 1-Dimensional and 2-Dimensional Information Processing, Machine Learning approaches for building Multimodal Information Processing based Intelligent Systems:	4	PO1, PO2, PO3, PSO1
CO6	Examine the signal processing approaches related to transformation, filtering, feature extraction, machine learning for signal processing.	4	PO1, PO2, PO3, PSO1

Syllabus

Signals and Systems: Types of Signals: Analog, deterministic, non-deterministic, random signals, periodic, aperiodic signals, discrete time signals, digital signals. Elementary signals: impulse, unit step, ramp, sinusoidal signal, complex exponential. Systems: impulse response, Convolution, Difference Equations for representation of systems, properties of systems, linearity, superposition principle, shift invariance, causality, stability. Fourier series for periodic signals, Fourier transforms, properties of Fourier Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transforms (DFT), Fast Fourier Transforms (FFT), Phase and group delays, Sampling and Quantization.

Transforms and Filter Design: Z-Transforms, Region of convergence (ROC), Properties of Z-Transforms, Causality and stability of filters, Finite Impulse Response (FIR), Infinite Impulse Response (IIR), Pole-Zero representation, Digital filter design: FIR filter design by Fourier Transform, Linear Phase Characteristics, low pass, high pass, band pass and band reject filters, IIR filter design by coefficient calculation, Frequency response of filters, All pass filters, Hilbert Transform, Filter realizations.

1-Dimensional and 2-Dimensional Information Processing: Windowing techniques: Rectangular, Bartlett, Hamming, Hanning, Blackwell, Kaiser. Shorttime analysis: Short Time Fourier Transform (STFT) of Speech signals, Enhancement (denoising) techniques such as Mean, Median, and Moving average filter for images. Feature extraction techniques: MelFrequency Cepstral Coefficients (MFCC), Linear Prediction Coefficients (LPC) for speech, Audio Reconstruction using Analysis by Synthesis approach. Wavelet based image decomposition, Image Reconstruction using Analysis by Synthesis approach.

Machine Learning approaches for building Multimodal Information Processing based Intelligent Systems: Pre-processing, feature extraction and classification using Convolutional Neural Networks (CNN) and Deep Neural Networks (DNN). Data augmentation using Generative Adversarial Networks (GAN), synthesis of signals using Recurrent Neural Network (RNN).

Studies on Advanced topics of Signals and Systems, Transforms and Filter Design, 1-Dimensional and 2-Dimensional Information Processing, Machine Learning approaches for building Multimodal Information Processing based Intelligent Systems

Reference Books

- 1 Discrete Time Signal Processing , Alan V. Oppenheim and R. W. Schaffer , 2nd , Prentice Hall, MIT Press, 1999 .

- 2 Signals and Systems , Simon Haykin and Barry Van Veen, , 2nd, Wiley, 2007 .
- 3 Digital Signal Processing: Fundamentals and Applications , LiTan , 1st, Academic Press, 2008 .
- 4 Deep Learning , Ian Goodfellow, Yoshua Bengio, and Aaron Courville , 1st, MIT Press, 2021 .
- 5 Digital Signal Processing: Principles, Algorithms, and Applications , J. G. Proakis and M G , Monolakis, , 4th, Prentice Hall, 2007 .

23AIP3203R - MULTI MODAL INFORMATION PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3203R	MULTI MODAL INFORMATION PROCESSING	MMIP	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize the various types of signals, systems and their frequency domain transformation.	3	PO1, PSO1
CO2	Apply the design methodology of different filters and their realizations.	3	PO1, PO3, PSO1
CO3	Examine signal processing approaches for extraction of information present in the natural signals.	4	PO1, PO2, PSO1
CO4	Discover machine learning approaches for processing of signals.	4	PO1, PO3, PSO1
CO5	Examine the signal processing approaches related to transformation, filtering, feature extraction, machine learning for signal processing.	4	PO1, PO2, PO3, PSO1

Syllabus

Signals and Systems: Types of Signals: Analog, deterministic, non-deterministic, random signals, periodic, aperiodic signals, discrete time signals, digital signals. Elementary signals: impulse, unit step, ramp, sinusoidal signal, complex exponential. Systems: impulse response, Convolution, Difference Equations for representation of systems, properties of systems, linearity, superposition principle, shift invariance, causality, stability. Fourier series for periodic signals, Fourier transforms, properties of Fourier Transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transforms (DFT), Fast Fourier Transforms (FFT), Phase and group delays, Sampling and Quantization.

Transforms and Filter Design: Z-Transforms, Region of convergence (ROC), Properties of Z-Transforms, Causality and stability of filters, Finite Impulse Response (FIR), Infinite Impulse Response (IIR), Pole-Zero representation, Digital filter design: FIR filter design by Fourier Transform, Linear Phase Characteristics, low pass, high pass, band pass and band reject filters, IIR filter design by coefficient calculation, Frequency response of filters, All pass filters, Hilbert Transform, Filter realizations.

1-Dimensional and 2-Dimensional Information Processing: Windowing techniques: Rectangular, Bartlett, Hamming, Hanning, Blackwell, Kaiser. Shorttime analysis: Short Time Fourier Transform (STFT) of Speech signals, Enhancement (denoising) techniques such as Mean, Median, and Moving average filter for images. Feature extraction techniques: MelFrequency Cepstral Coefficients (MFCC), Linear Prediction Coefficients (LPC) for speech, Audio Reconstruction using Analysis by Synthesis approach. Wavelet based image decomposition, Image Reconstruction using Analysis by Synthesis approach.

Machine Learning approaches for building Multimodal Information Processing based Intelligent Systems: Pre-processing, feature extraction and classification using Convolutional Neural Networks (CNN) and Deep Neural Networks (DNN). Data augmentation using Generative Adversarial Networks (GAN), synthesis of signals using Recurrent Neural Network (RNN).

Reference Books

- 1 Discrete Time Signal Processing , Alan V. Oppenheim and R. W. Schaffer , 2nd , Prentice Hall, MIT Press, 1999 .
- 2 Signals and Systems , Simon Haykin and Barry Van Veen, , 2nd, Wiley, 2007 .
- 3 Digital Signal Processing: Fundamentals and Applications , LiTan, 1st, Academic Press, 2008 .
- 4 Deep Learning , Ian Goodfellow, Yoshua Bengio, and Aaron Courville , 1st, MIT Press, 2021 .

- 5 Digital Signal Processing: Principles, Algorithms, and Applications , J. G. Proakis and M G , Monolakis, , 4th, Prentice Hall, 2007 .
- 6 Discrete-Time Speech Signal Processing: Principles and Practice , Thomas F. Quatieri , 1st , Pearson Prentice Hall, 2001 .
- 7 A Practical Guide to Wavelet Analysis , Christopher Torrence and Gilbert P. Compo, , 1st , Bulletin of the American Meteorological Society .
- 8 Digital Image Processing , R. Gonzalez and R. Woods , 4th , Pearson, 2018 .

23AIP3204A - ARTIFICIAL NEURAL NETWORKS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3204A	ARTIFICIAL NEURAL NETWORKS	ANN	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate core principles of artificial neural networks, from their inception to their application in learning and information processing.	2	PO1, PO2, PSO1
CO2	Apply various techniques for training and optimizing neural networks and equips you with the understanding of key learning algorithms like Hebbian rule, Perceptron learning, Delta rule, and Backpropagation.	3	PO1, PO2, PSO1
CO3	Apply different techniques of neural networks for information storage and retrieval, exploring advanced methods like auto-associative networks, associative memory models, and stochastic techniques	3	PO2, PO3, PSO2
CO4	Analyze various learning algorithm techniques for neural networks and acquire familiarity with emerging software, tools, and technologies.	4	PO2, PO3, PSO2
CO5	Critically evaluate their ethical implications, including bias, fairness, transparency, and future directions in this rapidly evolving field.	5	PO2, PO8, PSO2

Syllabus

Basics of Artificial Neural Networks: Historical perspective; Characteristics of Neural Networks; Artificial Neural Networks (ANN) terminology; Neuron Models; Topology; Basic learning laws, Activation dynamics models; Synaptic dynamics models

Learning methods; Stability and convergence; Feed forward Neural Networks: Analysis of Pattern association; pattern classification and pattern mapping by feedforward neural networks (FFNNs); Hebbian Rule; Perceptron learning; Delta rule; Backpropagation Algorithm

Analysis of linear auto associative networks; Associative Memory, exponential BAM Hopfield model for pattern storage; Stochastic networks and Simulated annealing; Restricted Boltzmann machine.

Counter Propagation Networks, dynamically driven recurrent networks (RNN), Learning algorithms (BPTT, RTRL, Kalman Filter) Applications of neural networks.

Ethical implications of using neural networks in decision-making processes Bias and fairness issues in neural network models Transparency and interpretability challenges in complex neural networks Emerging trends and future directions in neural network research and development

Reference Books

- 1 Artificial Neural Networks, B. Yegnanarayana, 2006, PHI.
- 2 Neural Networks Algorithms, Applications, and Programming Techniques, James A. Freeman David M. Skapura,, 2008, Addison-Wesley Publishing Company.
- 3 Neural Networks: A Comprehensive Foundation, Simon Haykin, 2008, Pearson Prentice Hall.
- 4 Neural networks for Pattern Recognition, Christopher M Bishop, 2010, Oxford.

23AIP3204E - ARTIFICIAL NEURAL NETWORKS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3204E	ARTIFICIAL NEURAL NETWORKS	ANN	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate core principles of artificial neural networks, from their inception to their application in learning and information processing.	2	PO1, PO2, PSO1
CO2	Apply various techniques for training and optimizing neural networks and equips you with the understanding of key learning algorithms like Hebbian rule, Perceptron learning, Delta rule, and Backpropagation.	3	PO1, PO2, PSO1
CO3	Apply different techniques of neural networks for information storage and retrieval, exploring advanced methods like auto-associative networks, associative memory models, and stochastic techniques	3	PO2, PO3, PSO2
CO4	Analyze various learning algorithm techniques for neural networks and acquire familiarity with emerging software, tools, and technologies.	4	PO2, PO3, PSO2
CO5	Critically evaluate their ethical implications, including bias, fairness, transparency, and future directions in this rapidly evolving field.	5	PO2, PO8, PSO2

Syllabus

Basics of Artificial Neural Networks: Historical perspective; Characteristics of Neural Networks; Artificial Neural Networks (ANN) terminology; Neuron Models; Topology; Basic learning laws, Activation dynamics models; Synaptic dynamics models

Learning methods; Stability and convergence; Feed forward Neural Networks: Analysis of Pattern association; pattern classification and pattern mapping by feedforward neural networks (FFNNs); Hebbian Rule; Perceptron learning; Delta rule; Backpropagation Algorithm

Analysis of linear auto associative networks; Associative Memory, exponential BAM Hopfield model for pattern storage; Stochastic networks and Simulated annealing; Restricted Boltzmann machine.

Counter Propagation Networks, dynamically driven recurrent networks (RNN), Learning algorithms (BPTT, RTRL, Kalman Filter) Applications of neural networks.

Ethical implications of using neural networks in decision-making processes Bias and fairness issues in neural network models Transparency and interpretability challenges in complex neural networks Emerging trends and future directions in neural network research and development

Reference Books

- 1 Artificial Neural Networks, B. Yegnanarayana, 2006, PHI.
- 2 Neural Networks Algorithms, Applications, and Programming Techniques, James A. Freeman David M. Skapura,, 2008, Addison-Wesley Publishing Company .
- 3 Neural Networks: A Comprehensive Foundation , Simon Haykin , 2008 , Pearson Prentice Hall.
- 4 Neural networks for Pattern Recognition , Christopher M Bishop , 2010 , Oxford.

23AIP3204R - ARTIFICIAL NEURAL NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3204R	ARTIFICIAL NEURAL NETWORKS	ANN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate core principles of artificial neural networks, from their inception to their application in learning and information processing.	2	PO1, PO2, PSO1
CO2	Apply various techniques for training and optimizing neural networks and equips you with the understanding of key learning algorithms like Hebbian rule, Perceptron learning, Delta rule, and Backpropagation.	3	PO1, PO2, PSO1
CO3	Apply different techniques of neural networks for information storage and retrieval, exploring advanced methods like auto-associative networks, associative memory models, and stochastic techniques	3	PO2, PO3, PSO2
CO4	Analyze various learning algorithm techniques for neural networks and acquire familiarity with emerging software, tools, and technologies.	4	PO2, PO3, PSO2

Syllabus

Basics of Artificial Neural Networks: Historical perspective; Characteristics of Neural Networks; Artificial Neural Networks (ANN) terminology; Neuron Models; Topology; Basic learning laws, Activation dynamics models; Synaptic dynamics models

Learning methods; Stability and convergence; Feed forward Neural Networks: Analysis of Pattern association; pattern classification and pattern mapping by feedforward neural networks (FFNNs); Hebbian Rule; Perceptron learning; Delta rule; Backpropagation Algorithm

Analysis of linear auto associative networks; Associative Memory, exponential BAM Hopfield model for pattern storage; Stochastic networks and Simulated annealing; Restricted Boltzmann machine.

Counter Propagation Networks, dynamically driven recurrent networks (RNN), Learning algorithms (BPTT, RTRL, Kalman Filter) Applications of neural networks.

Reference Books

- 1 Artificial Neural Networks, B. Yegnanarayana, 2006, PHI.
- 2 Neural Networks Algorithms, Applications, and Programming Techniques, James A. Freeman David M. Skapura,, 2008, Addison-Wesley Publishing Company.
- 3 Neural Networks: A Comprehensive Foundation, Simon Haykin, 2008, Pearson Prentice Hall.
- 4 Neural networks for Pattern Recognition , Christopher M Bishop, 2010, Oxford.

23AIP3305A - GENERATIVE DEEP LEARNING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3305A	GENERATIVE DEEP LEARNING	GDL	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Generative AI and its real time applications	2	PO1, PSO1
CO2	Apply Advanced generative models like WGAN,StyleGAN,Cycle GAN for real time applciations for image generation	3	, PSO1
CO3	Build text generation pipelines using advanced techniques such as Long Short-Term Memory (LSTM) networks, BERT, and attention mechanisms	3	PO1, PSO1
CO4	Apply Cross-modal generation models like ATtnGan, MuseGAN	3	PO3, PO4, PSO2
CO5	Apply Fine-tuning on real time applications using large language models	3	PO4, PSO2
CO6	Implement real time application using Generative AI using Cycle Gan, StyleGAN MuseGan	5	PO3, PO5, PSO2
CO7	Experiment with real time applcation using Generative AI using Cycle Gan, StyleGAN MuseGan, AttnGan, Alchat, and develop application.	5	PO5, PSO2

Syllabus

Introduction to Generative AI , Applications in generative models, Varational Autoencoder, GANs, Conditional Variational Autoencoders (CVAEs),Adversarial Variational Bayes (AVB),Importance of latent space in VAEs

Advanced GAN Architectures:, Wasserstein GANs (WGANs) and WGAN-GP, CycleGAN , paired and unpaired style transfer -StyleGAN and StyleGAN2, Progressive Growing GANs (PGGANs)

Build several text generation pipelines based on LSTMs, BERT, Attention Mechanisms: Self-attention mechanism,Transformer architecture,Analysis of Rnn with Attention

Text-to-Image Generation,Text-to-image synthesis techniques, AttnGAN: Attentional Generative Adversarial Networks for image generation from textual descriptions, Cross-modal generation models,Analysis of MuseGAN

AttnGAN: Attentional Generative Adversarial Networks for image generation from textual descriptions to develop language models,BERT

Reference Books

- 1 Generative Deep Learning, David Foste , 2019, O relly publications.
- 2 Generative AI with Python and TensorFlow 2, Joseph Babcock and Raghav Bal , 2020, Packt.
- 3 Modern Generative AI with ChatGPT and OpenAI Models: Leverage the capabilities of OpenAI's LLM for productivity and innovation with GPT3 and GPT4 By Valentina Alto, Valentina Alto, 2023, Packt.
- 4 deep Generative Modeling , Jakub M. Tomczak, 2022, Springer.

23AIP3305E - GENERATIVE DEEP LEARNING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3305E	GENERATIVE DEEP LEARNING	GDL	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Generative AI and its real time applications	2	PO1, PO2, PSO1
CO2	Apply Advanced generative models like WGAN, StyleGAN, Cycle GAN for real time applications for image generation	3	PO2, PO3, PSO1
CO3	Build text generation pipelines using advanced techniques such as Long Short-Term Memory (LSTM) networks, BERT, and attention mechanisms	3	PO1, PO3, PSO1
CO4	Apply Cross-modal generation models like ATtnGan, MuseGAN	3	PO2, PSO2
CO5	Apply very large language models for real time application like chat	3	PO2, PSO2
CO6	Implement real time application using Generative AI using Cycle Gan, StyleGAN MuseGan	5	PO5, PSO2
CO7	Experiment with real time application using Generative AI using Cycle Gan, StyleGAN MuseGan, AttnGan, Alchat, and develop application.	5	PO5, PSO2

Syllabus

Introduction to Generative AI , Applications in generative models, Variational Autoencoder, GANs, Conditional Variational Autoencoders (CVAEs), Adversarial Variational Bayes (AVB), Importance of latent space in VAEs

Advanced GAN Architectures:, Wasserstein GANs (WGANs) and WGAN-GP, CycleGAN , paired and unpaired style transfer -StyleGAN and StyleGAN2, Progressive Growing GANs (PGGANs)

Build several text generation pipelines based on LSTMs, BERT, Attention Mechanisms: Self-attention mechanism, Transformer architecture, Analysis of Rnn with Attention

Text-to-Image Generation, Text-to-image synthesis techniques, AttnGAN: Attentional Generative Adversarial Networks for image generation from textual descriptions, Cross-modal generation models, Analysis of MuseGAN

AttnGAN: Attentional Generative Adversarial Networks for image generation from textual descriptions to develop language models, BERT

Reference Books

- 1 Generative Deep Learning , David Foster , 2019 , O'Reilly publications.
- 2 Generative AI with Python and TensorFlow 2, Joseph Babcock and Raghav Bal, 2020 , Packt.
- 3 Modern Generative AI with ChatGPT and OpenAI Models: Leverage the capabilities of OpenAI's LLM for productivity and innovation with GPT3 and GPT4 , Valentina Alto, 2023, Packt.
- 4 Deep Generative Modeling , Jakub M. Tomczak, 2022 , Springer.

23AIP3305R - GENERATIVE DEEP LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3305R	GENERATIVE DEEP LEARNING	GDL	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Generative AI and its real time applications	2	PO1, PO2, PSO1
CO2	Apply Advanced generative models like WGAN, StyleGAN, Cycle GAN for real time applications for image generation	3	PO2, PO3, PSO1
CO3	Build text generation pipelines using advanced techniques such as Long Short-Term Memory (LSTM) networks, BERT, and attention mechanisms	3	PO1, PO3, PSO1
CO4	Apply Cross-modal generation models like ATtnGan, MuseGAN	3	PO2, PSO2
CO5	Implement real time application using Generative AI using Cycle Gan, StyleGAN MuseGan	5	PO2, PO5, PSO2
CO6	Experiment with real time application using Generative AI using Cycle Gan, StyleGAN MuseGan, AttnGan, Alchat, and develop application.	5	PO5, PSO2

Syllabus

" Introduction to Generative AI , Applications in generative models, Variational Autoencoder, GANs, Conditional Variational Autoencoders (CVAEs), Adversarial Variational Bayes (AVB), Importance of latent space in VAEs "

" Advanced GAN Architectures:, Wasserstein GANs (WGANs) and WGAN-GP, CycleGAN , paired and unpaired style transfer -StyleGAN and StyleGAN2, Progressive Growing GANs (PGGANs) "

Build several text generation pipelines based on LSTMs, BERT, Attention Mechanisms: Self-attention mechanism, Transformer architecture, Analysis of Rnn with Attention

Text-to-Image Generation, Text-to-image synthesis techniques, AttnGAN: Attentional Generative Adversarial Networks for image generation from textual descriptions, Cross-modal generation models, Analysis of MuseGAN

Reference Books

- 1 Generative AI, David Foster, 2019, O'Reilly publications.
- 2 Generative AI with Python and TensorFlow 2 , Joseph Babcock and Raghav Bal , 2020, Packt.
- 3 Modern Generative AI with ChatGPT and OpenAI Models: Leverage the capabilities of OpenAI's LLM for productivity and innovation with GPT3 and GPT4 By Valentina Alto, Valentina Alto, 2023, Packt.
- 4 Deep Generative Modeling, Jakub M. Tomczak, 2022, Springer.

23AIP3406M - COGNITIVE COMPUTING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3406M	COGNITIVE COMPUTING	CC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts of cognitive systems, including their computation, knowledge-based AI, cognition, and design principles, with an emphasis on building the corpus, integrating data, machine learning, hypothesis generation, and visualization services.	2	PO1, PO2, PO3
CO2	Apply cognitive functioning principles such as learning, memorizing, adaptation, and decision-making, along with natural language processing techniques and knowledge representation models, to develop and enhance cognitive systems for addressing business problems.	3	PO1, PO2, PO5
CO3	Analyze the integration of mental states such as belief, desire, and intention with advanced analytics capabilities, including machine learning, predictive analytics, and various forms of data analytics, to enhance cognitive functioning in machines and assess their business implications.	4	PO1, PO3, PO5
CO4	Interpret the process of defining objectives and domains, formulating questions, exploring insights, and applying cognitive computing principles to develop applications in healthcare, smarter cities, and government.	4	PO1, PO3, PO5

Syllabus

Introduction to Cognitive Systems and computation, Knowledge based AI: Cognitive systems. Artificial Intelligence as the Foundation of Cognitive Computing, Understanding Cognition, The Elements of a Cognitive System, Cognitive Applications. Design Principles for Cognitive Systems: Building the Corpus, Bringing Data into the Cognitive System, Machine Learning, Hypotheses Generation and Scoring, Presentation and Visualization Services.

Cognitive Functioning: Learning, Memorising, Adaptation, Self Origination, Control, Thinking, Reasoning, Decision Making & Judgement. Natural Language Processing in Support of a Cognitive System: The Role of NLP in a Cognitive System Understanding Linguistics, Applying Natural Language Technologies to Business Problems. Representing Knowledge in Taxonomies and Ontologies: Developing a Cognitive System, Models for Knowledge Representation, Other Methods of Knowledge Representation

Mental States: Belief Desire Intention (BDI) emotion and feeling. Computation of Cognitive Functioning in machines: Applying Advanced Analytics to Cognitive Computing: Key Capabilities in Advanced Analytics, Using Machine Learning in the Analytics Process, Predictive Analytics Text Analytics, Image Analytics, Speech Analytics Using Advanced Analytics to Create Value. Business Implications:

Defining the Objective, Defining the Domain, Defining Questions and Exploring Insights, Building a Cognitive Healthcare Application, Smarter Cities Cognitive Computing in Government

Reference Books

- 1 Cognitive Computing: A Hands-On Approach, Phil Perricone, 2019, A press.
- 2 Cognitive Computing: Theory and Applications, Vijay V. Raghavan, 2016, CRC Press.
- 3 Cognitive Computing: A Brief Guide for Game Changers, Kumar Vuppala, 2015, Apress.
- 4 Practical Cognitive Computing: Learning from Data at Scale, Manjeet Rege, 2018, Apress.
- 5 Introduction to Cognitive Computing: A Guide for Individuals and Small Teams, Joshua Eckroth, 2016, O'Reilly Media.

23AIP3407M - PERCEPTION AND COMPUTER VISION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3407M	PERCEPTION AND COMPUTER VISION	PCV	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental image processing techniques, including filtering and edge detection, to analyze and manipulate digital images.	2	PO1, PO2, PSO1
CO2	Apply various image transformations including orthogonal, Euclidean, affine, and projective transformations.	3	PO1, PO3, PSO1
CO3	Apply and Analyze Image Segmentation&Feature Extraction techniques, detect shapes and lines using the Hough Transform technique.	3	PO1, PO3, PSO1
CO4	Analyze the various feature extraction and classification techniques to recognize and localize objects within images.	4	PO1, PO4, PSO1

Syllabus

Introduction: Overview of Computer Vision, Related Areas, and Applications. Fundamental of Image Processing Techniques, Pixel relationship, Sampling and Quantization, Human Color Perception, Image Filtering Techniques (Spatial and Frequency Domain), Edge Detection (Canny/Sobel/ Gabor/Texture Edges/ Prewitt / Robert)

Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine and Projective, Linear Filters: Linear Filters and Convolution (1D and 2D), Image Enhancement, Histogram Equalization, Image Restoration, Image Thresholding.

Image Segmentation&Feature Extraction: LOG, DOG,HOG, DWT, Hough Transform, SIFT, SURF, Region Growing, Graph-Cut, Texture Segmentation; Morphological Operations Object Detection.

Pattern Analysis& Image Fusion Clustering: Clustering: K-Means, EM Algorithm, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA, Overview of Image Fusion & Pixel Fusion, Multiresolution based Fusion, Object Recognition.

Reference Books

- 1 Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, 2017, Pearson Education.
- 2 Computer vision Algorithms & Applications, Richard Szeliski, 2010, Springer Publication.
- 3 Handbook of Research on Computer Vision and Image Processing in the Deep Learning Era , A. Srinivasan , 2022, Business Science Reference .
- 4 Digital Image Processing and Computer Vision, R.C. Gonzalez and R.E. Woods, 2008, Pearson Education.
- 5 Computer Vision Applications of Visual AI and Image Processing, Pancham Shukla , Rajanikanth Aluvalu , Shilpa Gite and Uma Maheswar, 2023, De Gruyter .

23AIP3408M - MACHINE LEARNING ON CLOUD (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3408M	MACHINE LEARNING ON CLOUD	MLC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts and principles of Cloud Computing, including service models (IaaS, PaaS, SaaS), deployment models (public, private, hybrid), and key providers (AWS, Azure, Google Cloud).	2	PO1, PO2, PO6, PSO2
CO2	Apply data preprocessing and feature engineering techniques using cloud-based tools. Explore Machine Learning Algorithms and Techniques.	3	PO2, PO4, PO6, PSO2
CO3	Analyze the performance of machine learning models in the cloud environment. Hands-on Experience with Cloud Machine Learning Services.	4	PO1, PO3, PO6, PSO2
CO4	Analyze the impact of cloud resources on model performance and cost. Deploying Machine Learning Models in Cloud Environments.	4	PO3, PO4, PO6, PSO2

Syllabus

Cloud Computing Fundamentals: This module introduces students to the foundational concepts of cloud computing, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). They learn about cloud service models, deployment models, and key cloud providers such as AWS, Azure, and Google Cloud Platform. Additionally, students explore cloud architecture, resource provisioning, and management techniques essential for deploying machine learning applications in cloud environments.

Machine Learning Algorithms and Techniques: In this module, students delve into various machine learning algorithms and techniques, including supervised learning, unsupervised learning, and reinforcement learning. They learn how to preprocess data, select appropriate features, and train machine learning models using popular libraries such as TensorFlow and scikit-learn. Emphasis is placed on understanding the strengths and limitations of different algorithms and selecting the most suitable ones for specific tasks.

Cloud-based Machine Learning Services: This module focuses on leveraging cloud-based machine learning services and platforms to streamline the development and deployment of machine learning models. Students explore services such as Amazon SageMaker, Azure Machine Learning, and Google AI Platform, learning how to use them for tasks such as model training, hyperparameter tuning, and model deployment. They gain practical experience through hands-on exercises and projects, deploying machine learning solutions on cloud platforms.

Scalability and Performance Optimization: In this module, students learn techniques for scaling machine learning workloads on the cloud to handle large datasets and high computational demands efficiently. Topics covered include distributed computing, parallel processing, and auto-scaling strategies. Students also explore optimization techniques for improving the performance and efficiency of machine learning algorithms in cloud environments. Additionally, they learn about monitoring and debugging tools for diagnosing performance issues and optimizing resource utilization. Install and configure IBM watson studio, apply feature selection and feature extractions on the available data sets from the studio, visualize data set, Apply Binary Prediction algorithm, Value Prediction algorithms from the available algorithms in the studio, Selecting the machine learning classification algorithm and applying the algorithm on a dataset. Selecting the machine learning clustering algorithm and applying the algorithm on a dataset. Install and configure IBM watson studio, apply feature selection and feature extractions on the available data sets from the studio, visualize data set, Apply Binary Prediction algorithm, Value Prediction algorithms from the available algorithms in the studio, Selecting the machine learning classification algorithm and applying the algorithm on a dataset. Selecting the machine learning clustering algorithm and applying the algorithm on a dataset.

Reference Books

- "Machine Learning on AWS: A Comprehensive Guide to Building, Deploying, and Scaling ML Models", Pratap Dangeti, 2021, O'Reilly Media.

- 2 "Machine Learning with Azure: Implementing End-to-End AI Solutions on the Microsoft AI Platform", Dipankar Sarkar, 2019, Apress.
- 3 "Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Peter Flach, , 2012, Cambridge University Press .
- 4 Cloud Computing for Machine Learning and Cognitive Applications , Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra, Morgan Kaufmann , 2017, Apress .
- 5 Machine Learning Yearning, Andrew Ng, 2018, Self-published.

23AIP3509 - COMPUTATIONAL EPIDEMIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3509	COMPUTATIONAL EPIDEMIOLOGY	CE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the models of Epidemiology and applications of computational science in Epidemiology	2	PO1, PO2, PSO2
CO2	Apply the principles of mathematical modeling used to simulate disease transmission and predict outbreaks	3	PO1, PO2, PSO2
CO3	Analyze the importance of using computational models for designing surveillance and infection control policies, and how low cost policies can be developed using such models.	4	PO3, PO5, PSO2
CO4	Analyze the principles of machine learning and how it can be applied to develop computational models for epidemic spread.	4	PO5, PSO2

Syllabus

Introduction, models, and Disease dynamics: Epidemiology and computational epidemiology, historical overview of epidemiology and computational epidemiology. The importance of understanding and controlling disease-spread. Mass action disease models. Networked computational epidemiology.

Dynamics of disease-spread in mass action models and on contact network models. Inference, Prediction, and forecasting: Inferring disease model parameters-transmission probability, period of infectivity and reproduction number. Inferring infection source and most likely cascades. Predicting future cases and forecasting epidemics.

Infection Surveillance and Control: Designing low-cost disease surveillance and infection control policies. Surveillance includes placing data collection sites in clinics, performing extra testing on selected patients, swabbing selected surfaces in a hospital, etc. Infection control policies include vaccination, prescribing antibiotics and antivirals, quarantining, sequestering, etc.

Machine Learning Application in Computational Epidemiology: Prediction in the Context of Observational Epidemiology, clinical decision support, disease surveillance, introduction to super learner.

Reference Books

- 1 "Computational Epidemiology Data-Driven Modeling of COVID-19" , Ellen Kuhl , 2021, Springer .
- 2 Computational Epidemiology-From disease transmission modelling to vaccination decision making , Jiming Liu, Shang and Xia , 2020, Springer .
- 3 Mathematical Models in Epidemiology , Fred Brauer , Carlos Castillo-Chavez and Zhilan Feng , 2019, Springer .
- 4 Epidemiological Studies of Specified Rare and Intractable Disease, Masakazu Washio, Gen Kobashi, 2018, Springer.

23AIP3510 - NATURAL LANGUAGE PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3510	NATURAL LANGUAGE PROCESSING	NLP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various approaches to syntax and semantics in Natural Language Processing	3	PO1, PO2, PSO2
CO2	Apply the statistical estimation and statistical alignment models for language modelling and parsing.	3	PO2, PO3, PSO2
CO3	Apply Vector models for documents to gain insights of the document.	3	PO2, PO3, PSO1
CO4	Apply various statistical models for classification, information extraction, translation, and generation.	3	PO2, PO3, PSO1

Syllabus

Introduction to language processing: tokens, sentences, paragraphs, Sentence and Paragraph Segmentation, Introduction to Text Normalization (lowercasing, stemming, lemmatization, Corpora and their construction: representativeness, Regular expressions, extraction of information using Regex, Named Entity Recognition, Rule-Based Approaches for NER, Advanced smoothing for language modelling, POS tagging, Introduction to Hidden Markov Models

Models for Sequential tagging: MaxEnt, Viterbi Algorithm, CRF, Spelling Correction, Language Modelling, Computational Semantics, Lexical semantics: WordNet and FrameNet, Syntax: Constituency Parsing, Probabilistic Context-Free Grammars (PCFGs), Dependency Parsing: Dependency Trees, Transition-Based Parsing Comparison of Constituency and Dependency Parsing

Vector Space Model word vectors, GloVe/Word2Vec model, word embedding, Document Similarity measures Cosine and cluster measures, Text Classification, Clustering, and Summarization

Information Extraction, Document Classification, Clustering, topic modelling techniques, Machine Translation, Language Generation

Reference Books

- 1 Speech and Language Processing, Daniel Jurafsky and James H. Martin, 2023, MIT Press.
- 2 Natural language Understanding, James A., 2020, Pearson Education.
- 3 Natural language processing: A Paninian perspective, Bharati Akshar, Chaitanya Vineet, Sangal, Rajeev, 2002, PHI.
- 4 Foundations of Statistical Natural Language Processing, I. Manning, Christopher D.; Hinrich Schuetze; 1999, MIT Press.

23AIP3511 - SPEECH PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3511	SPEECH PROCESSING	SP	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop the knowledge of the speech production and perception mechanism, acoustic phonetics and phonology, speech prosody, and speech sound units.	3	PO1, PSO1
CO2	Make use of the knowledge of the speech signal processing in time and frequency domain, discrete Fourier transform, short-time analysis of speech, linear prediction and cepstral analysis of speech.	3	PO1, PO3, PSO1
CO3	Examine Machine learning (Traditional and State of the Art) models for speech processing such as Dynamic time warping (DTW), Gaussian mixture models (GMM), hidden Markov models (HMM), Neural network models, Support vector machines. Deep Neural Networks, LSTM Recurrent neural networks, Convolutional neural networks, Reinforcement learning	4	PO1, PO2, PSO1
CO4	Analyze End-to-end speech-to-speech Translation systems which has functional blocks such as Speech and Speaker recognition, Speech synthesis and Speech enhancement, Language identification	4	PO1, PSO1
CO5	Examine the speech processing approaches related to feature extraction, and development of machine learning models for speech processing.	4	PO1, PO2, PO3, PSO1

Syllabus

(Speech Science): Overview of speech communication, Speech signal to symbol (sound unit) transformation, nature of speech signal, Speech Production and Perception, Phonetics and Phonology, Acoustics Phonetics, Speech Prosody, Different types of Speech Sound units.

(Speech signal processing (Analysis of speech)): Review of DSP techniques, Time and frequency domain analysis, z-transform, Discrete Fourier transform, short-time analysis of speech, spectrograms, Segmental analysis of speech, Cepstral analysis, Mel frequency cepstral coefficients (MFCC), linear prediction analysis, Linear prediction cepstral coefficients (LPCC).

(Machine learning models for speech processing): Traditional Approaches: Dynamic time warping (DTW), Gaussian mixture models (GMM), hidden Markov models (HMM), Neural network models, Support vector machines State of the Art Models: Deep Neural Networks, LSTM Recurrent neural networks, Convolutional neural networks, Reinforcement learning

(End-to-end speech-to-speech Translation): Speech recognition, Speaker recognition, Speech synthesis, Speech enhancement, Language identification, Emotion recognition, Prosody manipulation.

Reference Books

- 1 Fundamental of Speech Recognition, L. R. Rabiner and B. H. Juang, 1993, Prentice- Hal International, Inc.
- 2 Digital processing of speech signals, L.R.Rabiner and R.W.Schafer, 2013, Pearson LPE.
- 3 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, The MIT Press.
- 4 Machine Learning, Tom M. Mitchell, 1997, Mg-Graw Hill, Indian Edition.
- 5 Text-to-Speech Synthesis, Paul Taylor, 2009, Cambridge University Press.

23AIP3512 - DESIGN & MANAGEMENT OF DISTRIBUTED APPLICATIONS FOR AI ON CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3512	DESIGN & MANAGEMENT OF DISTRIBUTED APPLICATIONS FOR AI ON CLOUD	DMDAAC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of distributed systems involves grasping how multiple independent computers work together to provide a unified service	2	PO1, PO3, PSO2
CO2	Understand various cloud computing platforms involves learning about different services and solutions provided by companies	2	PO1, PO2
CO3	Apply skills to demonstrate and manage distributed AI applications on cloud platforms.	3	PO2, PO4, PSO1
CO4	Identify various operation of distributed AI applications by applying techniques in distributed computing.	3	PO1, PO3

Syllabus

Introduction: Introduction to Distributed Applications for AI on Cloud, Overview of cloud computing and its role in AI applications, Introduction to distributed systems and their challenges, Design considerations for scalable and fault-tolerant applications, Cloud Infrastructure for AI Applications, Cloud service models: IaaS, PaaS, and SaaS, Virtual machines, containers, and serverless computing, Selecting and provisioning cloud resources for AI workloads, Distributed Computing Fundamentals, Parallel computing concepts and models, Distributed file systems and storage solutions, Introduction to MapReduce and Hadoop

AI Algorithms for Distributed Systems, Overview of machine learning algorithms for distributed environments, Distributed training and inference techniques, Model synchronization and aggregation, Data Management in Distributed AI Systems, Data preprocessing and feature engineering in distributed settings, Distributed databases and data warehousing, Data consistency and replication strategies, Performance Optimization for Distributed AI Systems, Load balancing and resource allocation strategies, Caching mechanisms and data locality, Bottleneck identification and system profiling

Security and Privacy in Distributed AI Applications, Threats and vulnerabilities in distributed systems, Authentication and access control in the cloud, Privacy-preserving techniques for distributed AI, Monitoring and Fault Tolerance, Distributed system monitoring and logging, Fault detection and recovery mechanisms, Handling node failures and network partitions, Designing Scalable and Resilient Architectures, Architectural patterns for distributed AI systems, Scalability considerations for large-scale deployments, Building fault-tolerant and highly available systems

Deployment and DevOps for Distributed AI Applications, Continuous integration and deployment (CI/CD) pipelines, Automation and orchestration tools for managing distributed systems, Infrastructure as code (IaC) and configuration management, Performance Evaluation and Benchmarking, Metrics for evaluating the performance of distributed AI applications, Benchmarking frameworks and tools, Analyzing and interpreting performance results, Case Studies and Best Practices, Real-world case studies of successful distributed AI applications, Best practices for designing, deploying, and managing distributed AI systems, Future trends and challenges in the field

Reference Books

- 1 Distributed Computing: Principles, Algorithms, and Systems , Ajay D. Kshemkalyani and Mukesh Singhal , 2011, Cambridge University Press .
- 2 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment , Justin Garrison and Kris Nova , 2017, O'Reilly Media .
- 3 Distributed Systems: Principles and Paradigms , Andrew S. Tanenbaum and Maarten Van Steen , 2016, Pearson.

- 4 Cloud Computing: Concepts, Technology, and Architecture , Thomas Erl, Ricardo Puttini, and Zaigham Mahmood , 2013, Prentice Hall.
- 5 Designing Distributed Systems: Patterns and Paradigms for Scalable, Reliable Services , Brendan Burns , 2018, O'Reilly Media.

23AIP3513 - ARCHITECTING DEEP LEARNING WORKLOADS ON CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AIP3513	ARCHITECTING DEEP LEARNING WORKLOADS ON CLOUD	ADLWC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying deep learning techniques using a cloud platform leverages scalable computing resources, specialized tools, and infrastructure from providers like AWS, GCP, or Azure to efficiently train, deploy, and manage deep learning models.	3	PO1, PO2, PO3, PSO1
CO2	Apply cloud services to enhance deep learning capabilities through scalable computing resources and specialized infrastructure.	3	PO1, PO2, PO3, PSO1
CO3	Apply deep learning architectures efficiently using cloud-based infrastructure for scalable computation and model deployment.	3	PO1, PO2, PO3, PSO1
CO4	Design and construct a deep learning architecture as a cloud service, incorporating various elements and functionalities.	3	PO1, PO2, PO3, PSO1

Syllabus

Overview of Cloud computing enhances deep learning by providing scalable, on-demand resources that optimize cost-efficiency and accelerate model development with specialized hardware like GPUs and TPUs. Leading platforms such as AWS, Google Cloud Platform, and Microsoft Azure offer comprehensive services tailored to deep learning, including managed solutions for training, inference, and data management, facilitating streamlined development and deployment workflows for AI applications.

Overview of Cloud services such as compute (e.g., AWS EC2, Azure VMs, Google Compute Engine), storage, networking, and data management form the backbone of cloud computing infrastructure. For deep learning workloads, selecting appropriate compute instances with GPU support, robust storage solutions for handling large datasets, and optimized networking configurations is crucial to achieving efficient model training and inference at scale.

Designing scalable architectures for deep learning involves implementing distributed training strategies like data parallelism for processing subsets of data across multiple nodes, and model parallelism for distributing different model parts across nodes. Autoscaling and load balancing techniques are then applied to dynamically adjust resources based on workload demands, optimizing resource utilization and maintaining responsiveness across varying computational intensities during training and inference tasks.

Deploying deep learning models as cloud services (e.g., REST APIs, gRPC). Monitoring and managing deployed models in the cloud. Using containerization (Docker) and orchestration (Kubernetes).

Reference Books

- 1 Building Machine Learning and Deep Learning Models on Google Cloud Platform: A Comprehensive Guide for Beginners, Ekaba Bisong, 2019, Apress.
- 2 Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis, 2014, Wiley.
- 3 Hands-On Machine Learning on Google Cloud Platform: Implementing Smart and Secure Applications with Cloud Machine Learning Engine, Giuseppe Ciaburro, 2018, Packt Publishing.
- 4 Practical Deep Learning for Cloud, Mobile, and Edge: Real-World AI & Computer-Vision Projects Using Python, Keras & TensorFlow, Anirudh Koul, Siddha Ganju, and Meher Kasam, 2019, O Reilly Media.

23ALT3101A - APPLIED MACHINE LEARNING FOR TEXT ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3101A	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	AMLFTA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Core Concepts-Overview of text analysis tasks, Introduction to machine learning algorithms, Basics of text preprocessing	2	PO1, PSO1
CO2	Understanding Text Preprocessing Proficiency-Tokenization, stemming, and lemmatization Stop words removal and punctuation handling Text normalization techniques	2	PO2, PSO1
CO3	Implement a bag-of-words model by pre-processing text, building a vocabulary, creating feature vectors with word counts, and evaluating it through the performance of a subsequent machine learning task it feeds into	3	PO3, PSO1
CO4	Analyze the Tool Proficiency-TF-IDF (Term Frequency-Inverse Document Frequency) Word embeddings (Word2Vec, GloVe)	4	PO4, PSO1
CO5	Analyze the Critical Analysis and Interpretation-Supervised Learning for Text Classification, Unsupervised Learning for Text Clustering,	4	PO3, PSO2
CO6	Analyze the Ethical Considerations-Understanding bias in text data and machine learning models, Ethical considerations in text analysis applications, Case studies and discussions on ethical dilemmas in text analysis	4	PO2, PSO1
CO7	Examine the Advanced Topics in Text Analysis by utilizing sophisticated techniques from Natural Language Processing (NLP) to unlock richer insights from textual data.	4	PO1, PSO1

Syllabus

Understanding Core Concepts-Overview of text analysis tasks, Introduction to machine learning algorithms, Basics of text preprocessing

Text Preprocessing Proficiency-Tokenization, stemming, and lemmatization Stop words removal and punctuation handling Text normalization techniques

Model implementation and evaluation include the Bag-of-Words model, which represents text data as fixed-length vectors based on word occurrence. This method simplifies text into numerical features for machine learning algorithms, enabling effective text classification and clustering.

Tool proficiency includes TF-IDF (Term Frequency-Inverse Document Frequency) for weighting terms, and word embeddings such as Word2Vec and GloVe for capturing semantic relationships.

Critical analysis and interpretation involve evaluating the performance of supervised learning models for text classification and unsupervised learning models for text clustering. Understanding the strengths and limitations of these models helps in effectively interpreting their results.

Reference Books

- 1 Applied Text Analysis with Python: Enabling Language-Aware Data Products with Machine Learning, Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda, 2018, O'Reilly Media.
- 2 Introduction to Information Retrieval, Christopher D. Manning, 2024, Cambridge University Press.
- 3 Applied Machine Learning, M. Gopal, 2019, McGraw-Hill.
- 4 Natural Language Processing in Action, Lane, Howard, and Hapke, 2019, Manning Publications.

23ALT3101E - APPLIED MACHINE LEARNING FOR TEXT ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3101E	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	AMLFTA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Core Concepts-Overview of text analysis tasks, Introduction to machine learning algorithms, Basics of text preprocessing	2	PO1, PSO1
CO2	Understanding Text Preprocessing Proficiency-Tokenization, stemming, and lemmatization Stop words removal and punctuation handling Text normalization techniques	2	PO2, PSO2
CO3	Implement a bag-of-words model by pre-processing text, building a vocabulary, creating feature vectors with word counts, and evaluating it through the performance of a subsequent machine learning task it feeds into	3	PO3, PSO2
CO4	Analyze the Tool Proficiency-TF-IDF (Term Frequency-Inverse Document Frequency) Word embeddings (Word2Vec, GloVe)	4	PO4, PSO1
CO5	Analyze the Critical Analysis and Interpretation-Supervised Learning for Text Classification,Unsupervised Learning for Text Clustering,	4	PO3, PSO1
CO6	Analyze the Ethical Considerations-Understanding bias in text data and machine learning models, Ethical considerations in text analysis applications, Case studies and discussions on ethical dilemmas in text analysis	4	PO1, PSO1
CO7	Examine the Advanced Topics in Text Analysis by utilizing sophisticated techniques from Natural Language Processing (NLP) to unlock richer insights from textual data.	4	PO2

Syllabus

The syllabus covers text analysis tasks like sentiment analysis and topic modeling, and introduces machine learning algorithms for text analysis, including supervised and unsupervised methods.

Text preprocessing techniques are discussed, including tokenization, stemming, lemmatization, stop words removal, punctuation handling, and text normalization.

Supervised learning for text classification using labeled data and unsupervised learning for text clustering are key components of the curriculum.

Tool proficiency is emphasized through model implementation, evaluation, and critical analysis to understand and interpret model performance and results effectively.

Critical Analysis and Interpretation-Supervised Learning for Text Classification,Unsupervised Learning for Text Clustering

Reference Books

- 1 Applied Text Analysis with Python: Enabling Language-Aware Data Products with Machine Learning, Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda, 2018, O'Reilly Media.
- 2 Introduction to Information Retrieval, Michael W. Berry and Jacob Kogan, 2024, Wiley-Interscience.
- 3 Applied Machine Learning, M. Gopal, 2019, McGraw-Hill.
- 4 Natural Language Processing in Action, Lane, Howard, and Hapke, 2019, Manning Publications.

23ALT3101R - APPLIED MACHINE LEARNING FOR TEXT ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3101R	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	AMLFTA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Core Concepts-Overview of text analysis tasks, Introduction to machine learning algorithms, Basics of text preprocessing	2	PO1, PSO1
CO2	Understanding Text Preprocessing Proficiency-Tokenization, stemming, and lemmatization Stop words removal and punctuation handling Text normalization techniqueson techniques,	2	PO2, PSO1
CO3	Implement a bag-of-words model by pre-processing text, building a vocabulary, creating feature vectors with word counts, and evaluating it through the performance of a subsequent machine learning task it feeds into	3	PO2, PSO2
CO4	Analyze the Tool Proficiency-TF-IDF (Term Frequency-Inverse Document Frequency) Word embeddings (Word2Vec, GloVe)	4	PO3, PSO2
CO5	Analyze the Critical Analysis and Interpretation-Supervised Learning for Text Classification,Unsupervised Learning for Text Clustering,	4	PO3, PSO2
CO6	Analyze the Ethical Considerations-Understanding bias in text data and machine learning models, Ethical considerations in text analysis applications, Case studies and discussions on ethical dilemmas in text analysis	4	PO4, PSO2

Syllabus

Introduction to Text Analysis and Machine Learning Overview of text analysis tasks Introduction to machine learning algorithms for text analysis

Text Preprocessing Techniques, Tokenization, stemming, and lemmatization Stop words removal and punctuation handling Text normalization techniques

Model Implementation and Evaluation and Tool Proficiency-Bag-of-words model

Supervised Learning for Text Classification, Unsupervised Learning for Text Clustering

Ethical Considerations and Bias in Text Analysis Understanding bias in text data and machine learning models Ethical considerations in text analysis applications Case studies and discussions on ethical dilemmas in text analysis

Reference Books

- 1 Applied Text Analysis with Python: Enabling Language-Aware Data Products with Machine Learning, Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda, 2018, O'Reilly Media.
- 2 Introduction to Information Retrieval, Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, 2024, Cambridge University Press.
- 3 Applied Machine Learning, M. Gopal, 2019, McGraw-Hill.
- 4 Natural Language Processing in Action, Lane, Howard, and Hapke, 2019, Manning Publications.

23ALT3202A - DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3202A	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	DLFNLP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various types of neural networks utilized in Natural Language Processing, including multilayer neural networks, recurrent neural networks (RNNs), convolutional networks, and recursive neural networks.	2	PO1, PO5, PSO1, PSO2
CO2	Apply statistical estimation, HMMs (with Forward and Viterbi algorithms), and sequence labeling for NLP system development.	3	PO1, PO3, PSO1, PSO2
CO3	Analyze and develop proficiency in implementing word vector representations like word2vec and GloVe, as well as generating sentence, paragraph, and document representations using deep learning techniques.	4	PO1, PO2, PSO1, PSO2
CO4	Analyze attention models and memory networks for language understanding, and evaluate their effectiveness in solving complex NLP problems, thereby demonstrating the ability to innovate and adapt deep learning architectures to practical NLP applications.	4	PO1, PO2, PO3, PSO2
CO5	Develop and evaluate the performance of deep learning models in Natural Language Processing tasks and demonstrate the ability to fine-tune and optimize model architectures and hyperparameters to achieve state-of-the-art results.	5	PO1, PO2, PSO2

Syllabus

Overview of Natural Language Processing (NLP). Introduction to Deep Learning Neural network basics Activation functions Loss functions. Applications of Deep Learning in NLP Text classification Named Entity Recognition (NER) Language generation. Basics of Multilayer Neural Networks Perceptrons and neurons Feedforward architecture. Back-propagation Algorithm Chain rule Gradient descent Stochastic gradient descent

Entropy, relative entropy, cross entropy, Statistical estimation and smoothing for language models, Parts of Speech Tagging and Sequence Labelling, Lexical syntax, Hidden Markov Models (Forward and Viterbi algorithms and EM training), n-gram models.

Recursive Neural Networks Tree-based structures in NLP Recursive neural tensor networks. Gated Recurrent Units (GRUs) and Long Short-Term Memory (LSTM) Networks Architecture and advantages Applications in sequence modeling and language generation. Building attention models Attention mechanism in neural networks Self-attention and transformer architectures. Memory networks for language understanding Architecture and operations Applications in question answering and dialogue systems

Design and Applications of Deep Nets to Language Modeling Neural language models Sequence-to-sequence models. Parsing with Deep Learning Dependency parsing Constituency parsing. Sentiment Analysis using Deep Learning Sentiment classification Aspect-based sentiment analysis. Machine Translation with Deep Learning Neural machine translation Transformer models

Model Evaluation Metrics Precision, Recall, F1-score Accuracy, Confusion Matrix ROC Curve, AUC-ROC BLEU, METEOR for machine translation evaluation. Hyperparameter Tuning Techniques Grid search Random search Bayesian optimization Hyperband. Model Interpretability Feature importance analysis Visualization techniques (e.g., t-SNE) Attention visualization

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 2 Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2009, O'Reilly Media.

- 3 Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Daniel Jurafsky and James H. Martin, 2023, Pearson.
- 4 Neural Network Methods for Natural Language Processing, Yoav Goldberg, 2017, Morgan & Claypool Publishers.
- 5 Foundations of Statistical Natural Language Processing, Christopher D. Manning and Hinrich Schütze, 1999, The MIT Press.

23ALT3202E - DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3202E	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	DLFNL	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various types of neural networks utilized in Natural Language Processing, including multilayer neural networks, recurrent neural networks (RNNs), convolutional networks, and recursive neural networks	2	PO1, PO5, PSO1, PSO2
CO2	Apply statistical estimation, HMMs (with Forward and Viterbi algorithms), and sequence labeling for NLP system development.	3	PO1, PO3, PSO1, PSO2
CO3	Analyze and Develop proficiency in implementing word vector representations like word2vec and GloVe, as well as generating sentence, paragraph, and document representations using deep learning techniques.	4	PO1, PO2, PSO1, PSO2
CO4	Analyze attention models and memory networks for language understanding, and evaluate their effectiveness in solving complex NLP problems, thereby demonstrating the ability to innovate and adapt deep learning architectures to practical NLP applications	4	PO1, PO2, PO3, PSO1
CO5	Develop and evaluate the performance of deep learning models in Natural Language Processing tasks and demonstrate the ability to fine-tune and optimize model architectures and hyperparameters to achieve state-of-the-art results.	5	PO1, PO2, PSO1

Syllabus

Overview of Natural Language Processing (NLP). Introduction to Deep Learning Neural network basics Activation functions Loss functions. Applications of Deep Learning in NLP Text classification Named Entity Recognition (NER) Language generation. Basics of Multilayer Neural Networks Perceptrons and neurons Feedforward architecture. Back-propagation Algorithm Chain rule Gradient descent Stochastic gradient descent

Entropy, relative entropy, cross entropy, Statistical estimation and smoothing for language models, Parts of Speech Tagging and Sequence Labelling, Lexical syntax, Hidden Markov Models (Forward and Viterbi algorithms and EM training), n-gram models.

Recursive Neural Networks Tree-based structures in NLP Recursive neural tensor networks. Gated Recurrent Units (GRUs) and Long Short-Term Memory (LSTM) Networks Architecture and advantages Applications in sequence modeling and language generation. Building attention models Attention mechanism in neural networks Self-attention and transformer architectures. Memory networks for language understanding Architecture and operations Applications in question answering and dialogue systems

Design and Applications of Deep Nets to Language Modeling Neural language models Sequence-to-sequence models. Parsing with Deep Learning Dependency parsing Constituency parsing. Sentiment Analysis using Deep Learning Sentiment classification Aspect-based sentiment analysis. Machine Translation with Deep Learning Neural machine translation Transformer models

Model Evaluation Metrics Precision, Recall, F1-score Accuracy, Confusion Matrix ROC Curve, AUC-ROC BLEU, METEOR for machine translation evaluation. Hyperparameter Tuning Techniques Grid search Random search Bayesian optimization Hyperband. Model Interpretability Feature importance analysis Visualization techniques (e.g., t-SNE) Attention visualization

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 2 Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2009, O'Reilly Media.

- 3 Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Daniel Jurafsky and James H. Martin, 2023, Pearson.
- 4 Neural Network Methods for Natural Language Processing, Yoav Goldberg, 2017, Morgan & Claypool Publishers.
- 5 Foundations of Statistical Natural Language Processing, Christopher D. Manning and Hinrich Schütze, 1999, The MIT Press.

23ALT3202R - DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3202R	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	DLFNLP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various types of neural networks utilized in Natural Language Processing, including multilayer neural networks, recurrent neural networks (RNNs), convolutional networks, and recursive neural networks.	2	PO1, PO5, PSO1, PSO2
CO2	Apply statistical estimation, HMMs (with Forward and Viterbi algorithms), and sequence labeling for NLP system development.	3	PO1, PO3, PSO1, PSO2
CO3	Analyze and develop proficiency in implementing word vector representations like word2vec and GloVe, as well as generating sentence, paragraph, and document representations using deep learning techniques.	4	PO1, PO2, PO3, PSO1, PSO2
CO4	Analyze attention models and memory networks for language understanding, and evaluate their effectiveness in solving complex NLP problems, thereby demonstrating the ability to innovate and adapt deep learning architectures to practical NLP applications.	4	PO1, PO2, PO3, PSO1, PSO2

Syllabus

Overview of Natural Language Processing (NLP). Introduction to Deep Learning Neural network basics Activation functions Loss functions. Applications of Deep Learning in NLP Text classification Named Entity Recognition (NER) Language generation. Basics of Multilayer Neural Networks Perceptrons and neurons Feedforward architecture. Back-propagation Algorithm Chain rule Gradient descent Stochastic gradient descent

Entropy, relative entropy, cross entropy, Statistical estimation and smoothing for language models, Parts of Speech Tagging and Sequence Labelling, Lexical syntax, Hidden Markov Models (Forward and Viterbi algorithms and EM training), n-gram models.

Recursive Neural Networks Tree-based structures in NLP Recursive neural tensor networks. Gated Recurrent Units (GRUs) and Long Short-Term Memory (LSTM) Networks Architecture and advantages Applications in sequence modeling and language generation. Building attention models Attention mechanism in neural networks Self-attention and transformer architectures. Memory networks for language understanding Architecture and operations Applications in question answering and dialogue systems

Design and Applications of Deep Nets to Language Modeling Neural language models Sequence-to-sequence models. Parsing with Deep Learning Dependency parsing Constituency parsing. Sentiment Analysis using Deep Learning Sentiment classification Aspect-based sentiment analysis. Machine Translation with Deep Learning Neural machine translation Transformer models

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 2 Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2009, O'Reilly Media.
- 3 Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Daniel Jurafsky and James H. Martin, 2023, Pearson.
- 4 Neural Network Methods for Natural Language Processing, Yoav Goldberg, 2017, Morgan & Claypool Publishers.
- 5 Foundations of Statistical Natural Language Processing, Christopher D. Manning and Hinrich Schütze, 1999, The MIT Press.

23ALT3303A - CONVERSATIONAL AI AND CHATBOT DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3303A	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	CAICBD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the principles and challenges of conversational AI and recall the components of chatbot architecture.	2	PO1, PO2, PO3, PSO1
CO2	Explain the basics of natural language processing (NLP). Understand the concepts of intent recognition and entity extraction in NLP.	2	PO3, PO4, PSO1
CO3	Build text preprocessing techniques. Develop a simple chatbot using NLU(Natural Language Understanding) frameworks.	3	PO2, PO4, PSO1
CO4	Examine different machine learning models for chatbots. Analyze dialog flows and state tracking mechanisms.	4	PO1, PO3, PO4, PSO1
CO5	Determine the ethical implications of chatbot development. Assess the effectiveness of chatbot architectures in real-world scenarios.	5	PO1, PO3, PSO1
CO6	Design and develop a chatbot capable of context-aware responses in real-time scenarios.	6	PO2, PO4, PSO1
CO7	Evaluate the performance and ethical implications of chatbot applications in various domains.	5	PO3, PSO1

Syllabus

Introduction to Conversational AI, Definition and applications, Evolution of chatbots, Challenges and opportunities, Natural Language Processing (NLP), Basics Text preprocessing, Tokenization and stemming, Part-of-speech tagging, Named entity recognition (NER).

Natural Language Understanding (NLU), Intent recognition, Entity extraction, Slot filling, NLU frameworks and tools Natural Language Generation (NLG), Text generation techniques, NLG architectures, NLG evaluation metrics.

Machine learning models for chatbots, Introduction to machine learning, Supervised, unsupervised, and reinforcement learning, Deep learning models for NLP (e.g., RNNs, Transformers), Transfer learning for chatbot development, Chatbot Architectures, Components of chatbot architecture, Design considerations, Single-turn vs. multi-turn conversations.

Dialog Management, State tracking, Context management, Handling user utterances, Dialog flow design, Integration with Backend Systems, Database integration, API usage, Web scraping for data retrieval.

Personalization and context awareness, User profiling, Contextual understanding, Recommendation systems for chatbots Multimodal Interaction, Voice-based interaction, Visual inputs and responses, Integration with voice assistants, Ethical considerations in chatbot development, Privacy and data security, Bias and fairness, Transparency and accountability.

Reference Books

- 1 Conversational Artificial Intelligence, Romil Rawat, Rajesh Kumar Chakrawarti, Sanjaya Kumar Sarangi, Anand Rajavat, Mary Sowjanya Alamanda, Kotagiri Srividya, and K. Sakthidasan Sankaran, 2024, Scrivener Publishing.
- 2 Building Chatbots with Python: Using Natural Language Processing and Machine Learning, Sumit Raj, 2018, Apress.
- 3 Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots (Synthesis Lectures on Human Language Technologies), Michael McTear, 2020, Springer.
- 4 Building Chatbots with Microsoft Bot Framework and Azure, Masi, N., 2017, Apress.
- 5 Deep Learning for NLP and Speech Recognition, Uday Kamath, John Liu, James (Jimmy) Whitaker, 2020, Springer.

23ALT3303E - CONVERSATIONAL AI AND CHATBOT DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3303E	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	CAICBD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the principles and challenges of conversational AI and recall the components of chatbot architecture.	2	PO1, PO2, PO3, PSO1
CO2	Explain the basics of natural language processing (NLP). Understand the concepts of intent recognition and entity extraction in NLP.	2	PO3, PO4, PSO1
CO3	Build text preprocessing techniques. Develop a simple chatbot using NLU(Natural Language Understanding) frameworks.	3	PO2, PO4, PSO1
CO4	Examine different machine learning models for chatbots. Analyze dialog flows and state tracking mechanisms.	4	PO1, PO3, PO4, PSO1
CO5	Determine the ethical implications of chatbot development. Assess the effectiveness of chatbot architectures in real-world scenarios..	5	PO1, PO3, PSO1
CO6	Design and develop a chatbot capable of context-aware responses in real-time scenarios.	6	PO2, PO4, PSO1
CO7	Evaluate the performance and ethical implications of chatbot applications in various domains.	5	PO3, PSO1

Syllabus

Introduction to Conversational AI, Definition and applications, Evolution of chatbots, Challenges and opportunities
 Natural Language Processing (NLP), Basics Text preprocessing, Tokenization and stemming, Part-of-speech tagging, Named entity recognition (NER).

Natural Language Understanding (NLU), Intent recognition, Entity extraction, Slot filling, NLU frameworks and tools
 Natural Language Generation (NLG), Text generation techniques, NLG architectures, NLG evaluation metrics.

Machine Learning Models for NLP, Basics of machine learning, Supervised, unsupervised, and reinforcement learning,
 Deep learning models for NLP (e.g., RNNs, Transformers), Dialog Management, State tracking, Context management,
 Handling user utterances, Dialog flow design.

Ethical Considerations in Conversational AI, Privacy and data security, Bias and fairness, Transparency and accountability,
 Integration with Backend Systems, Database integration, API usage, Web scraping for data retrieval.

Multimodal Interaction, Voice-based interaction, Visual inputs and responses, Integration with voice assistants,
 Personalization and Context Awareness, User profiling, Contextual understanding, Recommendation systems for chatbots,
 Chatbot Deployment and Maintenance Scalability and reliability, Security considerations, Continuous learning and improvement.

Reference Books

- 1 Conversational Artificial Intelligence, Romil Rawat, Rajesh Kumar Chakrawarti, Sanjaya Kumar Sarangi, Anand Rajavat, Mary Sowjanya Alamanda, Kotagiri Srividya, and K. Sakthidasan Sankaran, 2024, Scrivener Publishing.
- 2 Building Chatbots with Python: Using Natural Language Processing and Machine Learning, Sumit Raj, 2018, Apress.
- 3 Deep Learning for NLP and Speech Recognition, Uday Kamath, John Liu, James (Jimmy) Whitaker, 2020, Springer.
- 4 Building Chatbots with Microsoft Bot Framework and Azure, Masi, N., 2017, Apress.

23ALT3303R - CONVERSATIONAL AI AND CHATBOT DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3303R	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	CAICBD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the principles and challenges of conversational AI and recall the components of chatbot architecture.	2	PO1, PO2, PO3, PSO1
CO2	Explain the basics of natural language processing (NLP). Understand the concepts of intent recognition and entity extraction in NLP.	2	PO3, PO4, PSO1
CO3	Build text preprocessing techniques. Develop a simple chatbot using NLU(Natural Language Understanding) frameworks.	3	PO2, PO4, PSO1
CO4	Examine different machine learning models for chatbots. Analyze dialog flows and state tracking mechanisms.	4	PO1, PO3, PO4, PSO1
CO5	Design and develop a chatbot capable of context-aware responses in real-time scenarios.	6	PO1, PO3, PSO1
CO6	Evaluate the performance and ethical implications of chatbot applications in various domains.	5	PO2, PO4, PSO1

Syllabus

Introduction to Conversational AI, Applications of conversational AI Basics of Natural Language Processing (NLP), Understanding user input Tokenization and basic text processing, Introduction to chatbot frameworks, Building Simple Chatbots, Implementing basic chatbot functionalities.

Dialog Management, Basics understanding dialog flow, Handling basic conversation scenarios, Ethical Considerations in Conversational AI, Privacy and data security, Bias and fairness, Transparency and accountability Integration with Backend Systems

Database integration API usage, Web scraping for data retrieval, Machine Learning Models for NLP, Basics of machine learning Supervised, unsupervised, and reinforcement learning Deep learning models for NLP (e.g., RNNs, Transformers)

Personalization and Context Awareness, User profiling Contextual understanding, Recommendation systems for chatbots, Multimodal Interaction, Voice-based interaction, Visual inputs and responses. Integration with voice assistants, Ethical Considerations in Chatbot Development, Privacy and data security.

Reference Books

- 1 Conversational Artificial Intelligence, Romil Rawat, Rajesh Kumar Chakrawarti, Sanjaya Kumar Sarangi, Anand Rajavat, Mary Sowjanya Alamanda, Kotagiri Srividya, and K. Sakthidasan Sankaran, 2024, Scrivener Publishing.
- 2 Building Chatbots with Python: Using Natural Language Processing and Machine Learning, Sumit Raj, 2018, Apress.
- 4 Deep Learning for NLP and Speech Recognition, Uday Kamath, John Liu, James (Jimmy) Whitaker, 2020, Springer.
- 5 Building Chatbots with Microsoft Bot Framework and Azure, Masi, N., 2017, Apress.
- 6 Designing Bots: Creating Conversational Experiences, Amir Shevat, 2017, O'Reilly Media.

23ALT3404M - TEXT UNDERSTANDING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3404M	TEXT UNDERSTANDING	TUS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline to identify, extract, and analyze valuable information from text data through text mining techniques and its applications, challenges, and data preparation methods	2	PO1, PSO2
CO2	Relate different text preprocessing techniques for analysing the data, techniques for cleaning and analyzing text data, including stop-word removal, stemming, lemmatization, and part-of-speech tagging	3	PO6
CO3	Examine different feature extraction methods to apply for text data, techniques for transforming text data into numerical representations, including Bag-of-Words, TF-IDF, and word embedding models like Word2Vec and GloVe.	4	PO4
CO4	Analyse the machine learning algorithms for text classification, clustering, and sentiment analysis and techniques for classifying text data, organizing text into groups, and understanding sentiment in written language.	4	PO1, PSO1

Syllabus

Introduction to Text Mining Definition and scope of text mining Applications and challenges Text Preprocessing

Tokenization Stop-word removal Stemming and Lemmatization Part-of-speech tagging

Feature Extraction Bag-of-Words model TF-IDF (Term Frequency-Inverse Document Frequency) Word embeddings (Word2Vec, GloVe)

Text Classification Naive Bayes classifier Support Vector Machines (SVM) Deep learning approaches (e.g., Recurrent Neural Networks) Text Clustering K-means clustering Hierarchical clustering Density-based clustering (DBSCAN) Sentiment Analysis Lexicon-based methods Machine learning approaches Aspect-based sentiment analysis

Reference Books

- 1 Introduction to Information Retrieval , Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze, 2022, Cambridge University Press.
- 2 Text Mining: Applications and Theory, Michael W. Berry and Jacob Kogan, 2014, Wiley.
- 3 Hands-On Text Mining and Natural Language Processing (NLP) using Python, Shubham Choudhary and Nitin Kumar , 2020, Packt Publishing.
- 4 Applied Text Analysis with Python, Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda, 2018, O'Reilly Media, Inc..
- 5 Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2009, O'Reilly .

23ALT3405M - NATURAL LANGUAGE PROCESSING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3405M	NATURAL LANGUAGE PROCESSING	NLP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various approaches to syntax and semantics in Natural Language Processing	3	PO1, PO2, PSO2
CO2	Apply the statistical estimation and statistical alignment models for language modelling and parsing.	3	PO2, PO3, PSO2
CO3	Apply Vector models for documents to gain insights of the document.	3	PO2, PO3, PSO1
CO4	Apply various statistical models for classification, information extraction, translation, and generation.	3	PO2, PO3, PSO1

Syllabus

Introduction to language processing: tokens, sentences, paragraphs, Sentence and Paragraph Segmentation, Introduction to Text Normalization (lowercasing, stemming, lemmatization, Corpora and their construction: representativeness, Regular expressions, extraction of information using Regex, Named Entity Recognition, Rule-Based Approaches for NER, Advanced smoothing for language modelling, POS tagging, Introduction to Hidden Markov Models

Models for Sequential tagging: MaxEnt, Viterbi Algorithm, CRF, Spelling Correction, Language Modelling, Computational Semantics, Lexical semantics: WordNet and FrameNet, Syntax: Constituency Parsing, Probabilistic Context-Free Grammars (PCFGs), Dependency Parsing: Dependency Trees, Transition-Based Parsing Comparison of Constituency and Dependency Parsing

Vector Space Model word vectors, GloVe, Word2Vec model, word embedding, Document Similarity measures Cosine and cluster measures, Text Classification, Clustering, and Summarization

Information Extraction, Document Classification, Clustering, topic modelling techniques, Machine Translation, Language Generation

Reference Books

- 1 Speech and Language Processing, Daniel Jurafsky and James H. Martin, 2023, MIT Press.
- 2 Foundations of Statistical Natural Language Processing, J. Manning, Christopher D.; Hinrich Schuetze; , 1999, MIT Press.
- 3 Natural language processing and Information Retrieval, U.S. Tiwary & Tanveer Siddiqui, 2020, Oxford University Press.
- 4 Natural language processing: A Paninian perspective, Bharati Akshar, Chaitanya Vineet, Sangal, Rajeev, 2002, PHI.

23ALT3506 - LANGUAGE UNDERSTANDING WITH PRE-TRAINED MODELS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3506	LANGUAGE UNDERSTANDING WITH PRE-TRAINED MODELS	LUWPTM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Pre-trained Models is, and pre-trained language models, Evolution of pre-training techniques.	2	PO1, PSO2
CO2	Apply the Pre-trained Models- Transfer learning principles, Fine-tuning strategies, Domain adaptation techniques .	3	PO2, PO4, PSO2
CO3	Develop a project that Popular pre-trained models: BERT, GPT, RoBERTa, etc.Masked language modeling (MLM) Next sentence prediction (NSP) .	4	PO2, PO4, PSO2
CO4	Analyze and discuss the language generation tasks- Fine-tuning pre-trained models for language generation..	4	PO2, PO4, PSO2

Syllabus

Introduction to Pre-trained Models: Overview of pre-trained language model, Evolution of pre-training techniques, Popular pre-trained models: BERT, GPT, RoBERTa, etc, Pre-training Objectives: Masked language modeling (MLM), Next sentence prediction (NSP), Contrastive pre-training objectives, Self-supervised learning and unsupervised pre-training

Fine-tuning Pre-trained Models , Transfer learning principles, Fine-tuning strategies, Domain adaptation techniques, Handling different downstream tasks Text Classification with Pre-trained Models: Overview of text classification , Fine-tuning for text classification tasks , Implementing text classification pipelines , Evaluation metrics for text classification

Introduction of Sentiment Analysis and its implementation: Introduction to sentiment analysis, Fine-tuning pre-trained models for sentiment analysis, Implementing sentiment analysis pipelines , Evaluation metrics for sentiment analysis.

Introduction of Language Generation and implantation: Overview of language generation tasks , Fine-tuning pre-trained models for language generation, Implementing language generation pipelines , Evaluation metrics for language generation , Multi-task learning with pre-trained models , Knowledge distillation techniques, Handling large datasets and distributed training.

Reference Books

- 1 Natural Language Processing with PyTorch: Build Intelligent Language Applications Using Deep Learning, Delip Rao and Brian McMahan, 2019, O'Reilly Media.
- 2 Natural Language Processing in Action, Lane, Howard, and Hapke, 2019, Manning Publications.
- 3 Transformers for Natural Language Processing, Shibamouli Lahiri and Anuj Gupta, 2024, O'Reilly Media.
- 4 Deep Learning for Natural Language Processing: Creating Neural Networks with Python, Palash Goyal, Sumit Pandey, and Karan Jain, 2018, Packt Publishing.

23ALT3507 - LARGE LANGUAGE MODEL FOR SPEECH PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ALT3507	LARGE LANGUAGE MODEL FOR SPEECH PROCESSING	LLMFSP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the speech sounds, their physical properties and speech signals using digital techniques like Short-Time Fourier Transform, filter banks, and Linear Predictive Coding (LPC).	2	PO1, PSO1
CO2	Understand the extracting features from speech signals, compare speech patterns using techniques like cepstral distance and dynamic time warping, and delve into distortion measures.	2	PO1, PO2, PO3, PSO1
CO3	Apply the power of machine learning for speech processing, exploring techniques like DTW, GMMs, HMMs, SVMs, and cutting-edge deep neural networks.	3	PO1, PO2, PSO1
CO4	Apply the text-to-speech synthesis methods (concatenative, waveform) and prosody for natural sounding speech its applications.	3	PO1, PO5, PSO2

Syllabus

Speech Fundamentals: Articulatory Phonetics Production and Classification of Speech Sounds; Acoustic Phonetics ,acoustics of speech production; Review of Digital Signal Processing concepts; ShortTime Fourier Transform, FilterBank and LPC Methods

Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures mathematical and perceptual Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization Dynamic Time Warping, Multiple Time Alignment Path

Hidden Markov Models: Markov Processes, HMMs Evaluation, Optimal State Sequence Viterbi Search, BaumWelch Parameter Re-estimation, Implementation issues, Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system

Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness role of prosody, Applications and present status

Reference Books

- 1 Fundamentals of Speech Recognition, Lawrence Rabiner and Biing Hwang Juang, 2003, Pearson Education.
- 2 Speech and Language Processing An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Daniel Jurafsky and James H Martin, 2004, Pearson Education.
- 3 The Scientist and Engineers Guide to Digital Signal Processing, .Steven W. Smith, 2011, California Technical Publishing.
- 4 Discrete-Time Speech Signal Processing Principles and Practice, Thomas F Quatieri, 2006, Pearson Education.
- 6 Speech and audio signal processing, Ben gold and Nelson Morgan, 2006, Wiley India Edition.
- 7 Statistical Methods of Speech Recognition, Frederick Jelinek, 2013, MIT Press.
- 8 Mastering Large Language Models: Advanced techniques, Sanket Subhash Khandare , 2024, Kindle Press.

23ASS3101A - AUTONOMOUS DRIVER ASSISTIVE SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3101A	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	ADAS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the core concepts and principles underlying Autonomous Driver Assistive Systems (ADAS).	2	PO1, PO2, PO3, PSO2
CO2	Identify and describe the key components and technologies used in ADAS, including sensors, cameras, radar, LIDAR, and processing units.	3	PO1, PO2, PO3, PSO1
CO3	Understand the various sensor technologies employed in ADAS and their roles in different driving scenarios.	2	PO1, PO2, PO3, PSO1
CO4	Examine the strengths and limitations of different sensor types (e.g., cameras, radar, LIDAR) in diverse environmental conditions.	4	PO1, PO2, PO3, PSO2
CO5	Apply principles of sensor fusion to integrate data from multiple sensors, creating a comprehensive view of the vehicle's surroundings	3	PO1, PO2, PO3, PSO2
CO6	Develop algorithms for processing sensor data to detect and track objects, lanes, and traffic signs.	3	PO1, PO2, PO3, PSO1
CO7	Implement computer vision techniques for tasks such as object detection, lane detection, and traffic sign recognition	3	PO1, PO2, PO11, PSO1

Syllabus

Introduction to Autonomous Driver Assistive Systems. Overview of ADAS. History and evolution of ADAS. Levels of driving automation (SAE levels). Current trends and future directions. ADAS Architecture and Components. System architecture. Key components: sensors, actuators, and processing units

Sensor Technologies and Data Acquisition. Camera Systems. Types of cameras (monocular, stereo, surround-view). Image processing basics. Radar and LIDAR. Radar principles and applications. LIDAR technology and 3D mapping. Ultrasonic Sensors and GNSS. Ultrasonic sensor applications in parking assistance. Global Navigation Satellite System (GNSS) for vehicle localization

Sensor Fusion and Data Processing. Introduction to Sensor Fusion. Basics of sensor fusion. Importance in ADAS. Sensor Fusion Algorithms. Kalman filtering. Bayesian networks. Data association techniques

Computer Vision for ADAS. Object Detection and Recognition. Techniques for object detection. Deep learning models (e.g., CNNs). Lane Detection and Tracking. Image processing for lane detection. Algorithms for lane tracking. Traffic Sign Recognition. Methods for traffic sign detection and classification. Machine learning applications.

System Integration and Testing. System Integration. Integration of sensors, ECUs, and actuators. Software architecture for ADAS. Simulation and Testing. Simulation tools and environments (e.g., MATLAB, CARLA). Testing methodologies and validation techniques.

Reference Books

- 1 Autonomous Driving: How the Driverless Revolution will Change the World, Andreas Herrmann, Walter Brenner, Rupert Stadler, 2018, Emerald Group Publishing.
- 2 Automated Driving: Safer and More Efficient Future Driving, Daniel Watzenig, Martin Horn, 2017, Springer.
- 3 Road Vehicle Automation, Gereon Meyer, Sven Beiker, 2014, Springer.
- 4 Autonomous Vehicles: Opportunities, Challenges, and Risks, Kasap, Sezgin, 2019, Wiley-IEEE Press.

- 5 Autonomous Vehicle Technology: A Guide for Policymakers, James M. Anderson, Nidhi Kalra, Karlyn D. Stanley, Paul Sorensen, 2016, RAND Corporation.

23ASS3101E - AUTONOMOUS DRIVER ASSISTIVE SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3101E	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	ADAS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the core concepts and principles underlying Autonomous Driver Assistive Systems (ADAS).	2	PO1, PO2, PO3, PSO2
CO2	Identify and describe the key components and technologies used in ADAS, including sensors, cameras, radar, LIDAR, and processing units.	3	PO1, PO2, PO3, PSO1
CO3	Understand the various sensor technologies employed in ADAS and their roles in different driving scenarios.	2	PO1, PO2, PO3, PSO1
CO4	Examine the strengths and limitations of different sensor types (e.g., cameras, radar, LIDAR) in diverse environmental conditions.	4	PO1, PO2, PO3, PSO2
CO5	Apply principles of sensor fusion to integrate data from multiple sensors, creating a comprehensive view of the vehicle's surroundings	3	PO1, PO2, PO3, PSO2
CO6	Develop algorithms for processing sensor data to detect and track objects, lanes, and traffic signs.	3	PO1, PO2, PO3, PSO1
CO7	Implement computer vision techniques for tasks such as object detection, lane detection, and traffic sign recognition	3	PO1, PO2, PO11, PSO1

Syllabus

Introduction to Autonomous Driver Assistive Systems. Overview of ADAS. History and evolution of ADAS. Levels of driving automation (SAE levels). Current trends and future directions. ADAS Architecture and Components. System architecture. Key components: sensors, actuators, and processing units.

Sensor Technologies and Data Acquisition. Camera Systems. Types of cameras (monocular, stereo, surround-view). Image processing basics. Radar and LIDAR. Radar principles and applications. LIDAR technology and 3D mapping. Ultrasonic Sensors and GNSS. Ultrasonic sensor applications in parking assistance. Global Navigation Satellite System (GNSS) for vehicle localization.

Sensor Fusion and Data Processing. Introduction to Sensor Fusion. Basics of sensor fusion. Importance in ADAS. Sensor Fusion Algorithms. Kalman filtering. Bayesian networks. Data association techniques

Computer Vision for ADAS. Object Detection and Recognition. Techniques for object detection. Deep learning models (e.g., CNNs). Lane Detection and Tracking. Image processing for lane detection. Algorithms for lane tracking. Traffic Sign Recognition. Methods for traffic sign detection and classification. Machine learning applications.

System Integration and Testing. System Integration. Integration of sensors, ECUs, and actuators. Software architecture for ADAS. Simulation and Testing. Simulation tools and environments (e.g., MATLAB, CARLA). Testing methodologies and validation techniques.

Reference Books

- 1 Autonomous Driving: How the Driverless Revolution will Change the World, Andreas Herrmann, Walter Brenner, Rupert Stadler, 2018, Emerald Group Publishing.
- 2 Automated Driving: Safer and More Efficient Future Driving, Daniel Watzenig, Martin Horn, 2017, Springer.
- 3 Road Vehicle Automation, Gereon Meyer, Sven Beiker, 2014, Springer.
- 4 Autonomous Vehicles: Opportunities, Challenges, and Risks, Kasap, Sezgin, 2019, Wiley-IEEE Press.

- 5 Autonomous Vehicle Technology: A Guide for Policymakers, James M. Anderson, Nidhi Kalra, Karlyn D. Stanley, Paul Sorensen, Constantine Samaras, Oluwatobi A. Oluwatola, 2016, RAND Corporation.

23ASS3101R - AUTONOMOUS DRIVER ASSISTIVE SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3101R	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	ADAS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the core concepts and principles underlying Autonomous Driver Assistive Systems (ADAS).	2	PO1, PO2, PO3, PSO2
CO2	Identify and describe the key components and technologies used in ADAS, including sensors, cameras, radar, LIDAR, and processing units.	3	PO1, PO2, PO3, PSO1
CO3	Understand the various sensor technologies employed in ADAS and their roles in different driving scenarios.	2	PO1, PO2, PO3, PSO1
CO4	Examine the strengths and limitations of different sensor types (e.g., cameras, radar, LIDAR) in diverse environmental conditions.	4	PO1, PO2, PO3, PSO2
CO5	Apply principles of sensor fusion to integrate data from multiple sensors, creating a comprehensive view of the vehicle's surroundings.	3	PO1, PO2, PO3, PSO2
CO6	Develop algorithms for processing sensor data to detect and track objects, lanes, and traffic signs.	3	PO1, PO2, PO11, PSO1

Syllabus

Introduction to Autonomous Driver Assistive Systems. Overview of ADAS. History and evolution of ADAS. Levels of driving automation (SAE levels). Current trends and future directions. ADAS Architecture and Components. System architecture. Key components: sensors, actuators, and processing units.

Sensor Technologies and Data Acquisition. Camera Systems. Types of cameras (monocular, stereo, surround-view). Image processing basics. Radar and LIDAR. Radar principles and applications. LIDAR technology and 3D mapping. Ultrasonic Sensors and GNSS. Ultrasonic sensor applications in parking assistance. Global Navigation Satellite System (GNSS) for vehicle localization.

Sensor Fusion and Data Processing. Introduction to Sensor Fusion. Basics of sensor fusion. Importance in ADAS. Sensor Fusion Algorithms. Kalman filtering. Bayesian networks. Data association techniques

Computer Vision for ADAS. Object Detection and Recognition. Techniques for object detection. Deep learning models (e.g., CNNs). Lane Detection and Tracking. Image processing for lane detection. Algorithms for lane tracking. Traffic Sign Recognition. Methods for traffic sign detection and classification. Machine learning applications.

Control Systems and Algorithms. Adaptive Cruise Control (ACC). ACC algorithms. Longitudinal control strategies. Lane Keeping Assist (LKA). Lateral control strategies. Steering control algorithms. Automatic Emergency Braking (AEB). Collision detection algorithms. Emergency braking strategies.

System Integration and Testing. System Integration. Integration of sensors, ECUs, and actuators. Software architecture for ADAS. Simulation and Testing. Simulation tools and environments (e.g., MATLAB, CARLA). Testing methodologies and validation techniques.

Reference Books

- 1 Autonomous Driving: How the Driverless Revolution will Change the World, Andreas Herrmann, Walter Brenner, Rupert Stadler, 2018, Emerald Group Publishing.
- 2 Automated Driving: Safer and More Efficient Future Driving, Daniel Watzenig, Martin Horn, 2017, Springer.
- 3 Road Vehicle Automation, Gereon Meyer, Sven Beiker, 2014, Springer.
- 4 Autonomous Vehicles: Opportunities, Challenges, and Risks, Kasap, Sezgin, 2019, Wiley-IEEE Press.

- 5 Autonomous Vehicle Technology: A Guide for Policymakers, James M. Anderson, Nidhi Kalra, Karlyn D. Stanley, Paul Sorensen, 2016, RAND Corporation.

23ASS3102A - AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3102A	AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE	AICAFT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of AI and control theory, for electric vehicle systems.	3	PO1, PO2
CO2	Develop a deep understanding of the integration of AI and control systems for Electric vehicle functions.	3	PO1, PO2
CO3	Apply AI techniques for perception, planning, decision-making ,and control of autonomous vehicles.	3	PO1, PO2
CO4	Examine the role of AI in optimizing electric vehicle performance energy management, and charging infrastructure.	4	PO1, PO2
CO5	Analyze the challenges and opportunities in developing autonomous electric vehicles.	4	PO1, PO2
CO6	Analyze the various AI control of Autonomous Vehicle transportation components testing using software tools with Simulink, OBD2, and Can Analyzer	4	PO1, PO2
CO7	Examine the Autonomous Vehicle systems based on various tools on AI techniques, Computer vision, NLP, and deep learning	4	PO1, PO2

Syllabus

Fundamentals of Autonomous vehicle: Introduction to autonomous vehicles, Vehicledynamics and control, Sensor fusion and perception, Path planning and motion planning, Control systemdesign for autonomous vehicles

AI for Autonomous Vehicle: Autonomous driving - Machine learningand deep learning, Computer vision and image processing for perception, Natural language processing forhuman-vehicle interaction, Reinforcement learning for autonomous decision-making

EV Fundamentals:Electric vehicle components and systems, Battery technology and management, Electric powertrain andcontrol, Energy management strategies, Charging Infrastructure and Power Electronics

AI for ElectricalVehicle: Battery management and state estimation with AI, Electric powertrain optimization strategies, AI forcharging infrastructure management, AI for vehicle-to-grid (V2G) interactions.

Integration of AI andControl for Autonomous Electric Vehicles: Co-design of AI and control systems, Energy-efficient autonomoustriving, AI-based predictive control for EVs, Challenges and future directions

Reference Books

- 1 Building Chatbots with Python Using Natural Language Processing and Machine Learning, Sumit Raj, 1, 2019, Apress.
- 2 Computer Vision for Visual Effects, RICHARD J. RADKE, 2,2020, Cambridge University Press.
- 3 Neural Network Methods for Natural Language Processing, Yoav Goldberg, 1, 2017, Morgan & cLaypool publishers.

23ASS3102E - AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3102E	AI AND CONTROLS FOR AUTONOMUS FUTURE VEHICLE	AICAFT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of AI and control theory, for electric vehicle systems.	3	PO1, PO2
CO2	Develop a deep understanding of the integration of AI and control systems for Electric vehicle functions.	3	PO1, PO2
CO3	Apply AI techniques for perception, planning, decision-making ,and control of autonomous vehicles.	3	PO1, PO2
CO4	Examine the role of AI in optimizing electric vehicle performance energy management, and charging infrastructure.	4	PO1, PO2
CO5	Analyze the challenges and opportunities in developing autonomous electric vehicles.	4	PO1, PO2
CO6	Analyze the various AI control of Autonomous Vehicle transportation components testing using software tools with Simulink, OBD2, and Can Analyzer	4	PO1, PO2
CO7	Examine the Autonomous Vehicle systems based on various tools on AI techniques, Computer vision, NLP, and deep learning	4	PO1, PO2

Syllabus

Fundamentals of Autonomous vehicle: Introduction to autonomous vehicles, Vehicledynamics and control, Sensor fusion and perception, Path planning and motion planning, Control systemdesign for autonomous vehicles

AI for Autonomous Vehicle: Autonomous driving - Machine learningand deep learning, Computer vision and image processing for perception, Natural language processing forhuman-vehicle interaction, Reinforcement learning for autonomous decision-making

EV Fundamentals:Electric vehicle components and systems, Battery technology and management, Electric powertrain andcontrol, Energy management strategies, Charging Infrastructure and Power Electronics

AI for ElectricalVehicle: Battery management and state estimation with AI, Electric powertrain optimization strategies, AI forcharging infrastructure management, AI for vehicle-to-grid (V2G) interactions.

Integration of AI andControl for Autonomous Electric Vehicles: Co-design of AI and control systems, Energy-efficient autonomoustriving, AI-based predictive control for EVs, Challenges and future directions

Reference Books

- 1 Building Chatbots with Python Using Natural Language Processing and Machine Learning, Sumit Raj, 1, 2019, Apress.
- 2 Computer Vision for Visual Effects, RICHARD J. RADKE , 2,2020 , Cambridge University Press.
- 3 Neural Network Methods for Natural Language Processing, Yoav Goldberg, 1, 2017 , Morgan & cLaypool publishers .

23ASS3102R - AI AND CONTROLS FOR AUTONOMOUS FUTURE VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3102R	AI AND CONTROLS FOR AUTONOMOUS FUTURE VEHICLE	AICAFT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of AI and control theory, for electric vehicle systems.	3	PO1, PO2
CO2	Develop a deep understanding of the integration of AI and control systems for Electric vehicle functions.	3	PO1, PO2
CO3	Apply AI techniques for perception, planning, decision-making ,and control of autonomous vehicles.	3	PO1, PO2
CO4	Examine the role of AI in optimizing electric vehicle performance energy management, and charging infrastructure.	4	PO1, PO2

Syllabus

Fundamentals of Autonomous vehicle: Introduction to autonomous vehicles, Vehicledynamics and control, Sensor fusion and perception, Path planning and motion planning, Control systemdesign for autonomous vehicles

AI for Autonomous Vehicle: Autonomous driving - Machine learningand deep learning, Computer vision and image processing for perception, Natural language processing forhuman-vehicle interaction, Reinforcement learning for autonomous decision-making

EV Fundamentals:Electric vehicle components and systems, Battery technology and management, Electric powertrain andcontrol, Energy management strategies, Charging Infrastructure and Power Electronics

AI for ElectricalVehicle: Battery management and state estimation with AI, Electric powertrain optimization strategies, AI forcharging infrastructure management, AI for vehicle-to-grid (V2G) interactions, Energy-efficient autonomoustraveling, AI-based predictive control for EVs, Challenges and future directions

Reference Books

- 1 Building Chatbots with Python Using Natural Language Processing and Machine Learning, Sumit Raj , 1, 2019 , Apress.
- 2 Computer Vision for Visual Effects , RICHARD J. RADKE, 2,2020 , Cambridge University Press.
- 3 Neural Network Methods for Natural Language Processing, Yoav Goldberg, 1, 2017 , Morgan & cLaypool publishers.

23ASS3202A - INTRODUCTION TO INTELLIGENT DRONES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3202A	INTRODUCTION TO INTELLIGENT DRONES	IID	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles and technologies behind intelligent drones, including sensing, perception, and control.	2	PO1, PSO1, PSO2
CO2	Apply theoretical knowledge to develop practical solutions for drone navigation and object detection using machine learning and computer vision techniques.	3	PO1, PO3, PSO1
CO3	Evaluate real-world scenarios to identify suitable applications of intelligent drones across diverse industries, considering their benefits and limitations.	4	PO3, PSO2
CO4	Collaborate effectively in peer mentor study groups to solve complex problems related to drone design, operation, and ethical considerations.	4	PO9, PSO1
CO5	Communicate ideas and findings clearly and persuasively through presentations and written reports, demonstrating proficiency in technical communication.	5	PO10, PSO2

Syllabus

Foundations of Intelligent Drones: Introduction to Drone Technology, Principles of Sensing and Perception, Basics of Drone Control Systems, Navigation Techniques for Intelligent Drones, Ethical and Legal Considerations in Drone Operations.

Machine Learning for Drone Applications: Fundamentals of Machine Learning, Supervised Learning for Drone Navigation, Unsupervised Learning for Anomaly Detection, Reinforcement Learning for Autonomous Flight, Transfer Learning for Object Recognition.

Computer Vision for Drones: Introduction to Computer Vision, Image Processing Techniques for Drone Vision, Object Detection and Tracking Algorithms, Semantic Segmentation for Scene Understanding, Deep Learning Approaches for Visual Perception.

Applications of Intelligent Drones: Agricultural Applications: Crop Monitoring and Spraying, Surveillance and Security: Intrusion Detection and Monitoring, Search and Rescue Operations: Disaster Response with Drones, Environmental Monitoring: Wildlife Conservation and Forest Management, Industrial Inspections: Infrastructure Monitoring and Maintenance.

Peer Mentor Collaboration and Project Presentation: Group Discussions and Problem-Solving Sessions, Peer Review and Feedback Mechanisms, Project Planning and Execution, Presentation Skills and Public Speaking, Final Project Presentations and Evaluation

Reference Books

- 1 Introduction to Autonomous Robots: Mechanics, Sensors, Actuators, and Algorithms, Vijay Kumar, Ani Hsieh, and Daniel Mellinger, 2022, The MIT Press.
- 2 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, The MIT Press.
- 3 Computer Vision: Algorithms and Applications, Richard Szeliski, 2022, Springer.
- 4 Revolutionary Applications of Intelligent Drones, Mohit Angurula and Vikas Khullar, 2022, Nova Science Publishers.

23ASS3202E - INTRODUCTION TO INTELLIGENT DRONES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3202E	INTRODUCTION TO INTELLIGENT DRONES	IID	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles and technologies behind intelligent drones, including sensing, perception, and control.	2	PO1, PSO1, PSO2
CO2	Apply theoretical knowledge to develop practical solutions for drone navigation and object detection using machine learning and computer vision techniques.	3	PO1, PO3, PSO1
CO3	Evaluate real-world scenarios to identify suitable applications of intelligent drones across diverse industries, considering their benefits and limitations	4	PO3, PSO2
CO4	Collaborate effectively in peer mentor study groups to solve complex problems related to drone design, operation, and ethical considerations.	4	PO9, PSO1
CO5	Communicate ideas and findings clearly and persuasively through presentations and written reports, demonstrating proficiency in technical communication.	5	PO10, PSO2

Syllabus

Foundations of Intelligent Drones: Introduction to Drone Technology, Principles of Sensing and Perception, Basics of Drone Control Systems, Navigation Techniques for Intelligent Drones, Ethical and Legal Considerations in Drone Operations

Machine Learning for Drone Applications: Fundamentals of Machine Learning, Supervised Learning for Drone Navigation, Unsupervised Learning for Anomaly Detection, Reinforcement Learning for Autonomous Flight, Transfer Learning for Object Recognition

Computer Vision for Drones: Introduction to Computer Vision, Image Processing Techniques for Drone Vision, Object Detection and Tracking Algorithms, Semantic Segmentation for Scene Understanding, Deep Learning Approaches for Visual Perception

Applications of Intelligent Drones: Agricultural Applications: Crop Monitoring and Spraying, Surveillance and Security: Intrusion Detection and Monitoring, Search and Rescue Operations: Disaster Response with Drones, Environmental Monitoring: Wildlife Conservation and Forest Management, Industrial Inspections: Infrastructure Monitoring and Maintenance

Peer Mentor Collaboration and Project Presentation: Group Discussions and Problem-Solving Sessions, Peer Review and Feedback Mechanisms, Project Planning and Execution, Presentation Skills and Public Speaking, Final Project Presentations and Evaluation

Reference Books

- 1 Introduction to Unmanned Aircraft Systems, Reg Austin, 2022, CRC Press.
- 2 Introduction to Machine Learning, Ethem Alpaydin, 2016, The MIT Press.
- 3 Computer Vision: Algorithms and Applications, Richard Szeliski, 2022, Springer.
- 4 Revolutionary Applications of Intelligent Drones, Mohit Angurala and Vikas Khullar, 2022, Nova Science Publishers.

23ASS3202R - INTRODUCTION TO INTELLIGENT DRONES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3202R	INTRODUCTION TO INTELLIGENT DRONES	IID	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts and principles of intelligent drone technology, including hardware components and software algorithms.	2	PO1, PO5, PSO1
CO2	Analyze the applications and use cases of intelligent drones across various industries, identifying their benefits and limitations.	4	PO1, PO3, PSO1
CO3	Apply programming languages and development tools to implement basic control algorithms and autonomous behaviors in intelligent drones.	3	PO3, PSO2
CO4	Demonstrate proficiency in operating and troubleshooting intelligent drones, adhering to safety regulations and ethical considerations.	3	PO3, PO5, PSO2

Syllabus

Introduction to Intelligent Drones: Overview of Drone Technology, Components of Intelligent Drones (Sensors, Actuators, Flight Controllers), Types of Drones (Fixed-Wing, Multirotor, Hybrid), Drone Navigation Systems (GPS, IMU, Vision-based Navigation), Regulations and Ethics in Drone Operations

Intelligent Drone Applications: Aerial Photography and Videography, Agriculture and Crop Monitoring, Search and Rescue Operations, Infrastructure Inspection and Maintenance, Environmental Monitoring and Conservation

Drone Control and Navigation: Basics of Drone Control: PID Controllers, Proportional Navigation, Autonomous Flight Modes (Waypoint Navigation, Follow Me Mode), Obstacle Avoidance Algorithms, Path Planning and Trajectory Generation, Simulators and Testing Environments for Drone Development

Programming Intelligent Drones: Introduction to Drone Programming Languages (Python, C/C++), Drone API and SDK: DJI SDK, PX4 Autopilot, Developing Basic Control Algorithms (Takeoff, Landing, Hovering), Implementing Autonomous Behaviors - Mission Planning & Autonomous Landing, Integrating Computer Vision and Machine Learning for Intelligent Drones Drone Operation and Safety: Pre-flight Checks and Procedures, Emergency Response and Recovery.

Reference Books

- 1 Small Unmanned Aircraft: Theory and Practice, Randal W. Beard, Timothy W. McLain, 2022, Princeton University Press.
- 2 Python Machine Learning, Sebastian Raschka, Vahid Mirjalili, 2016, Packt Publishing.
- 3 Computer Vision: Algorithms and Applications, Richard Szeliski, 2022, Springer.
- 4 Revolutionary Applications of Intelligent Drones, Mohit Angurala and Vikas Khullar, 2022, Nova Science Publishers.

23ASS3203A - AI AND IOT FOR AUTONOMOUS VEHICLE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3203A	AI AND IOT FOR AUTONOMOUS VEHICLE	AIAV	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of autonomous vehicles and their significance in modern transportation systems.	2	PO1, PO2, PO3, PSO2
CO2	Identify the key components and technologies involved in autonomous vehicles, including sensors, actuators, and communication systems.	3	PO1, PO3, PO4, PSO1
CO3	Develop algorithms for autonomous navigation, path planning, and obstacle avoidance using AI.	3	PO1, PO2, PO3, PSO2
CO4	Inspect the fundamental principles of artificial intelligence and its application in autonomous vehicle systems.	4	PO1, PO2, PO3, PSO2
CO5	Evaluate the various sensor technologies used in autonomous vehicles, including cameras, LiDAR, radar, and ultrasonic sensors.	5	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Autonomous Vehicles. Overview of Autonomous Vehicles. Evolution and Current State of Autonomous Driving Technology. Challenges and Opportunities in Autonomous Vehicle Development.

Basics of Artificial Intelligence (AI). Introduction to Artificial Intelligence. Machine Learning Fundamentals. Deep Learning and Neural Networks.

Sensor Technologies for Autonomous Vehicles. Types of Sensors Used in Autonomous Vehicles (LiDAR, Radar, Cameras, etc.). Sensor Fusion Techniques. Data Processing and Filtering for Sensor Data.

Machine Learning for Perception. Object Detection and Recognition. Semantic Segmentation. Sensor Data Fusion using Machine Learning Techniques.

Decision Making and Control. Path Planning Algorithms. Trajectory Optimization. Reinforcement Learning for Autonomous Vehicle Control.

Reference Books

- 1 Autonomous Vehicles and Future Mobility, Pierluigi Coppola, Domokos Eszterg r-Kiss, 2019, Elsevier.
- 2 Artificial Intelligence for Autonomous Networks, Mazin Gilbert, 2018, CRC Press.
- 3 Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, 2014, VPT.
- 4 Artificial Intelligence for Autonomous Driving: A Hands-On Approach, Sinan Ozdemir, Francesco Masulli, Enrico Giunchiglia, 2021, Springer.
- 5 IoT and Edge Computing for Architects, Perry Lea, 2018, Packt Publishing.

23ASS3203E - AI AND IOT FOR AUTONOMOUS VEHICLE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3203E	AI AND IOT FOR AUTONOMOUS VEHICLE	AIAV	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of autonomous vehicles and their significance in modern transportation systems.	2	PO1, PO2, PO3, PSO2
CO2	Identify the key components and technologies involved in autonomous vehicles, including sensors, actuators, and communication systems.	3	PO1, PO3, PO4, PSO1
CO3	Develop algorithms for autonomous navigation, path planning, and obstacle avoidance using AI.	3	PO1, PO2, PO3, PSO2
CO4	Inspect the fundamental principles of artificial intelligence and its application in autonomous vehicle systems.	4	PO1, PO2, PO3, PSO2
CO5	Evaluate the various sensor technologies used in autonomous vehicles, including cameras, LiDAR, radar, and ultrasonic sensors.	5	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Autonomous Vehicles. Overview of Autonomous Vehicles. Evolution and Current State of Autonomous Driving Technology. Challenges and Opportunities in Autonomous Vehicle Development.

Basics of Artificial Intelligence (AI). Introduction to Artificial Intelligence. Machine Learning Fundamentals. Deep Learning and Neural Networks.

Sensor Technologies for Autonomous Vehicles. Types of Sensors Used in Autonomous Vehicles (LiDAR, Radar, Cameras, etc.). Sensor Fusion Techniques. Data Processing and Filtering for Sensor Data.

Machine Learning for Perception. Object Detection and Recognition. Semantic Segmentation. Sensor Data Fusion using Machine Learning Techniques.

Decision Making and Control. Path Planning Algorithms. Trajectory Optimization. Reinforcement Learning for Autonomous Vehicle Control.

Reference Books

- 1 Autonomous Vehicles and Future Mobility, Pierluigi Coppola, Domokos Eszterg r-Kiss, 2019, Elsevier.
- 2 Artificial Intelligence for Autonomous Networks, Mazin Gilbert, 2018, CRC Press.
- 3 Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, 2014, VPT.
- 4 Artificial Intelligence for Autonomous Driving: A Hands-On Approach, Sinan Ozdemir, Francesco Masulli, Enrico Giunchiglia, 2021, Springer.
- 5 IoT and Edge Computing for Architects, : Perry Lea, 2018, Packt Publishing.

23ASS3203R - AI AND IOT FOR AUTONOMOUS VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3203R	AI AND IOT FOR AUTONOMOUS VEHICLE	AIAV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of autonomous vehicles and their significance in modern transportation systems.	2	PO1, PO2, PO3, PSO2
CO2	Identify the key components and technologies involved in autonomous vehicles, including sensors, actuators, and communication systems.	3	PO1, PO3, PO4, PSO1
CO3	Develop algorithms for autonomous navigation, path planning, and obstacle avoidance using AI.	3	PO1, PO2, PO3, PSO2
CO4	Inspect the fundamental principles of artificial intelligence and its application in autonomous vehicle systems.	4	PO1, PO2, PO3, PSO2

Syllabus

Introduction to Autonomous Vehicles. Overview of Autonomous Vehicles. Evolution and Current State of Autonomous Driving Technology. Challenges and Opportunities in Autonomous Vehicle Development.

Basics of Artificial Intelligence (AI). Introduction to Artificial Intelligence. Machine Learning Fundamentals. Deep Learning and Neural Networks.

Sensor Technologies for Autonomous Vehicles. Types of Sensors Used in Autonomous Vehicles (LiDAR, Radar, Cameras, etc.). Sensor Fusion Techniques. Data Processing and Filtering for Sensor Data.

Machine Learning for Perception. Object Detection and Recognition. Semantic Segmentation. Sensor Data Fusion using Machine Learning Techniques.

Reference Books

- 1 Autonomous Vehicles and Future Mobility, Pierluigi Coppola, Domokos Eszterg r-Kiss, 2019, Elsevier.
- 2 Artificial Intelligence for Autonomous Networks, Mazin Gilbert, 2018, CRC Press.
- 3 Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, 2014, VPT.
- 4 Artificial Intelligence for Autonomous Driving: A Hands-On Approach, Sinan Ozdemir, Francesco Masulli, Enrico Giunchiglia, 2021, Springer.
- 5 IoT and Edge Computing for Architects, Perry Lea, 2018, Packt Publishing.

23ASS3205A - AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3205A	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	AVECUDA	A	3	0	4	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the challenges and opportunities in ECU development for Autonomous & Electric Vehicle.	2	PO1, PO4, PSO1
CO2	Apply the fundamentals of Autonomous and EV ECU design including hardware architecture, software development	3	PO2, PO5, PSO2
CO3	Analyze the Autonomous and EV ECU design including hardware architecture, software testing methodologies.	4	PO2, PO4, PSO1
CO4	Analyze the Integration of AI and control algorithms into ECU software to enhance vehicle performance for Autonomous and EV Vehicle	4	PO1, PO4, PSO2
CO5	Explore how the industry is applying Autosar Standards for developing the Software for Autonomous and EV Vehicle.	4	PO1, PO5, PSO1
CO6	Test the basic Autonomous and EV ECU design by hardware realization and CANoe software	4	PO2, PO5, PSO1

Syllabus

Introduction to In Vehicle Networks for Autonomous Vehicle and Electrical Vehicle-LIN Communication Overview, CAN Communication Overview, ISO-14229, 2020, Road Vehicles, Unified Diagnostic Services, Overview, Measurement and Calibration of Autonomous, EV System, Automotive Calibration Tools

Overview of Autonomous Vehicle System Design and Electrical Vehicle Design, Product Specifications, System, Mechanical, Electrical and Software Components of a product, System Architecture and System Level Features,

Hardware Block Diagram, schematics and Interfaces, Software Architecture and Components Description, Boundary Diagram of a product, Understanding System level block diagram of a product, Design consideration

System design of Powertrain ECU and its features, Battery Management System Design, Motor control Unit and control Algorithm, Charging System Design, Interface to Vehicle, Gateway, Design consideration

Domain Controllers, ADAS, Chassis, Powertrain, ECU for Sensor Fusion, Perception and Actuation, Interface to Cloud, V2I and its applications, Cybersecurity Controls for Autonomous vehicles, Design consideration

Software design of Autonomous and EV System. Overview of Autosar Software Layers, Microcontroller Abstraction Layer - Micro-controller Drivers, Memory Drivers, IO Drivers, Communication Drivers, ECU Abstraction Layer, IO Hardware Abstraction, Memory Abstraction, Communication Abstraction, Services Layer, Memory Services, System Services, Communication services, Autosar RTE and Autosar Application, Autosar Interfaces, Autosar Stack and Design flow

Reference Books

- 1 Sensor Systems and Communication Technologies in Autonomous Driving. Germany: GRIN Verlag. , Nitsch, T, First, Wiley.
- 2 Vehicular Communications for Smart Cars, Protocols, Chowdhury, Lewis Mackenzie, Third, John Wiley and Sons.
- 3 Autonomous and Connected Vehicles: Network Architectures from Legacy Networks to Automotive Ethernet, Paret, D., Rebaine, H, Second, Wiley.
- 4 Vehicular Communications for Smart Cars,, Niaz Chowdhury, Lewis Mackenzie, First, John Wiley and Sons.

23ASS3205E - AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3205E	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	AVECUDA	E	3	0	4	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the challenges and opportunities in ECU development for Autonomous & Electric Vehicle.	2	PO1, PO4, PSO1
CO2	Apply the fundamentals of Autonomous and EV ECU design including hardware architecture, software development	3	PO2, PO5, PSO2
CO3	Analyze the Autonomous and EV ECU design including hardware architecture, software testing methodologies.	4	PO1, PO5, PSO1
CO4	Analyze the Integration of AI and control algorithms into ECU software to enhance vehicle performance for Autonomous and EV Vehicle	4	PO2, PO4, PSO2
CO5	Explore how the industry is applying Autosar Standards for developing the Software for Autonomous and EV Vehicle.	4	PO2, PO5, PSO1
CO6	Test the basic Autonomous and EV ECU design by hardware realization and CANoe software	4	PO1, PO4, PSO2

Syllabus

Introduction to In Vehicle Networks for Autonomous Vehicle and Electrical Vehicle-LIN Communication Overview, CAN Communication Overview, ISO-14229, 2020, Road Vehicles, Unified Diagnostic Services, Overview, Measurement and Calibration of Autonomous, EV System, Automotive Calibration Tools

Overview of Autonomous Vehicle System Design and Electrical Vehicle Design, Product Specifications, System, Mechanical, Electrical and Software Components of a product, System Architecture and System Level Features,

Hardware Block Diagram, schematics and Interfaces, Software Architecture and Components Description, Boundary Diagram of a product, Understanding System level block diagram of a product, Design consideration

System design of Powertrain ECU and its features, Battery Management System Design, Motor control Unit and control Algorithm, Charging System Design, Interface to Vehicle, Gateway, Design consideration

Domain Controllers, ADAS, Chassis, Powertrain, ECU for Sensor Fusion, Perception and Actuation, Interface to Cloud, V2I and its applications, Cybersecurity Controls for Autonomous vehicles, Design consideration

Software design of Autonomous and EV System. Overview of Autosar Software Layers, Microcontroller Abstraction Layer - Micro-controller Drivers, Memory Drivers, IO Drivers, Communication Drivers, ECU Abstraction Layer, IO Hardware Abstraction, Memory Abstraction, Communication Abstraction, Services Layer, Memory Services, System Services, Communication services, Autosar RTE and Autosar Application, Autosar Interfaces, Autosar Stack and Design flow

Reference Books

- 1 Sensor Systems and Communication Technologies in Autonomous Driving. Germany: GRIN Verlag., Nitsch, T, First, John Wiley and Sons.
- 2 Vehicular Communications for Smart Cars, Protocols, Chowdhury, Lewis Mackenzie, Third, John Wiley and Sons.
- 3 Autonomous and Connected Vehicles: Network Architectures from Legacy Networks to Automotive Ethernet, Paret, D., Rebaine, H, Second, John Wiley and Sons.
- 4 Vehicular Communications for Smart Cars, Niaz Chowdhury, Lewis Mackenzie, First, John Wiley and Sons.

23ASS3205R - AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3205R	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	AVECUDA	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the challenges and opportunities in ECU development for Autonomous & Electric Vehicle.	2	PO1, PO4, PSO1
CO2	Apply the fundamentals of Autonomous and EV ECU design including hardware architecture, software development	3	PO2, PO5, PSO2
CO3	Analyze the Autonomous and EV ECU design including hardware architecture, software testing methodologies.	4	PO2, PO5, PSO2
CO4	Explore how the industry is applying Autosar Standards for developing the Software for Autonomous and EV Vehicle.	4	PO2, PO4, PSO1
CO5	Test the basic Autonomous and EV ECU design by hardware realization and CANoe software	4	PO1, PO5, PSO2

Syllabus

Introduction to In Vehicle Networks for Autonomous Vehicle and Electrical Vehicle-LIN Communication Overview, CAN Communication Overview, ISO-14229, 2020, Road Vehicles, Unified Diagnostic Services, Overview, Measurement and Calibration of Autonomous, EV System, Automotive Calibration Tools

Overview of Autonomous Vehicle System Design and Electrical Vehicle Design, Product Specifications, System, Mechanical, Electrical and Software Components of a product, System Architecture and System Level Features

System design of Powertrain ECU and its features, Battery Management System Design, Motor control Unit and control Algorithm, Charging System Design, Interface to Vehicle, Gateway, Design consideration

Domain Controllers, ADAS, Chassis, Powertrain, ECU for Sensor Fusion, Perception and Actuation, Interface to Cloud, V2I and its applications, Cybersecurity Controls for Autonomous vehicles, Design consideration

Software design of Autonomous and EV System. Overview of Autosar Software Layers, Microcontroller Abstraction Layer - Micro-controller Drivers, Memory Drivers, IO Drivers, Communication Drivers, ECU Abstraction Layer, IO Hardware Abstraction, Memory Abstraction, Communication Abstraction, Services Layer, Memory Services, System Services

Reference Books

- 1 Sensor Systems and Communication Technologies in Autonomous Driving. Germany: GRIN Verlag., Nitsch, T, First, Wiley.
- 2 Vehicular Communications for Smart Cars, Protocols, Chowdhury, Lewis Mackenzie, Third, Wiley.
- 3 Autonomous and Connected Vehicles: Network Architectures from Legacy Networks to Automotive Ethernet, Paret, D., Rebaine, H, Second, John Wiley and Sons.
- 4 Vehicular Communications for Smart Cars,, Niaz Chowdhury, Lewis Mackenzie, First, Wiley.

23ASS3304A - APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3304A	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	ADLAS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand deep learning and its role in perception, decision-making, and control, key components and architectures of autonomous systems	2	PO1, PO3, PO4, PSO1
CO2	Develop the fundamentals of deep learning architectures, training techniques, and optimization strategies for solving complex problems	3	PO1, PO3, PO4, PSO1
CO3	Apply knowledge of deep learning techniques (CNNs) for processing sensor data (cameras, LiDAR, radar) used in autonomous systems for tasks like object detection, segmentation, and sensor fusion.	3	PO2, PO3, PSO1
CO4	Build knowledge and techniques to design intelligent agents that can learn to make optimal decisions, navigate complex environments, and control dynamical systems.	3	PO1, PO3, PSO1
CO5	Design, implement, and ethically analyze high-performing and secure autonomous systems using deep learning.	4	PO2, PO4, PSO1
CO6	Evaluate end-to-end deep learning solutions for autonomous navigation and environment interaction.	5	PO2, PO4, PSO1
CO7	Adapt the ethical implications and safety considerations in deploying deep learning for autonomous systems.	6	PO1, PO2, PO4, PSO1

Syllabus

Overview of autonomous systems - Introduction to deep learning - Key components and architecture of autonomous systems - Role of deep learning in perception, decision-making, and control

Neural networks, Convolutional Neural Networks (CNNs) ,LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Recurrent Neural Networks (RNNs) - Training techniques: backpropagation, gradient descent - Regularization and optimization strategies - Transfer learning and fine-tuning

Convolutional Neural NetworkComputer vision for autonomous systems: object detection, segmentation - Sensor fusion: integrating data from cameras, LiDAR, radar - Deep learning for sensor data processing (CNNs)

Reinforcement learning for decision making - Policy gradient methods and Q-learning - Integrating deep learning with control systems - Path planning and obstacle avoidance

Real-time performance and optimization - Safety and robustness in autonomous systems - Ethical considerations and regulatory aspects - Future trends in deep learning for autonomous systems

Reference Books

- 1 Deep Learning, Ian Goodfellow (Author), Yoshua Bengio (Author), Aaron Courville (Author) , 2016, Alanna Maldonado.
- 2 Autonomous Robotics and Deep Learning , Vishnu Nath (Author), Stephen E. Levinson (Author) , 2014, pringer International Publishing AG;.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurlien Gron , 2022, O'Reilly Media.
- 4 Deep Reinforcement Learning Hands-On, Maxim Lapan, 2020, Packt Publishing.
- 5 Applied Deep Learning , Dr. Rajkumar Tekchandani, Dr. Neeraj Kumar, 2023, BPB Publications.

23ASS3304E - APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3304E	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	ADLAS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand deep learning and its role in perception, decision-making, and control, key components and architectures of autonomous systems	2	PO1, PO3, PO4, PSO1
CO2	Develop the fundamentals of deep learning architectures, training techniques, and optimization strategies for solving complex problems	3	PO1, PO3, PO4, PSO1
CO3	Apply knowledge of deep learning techniques (CNNs) for processing sensor data (cameras, LiDAR, radar) used in autonomous systems for tasks like object detection, segmentation, and sensor fusion.	3	PO2, PO3, PSO1
CO4	Build knowledge and techniques to design intelligent agents that can learn to make optimal decisions, navigate complex environments, and control dynamical systems.	4	PO1, PO3, PSO1
CO5	Design, implement, and ethically analyze high-performing and secure autonomous systems using deep learning.	5	PO2, PO4, PSO1
CO6	Evaluate end-to-end deep learning solutions for autonomous navigation and environment interaction.	5	PO2, PO4, PSO1
CO7	Adapt the ethical implications and safety considerations in deploying deep learning for autonomous systems	6	PO1, PO2, PO4, PSO1

Syllabus

Overview of autonomous systems - Introduction to deep learning - Key components and architecture of autonomous systems - Role of deep learning in perception, decision-making, and control

Neural networks, Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) - Training techniques: backpropagation, gradient descent - Regularization and optimization strategies - Transfer learning and fine-tuning

Convolutional Neural Network Computer vision for autonomous systems: object detection, segmentation - Sensor fusion: integrating data from cameras, LiDAR, radar - Deep learning for sensor data processing (CNNs)

Reinforcement learning for decision making - Policy gradient methods and Q-learning - Integrating deep learning with control systems - Path planning and obstacle avoidance

Real-time performance and optimization - Safety and robustness in autonomous systems - Ethical considerations and regulatory aspects - Future trends in deep learning for autonomous systems

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, MIT Press.
- 2 Deep Reinforcement Learning Hands-On, Maxim Lapan, 2020, Packt Publishing.
- 3 Pattern Recognition and Machine Learning, Christopher M. Bishop, 2006, Springer.
- 4 Artificial Intelligence: A Modern Approach, Stuart Russell, Peter Norvig, 2020, Pearson.
- 5 Applied Deep Learning, Dr. Rajkumar Tekchandani, Dr. Neeraj Kumar, 2023, BPB Publications.

23ASS3304R - APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3304R	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	ADLAS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand deep learning and its role in perception, decision-making, and control, key components and architectures of autonomous systems	2	PO1, PO2, PSO1
CO2	Develop the fundamentals of deep learning architectures, training techniques, and optimization strategies for solving complex problems	3	PO3, PO4, PSO1
CO3	Apply knowledge of deep learning techniques (CNNs) for processing sensor data (cameras, LiDAR, radar) used in autonomous systems for tasks like object detection, segmentation, and sensor fusion.	4	PO2, PO3, PO4, PSO1
CO4	Build knowledge and techniques to design intelligent agents that can learn to make optimal decisions, navigate complex environments, and control dynamical systems	4	PO1, PO4, PSO1
CO5	Design, implement, and ethically analyze high-performing and secure autonomous systems using deep learning.	6	PO3, PSO1
CO6	Evaluate ethical considerations and ensure the safety and robustness of autonomous systems.	6	PO1, PO2, PSO1

Syllabus

Overview of autonomous systems Introduction to deep learning Neural network architectures Role of deep learning in autonomous systems

Convolutional Neural Networks (CNNs) for image classification Object detection and segmentation Recurrent Neural Networks (RNNs) for sequence prediction Sensor fusion: combining camera, LiDAR, and radar data

Reinforcement learning for decision making Policy gradient methods and Q-learning Path planning and obstacle avoidance Model optimization techniques for real-time performance

Deployment of deep learning models in autonomous systems Safety and robustness in real-time applications Ethical considerations and regulatory frameworks Future trends in deep learning for autonomous systems

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, MIT Press.
- 2 Deep Reinforcement Learning Hands-On, Maxim Lapan, 2020, Packt Publishing.
- 3 Pattern Recognition and Machine Learning, Christopher M. Bishop, 2006, Springer.
- 4 Artificial Intelligence: A Modern Approach, Stuart Russell, Peter Norvig, 2020, Pearson.
- 5 Deep Learning for Autonomous Systems, Yuxi Li, 2021, Packt Publishing.
- 7 Applied Deep Learning, Dr. Rajkumar Tekchandani, Dr. Neeraj Kumar, 2023, BPB Publication.

23ASS3309A - AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3309A	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	AAAV	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and Understand the various application features available in AV Vehicle	3	PO1, PO2
CO2	Explore the Various application features of EV Vehicle	3	PO1, PO2
CO3	Explore the deployment of AI/ML/DL fundamentals to achieve the expected application features	3	PO1, PO2
CO4	Explore the vehicular networks and its application.	3	PO1, PO2
CO5	Analyze global standards and regulations followed for developing Applications.	4	PO1, PO2
CO6	Analyze the various features of AV and EV with AI/ML/DL networks using tools	4	PO1, PO2
CO7	Analyze the AV and EV system with advanced AI/ML/DL tools.	4	PO1, PO2

Syllabus

Overview of Autonomous Vehicle Design, Applications and its principles, Autonomous parking, Blind Spot Monitoring, Autonomous Emergency Braking, Lane Keeping Assist, AI/ML algorithm for Autonomous vehicle applications, Software Design consideration - AUTOSAR stack

Overview of Electric Vehicle Design, Features and its principles, Cell Balancing, Regenerative Braking, Thermal Management, Energy Management, AI/ML algorithm for Autonomous vehicle applications, Software Design consideration- AUTOSAR Stack

Artificial Intelligence and IoT in Autonomous Applications, Cloud Computing and Big Data, Challenges in AI-driven Automated Vehicles, Various Learning Methods, Statistical Learning, Deep Learning Deep Reinforcement

Optimizing Traffic flow with V2V communication, Traffic Management with V2I, Parking Management with V2V, Energy Management with V2G, Gateway ECU Design, Software Stack and Design Consideration

Legal and Regulatory Compliance, ISO 26262 Functional Safety-International Standards, Management of functional safety, Hazard analysis and Risk assessment, Product development, Adaptation in EV and AV, ASIL and Safety oriented analysis, UNECE Regulation No. 19, SAE International Standards, Hazard Identification and Risk Management, Safety Goals and Safety Mechanism, Cybersecurity-An Overview

Reference Books

- 1 Deep Learning for Autonomous Vehicle Control: Algorithms and Implementations , Suman Gupta, Kuntal Sengupta, 1, 2022 , CRC Press.
- 2 Autonomous Driving: How the Driverless Revolution Will Change the World, Andreas Herrmann, Walter Brenner, Rupert Stadler , 1, 2018 , Emerald Publishing.
- 3 Self-Driving Cars: The Road to Autonomous Vehicles , Lance Eliot , 1, 2020, Apress.
- 4 Deep Learning and Autonomous Vehicles: Computer Vision and AI Techniques for ADAS , Brandon Correa , 1, 2021 , Springer.
- 5 Machine Learning and AI for Autonomous Vehicles , John Ball, Lentin Joseph , 1, 2020 , Packt Publishing.

23ASS3309E - AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3309E	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	AAAV	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and Understand the various application features available in AV Vehicle	3	PO1, PO2
CO2	Explore the Various application features of EV Vehicle	3	PO1, PO2
CO3	Explore the deployment of AI/ML/DL fundamentals to achieve the expected application features	3	PO1, PO2
CO4	Explore the vehicular networks and its application.	3	PO1, PO2
CO5	Analyze global standards and regulations followed for developing Applications.	4	PO1, PO2
CO6	Analyze the various features of AV and EV with AI/ML/DL networks using tools	4	PO1, PO2
CO7	Analyze the AV and EV system with advanced AI/ML/DL tools.	4	PO1, PO2

Syllabus

Overview of Autonomous Vehicle Design, Applications and its principles, Autonomous parking, Blind Spot Monitoring, Autonomous Emergency Braking, Lane Keeping Assist, AI/ML algorithm for Autonomous vehicle applications, Software Design consideration - AUTOSAR stack

Overview of Electric Vehicle Design, Features and its principles, Cell Balancing, Regenerative Braking, Thermal Management, Energy Management, AI/ML algorithm for Autonomous vehicle applications, Software Design consideration- AUTOSAR Stack

Artificial Intelligence and IoT in Autonomous Applications, Cloud Computing and Big Data, Challenges in AI-driven Automated Vehicles, Various Learning Methods, Statistical Learning, Deep Learning Deep Reinforcement

Optimizing Traffic flow with V2V communication, Traffic Management with V2I, Parking Management with V2V, Energy Management with V2G, Gateway ECU Design, Software Stack and Design Consideration

Legal and Regulatory Compliance, ISO 26262 Functional Safety-International Standards, Management of functional safety, Hazard analysis and Risk assessment, Product development, Adaptation in EV and AV, ASIL and Safety oriented analysis, UNECE Regulation No. 19, SAE International Standards, Hazard Identification and Risk Management, Safety Goals and Safety Mechanism, Cybersecurity-An Overview

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- 1 Deep Learning for Autonomous Vehicle Control: Algorithms and Implementations, Suman Gupta, Kuntal Sengupta, 1, 2022, CRC Press.
- 2 Autonomous Driving: How the Driverless Revolution Will Change the World, Andreas Herrmann, Walter Brenner, Rupert Stadler, 1, 2018, Emerald Publishing.
- 3 Self-Driving Cars: The Road to Autonomous Vehicles, Lance Eliot, 1, 2020, Apress.
- 4 Deep Learning and Autonomous Vehicles: Computer Vision and AI Techniques for ADAS, Brandon Correa, 1, 2021, Springer.
- 5 Machine Learning and AI for Autonomous Vehicles, John Ball, Lentin Joseph, 1, 2020, Packt Publishing.

23ASS3309R - AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3309R	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	AAAV	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and Understand the various application features available in AV Vehicle	3	PO1, PO2
CO2	Explore the Various application features of EV Vehicle	3	PO1, PO2
CO3	Explore the deployment of AI/ML/DL fundamentals to achieve the expected application features	3	PO1, PO2
CO4	Explore the vehicular networks and its application.	3	PO1, PO2
CO5	Analyze global standards and regulations followed for developing Applications.	4	PO1, PO2

Syllabus

Overview of Autonomous Vehicle Design, Applications and its principles, Autonomous parking, Blind Spot Monitoring, Autonomous Emergency Braking, Lane Keeping Assist, AI/ML algorithm for Autonomous vehicle applications, Software Design consideration - AUTOSAR stack

Overview of Electric Vehicle Design, Features and its principles, Cell Balancing, Regenerative Braking, Thermal Management, Energy Management, AI/ML algorithm for Autonomous vehicle applications, Software Design consideration- AUTOSAR Stack

Artificial Intelligence and IoT in Autonomous Applications, Cloud Computing and Big Data, Challenges in AI-driven Automated Vehicles, Various Learning Methods, Statistical Learning, Deep Learning Deep Reinforcement

Optimizing Traffic flow with V2V communication, Traffic Management with V2I, Parking Management with V2V, Energy Management with V2G, Gateway ECU Design, Software Stack and Design Consideration

Legal and Regulatory Compliance, ISO 26262 Functional Safety-International Standards, Management of functional safety, Hazard analysis and Risk assessment, Product development, Adaptation in EV and AV, ASIL and Safety oriented analysis, UNECE Regulation No. 19, SAE International Standards, Hazard Identification and Risk Management, Safety Goals and Safety Mechanism, Cybersecurity-An Overview

Reference Books

- 1 Deep Learning for Autonomous Vehicle Control: Algorithms and Implementations , Suman Gupta, Kuntal Sengupta , 1, 2022 , CRC Press.
- 2 Autonomous Driving: How the Driverless Revolution Will Change the World rt Stadler , Andreas Herrmann, Walter Brenner, Rupe, 1, 2018, Emerald Publishing.
- 3 Self-Driving Cars: The Road to Autonomous Vehicles , Lance Eliot , 1, 2020 , Apress.
- 4 Deep Learning and Autonomous Vehicles: Computer Vision and AI Techniques for ADAS , Brandon Correa , 1, 2021 , Springer.
- 5 Machine Learning and AI for Autonomous Vehicles , John Ball, Lentin Joseph, 1, 2020, Packt Publishing.

23ASS3405M - EXPERT SYSTEMS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3405M	EXPERT SYSTEMS	ES	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the foundational concepts and principles of expert systems, including knowledge representation, inference mechanisms, and rule-based reasoning.	2	PO1, PO5, PSO1
CO2	Apply expert system methodologies and tools to solve complex real-world problems in various domains, demonstrating proficiency in knowledge engineering and system development.	3	PO1, PO3, PSO2
CO3	Analyze and evaluate the performance of expert systems in terms of accuracy, efficiency, and usability, and propose enhancements or optimizations where necessary.	4	PO2, PO5, PSO1
CO4	Design and implement advanced expert systems incorporating machine learning techniques, natural language processing, or other AI technologies to enhance decision-making capabilities.	6	PO3, PO5, PSO2

Syllabus

Introduction to Expert Systems: Overview of Expert Systems, Knowledge Representation in Expert Systems, Inference Mechanisms: Forward Chaining and Backward Chaining, Rule-Based Reasoning and Production Systems, Knowledge Acquisition and Elicitation Techniques

Expert Systems Development: Expert System Shells and Development Environments, Knowledge Engineering - Knowledge Base Design and Construction, Rule-based vs. Case-based Reasoning, Uncertainty Handling in Expert Systems, Validation and Verification of Expert Systems

Advanced Topics in Expert Systems: Knowledge Refinement and Revision, Explanation and Justification in Expert Systems, Distributed and Collaborative Expert Systems, Integration of Machine Learning with Expert Systems, Natural Language Processing for Expert System Interfaces

Applications and Case Studies: 1 Medical Diagnosis and Healthcare Systems, Financial Analysis and Decision Support Systems, Engineering Design and Fault Diagnosis, Intelligent Tutoring Systems, Legal and Regulatory Compliance Systems

Reference Books

- 1 Introduction to Expert Systems, Peter Jackson, 2010, Addison-Wesley.
- 2 Expert Systems: Principles and Programming, Giarratano, Joseph C., and Gary D. Riley, 2021, PWS Publishing Company.
- 3 The Handbook of Artificial Intelligence: Volume II, Avron Barr, Edward A. Feigenbaum, 2012, Morgan Kaufmann.
- 4 Digital Medicine: Health Care in the Internet Era, Darrell M. West, 2009, Brookings Institution Press.

23ASS3406M - SELF-DRIVING CARS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3406M	SELF-DRIVING CARS	SDC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic architecture of self-driving car including its perception systems, decision-making processes, and safety considerations.	2	PO1, PO2, PO3, PSO1
CO2	Apply the deep learning technique in self-driving car like TensorFlow and Keras with convolutional neural networks for enhanced performance.	3	PO2, PO3, PO4, PSO1
CO3	Demonstrate the various sensor fusion techniques using Kalman filters and navigate self-driving cars using particle filters, along with solidifying your understanding of localization concepts.	3	PO2, PO3, PO4, PSO1
CO4	Analyze planning, control and system integration concept in autonomous vehicle using ROS (Robot Operating System).	4	PO2, PO3, PO4, PSO1

Syllabus

Introduction: Introduction to self-driving car- Taxonomy of Driving- Requirements for Perception- Driving Decisions and Actions- Sensors and Computing Hardware- Hardware Configuration Design- Software Architecture- Environment Representation- Safety Assurance for Self-Driving Vehicles- Industry Methods for Safety Assurance and Testing- Safety Frameworks for Self-Driving.

Computer Vision: Computer Vision Fundamentals- Detect Lane Lines- Advanced Computer Vision- Advanced Lane Detection- Deep Learning: Neural Networks- TensorFlow- Deep Neural Networks- Convolutional Neural Networks- Traffic Sign Classifier-Keras- Transfer Learning.

Sensor Fusion: Sensors - Kalman Filters- Geometry and Trigonometry- Extended Kalman Filters. Localization: Introduction to Localization- Markov Localization- Motion Models- Particle Filter- Implementation of a Particle Filter.

Planning: Search- Prediction- Behavior Planning- Trajectory Generation- Highway Driving. Control: Control- PID Control. System Integration: Autonomous Vehicle Architecture- Introduction to Robot Operating System- Packages & Catkin Workspaces- Writing ROS Nodes- Program an Autonomous Vehicle. Introduction of localization, Markov localization, motion models, particle filters, implementation of particle filters, Automotive vehicle architecture, PID models

Reference Books

- 1 Self-Driving Cars: The New Way Forward, Michael Fallon, 2018, Twenty-First Century Books.
- 2 Self-Driving Cars, Lauren Newman, 2017, Cherry Lake Publishing.
- 3 Self-Driving Cars: Key Challenges and Future Directions, Steven M. Lavalley, 2020, River Publishers.
- 4 Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms, Nikolaus Correll, Bradley Hayes, and David Coleman, 2022, CreateSpace Independent Publishing Platform.
- 5 Robot Motion Planning and Control, Jean-Claude Latombe, 2006, Springer.

23ASS3410M - CYBERSECURITY IN AUTONOMUS VEHICLE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3410M	CYBERSECURITY IN AUTONOMUS VEHICLE	CAV	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Cyber security process, strategy, concepts and controls for AV and EV Vehicle	2	PO1, PO4, PSO1
CO2	Expose to Cybersecurity attacks of AV and EV system and understand various control measures	3	PO2, PO5, PSO2
CO3	Analyze the Software development for Cybersecurity controls	4	PO2, PO4, PSO1
CO4	Analyze the various advanced Cyber Applications for AV and EV using Cloud and IoT and Risk management of Cyber Security systems using various standards	4	PO1, PO5, PSO2

Syllabus

Autonomous Feature Scoping, Threat Analysis and Risk Assessment, Asset Identification, Threat scenarios identification of AEV System, Identify the damage scenarios and analyse impact rating of AV and EV System, Identify goals, AI based Threat Analysis, EV and AV Cybersecurity Concepts, Cybersecurity Controls, Secure Boot, Secure Debug, Secure Communication, Secure Diagnostics, Secure Access, Cryptography, Encryption Algorithms, AI based Control.

Security Attacks on AV Sensors, Spoofing, Replay, Jamming, Security Attack on Grid, Charging Station, Intrusion detection and Prevention System, OTA updates, AI Driven Advanced Applications, Cyberattacks, Attack category, Runtime Tamper Protection, Security Life Cycle Handling, Secure Communication.

Introduction to Autosar MCAL, Cyber Driver, Cyber stack overview, Data flow of Cyber stack, Software Design of Artificial Intelligence, Hardware Accelerator, HSE Firmware, Fuzz testing and Penetration testing.

Enhancing Safety using IoT, Collision Avoidance System, Traffic Management and Optimization, Route Optimization, Emergency Response Coordination, AI based Speech Recognition and Speech Synthesis

Reference Books

- 1 Autonomous Vehicle Technology: A Guide for Policymakers, James M. Anderson, Nidhi Kalra, Karlyn D. Stanley, et al, 1st Edition, RAND Corporation.
- 2 Cybersecurity for Connected and Autonomous Vehicles, Iyad Rahwan, Carlo Ratti, Jonathan Petit, 1st Edition, Springer.
- 3 The Car Hacker's Handbook: A Guide for the Penetration Tester, Craig Smith, 2nd Edition, Springer.
- 4 Connected and Autonomous Vehicles: Cybersecurity and Policy Implications, Nicolas Beaumont, Ciaran Hebert, 1st Edition, Taylor & Francis.

23ASS3507 - LOCALIZATION & PROGRAMMING REAL-TIME AUTONOMOUS SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3507	LOCALIZATION & PROGRAMMING REAL-TIME AUTONOMOUS SYSTEMS	LPRAS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand deep learning and its role in perception, decision-making, and control, key components and architectures of autonomous systems	2	PO1, PO2, PSO1
CO2	Develop the fundamentals of deep learning architectures, training techniques, and optimization strategies for solving complex problems	3	PO3, PO4, PSO1
CO3	Apply knowledge of deep learning techniques (CNNs) for processing sensor data (cameras, LiDAR, radar) used in autonomous systems for tasks like object detection, segmentation, and sensor fusion	4	PO4, PSO1
CO4	Build knowledge and techniques to design intelligent agents that can learn to make optimal decisions, navigate complex environments, and control dynamical systems.	5	PO1, PO2, PSO1

Syllabus

Fundamentals of localization and mapping Overview of autonomous systems and their components Types of localization: absolute, relative, and global Sensors used in localization: GPS, IMU, LiDAR, cameras

Probabilistic localization: Kalman filters, Particle filters SLAM (Simultaneous Localization and Mapping) Visual odometry and feature-based localization Sensor fusion techniques for improved localization

Integration of localization with navigation systems Path planning algorithms: A*, D*, RRT Real-time programming and ROS (Robot Operating System) Middleware and communication protocols in autonomous systems

Metrics for evaluating localization performance Testing and validation in simulated and real environments Case studies on real-world applications Challenges and future trends in localization for autonomous systems

Reference Books

- 1 Probabilistic Robotics, Sebastian Thrun, Wolfram Burgard, Dieter Fox, 2005, MIT Press.
- 2 Robotics: Modelling, Planning and Control, Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, 2010, Springer.
- 3 Introduction to Autonomous Robots, Nikolaus Correll, Bradley Hayes, Adam Hall, 2016, Creative Commons.
- 4 Simultaneous Localization and Mapping for Mobile Robots: Introduction and Methods, Fernandez-Madrigal, Juan-Antonio, Jos? Luis Blanco-Claraco, 2012, IGI Global.
- 5 Programming Robots with ROS, Morgan Quigley, Brian Gerkey, William D. Smart, 2015, O'Reilly Media.
- 6 Applied Deep Learning, Rajkumar Tekchandani , Dr. Neeraj Kumar, 2023, BPB Publicatio.

23ASS3508 - REINFORCEMENT LEARNING FOR AUTONOMOUS SYSTEM (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3508	REINFORCEMENT LEARNING FOR AUTONOMOUS SYSTEM	RLA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of reinforcement learning and its relevance to autonomous systems.	2	PO1, PO2, PO3, PSO2
CO2	Identify different RL algorithms and their suitability for various applications.	3	PO1, PO3, PO4, PSO1
CO3	Build Reinforcement Learning algorithms for autonomous systems.	3	PO1, PO2, PO3, PSO2
CO4	Examine real-world applications of RL in autonomous vehicles, robotics, and other domains.	4	PO1, PO2, PO3, PSO2

Syllabus

Introduction to Reinforcement Learning, Definition and key concepts, Components of RL: agents, environment, actions, rewards, Markov decision processes (MDPs)

RL Algorithms Value-based methods: Q-Learning, SARSA Policy-based methods: Policy Gradient, Actor-Critic Model-based methods: Dyna-Q, Monte Carlo Tree Search (MCTS) Deep Reinforcement Learning: Deep Q-Networks (DQN), Deep Deterministic Policy Gradient (DDPG), Proximal Policy Optimization (PPO)

Implementation of RL Algorithms, Python and RL libraries (e.g., TensorFlow, PyTorch, OpenAI Gym) Coding RL algorithms from scratch, Debugging and troubleshooting RL implementations

Applications of RL in Autonomous Systems Autonomous vehicles: path planning, decision-making Robotics: manipulation, navigation Smart environments: home automation, IoT devices Healthcare: personalized treatment, patient monitoring

Reference Books

- 1 "Reinforcement learning an introduction", Richard S. Sutton and Andrew G. Barto, 2018, The MIT Press.
- 2 "Deep Reinforcement Learning Hands-On" , Maxim Lapan, 2018, Packt Publishing.
- 3 "Reinforcement Learning and Optimal Control", Dimitri P. Bertsekas, 2019, Athena Scientific.
- 4 "Reinforcement Learning: State of the Art." , Marco Wiering and Martijn van Otterlo, 2022, Springer.

23ASS3511 - AI DRIVEN ECU DESIGN FOR AUTONOMOUS VEHICLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ASS3511	AI DRIVEN ECU DESIGN FOR AUTONOMOUS VEHICLES	AEDATT	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply embedded system functions for autonomous vehicle ECU functioning	3	PO1, PO5, PSO1
CO2	Analyze machine learning functions for autonomous vehicle ECU network	4	PO2, PO5, PSO1
CO3	Analyze deep learning functions for autonomous vehicle ECU network	4	PO2, PO5, PSO1
CO4	Analyze ECU performance with integrated artificial intelligent control	4	PO2, PO5, PSO1
CO5	Test ECU applications with integrated machine learning and deep learning control	3	PO2, PSO1

Syllabus

AEV ECU Product features overview: Overview of Autosar Architecture, Sensor Data Acquisition using Autosar MCAL, Microcontroller, Memory, IO, Communication, CAN Communication Establishing using Autosar COM-CAN, CAN If, PDUR, COM Stack, Vehicle Diagnostics using Autosar Diagnostics, DCM, DEM, Memory Handling through Autosar MEM-MEMIF, NVM, FEE, FLS, EA, Derive the Output stage driver using Autosar Complex Device Driver

AI/ML algorithm to identify and track vehicles, pedestrian, and traffic signs, Classify and categorize the images using DL algorithms, Generate best paths to avoid obstacle and reach destination, Support Complex maneuvers for Lane detection and parking assist, Predictive control and optimize control using AI/ML, Natural Language processing for HMI Interface

Battery Degradation and Life cycle prediction using AI/ML, Estimation of SOC using ML, Predicting Energy Consumption using Vehicle parameters, Optimize charging strategies, smart Charging, Efficient management of V2G interactions during peak demand, Design consideration

Design Guide, Defining Vehicle purpose, Select Components, Develop Planning and Control system, Integrate AI&ML, Develop HMI, Ensure Safety and Compliance, Design Consideration, Passenger Capacity, Range, Charging, Driving Conditions, safety features, cost, Autonomous Vehicle Design, Embedded Design - Data Acquisition through various sensing elements, Ultrasonic, LIDAR, Camera, Deploy AI&ML algorithm to perceive decision making, Control various actuator, Motor control, By Wire technology, Design Steer by Wire, Introduction to Flexray Protocol, Introduction to Ethernet Controller

Reference Books

- 1 Automotive Electronics Handbook, Ronald K. Jurgen, 1999, McGraw-Hill Education.
- 2 Deep Learning for Autonomous Vehicle Control, Suman Chakravorty, Jose Luis Blanco, 2020, Springer.
- 3 Machine Learning for Embedded Systems and Edge AI: A Practical Guide, Michael T. Koch, D. A. McQuarrie, 2021, O'Reilly Media.
- 4 Automotive Embedded Systems Handbook: Machine Learning and AI for ECU Design, Nicolas Navet, Françoise Simonot-Lion, 2017, CRC Press.

23AVI3101A - DEEP LEARNING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3101A	DEEP LEARNING	DL	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply optimization algorithms to solve neural networks involves iteratively adjusting the model parameters to minimize the loss function, using techniques like gradient descent, stochastic gradient descent (SGD), Adam, or RMSprop.	3	PO1, PO2, PO3, PO4, PSO1
CO2	Apply CNN model and its variants to real time data like LeNet, AlexNet, ZF-Net, VGGNet models.	3	PO1, PO2, PO3, PO4, PSO1
CO3	Apply sequential models such as RNN and Long Short-Term Memory (LSTM) involves leveraging their ability to process sequential data with memory and context preservation.	3	PO1, PO2, PO3, PO4, PSO1
CO4	Construct variational autoencoders and generative neural models for generating complex data distributions and learning latent representations.	3	PO1, PO2, PO3, PO4, PSO1
CO5	Apply Markov chain sampling for training Restricted Boltzmann Machines (RBMs) and Contrastive Divergence for efficient parameter estimation in RBMs.	3	PO1, PO2, PO3, PO4, PSO1
CO6	Implement basic Transformer models and their variants involves constructing architectures that utilize self-attention mechanisms for effective sequence processing tasks.	5	PO1, PO2, PO3, PO4, PSO1
CO7	Implement basic Large Language Models (LLMs) like GPT-3 and GPT-4 entails utilizing deep neural networks with attention mechanisms to generate coherent and contextually relevant text based on extensive pre-training on large-scale datasets.	5	PO1, PO2, PO3, PO4, PSO1

Syllabus

History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, Feedforward Neural Networks, Backpropagation, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Greedy Layer-wise Pre-training, Better Activation Functions and Better Weight Initialization Methods Batch Normalization and Learning Vectorial Representations of Words.

Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Encoder Decoder Models:Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders.

Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Loss Functions in RNNs, Sequence Prediction, Gated Recurrent Units (GRUs), Long Short TermMemory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs.

Encoder-Decoder Models, Attention Mechanism, Hierarchical Attention, Self Attention, Cross Attention, Deep Belief networks, Markov Networks. Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs. Variational autoencoders, Autoregressive Models: NADE, MADE, PixelRNN, Generative Adversarial Networks (GANs) Cycle GAN, Super resolution and Conditional GAN models.

Transformer models and their variants, such as BERT (Bidirectional Encoder Representations from Transformers), SciBERT, RoBERTa (Robustly optimized BERT approach), DistilBERT, ALBERT and XLNet. Large Language Models (LLMs) like GPT-3 and GPT-4.

Reference Books

- 1 Grokking Deep Learning, Andrew Trask, 2019, Manning publications.
- 2 Deep Learning with Python, Francois Chollet, 2018, Manning publications.
- 3 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, 2016, An MIT Press book.
- 4 Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal, 2019, Springer.

23AVI3101E - DEEP LEARNING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3101E	DEEP LEARNING	DL	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply optimization algorithms to solve neural networks involves iteratively adjusting the model parameters to minimize the loss function, using techniques like gradient descent, stochastic gradient descent (SGD), Adam, or RMSprop.	3	PO1, PO2, PO3, PO4, PSO1
CO2	Apply CNN model and its variants to real time data like LeNet, AlexNet, ZF-Net, VGGNet models.	3	PO1, PO2, PO3, PO4, PSO1
CO3	Apply sequential models such as RNN and Long Short-Term Memory (LSTM) involves leveraging their ability to process sequential data with memory and context preservation.	3	PO1, PO2, PO3, PO4, PSO1
CO4	Construct variational autoencoders and generative neural models for generating complex data distributions and learning latent representations.	3	PO1, PO2, PO3, PO4, PSO1
CO5	Apply Markov chain sampling for training Restricted Boltzmann Machines (RBMs) and Contrastive Divergence for efficient parameter estimation in RBMs.	3	PO1, PO2, PO3, PO4, PSO1
CO6	Implementing basic Transformer models and their variants involves constructing architectures that utilize self-attention mechanisms for effective sequence processing tasks.	5	PO1, PO2, PO3, PO4, PSO1
CO7	Implementing basic Large Language Models (LLMs) like GPT-3 and GPT-4 entails utilizing deep neural networks with attention mechanisms to generate coherent and contextually relevant text based on extensive pre-training on large-scale datasets.	5	PO1, PO2, PO3, PO4, PSO1

Syllabus

History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, Feedforward Neural Networks, Backpropagation, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Greedy Layer-wise Pre-training, Better Activation Functions and Better Weight Initialization Methods Batch Normalization and Learning Vectorial Representations of Words.

Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Encoder Decoder Models: Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders.

Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Loss Functions in RNNs, Sequence Prediction, Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs.

Encoder-Decoder Models, Attention Mechanism, Hierarchical Attention, Self Attention, Cross Attention, Deep Belief networks, Markov Networks. Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs. Variational autoencoders, Autoregressive Models: NADE, MADE, PixelRNN, Generative Adversarial Networks (GANs) Cycle GAN, Super resolution and Conditional GAN models.

Transformer models and their variants, such as BERT (Bidirectional Encoder Representations from Transformers), SciBERT, RoBERTa (Robustly optimized BERT approach), DistilBERT, ALBERT and XLNet. Large Language Models (LLMs) like GPT-3 and GPT-4.

Reference Books

- 1 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville., 2016, An MIT Press book..
- 2 Neural Networks and Deep Learning, Charu C. Aggarwal, 2019, Springer.
- 3 Deep Learning with Python, Francois Chollet, 2018, Manning publications.
- 4 Grokking Deep Learning, Andrew Trask, 2019, Manning publications.

23AVI3101R - DEEP LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3101R	DEEP LEARNING	DL	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply optimization algorithms to solve neural networks involves iteratively adjusting the model parameters to minimize the loss function, using techniques like gradient descent, stochastic gradient descent (SGD), Adam, or RMSprop.	3	PO1, PO2, PO3, PSO1
CO2	Apply CNN model and its variants to real time data like LeNet, AlexNet, ZF-Net, VGGNet models.	3	PO3, PO4, PSO1
CO3	Apply sequential models such as RNN and Long Short-Term Memory (LSTM) involves leveraging their ability to process sequential data with memory and context preservation.	3	PO2, PO4, PSO1
CO4	Construct variational autoencoders and generative neural models for generating complex data distributions and learning latent representations.	3	PO1, PO3, PO4, PSO1
CO5	Apply Markov chain sampling for training Restricted Boltzmann Machines (RBMs) and Contrastive Divergence for efficient parameter estimation in RBMs.	3	PO1, PO3, PSO1
CO6	Implementing basic Large Language Models (LLMs) like GPT-3 and GPT-4 entails utilizing deep neural networks with attention mechanisms to generate coherent and contextually relevant text based on extensive pre-training on large-scale datasets.	5	PO2, PO4, PSO1

Syllabus

History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, Feedforward Neural Networks, Backpropagation, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Greedy Layer-wise Pre-training, Better Activation Functions and Better Weight Initialization Methods Batch Normalization and Learning Vectorial Representations of Words.

Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Encoder Decoder Models:Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders.

Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Loss Functions in RNNs, Sequence Prediction, Gated Recurrent Units (GRUs), Long Short TermMemory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs, Encoder-Decoder Models, Attention Mechanism, Attention over image, Hierarchical Attention. Deep Belief networks, Markov Networks. Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Variational autoencoders, Autoregressive Models:NADE, MADE, PixelRNN , Generative Adversarial Networks (GANs) Cycle GAN ,Super resolution and Conditional GAN models.

Variational autoencoders, Autoregressive Models:NADE, MADE, PixelRNN , Generative Adversarial Networks (GANs) Cycle GAN ,Super resolution and Conditional GAN models. Transformer models and their variants, such as BERT (Bidirectional Encoder Representations from Transformers), SciBERT, RoBERTa (Robustly optimized BERT approach), DistilBERT, ALBERT (A Lite BERT), and XLNet.

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, MIT Press.
- 2 Grokking Deep Learning, Andrew Trask, 2019, Manning Publications.
- 3 Deep Learning: A Practitioner's Approach, Adam Gibson, Josh Patterson, 2017, O'Reilly Media.
- 4 Deep Learning from Scratch, Seth Weidman, 2019, Greyscale Indian Edition.

23AVI3202A - COMPUTER VISION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3202A	COMPUTER VISION	CV	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Undersatnd the basic concepts, terminology, theories, models and methods in the field of computer vision	2	PO1, PO2, PSO1
CO2	Outline camera calibration and image segmentation and principles of human visual system	2	PO1, PO3, PSO1
CO3	Apply methods such as monocular depth estimation, perspective geometry, and using algorithms like Structure from Motion (SfM)	3	PO1, PO3, PSO1
CO4	Identify the methods for constructing 3D structures from multiple 2D images, including multi-view stereo and photogrammetry	3	PO1, PO3, PSO1
CO5	Apply and evaluate various motion analysis methods for detecting and analyzing movement in video sequences.	3	PO1, PO4, PSO1

Syllabus

Image as it is today - A historic prespective - Point operators & filtering on images - Point and edge feature detection over 2-D images Stitching and mending of multiple images

Image alignment of global and pairwise cases - Geometric camera calibration models - handcrafted segmentation models - 2D images - Applied convolution Neural networks and transformers Radiometry and reflectance for images

Estimation of Z axis using monocular camera - Moving object tracking and estimation - Structure of motion over images

Construction of 3D structures from images Biomedical imaging modalities - Voxel based imagery and advanced topics

Different Motion Analysis methods, Optical flow, analysis based on correspondence of interest points, Detection of specific motion patterns, video tracking

Reference Books

- 1 Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, 2017, Pearson Education.
- 2 Computer vision Algorithms & Applications, Richard Szeliski, 2010, Springer Publication.
- 3 Handbook of Research on Computer Vision and Image Processing in the Deep Learning Era , A. Srinivasan , 2022, Business Science Reference .
- 4 Digital Image Processing and Computer Vision, R.C. Gonzalez and R.E. Woods, 2008, Pearson Education.
- 5 Computer Vision Applications of Visual AI and Image Processing, Pancham Shukla , Rajanikanth Aluvalu , Shilpa Gite and Uma Maheswar, 2023, De Gruyter .

23AVI3202E - COMPUTER VISION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3202E	COMPUTER VISION	CV	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Undersatnd the basic concepts, terminology, theories, models and methods in the field of computer vision	2	PO1, PO2, PSO1
CO2	Outline camera calibration and image segmentation and principles of human visual system	2	PO1, PO3, PSO1
CO3	Applying methods such as monocular depth estimation, perspective geometry, and using algorithms like Structure from Motion (SfM)	3	PO1, PO3, PSO1
CO4	Identify the methods for constructing 3D structures from multiple 2D images, including multi-view stereo and photogrammetry	4	PO1, PO3, PSO1
CO5	Examine themselves professionally and responsibly in the areas of computer vision image processing and assess scientific literature in the field of computer vision	5	PO1, PO4, PSO1

Syllabus

Image as it is today - A historic prespective - Point operators & filtering on images - Point and edge feature detection over 2-D images Stitching and mending of multiple images

Image alignment of global and pairwise cases - Geometric camera calibration models - handcrafted segmentation models - 2D images - Applied convolution Neural networks and transformers Radiometry and reflectance for images

Estimation of Z axis using monocular camera - Moving object tracking and estimation - Structure of motion over images

Construction of 3D structures from images Biomedical imaging modalities - Voxel based imagery and advanced topics

Different Motion Analysis methods, Optical flow, analysis based on correspondence of interest points, Detection of specific motion patterns, video tracking

Reference Books

- 1 Computer Vision, Forsyth David A and Ponce J, 2010, Pearson Publication.
- 2 Computer vision Algorithms and Applications, Richard Szeliski , 2010, Springer Publication.
- 3 Handbook of Research on Computer Vision and Image Processing in the Deep Learning Era , A. Srinivasan , 2022, Business Science Reference .
- 4 Digital Image Processing and Computer Vision, R.C. Gonzalez and R.E. Woods, 2008, Pearson Education.
- 5 Computer Vision Applications of Visual AI and Image Processing, Pancham Shukla , Rajanikanth Aluvalu , Shilpa Gite and Uma Maheswari , 2023, De Gruyter .

23AVI3202R - COMPUTER VISION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3202R	COMPUTER VISION	CV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Undersatnd the basic concepts, terminology, theories, models and methods in the field of computer vision	2	PO1, PO2, PSO1
CO2	Outline camera calibration and image segmentation and principles of human visual syste	2	PO1, PO3, PSO1
CO3	Apply methods such as monocular depth estimation, perspective geometry, and using algorithms like Structure from Motion (SfM)	3	PO1, PO3, PSO1
CO4	Apply and evaluate various motion analysis methods for detecting and analyzing movement in video sequences.	4	PO1, PO4, PSO1

Syllabus

Image as it is today - A historic prespective - Point operators & filtering on images - Point and edge feature detection over 2-D images Stitching and mending of multiple images

Image alignment of global and pairwise cases - Geometric camera calibration models - handcrafted segmentation models - 2D images - Applied convolution Neural networks and transformers Radiometry and reflectance for images

Estimation of Z axis using monocular camera - Moving object tracking and estimation - Structure of motion over images

Construction of 3D structures from images Biomedical imaging modalities - Voxel based imagery and advanced topics

Reference Books

- 1 Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, 2017, Pearson Education.
- 2 Computer vision Algorithms & Applications, Richard Szeliski, 2010, Springer Publication.
- 3 Handbook of Research on Computer Vision and Image Processing in the Deep Learning Era , A. Srinivasan , 2022, Business Science Reference .
- 4 Digital Image Processing and Computer Vision, R.C. Gonzalez and R.E. Woods, 2008, Pearson Education.
- 5 Computer Vision Applications of Visual AI and Image Processing, Pancham Shukla , Rajanikanth Aluvalu , Shilpa Gite and Uma Maheswar, 2023, De Gruyter .

23AVI3303A - OBJECT DETECTION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3303A	OBJECT DETECTION	OD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and explain the core concepts of object detection, its applications, and its historical development within the broader field of computer vision the fundamental concepts of object detection.	2	PO1, PO2, PSO2
CO2	Apply various object detection algorithms to real-world scenarios and classical object detection methods including feature extraction (SIFT, SURF, HOG), sliding window approaches, and region-based techniques (Selective Search & DPM).	3	PO1, PO3, PSO1
CO3	Construct a real-world problem using object detection techniques for a common and impactful application Explore modern object detection through Convolutional Neural Networks (CNNs), including R-CNN, Fast/Faster R-CNN, Single-Shot Detectors (SSD), and You Only Look Once (YOLO) architectures.	3	PO2, PO3, PSO1
CO4	Apply object detection models like Mask R-CNN, RetinaNet, EfficientDet, and CenterNet, exploring recent advancements and the state-of-the-art.	3	PO2, PSO2
CO5	Build and optimize robust object detection models through effective dataset preparation, data augmentation, training strategies, evaluation metrics (mAP, precision, recall), and error analysis techniques.	3	PO1, PSO2
CO6	Identify a tool for visualizing the object clusters for incorporating required object in the specified domain	3	PO1, PSO2
CO7	Determine the performance of various object detection methods to obtain the accuracy, speed, and efficiency on a given dataset.	5	PO1, PO11, PSO1

Syllabus

Introduction to Object Detection: Overview of Computer Vision and Image Processing, Basics of Object Detection, Historical Context and Evolution, Applications of Object Detection

Classical Object Detection Techniques: Feature Extraction (SIFT, SURF, HOG), Sliding Window Approach, Region-based Methods (Selective Search), DPM (Deformable Part-based Models)

Deep Learning for Object Detection: Convolutional Neural Networks (CNNs), Region-based CNN (R-CNN), Fast R-CNN and Faster R-CNN, Single Shot Detectors (SSD), You Only Look Once (YOLO)

Advanced Deep Learning Models: Mask R-CNN, RetinaNet, EfficientDet, CenterNet, Recent Advancements and State-of-the-Art Models

build and optimize robust object detection models through effective dataset preparation, data augmentation, training strategies, evaluation metrics (mAP, precision, recall), and error analysis techniques.

Reference Books

- 1 Object Detection and Recognition in Digital Images: Theory and Practice, by Boguslaw Cyganek and Przemyslaw Gancarski, 2013, John Wiley & Sons, Ltd.
- 2 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 3 Pattern Recognition and Machine Learning, Christopher Bishop, 2006, Springer.
- 4 Computer Vision: Algorithms and Applications, Richard Szeliski, 2010, Springer.

- 5 Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library , Adrian Kaehler and Gary Bradski, 2016, O'Reilly Media.
- 6 Deep Learning for Computer Vision: Expert techniques to train advanced neural networks using TensorFlow and Keras, Rajalingappaa Shanmugamani, 2018, Packt Publishing.

23AVI3303E - OBJECT DETECTION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3303E	OBJECT DETECTION	OD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and explain the core concepts of object detection, its applications, and its historical development within the broader field of computer vision the fundamental concepts of object detection.	3	PO1, PO2, PSO2
CO2	Apply various object detection algorithms to real-world scenarios and classical object detection methods including feature extraction (SIFT, SURF, HOG), sliding window approaches, and region-based techniques (Selective Search & DPM).	3	PO1, PO3, PSO1
CO3	Construct a real-world problem using object detection techniques for a common and impactful application Explore modern object detection through Convolutional Neural Networks (CNNs), including R-CNN, Fast/Faster R-CNN, Single-Shot Detectors (SSD), and You Only Look Once (YOLO) architectures.	3	PO2, PO3, PSO1
CO4	Apply object detection models like Mask R-CNN, RetinaNet, EfficientDet, and CenterNet, exploring recent advancements and the state-of-the-art.	3	PO2, PSO2
CO5	Build and optimize robust object detection models through effective dataset preparation, data augmentation, training strategies, evaluation metrics (mAP, precision, recall), and error analysis techniques.	3	PO1, PSO2
CO6	Identify a tool for visualizing the object clusters for incorporating required object in the specified domain	3	PO1, PSO2
CO7	Determine the performance of various object detection methods to obtain the accuracy, speed, and efficiency on a given dataset.	5	PO1, PO11, PSO1

Syllabus

Sliding Window Techniques, Histogram of Oriented Gradients (HOG), Viola-Jones Algorithm, Feature-based Methods, Region-based CNNs (R-CNN, Fast R-CNN, Faster R-CNN), You Only Look Once (YOLO) Algorithm, Single Shot MultiBox Detector (SSD)

Metrics for Object Detection (Precision, Recall, mAP) Benchmark Datasets (COCO, PASCAL VOC) Evaluation Techniques and Tools ,

Introduction to TensorFlow Object Detection API PyTorch for Object Detection Transfer Learning for Custom Object Detection Models

Project Proposal and Planning Data Collection and Annotation Model Training and Fine-tuning Performance Evaluation and Optimization Deployment and Presentation, Develop a project to solve a real-world problem using object detection techniques Regular progress presentations and peer reviews

Advanced Deep Learning Models: Mask R-CNN, RetinaNet, EfficientDet, CenterNet, Recent Advancements and State-of-the-Art Models

Reference Books

- 1 Object Detection and Recognition in Digital Images: Theory and Practice, by Boguslaw Cyganek and Przemyslaw Gancarski, 2013, Willey.
- 2 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 3 Pattern Recognition and Machine Learning, Christopher Bishop, 2006, Springer.

- 4 Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library, Adrian Kaehler and Gary Bradski, 2016, O'Reilly Media.

23AVI3303R - OBJECT DETECTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3303R	OBJECT DETECTION	OD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and explain the core concepts of object detection, its applications, and its historical development within the broader field of computer vision the fundamental concepts of object detection.	2	PO1, PO2, PSO2
CO2	Apply various object detection algorithms to real-world scenarios and classical object detection methods including feature extraction (SIFT, SURF, HOG), sliding window approaches, and region-based techniques (Selective Search & DPM).	2	PO1, PO3, PSO1
CO3	Construct a real-world problem using object detection techniques for a common and impactful application Explore modern object detection through Convolutional Neural Networks (CNNs), including R-CNN, Fast/Faster R-CNN, Single-Shot Detectors (SSD), and You Only Look Once (YOLO) architectures.	3	PO2, PO3, PO5, PSO1
CO4	Apply object detection models like Mask R-CNN, RetinaNet, EfficientDet, and CenterNet, exploring recent advancements and the state-of-the-art.	3	PO2, PSO2
CO5	build and optimize robust object detection models through effective dataset preparation, data augmentation, training strategies, evaluation metrics (mAP, precision, recall), and error analysis techniques.	3	PO1, PSO2
CO6	Determine the performance of various object detection methods to obtain the accuracy, speed, and efficiency on a given dataset.	5	PO1, PO5, PSO2

Syllabus

Introduction to Object Detection: Overview of Computer Vision and Image Processing, Basics of Object Detection, Historical Context and Evolution, Applications of Object Detection

Classical Object Detection Techniques: Feature Extraction (SIFT, SURF, HOG), Sliding Window Approach, Region-based Methods (Selective Search), DPM (Deformable Part-based Models)

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Advanced Deep Learning Models: Mask R-CNN, RetinaNet, EfficientDet, CenterNet, Recent Advancements and State-of-the-Art Models

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- 1 Object Detection and Recognition in Digital Images: Theory and Practice, Boguslaw Cyganek and Przemyslaw Gancarski, 2013, Willey.
- 2 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 3 Deep Learning for Computer Vision: Expert techniques to train advanced neural networks using TensorFlow and Keras, Rajalingappaa Shanmugamani, 2018, Packt Publishing.
- 4 Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library, Adrian Kaehler and Gary Bradski, 2016, O'Reilly Media.

23AVI3404M - VISUAL RECOGNITION AND SCENE UNDERSTANDING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3404M	VISUAL RECOGNITION AND SCENE UNDERSTANDING	VRASU	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of visual recognition and image processing techniques	2	PO2, PO3, PO4, PSO1
CO2	Apply object detection and recognition methodologies, including feature- based and deep learning-based techniques, and evaluate their performance using appropriate metrics.	3	PO1, PO2, PO3, PSO1
CO3	Identify suitable 3D vision and reconstruction techniques, along with their applications and challenges.	3	PO1, PO3, PO4, PSO1
CO4	Inspect ethical and social implications of visual recognition systems, including bias, fairness, privacy concerns, and ethical considerations.	4	PO1, PO2, PO4, PSO1

Syllabus

This module introduces the fundamentals of visual recognition, covering its historical development, importance across various fields, practical applications, and real-world examples. The module also delves into essential image processing techniques, including image enhancement, segmentation, and feature extraction.

This module provides an in-depth exploration of machine learning and deep learning algorithms for object detection and recognition methodologies, focusing on both feature-based and deep learning-based approaches. It also covers performance evaluation metrics crucial for assessing the effectiveness of these methods. Additionally, this module provides an overview of scene understanding, including semantic segmentation, scene classification, and contextual reasoning techniques.

This module provides a comprehensive introduction to 3D vision, reconstruction techniques, and visual perception in robotics. It covers fundamental concepts such as depth perception, 3D reconstruction methods, and their applications. It also explores visual perception in robotics, including object manipulation, grasping techniques, and navigation/mapping using visual data.

This module provides an in-depth exploration of the ethical and social implications surrounding the development, deployment, and use of visual recognition systems. As artificial intelligence advances, particularly in the realm of computer vision, critical issues regarding bias, fairness, privacy, and ethical considerations have emerged as significant concerns. It aims to equip with the necessary knowledge and skills to navigate and address these complex issues responsibly.

Reference Books

- 1 Computer Vision: Algorithms and Applications, Richard Szeliski, 2022, Springer.
- 2 Deep Learning for Computer Vision, Rajalingappaa Shanmugamani, 2018, Packt Publishers.
- 3 Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Peter Corke, 2013, Springer.
- 4 Multiple view geometry in computer vision , Richard Hartley and Andrew Zisserman, 2004, Cambridge .
- 5 Scene reconstruction, pose estimation and tracking , Rustam Stolkin, 2007, IntechOpen.

23AVI3405M - DEEP REINFORCEMENT LEARNING FOR VISION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3405M	DEEP REINFORCEMENT LEARNING FOR VISION	DRLV	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Core Concepts of Reinforcement Learning and Deep Learning.	2	PO1
CO2	Apply the principles of Markov Decision Processes (MDPs) and implement the Bellman equations using dynamic programming techniques	3	PO1, PO6, PSO1
CO3	Apply the Advanced Deep Reinforcement Learning Algorithms for solving complex real-world applications	3	PO1, PO5, PO7, PSO2
CO4	Analyze the performance of different deep Reinforcement Learning algorithms for various applications.	4	PO2, PO7, PSO2

Syllabus

Introduction to Reinforcement Learning (RL)-Basics of RL, including Markov Decision Processes (MDPs), policies, value functions, and exploration vs. exploitation, Basics of neural networks, Convolutional Neural Networks, Recurrent Neural Networks, Introduction to Deep Q-Networks (DQN) and other deep RL algorithms.

Markov Decision Processes (MDPs) and Bellman Equations - Formal Definition of Markov Decision Processes, Value Functions, Bellman Equations, Dynamic Programming for Solving MDPs, Policy and Value Iteration Algorithms, Applications.

Q-Learning and Deep Q-Networks (DQN) - Introduction to Q-Learning, The Q-Learning Algorithm, Deep Q-Learning and Deep Q-Networks (DQN), Policy Gradient Methods-REINFORCE Algorithm, Actor-Critic Methods, Advanced Deep RL Algorithms - Deep Deterministic Policy Gradient (DDPG), Proximal Policy Optimization (PPO), Applications

Applications and Performance Analysis-Case studies of deep RL applications in robotics, gaming, finance, and healthcare, Performance Evaluation and Analysis - Metrics for evaluating deep RL algorithms: convergence speed, final performance, robustness

Reference Books

- 1 Deep Reinforcement Learning in Action, Alexander Zai, Brandon Brown, 2020, Manning.
- 2 Deep Reinforcement Learning Hands-On, Maxim Lapan, 2018, Packt Publishing.
- 3 Deep Reinforcement Learning with Python, Sudharsan Ravichandiran, 2019, Packt Publishing.
- 4 Reinforcement Learning An Introduction, Richard S. Sutton and Andrew G. Barto, 2023, KDPUBLICATION.

23AVI3506 - HUMAN COMPUTER INTERACTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3506	HUMAN COMPUTER INTERACTION	HCI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the relationship between humans and computers, covering design principles, history, human capabilities, and error prevention.	2	PO1, PO2, PO12, PSO1
CO2	Understand user-centered design process, from understanding user needs to prototyping interactive systems.	2	PO1, PO2, PO12, PSO1
CO3	Apply core usability principles (learnability, flexibility, robustness) and decision-making frameworks (authority vs. generality, standards, heuristics).	3	PO1, PO2, PO12, PSO1
CO4	Apply design evaluation methods using experts (cognitive walkthroughs, heuristics) and user participation (observation, surveys, experiments) in labs and real-world settings.	3	PO1, PO2, PO12, PSO1

Syllabus

Introduction to Human-Computer Interaction , Definition of HCI, Importance of HCI in software development, Historical perspective and evolution of HCI. Human Factors in HCI, Human sensory capabilities, Cognitive processes, Models of human information processing, Human error and error prevention

HCI User Centered Design Principles of user-centered design, Understanding user needs and requirements, Task analysis and user modeling, Persona development. Interaction Design, Principles of interaction design, Designing interactive systems, Design guidelines and heuristics, Prototyping techniques Interaction Design

Authority vs. generality Principles, standards, and guidelines Golden rules and heuristics Three categories of primary usability principles: Learnability, flexibility, and robustness.

Two forms of design evaluation: Expert analysis and user participation Approaches to expert analysis: Cognitive walkthroughs, heuristic evaluation, modelbased evaluation, and evaluation based on existing research Lab vs. field research Types of user-based evaluation: Observational methods, query techniques, physiological and direct recording, and experimental methods.

Reference Books

- 1 Human-Computer Interaction, Dix, Finlay, Abowd and Beale, 2003 , Pearson.
- 2 Introduction to Human Factors Engineering, Wickens, Lee, Liu, and Gordon-Becker, 2004, Pearson.
- 3 Designing the User Interface: Strategies for Effective Human-Computer Interaction, Shneiderman, Plaisant, Cohen, and Jacobs, 2019, Addison Wesley.
- 4 Human-Computer Interaction, D. R. Olsen, 2017, Cengage Learning.

23AVI3507 - OBJECT LOCALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3507	OBJECT LOCALIZATION	OL	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand different image features, retrieval, locations and related algorithms	2	PO2
CO2	Apply similarity learning and related algorithms for human face analysis working with semantic segmentation	3	PO3, PSO1
CO3	Evaluate the performance of natural language and image processing Skills and working with generative adversarial networks	4	PO1, PSO2
CO4	Classify the videos and image-based approaches for videos deployment in cloud and devices	3	PO4

Syllabus

Understanding deep learning, deep learning for computer vision. Image retrieval: Understanding visual features, model inference, content based image retrieval Object detection: detecting objects in an image, localizing algorithms, detecting objects, object detecting API

Semantic segmentation: predicting pixels, algorithms for semantic segmentation, segmenting satellite images Similarity learning: algorithms for similarity learning, human face analysis

Image captioning: Understanding natural language processing for image captioning, approaches for image captioning and related problems. Generative models: Applications of generative models, Neural artistic style transfer, generative adversarial networks, visual dialogue model

Video classification,: Understanding and classifying videos, extending image based approaches to videos Deployment : performance of models, deployment in the cloud, deployment in devices

Reference Books

- 1 Deep Learning for Computer Vision, Rajalingappa Shanmugamani, 2018, Packt Publishing.
- 2 Computer Vision: , Richard Szeliski, 2022, Springer.
- 3 Object Detection and Recognition in Digital Images: Theory and Practice, Boguslaw Cyganek and J. Paul Siebert, 2013, Wiley.
- 4 Multiple View Geometry in Computer Vision, Richard Hartley, Richard Hartley, 2011, Cambridge University Press.

23AVI3508 - ADVANCED IMAGE PROCESSING AND ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AVI3508	ADVANCED IMAGE PROCESSING AND ANALYSIS	AIPA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate digital images using various techniques and apply them through programming assignments.	2	PO2, PO3, PO8, PSO1
CO2	Identify the fundamental image processing techniques and object recognition algorithms in OpenCV.	3	PO2, PO3, PO8, PSO1
CO3	Apply the fundamental image processing techniques and object recognition algorithms using OpenCV and mathematical transformations	3	PO3, PO4, PO8, PSO1
CO4	Analyze deep learning models for various image processing tasks, including image classification, object detection, and semantic segmentation	4	PO3, PO4, PO8, PSO1

Syllabus

Origin of digital image processing, fundamental concepts like pixel representation and color spaces, and frequency domain filtering using Fourier Transforms. It includes morphological image processing, wavelet transforms, noise modeling, and restoration techniques. Programming assignments involve implementing filtering techniques in Python using OpenCV or Scikit-image.

Digital image fundamentals, including thresholding and region-based segmentation, edge detection algorithms (Canny, Laplacian), boundary representation, and shape analysis. It introduces object recognition methods like template matching and feature-based techniques. Programming assignments involve implementing segmentation and object recognition using OpenCV.

Digital image fundamentals, including thresholding and region-based segmentation, edge detection algorithms like Canny and Laplacian, boundary representation, and shape analysis. It introduces object recognition techniques such as template matching and feature-based methods. Programming assignments involve implementing segmentation and object recognition using OpenCV.

Convolutional neural networks (CNNs) for image processing, covering architectures like VGG and ResNet for image classification, YOLO and R-CNN for object detection, and U-Net for semantic segmentation. It includes transfer learning and a project to implement a deep learning model for an image processing task.

Reference Books

- 1 Digital Image Processing, Rafael C Gonzalez, Richard E Woods, 2002, Pearson Education Asia.
- 2 DSP Algorithms for Programmers, Jorg Arndt, 2022, Pearson Education Asia, 2002.
- 3 Bio Medical Images, Goetre, 2017, Wiley.
- 4 Computer Vision: Algorithms and Applications, Richard Szeliski, 2004, Springer.
- 5 Learning OpenCV: Computer Vision with Python, Joseph Howse, 2010, O'Reilly Media.
- 6 An Introduction to Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2014, Publisher: MIT

23BEW3101A - INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3101A	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	ITBTCT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the basic concepts of Cryptography for Blockchain	2	PO1, PSO2
CO2	Understand the basics of Blockchain and mining process	2	PO5, PSO2
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO5, PSO2
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	4	PO7, PSO2
CO5	Analyze popular blockchain development platforms and tools for developing and testing smart contracts and tokens	4	PO5, PSO2
CO6	Apply and analyze basic cryptography concepts and smart contracts applications using soft wallet.	4	PO1
CO7	Learn and use solidity programming language to build smart contracts	4	PO1

Syllabus

Introduction to Cryptography: Structure of cryptosystem - symmetric key cryptography -asymmetric key cryptography - types of attacks - RSA algorithm - Elliptic Curve Cryptography (ECC) -authentication models - SHA-256 Hash algorithm - Digital Signature Standards (DSS) - Elliptic Curve Digital Signature Algorithm (ECDSA).

Basics of Blockchain concepts Architecture Properties of Blockchain Distributed ledger Merkle tree structure of a Block Smart contract Crowd funding Transaction Double spending Block propagation Consensus Protocols Proof of Work PoW Proof of Stake PoS Proof of Burn PoB Proof of Elapsed Time PoET PAXOS consensus RAFT consensus Delayed Proof of Work dPoW Delegated Proof of Stake DPOS

Byzantine general problem Byzantine Fault Tolerance BFT Delegated Byzantine Fault Tolerance dBFT Practical Byzantine fault tolerance Algorithm Three phase commit Protocol Mining Types of Blockchain Blockchain components

Permissioned Blockchain Permissionless Blockchain Consortium Blockchain Cryptocurrencies Cryptocurrencies applications using Blockchain Bitcoin Bitcoin properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoin anonymity

Tangle IOTA Ether ETH Ethereum properties smart contract Applications Financial Services Cross border payments KYC international trade Health Care Food safety Applications of Blockchain Blockchain based Internet of Things IoT Supply Chain Management and Healthcare etc

Reference Books

- 1 Cryptography and Network Security: Principles and Practice , William Stallings , 7th Edition , Pearson Education .
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction , Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, , -, Princeton University Press .
- 3 Blockchain: Blueprint for a New Economy , Melanie Swan , -, O'Reilly Media, Inc .
- 4 Bitcoin: A Peer-to-Peer Electronic Cash System , Satoshi Nakamoto , -, 2018 Annual Seminar Bitcoin Glossary .
- 5 ETHEREUM: A Secure Decentralized Transaction Ledger, , Dr. Gavin Wood, , -, Paper EIP-150 REVISION .

23BEW3101E - INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3101E	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	ITBTCT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Implement the basic concepts of Cryptography for Blockchain	3	PO1, PSO2
CO2	Demonstrate the basics of Blockchain and mining process	3	PO5, PSO2
CO3	Compare different types of crypto currencies & its importance and Blockchain applications	4	PO5, PSO2
CO4	Analyze popular blockchain development platforms and tools for developing and testing smart contracts and tokens	4	PO7, PSO2
CO5	Analyze Ethereum blockchain and using wallet for interacting with network	4	PO5, PSO2
CO6	Demonstrate different types of Blockchain and consensus algorithms	4	PO1
CO7	Learn and use solidity programming language to build smart contracts	4	PO1

Syllabus

Introduction to Cryptography: Structure of cryptosystem - symmetric key cryptography -asymmetric key cryptography - types of attacks - RSA algorithm - Elliptic Curve Cryptography (ECC) -authentication models - SHA-256 Hash algorithm - Digital Signature Standards (DSS) - Elliptic Curve Digital Signature Algorithm (ECDSA).

Basics of Blockchain concepts Architecture Properties of Blockchain Distributed ledger Merkle tree structure of a Block Smart contract Crowd funding Transaction Double spending Block propagation Consensus Protocols Proof of Work PoW Proof of Stake PoS Proof of Burn PoB Proof of Elapsed Time PoET PAXOS consensus RAFT consensus Delayed Proof of Work dPoW Delegated Proof of Stake DPoS

Permissioned Blockchain Permissionless Blockchain Consortium Blockchain Cryptocurrencies Cryptocurrencies applications using Blockchain Bitcoin Bitcoin properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoin anonymity

Tangle IOTA Ether ETH Ethereum properties smart contract Applications Financial Services Cross border payments KYC international trade Health Care Food safety Applications of Blockchain Blockchain based Internet of Things IoT Supply Chain Management and Healthcare etc

Ethereum Ethereum basics Wallet Technology Nondeterministic Wallets Deterministic Wallets Hierarchical Deterministic Wallets Ethereum Addresses accounts Ethers Ethereum networks Consensus Protocols Ethereum Proof of Work Algorithm Ethash Ethereum Proof of Stake Algorithm Casper Delegated Proof of Stake DPoS

Reference Books

- 1 Cryptography and Network Security: Principles and Practice , William Stallings , 7th Edition , Pearson Education .
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction , Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, , -, Princeton University Press .
- 3 Blockchain: Blueprint for a New Economy , Melanie Swan , -, O'Reilly Media, Inc .
- 4 Bitcoin: A Peer-to-Peer Electronic Cash System , Satoshi Nakamoto , -, 2018 Annual Seminar Bitcoin Glossary .
- 5 ETHEREUM: A Secure Decentralized Transaction Ledger, , Dr. Gavin Wood, , -, Paper EIP-150 REVISION .

23BEW3101R - INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3101R	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	ITBTCT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding or knowing the basic concepts of Cryptography for Blockchain	2	PO1, PSO2
CO2	Understand the basics of Blockchain and mining process	2	PO5, PSO2
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO5, PSO2
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	4	PO7, PSO2
CO5	Apply the different types of crypto currencies & its importance and Blockchain applications	4	PO5, PSO2
CO6	Apply and analyze basic cryptography concepts and smart contracts applications using soft wallet.	4	PO1
CO7	Apply popular blockchain development platforms and tools for developing and testing smart contracts and tokens.	4	PO1

Syllabus

Introduction to Cryptography: Structure of cryptosystem - symmetric key cryptography -asymmetric key cryptography - types of attacks - RSA algorithm - Elliptic Curve Cryptography (ECC) -authentication models - SHA-256 Hash algorithm - Digital Signature Standards (DSS) - Elliptic Curve Digital Signature Algorithm (ECDSA).

Basics of Blockchain concepts Architecture Properties of Blockchain Distributed ledger Merkle tree structure of a Block Smart contract Crowd funding Transaction Double spending Block propagation Consensus Protocols Proof of Work PoW Proof of Stake PoS Proof of Burn PoB Proof of Elapsed Time PoET PAXOS consensus RAFT consensus Delayed Proof of Work dPoW Delegated Proof of Stake DPoS

Byzantine general problem Byzantine Fault Tolerance BFT Delegated Byzantine Fault Tolerance dBFT Practical Byzantine fault tolerance Algorithm Three phase commit Protocol Mining Types of Blockchain Blockchain components

Permissioned Blockchain Permissionless Blockchain Consortium Blockchain Cryptocurrencies Cryptocurrencies applications using Blockchain Bitcoin Bitcoin properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoin anonymity

Tangle IOTA Ether ETH Ethereum properties smart contract Applications Financial Services Cross border payments KYC international trade Health Care Food safety Applications of Blockchain Blockchain based Internet of Things IoT Supply Chain Management and Healthcare etc

Reference Books

- 1 Cryptography and Network Security: Principles and Practice , William Stallings , 7th Edition , Pearson Education .
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction , Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, , -, Princeton University Press .
- 3 Blockchain: Blueprint for a New Economy , Melanie Swan , -, O'Reilly Media, Inc .
- 4 Bitcoin: A Peer-to-Peer Electronic Cash System , Satoshi Nakamoto , -, 2018 Annual Seminar Bitcoin Glossary .
- 5 ETHEREUM: A Secure Decentralized Transaction Ledger, , Dr. Gavin Wood, , -, Paper EIP-150 REVISION .

23BEW3202A - SMART CONTRACTS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3202A	SMART CONTRACTS	SCR	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Ethereum blockchain and using wallet for interacting with network	3	PO1, PO6
CO2	Learn and use solidity programming language to build smart contracts	4	PO2, PSO2
CO3	Building advanced smart contracts with various test setups and try-catch assertions.	4	, PSO2
CO4	Build interactive front end for smart contracts and use Contracts design patterns.	4	, PSO2
CO5	Build interactive front end for smart contracts and ERC20 tokens.	4	PO5, PSO2

Syllabus

Ethereum Ethereum basics Wallet Technology Nondeterministic Wallets Deterministic Wallets Hierarchical Deterministic Wallets Ethereum Addresses accounts Ethers Ethereum networks Consensus Protocols Ethers Proof of Work Algorithm Ethash Ethers Proof of Stake Algorithm Casper Delegated Proof of Stake DPoS

Ethers Cryptographic Hash Function Keccak256 mining on Ethereum Ethereum Virtual Machine EVM Smart contract Ethereum Name Service ENS managing contracts with wallet Ethereum wallets and transactions deploy and interact with contracts Ethereum app architecture Solidity Programming Language Contract structure Data Types Predefined Global Variables and function declarations Functions function modifiers Overview of Arrays overview of mapping and structs Pseudo random generator Gas and transactions Mnemonic phrases compiling solidity the Compile script contract deployment .

The Structure of a Transaction testing with remix redeploying contracts, Advanced Smart contracts Sending ether from contracts resetting contracts state trycatch assertions testing function modifiers Contract Constructor and selfdestruct Adding a Constructor and selfdestruct Contract Inheritance Error Handling assert require revert Events Calling Other Contracts send call callcode delegatecall Gas Considerations Avoid Dynamically Sized Arrays Avoid Calls to Other Contracts.

The lottery contract Lottery design Smart Contract Security, Building interactive front end CreateReactapp Web3 setup deploying contracts local contracts instances rendering contract data Form setup Contracts Design Patterns Contract selfdestruction pattern Factory contract pattern Name Registry pattern Mapping iterator pattern.

Setting up private blockchain network Boot node toolpeer discovery setting up a PoAClique Network Clique based private network testing ERC20 token specifications ERC20 token implementation

Reference Books

- 1 Ethereum Smart Contract Development in Solidity, by Gavin Zheng (Author), Longxiang Gao (Author), Liqun Huang (Author), Jian Guan (Author), 2020, Paperback.
- 2 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, by Lorne Lantz (Author), Daniel Cawry (Author), 2020, Paperback.
- 3 Mastering Ethereum, Andreas M. Antonopoulos and Dr. Gavin Wood, 2019, O'Reilly Media.
- 4 Introducing Ethereum and Solidity, Chris Danne, 2017, Apress.
- 5 LEARN ETHEREUM SOLIDITY, Janani Sathish, 2021, Kindle Edition.

23BEW3202E - SMART CONTRACTS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3202E	SMART CONTRACTS	SCR	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Ethereum blockchain and using wallet for interacting with network	3	PO1, PO3
CO2	Learn and use solidity programming language to build smart contracts	4	, PSO2
CO3	Building advanced smart contracts with various test setups and try-catch assertions.	4	PO4, PSO2
CO4	Build interactive front end for smart contracts and use Contracts design patterns.	4	PO3, PO4
CO5	Build interactive front end for smart contracts and ERC20 tokens.	4	PO5, PSO2

Syllabus

Ethereum Ethereum basics Wallet Technology Nondeterministic Wallets Deterministic Wallets Hierarchical Deterministic Wallets Ethereum Addresses accounts Ethers Ethereum networks Consensus Protocols Ethers Proof of Work Algorithm Ethash Ethers Proof of Stake Algorithm Casper Delegated Proof of Stake DPoS

Ethers Cryptographic Hash Function Keccak256 mining on Ethereum Ethereum Virtual Machine EVM Smart contract Ethereum Name Service ENS managing contracts with wallet Ethereum wallets and transactions deploy and interact with contracts Ethereum app architecture Solidity Programming Language Contract structure Data Types Predefined Global Variables and function declarations Functions function modifiers Overview of Arrays overview of mapping and structs Pseudo random generator Gas and transactions Mnemonic phrases compiling solidity the Compile script contract deployment .

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- 2 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, by Lorne Lantz (Author), Daniel Cawry (Author), 2020, Paperback.
- 3 Mastering Ethereum, Andreas M. Antonopoulos and Dr. Gavin Wood, 2019, O'Reilly Media.
- 4 Introducing Ethereum and Solidity, Chris Danne, 2017, Apress.
- 5 LEARN ETHEREUM SOLIDITY, Janani Sathish, 2021, Kindle Edition.

23BEW3202R - SMART CONTRACTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3202R	SMART CONTRACTS	SCR	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Ethereum blockchain and using wallet for interacting with network	3	PO1, PO5
CO2	Learn and use solidity programming language to build smart contracts	4	PO2, PSO2
CO3	Building advanced smart contracts with various test setups and try-catch assertions.	4	, PSO2
CO4	Build interactive front end for smart contracts and use Contracts design patterns.	4	PO4, PSO2

Syllabus

Ethereum Ethereum basics Wallet Technology Nondeterministic Wallets Deterministic Wallets Hierarchical Deterministic Wallets Ethereum Addresses accounts Ethers Ethereum networks Consensus Protocols Ethers Proof of Work Algorithm Ethash Ethers Proof of Stake Algorithm Casper Delegated Proof of Stake DPoS

Ethers Cryptographic Hash Function Keccak256 mining on Ethereum Ethereum Virtual Machine EVM Smart contract Ethereum Name Service ENS managing contracts with wallet Ethereum wallets and transactions deploy and interact with contracts Ethereum app architecture Solidity Programming Language Contract structure Data Types Predefined Global Variables and function declarations Functions function modifiers Overview of Arrays overview of mapping and structs Pseudo random generator Gas and transactions Mnemonic phrases compiling solidity the Compile script contract deployment The Structure of a Transaction testing with remix redeploying contracts

Advanced Smart contracts Sending ether from contracts resetting contracts state trycatch assertions testing function modifiers Contract Constructor and selfdestruct Adding a Constructor and selfdestruct Contract Inheritance Error Handling assert require revert Events Calling Other Contracts send call callcode delegatecall Gas Considerations Avoid Dynamically Sized Arrays Avoid Calls to Other Contracts The lottery contract Lottery design Smart Contract Security

Building interactive front end CreateReactapp Web3 setup deploying contracts local contracts instances rendering contract data Form setup Contracts Design Patterns Contract selfdestruction pattern Factory contract pattern Name Registry pattern Mapping iterator pattern Setting up private blockchain network Boot node toolpeer discovery setting up a PoA Clique Network Clique based private network testing ERC20 token specifications ERC20 token implementation

Reference Books

- 1 Ethereum Smart Contract Development in Solidity, by Gavin Zheng (Author), Longxiang Gao (Author), Liqun Huang (Author), Jian Guan (Author), 2020, Paperback.
- 2 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, ADD 1 Ethereum Smart Contract Development in Solidity by Gavin Zheng (Author), Longxiang Gao (Author), Liqun Huang (Author), Jian Guan (Author), 2020, Paperback.
- 3 Mastering Ethereum, Andreas M. Antonopoulos and Dr. Gavin Wood, 2019, O'Reilly Media.
- 4 Introducing Ethereum and Solidity, Chris Danne, 2017, Apress.
- 5 LEARN ETHEREUM SOLIDITY, Janani Sathish, 2021, Kindle Edition.

23BEW3303A - DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3303A	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	DADW	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of decentralization and blockchain technology.	2	PO1, PO2, PSO2
CO2	Develop proficiency in designing and implementing smart contracts using Solidity.	3	PO2, PSO2
CO3	Acquire knowledge of decentralized application development principles and techniques.	3	PO1, PO4, PSO2
CO4	Explore decentralized web technologies such as IPFS and their integration with dApps.	4	PO1, PO5, PSO1
CO5	Analyze advanced topics in decentralized applications and decentralized web and discuss their implications.	5	PO4, PO5, PSO2
CO6	Develop and deploy a decentralized application (dApp) using blockchain technology and decentralized web principles.	5	PO5, PSO1
CO7	Demonstrate proficiency in problem-solving and critical thinking skills through practical application of decentralized technologies.	5	PO4, PSO1

Syllabus

Definition and basic principles of decentralization, Overview of blockchain technology and its key components, Comparison between centralized and decentralized systems, Applications and use cases of blockchain technology

Understanding smart contracts: definition, characteristics, and applications, Introduction to the Ethereum platform and its ecosystem, Basics of Solidity programming language for smart contract development, Writing, deploying, and interacting with smart contracts on the Ethereum blockchain

Principles of decentralized application (dApp) architecture, Design considerations for dApp development, Frontend and backend development for dApps, Testing and deployment of decentralized applications

Overview of decentralized web concepts and principles, Introduction to InterPlanetary File System (IPFS) and its architecture, Storing and retrieving data with IPFS, Integrating IPFS with decentralized applications

Exploration of advanced topics in decentralized applications, Decentralized finance (DeFi) and its applications, Scalability solutions for blockchain networks, Emerging trends and future directions in decentralized applications and decentralized web

Reference Books

- 1 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Andreas M. Antonopoulos, 1, O'Reilly Media.
- 2 Building Decentralized Applications: Harnessing Bitcoin's Blockchain Technology, Kyle Drake, 3, Apress.
- 3 Ethereum: Building Decentralized Applications with Ethereum, Roberto Infante, 1, Packt Publishing.
- 4 Decentralized Applications, Siraj Raval, 1, O'Reilly Media, Inc..

23BEW3303E - DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3303E	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	DADW	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts of decentralized systems and blockchain technology.	2	PO1, PSO1
CO2	Analyze various cryptographic techniques used in blockchain and their significance in securing decentralized applications.	4	PO9, PSO1
CO3	Evaluate the architecture and components of decentralized applications (DApps).	5	PO1, PO9, PSO1
CO4	Compare and contrast the Web2 and Web3 paradigms, focusing on their underlying technologies and protocols.	4	PO2, PSO2
CO5	Discuss the challenges and emerging trends in the field of decentralized systems, including scalability and governance issues.	2	PO1, PO5, PSO2
CO6	Develop a basic decentralized application using appropriate blockchain platforms and tools.	3	PO2, PO5, PSO2
CO7	Demonstrate problem-solving and critical thinking skills by addressing real-world issues through decentralized solutions.	3	PO2, PO5, PO9, PSO2

Syllabus

Introduction to Decentralization: Centralized vs. Decentralized Systems, History and Evolution of Decentralized Systems, Blockchain Technology Basics, Blocks, Chains, Nodes, Consensus Mechanisms: Proof of Work (PoW), Proof of Stake (PoS), Introduction to Smart Contracts: Definitions and Characteristics, Functionality and Use Cases, Limitations

Cryptographic Foundations: Cryptographic Principles: Public and Private Keys, Hash Functions, Digital Signatures, Overview of Cryptocurrencies: Bitcoin: Concepts and Transactions, Ethereum: Concepts and Transactions, Security in Decentralized Systems: Common Vulnerabilities, Mitigation Techniques

Decentralized Applications (DApps): Architecture of DApps: Frontend, Backend, and Blockchain Layers, Interaction Between Components, Development Frameworks: Ethereum, Truffle, Hardhat, Programming Languages: Solidity, Vyper, Case Studies: Successful DApps and Their Impact, Analysis of DApp Failures

Decentralized Web (Web3): Fundamentals of Web3: Differences Between Web2 and Web3, Key Components of Web3, InterPlanetary File System (IPFS): Introduction and Significance, Operational Mechanisms, Web3 Protocols: Overview of Popular Protocols (HTTP vs. IPFS, ENS), Use Cases and Integration

Advanced Topics and Future Directions: Scaling Decentralized Systems: Layer 2 Solutions, Sharding, Governance Models: Decentralized Autonomous Organizations (DAOs), Voting Mechanisms and Implications, Emerging Trends and Challenges: Privacy Issues, Regulatory Concerns, Future Outlook

Reference Books

- 1 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Imran Bashir, Second Edition, Packt Publishing.
- 2 Decentralized Applications: Harnessing Bitcoin's Blockchain Technology, Siraj Raval, First Edition, O'Reilly Media.
- 3 Decentralized Applications, Siraj Raval, First Edition, O'Reilly Media, Inc..
- 4 Ethereum: Building Decentralized Applications with Ethereum, Roberto Infante, First Edition, Packt Publishing.

23BEW3303R - DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3303R	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	DADW	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of decentralization and blockchain technology.	1	PO1, PO2, PSO2
CO2	Develop proficiency in designing and implementing smart contracts using Solidity.	3	PO2, PSO2
CO3	Apply knowledge of decentralized application development principles and techniques to create a simple decentralized application.	3	PO1, PSO2
CO4	Explore decentralized web technologies such as IPFS and their integration with dApps.	4	PO1, PO5, PSO1
CO5	Develop and deploy a decentralized application (dApp) using blockchain technology and decentralized web principles.	5	PO5, PSO2
CO6	Demonstrate proficiency in problem-solving and critical thinking skills through practical application of decentralized technologies	6	PO5, PO11, PSO1

Syllabus

Definition and basic principles of decentralization, Overview of blockchain technology and its key components, Comparison between centralized and decentralized systems, Applications and use cases of blockchain technology

Understanding smart contracts: definition, characteristics, and applications, Introduction to the Ethereum platform and its ecosystem, Basics of Solidity programming language for smart contract development, Writing, deploying, and interacting with smart contracts on the Ethereum blockchain

Principles of decentralized application (dApp) architecture, Design considerations for dApp development, Frontend and backend development for dApps, Testing and deployment of decentralized applications

Overview of decentralized web concepts and principles, Introduction to InterPlanetary File System (IPFS) and its architecture, Storing and retrieving data with IPFS, Integrating IPFS with decentralized applications

Reference Books

- 1 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Andreas M. Antonopoulos, ISBN-10: 1491954388, O'Reilly Media.
- 2 Building Decentralized Applications: Harnessing Bitcoin's Blockchain Technology, Kyle Drake, ISBN-10: 1484239246, Apress.
- 3 Ethereum: Building Decentralized Applications with Ethereum, Roberto Infante, ISBN-10: 178712214X, Packt Publishing.
- 4 Decentralized Applications, Siraj Raval, ISBN: 9781491924549, O'Reilly Media, Inc..

23BEW3404M - BLOCKCHAIN PLATFORMS AND PROTOCOLS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3404M	BLOCKCHAIN PLATFORMS AND PROTOCOLS	BCPAP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding or knowing the basic concepts of Cryptography for Blockchain	2	PO1, PO8
CO2	Understand the basics of Blockchain and mining process	2	PO5, PO12
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO5, PO8, PO12, PSO1
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	3	PO1, PSO1

Syllabus

Introduction to Cryptography: Structure of cryptosystem - symmetric key cryptography -asymmetric key cryptography - types of attacks - RSA algorithm - Elliptic Curve Cryptography (ECC) -authentication models - SHA-256 Hash algorithm - Digital Signature Standards (DSS) - Elliptic CurveDigital Signature Algorithm (ECDSA).

Basics of Blockchain concepts Architecture Properties ofBlockchain Distributed ledger Merkle tree structure of a Block Smart contract Crowd funding Transaction Double spending Block propagation Consensus Protocols Proof of Work PoW Proof of Stack PoS Proof of Burn PoB Proof of Elapsed Time PoET PAXOS consensus RAFTconsensus Delayed Proof of Work dPoW Delegated Proof of Stake DPoS Byzantine general problem Byzantine Fault Tolerance BFT Delegated Byzantine Fault Tolerance dBFT Practical Byzantinefault tolerance Algorithm

Three phase commit Protocol Mining Types of Blockchain Blockchaincomponents Permissioned Blockchain Permissionless Blockchain Consortium BlockchainCryptocurrencies Cryptocurrencies applications using Blockchain Bitcoin Bitcoin properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoinanonymity

Tangle IOTA Ether ETH Ethereum properties smart contract Applications FinancialServices Cross border payments KYC international trade Health Care Food safety Applications ofBlockchain Blockchain based Internet of Things BloT Supply Chain Management and Healthcare etc

Reference Books

- 1 Cryptography and Network Security: Principles and Practice, William Stallings , 7th Edition, Pearson Education.
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction , Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, - , 1st Edition , Princeton University Press.
- 3 Blockchain: Blueprint for a New Economy , Melanie Swan - - , 1st Edition , O'Reilly Media, Inc.
- 4 Bitcoin: A Peer-to-Peer Electronic Cash System , Satoshi Nakamoto - , 1st Edition , 2018 Annual Seminar Bitcoin Glossary.

23BEW3405M - BLOCKCHAIN SECURITY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3405M	BLOCKCHAIN SECURITY	BCS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding or knowing the basic concepts of Cryptography for Blockchain	2	PO1, PO5, PSO1
CO2	Understand the basics of Blockchain and mining process	2	PO1, PO3, PO5, PSO1
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO1, PO3, PO5, PSO1
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	3	PO1, PO5, PSO1

Syllabus

Introduction to Cryptography: Structure of cryptosystem - symmetric key cryptography -asymmetric key cryptography - types of attacks - RSA algorithm - Elliptic Curve Cryptography (ECC) -authentication models - SHA-256 Hash algorithm - Digital Signature Standards (DSS) - Elliptic CurveDigital Signature Algorithm (ECDSA).

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- 4 Bitcoin: A Peer-to-Peer Electronic Cash System , Satoshi Nakamoto - , 1st Edition , 2018 Annual Seminar Bitcoin Glossary.

23BEW3406M - ORACLES AND DATA FEEDS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3406M	ORACLES AND DATA FEEDS	ODF	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain fundamental concepts of Oracle Database and architecture, including the roles of different components such as tablespaces, schemas, and data files.	2	PO1, PO2, PSO1, PSO2
CO2	Able to integrate data from various sources using Oracle data feeds, understanding how to extract, transform, and load (ETL) data efficiently.	3	PO1, PO3, PO4
CO3	Demonstrate proficiency in writing complex SQL queries to retrieve and manipulate data stored in Oracle databases, optimizing queries for performance and accuracy.	3	PO1, PO4
CO4	Able to up and manage real-time data feeds, including the use of Oracle tools and technologies to handle streaming data and ensure data integrity and consistency.	3	PO1, PO3, PO4

Syllabus

Oracle Database Fundamentals: Introduction to Oracle Database Architecture - Components of Oracle Databases: Tablespaces, Schemas, Data Files - Installation and Configuration of Oracle Database - Overview of Oracle Database Management Tools - Understanding Oracle Data Types and Storage Structures.

Data Integration and ETL Processes: Principles of Data Integration and Data Feeds, Extract, Transform, Load (ETL) Processes - Tools for ETL in Oracle: Oracle Data Integrator (ODI) - Working with External Data Sources: Files, APIs, and Other Databases - Data Cleansing and Transformation Techniques.

Advanced SQL for Oracle Databases: Writing Complex SQL Queries for Data Retrieval - Advanced SQL Functions and Features in Oracle - Query Optimization Techniques - Handling Large Datasets and Performance Tuning - Stored Procedures, Functions, and Triggers.

Real-Time Data Processing with Oracle: Introduction to Real-Time Data Processing - Setting Up Real-Time Data Feeds in Oracle - Using Oracle Streams and Oracle GoldenGate for Data Replication - Ensuring Data Integrity and Consistency in Real-Time Applications - Case Studies and Practical Applications of Real-Time Data Feeds.

Reference Books

- 1 Oracle Database 12c The Complete Reference, Bob Bryla and Kevin Loney, First Edition, 2014, McGraw-Hill Education.
- 2 Oracle PL/SQL Programming, Steven Feuerstein, Bill Pribyl, Sixth Edition, 2014, O'Reilly Media.
- 3 Oracle Data Integrator 12c: Getting Started, David Hecksel, Julie Johnson, Mark Rittman, First Edition, 2014, Packt Publishing.
- 4 Oracle GoldenGate 12c Implementer's Guide, John P. Jeffries, First Edition, 2015, Packt Publishing.
- 5 Expert Oracle Database Architecture: Oracle Database 9i, 10g, and 11g Programming Techniques and Solutions, Thomas Kyte, Second Edition, 2010, Apress.
- 6 Oracle Essentials: Oracle Database 12c, Rick Greenwald, Robert Stackowiak, Jonathan Stern, Fifth Edition, 2013, O'Reilly Media.

23BEW3507 - BLOCKCHAIN SCALABILITY AND LAYER 2 SOLUTIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3507	BLOCKCHAIN SCALABILITY AND LAYER 2 SOLUTIONS	BCSALS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Articulate the scalability challenges faced by blockchain networks, including issues related to throughput, latency, and network congestion	2	PO3, PO5, PSO1, PSO2
CO2	Design and implement basic layer 2 solutions for improving the scalability of blockchain networks.	3	PO3
CO3	Determine the trade-offs involved in implementing different layer 2 solutions, considering factors such as security, decentralization, and usability	3	PO4
CO4	Evaluate their knowledge of blockchain scalability and layer 2 solutions to real-world scenarios.	4	PO1

Syllabus

Introduction to Blockchain Scalability Challenges: Understanding Blockchain Scalability(Throughput, Latency, and Network Congestion), Scalability Limitations of Traditional Blockchain Networks (e.g., Bitcoin, Ethereum), Case Studies: Scalability Issues in Real-world Blockchain Applications

Layer 2 Scaling Solutions: Introduction to Layer 2 Scaling Solutions(Concept and Types),State Channels(Principles, Implementation, and Use Cases), Sidechains(Architecture, Interoperability, and Security Considerations), Off-chain Computation(Techniques, Benefits, and Challenges)

Evaluating Scalability Solutions: Analyzing Trade-offs in Blockchain Scalability-Security vs. Performance, Decentralization vs. Scalability- Finding the Balance, User Experience Considerations-Usability vs. Scalability Trade-offs, Regulatory and Compliance Implications of Scalability Solutions

Application and Case Studies: Scalability Solutions in Decentralized Finance (DeFi)-Challenges and Innovations, Layer 2 Solutions for Supply Chain Management- Use Cases and Benefits, Gaming and Non-Fungible Tokens (NFTs)- Scalability Requirements and Solutions, Future Trends and Emerging Technologies in Blockchain Scalability

Reference Books

- 1 "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", Andreas M. Antonopoulos, 2nd Edition,2017, O'Reilly Media.
- 2 "Scalability, Privacy, and Security in Blockchain Technologies", Jesus Diaz, Partha Dutta, et al., 1st Edition,2020, Springer.
- 3 "Mastering Ethereum: Building Smart Contracts and DApps", Andreas M. Antonopoulos, Gavin Wood, 1st Edition,2018, O'Reilly Media.
- 4 "Blockchain Scalability: Analysis and Solutions", Kartik Goyal, 1st Edition,2019, CRC Press.
- 5 "Building Ethereum DApps: Decentralized Applications on the Ethereum Blockchain", Roberto Infante, 1st Edition,2019, Apress.

23BEW3508 - REGULATORY LANDSCAPE AND COMPLIANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3508	REGULATORY LANDSCAPE AND COMPLIANCE	RLAC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the regulatory framework governing various industries and sectors.	2	PO1, PO4
CO2	Demonstrate knowledge of compliance practices and procedures to ensure adherence to regulatory standards.	3	PO1, PO4, PSO2
CO3	Analyze the impact of regulatory requirements on business operations and decision-making processes.	3	PO1, PO4, PSO2
CO4	Evaluate the role of regulatory bodies and agencies in enforcing compliance and maintaining industry standards.	4	PO1, PO4

Syllabus

Introduction to Regulatory Landscape Overview of regulatory framework and its significance Types of regulations: industry-specific, regional, and global Role of regulatory bodies and agencies in shaping compliance standards

Regulatory Compliance Practices Understanding compliance requirements and obligations Compliance risk assessment and management Compliance monitoring and reporting mechanisms

Regulatory Impact on Business Operations Impact assessment of regulations on business strategies and operations Compliance challenges and solutions in different industries Case studies on successful compliance management

Emerging Trends and Future Directions in Regulatory Compliance Emerging regulatory trends and developments Technology-driven solutions for regulatory compliance Regulatory compliance in the digital age: challenges and opportunities

Reference Books

- 1 Compliance Management: A How-to Guide for Executives, Lawyers, and Other Compliance Professionals, Robert Lindquist, 2nd Edition, Wiley.
- 2 Understanding Compliance: A Contemporary Approach, Stephen B. Morris, 1st Edition, Wolters Kluwer.
- 3 Regulatory Compliance Essentials for Pharmaceutical and Biologics Manufacturers, David A. Larcada, 1st Edition, CRC Press.
- 4 Corporate Compliance Answer Book, William L. Lawton and Margaret C. Pearson, 1st Edition, Practising Law Institute.

23BEW3509 - FUTURE TRENDS IN BLOCKCHAIN AND WEB3 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BEW3509	FUTURE TRENDS IN BLOCKCHAIN AND WEB3	FTBCAW	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the foundational concepts of blockchain technology and its evolution towards Web3.	2	PO1, PO2
CO2	Analyze current trends and emerging developments in blockchain and Web3 ecosystems.	3	PO1, PO2
CO3	Demonstrate proficiency in utilizing blockchain platforms and protocols for decentralized applications (dApps) development.	3	PO1, PO2, PSO2
CO4	Evaluate the potential impact of blockchain and Web3 technologies on various industries and sectors.	4	PO1, PO2

Syllabus

Introduction to Blockchain and Web3: Overview of blockchain technology: principles, components, and use cases - Evolution towards Web3: decentralized web architecture and interoperability - Blockchain platforms and protocols: Ethereum, Polkadot, Solana, etc.

Emerging Trends in Blockchain and Web3 - DeFi (Decentralized Finance) and the rise of digital assets - NFTs (Non-Fungible Tokens) and their implications for digital ownership - DAOs (Decentralized Autonomous Organizations) and decentralized governance models

Decentralized Application Development - Smart contract programming languages: Solidity, Rust, etc. - Building decentralized applications (dApps) on blockchain platforms - Web3 development frameworks and toolkits

Applications and Future Implications - Blockchain in supply chain management, healthcare, finance, and beyond - Challenges and opportunities in scaling blockchain networks - Ethical considerations and regulatory implications of blockchain and Web3 technologies

Reference Books

- 1 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Andreas M. Antonopoulos, 2nd Edition, O'Reilly Media.
- 2 Blockchain Basics: A Non-Technical Introduction in 25 Steps, Daniel Drescher, 2nd Edition, Apress.
- 3 Decentralized Applications: Harnessing Bitcoin's Blockchain Technology, Siraj Raval, 1st Edition, Manning Publications.
- 4 Blockchain Enabled Applications: Understand the Blockchain Ecosystem and How to Make it Work, Vikram Dhillon & David Metcalf & Max Hooper, -, Apress.

23BIS3101A - MOLECULAR MODELLING AND DRUG DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3101A	MOLECULAR MODELLING AND DRUG DESIGN	MMDD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the comprehensive knowledge of various drug discovery methods, including high-throughput screening, lead optimization, and pharmacophore modeling. Introduce the concepts and techniques of molecular modeling and simulation,	3	PO2, PO3
CO2	Interpret computer-based modeling techniques to predict and analyze protein functions and structures. Gain a deep understanding of the methods used to predict protein folding	3	PO2, PO3
CO3	Demonstrate biomolecular interactions, such as protein-protein, protein-ligand, and protein-DNA/RNA interactions in biological systems	3	PO2, PO5
CO4	Apply role of various modeling and drug design methods through detailed case studies. Analyze real-world examples of drug discovery projects to understand the practical applications of theoretical concepts, methodologies,	3	PO2, PO5
CO5	Apply the principles of molecular modeling and drug design (MMDD) to accurately determine and predict protein structures. Learn to use various computational tools and techniques to model protein conformations, study their stability	3	PO3, PO5
CO6	Demonstrate simulations to study biomolecular interactions in detail with principles of molecular dynamics, Monte Carlo simulations, and other computational techniques to predict and analyze how biomolecules interact within a biological environment	3	PO3, PO5
CO7	Illustrate mathematical modeling techniques to the process of drug design, with a particular focus on understanding and utilizing force fields. Learn how force fields are used to model molecular forces and energies, predict molecular conformations	3	PO3, PO5

Syllabus

PRACTICAL INTRODUCTION TO MOLECULAR MODELING AND DRUG DESIGN: High-Throughput Screening: Techniques for testing large numbers of compounds. Virtual Screening: Computational methods for identifying potential drug candidates. Molecular Docking: Predicting how small molecules bind to targets. Drug Metabolism and Pharmacokinetics: Absorption, distribution, metabolism, and excretion of drugs. Medicinal Chemistry: Design and development of new therapeutic compounds. Pharmaceutical Formulation: Creating drug formulations for effective delivery. Drug Design Strategies: Structure-based and ligand-based drug design approaches. Regulatory Affairs in Drug Development: Understanding FDA and EMA regulations for drug approval. Ethics in Drug Development: Ethical considerations in drug testing and research.

PREDICTION AND STRUCTURAL ANALYSIS OF MACROMOLECULES : Protein Function Prediction: Techniques for predicting the biological function of proteins from their structure. Structural Alignment and Comparison: Methods for comparing protein structures to identify similarities and differences. Structural Bioinformatics: Using computational tools and databases for analyzing macromolecular structures. Structural Genomics: Large-scale efforts to determine 3D structures of proteins and their implications for drug discovery. Proteomics: Techniques for studying the complete set of proteins expressed in an organism. Molecular Modeling Tools: Introduction to software tools for structure prediction and analysis (e.g., MODELLER, Rosetta). Advanced Visualization Techniques: Tools for detailed visualization of protein structures and interactions.

BIOMOLECULAR INTERACTIONS AND DRUG DISCOVERY METHODS: Drug Interactions Prediction: Techniques for identifying and analyzing drug-drug interactions. Cheminformatics Tools: Software and databases for drug discovery (e.g., ChemDraw, PubChem). Molecular Dynamics Simulations for Drug Discovery: Using MD simulations to study drug-target interactions. Quantitative Structure-Activity Relationship (QSAR) Models: Building and interpreting QSAR models for drug efficacy and safety. Pharmacophore Modeling: Identifying essential features for drug-receptor interactions. ADMET Prediction Tools: Tools for predicting drug Absorption, Distribution, Metabolism, Excretion, and Toxicity properties. Biological Activity Prediction: Techniques for predicting the effectiveness of compounds in biological systems. Advanced Drug Target Prediction: Methods for discovering and validating new drug targets.

METHODS IN SMALL MOLECULE DRUG ANALYSIS: Quantitative Structure-Activity Relationship (QSAR) Analysis: Developing and applying QSAR models to correlate chemical structure with biological activity. Pharmacophore Modeling: Designing models to identify essential features for drug-receptor interactions. Molecular Docking: Techniques for simulating the binding of small molecules to target proteins. Computational Chemistry Techniques: Advanced methods for analyzing small molecule interactions. Chemical Library Design: Creating and managing libraries of compounds for drug discovery. Virtual Screening Approaches: Methods for efficiently screening large chemical libraries. Synthesis and Optimization of Drug Candidates: Strategies for synthesizing and improving potential drug molecules.

VISUALIZATION AND ANALYSIS OF BIOMOLECULES: Molecular Visualization Tools: Software for visualizing macromolecules (e.g., PyMOL, Chimera). Modeling of Macromolecular Structures: Techniques for building and refining macromolecular models. Physicochemical Properties Analysis: Methods for analyzing properties like solubility, stability, and polarity of small molecules. Structural Interactions Analysis: Studying interactions between biomolecules and their implications for drug design. Bioinformatics Tools for Molecular Analysis: Using bioinformatics resources for sequence alignment and structural prediction. Molecular Dynamics Visualization: Visualizing results from molecular dynamics simulations. Drug Design Simulation Techniques: Advanced simulations for drug design and optimization.

Reference Books

- 1 Molecular Modeling of Proteins., Andreas Kukol, 2012, Springer New York.
- 2 Molecular Modeling: Basic Principles and Applications., Hans-Dieter Hltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers., 2016, John Wiley & Sons.
- 3 Molecular Modelling Principles and Applications., Pual Clinton, 2022, Pearson Publication.
- 4 Molecular Modelling: Computational Chemistry Demystified, Bladon P, 2018, Rsc Publishing.

23BIS3101E - MOLECULAR MODELLING AND DRUG DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3101E	MOLECULAR MODELLING AND DRUG DESIGN	MMDD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the comprehensive knowledge of various drug discovery methods, including high-throughput screening, lead optimization, and pharmacophore modeling. Introduce the concepts and techniques of molecular modeling and simulation,	3	PO2, PO3
CO2	Interpret computer-based modeling techniques to predict and analyze protein functions and structures. Gain a deep understanding of the methods used to predict protein folding	3	PO2, PO3
CO3	Demonstrate biomolecular interactions, such as protein-protein, protein-ligand, and protein-DNA/RNA interactions in biological systems	3	PO2, PO3
CO4	Apply role of various modeling and drug design methods through detailed case studies. Analyze real-world examples of drug discovery projects to understand the practical applications of theoretical concepts, methodologies,	3	PO2, PO3
CO5	Apply the principles of molecular modeling and drug design (MMDD) to accurately determine and predict protein structures. Learn to use various computational tools and techniques to model protein conformations, study their stability	3	PO2, PO3
CO6	Demonstrate simulations to study biomolecular interactions in detail with principles of molecular dynamics, Monte Carlo simulations, and other computational techniques to predict and analyze how biomolecules interact within a biological environment	3	PO2, PO4
CO7	Illustrate mathematical modeling techniques to the process of drug design, with a particular focus on understanding and utilizing force fields. Learn how force fields are used to model molecular forces and energies, predict molecular conformations	3	PO2, PO4

Syllabus

PRACTICAL INTRODUCTION TO MOLECULAR MODELING AND DRUG DESIGN: High-Throughput Screening: Techniques for testing large numbers of compounds. Virtual Screening: Computational methods for identifying potential drug candidates. Molecular Docking: Predicting how small molecules bind to targets. Drug Metabolism and Pharmacokinetics: Absorption, distribution, metabolism, and excretion of drugs. Medicinal Chemistry: Design and development of new therapeutic compounds. Pharmaceutical Formulation: Creating drug formulations for effective delivery. Drug Design Strategies: Structure-based and ligand-based drug design approaches. Regulatory Affairs in Drug Development: Understanding FDA and EMA regulations for drug approval. Ethics in Drug Development: Ethical considerations in drug testing and research.

PREDICTION AND STRUCTURAL ANALYSIS OF MACROMOLECULES : Protein Function Prediction: Techniques for predicting the biological function of proteins from their structure. Structural Alignment and Comparison: Methods for comparing protein structures to identify similarities and differences. Structural Bioinformatics: Using computational tools and databases for analyzing macromolecular structures. Structural Genomics: Large-scale efforts to determine 3D structures of proteins and their implications for drug discovery. Proteomics: Techniques for studying the complete set of proteins expressed in an organism. Molecular Modeling Tools: Introduction to software tools for structure prediction and analysis (e.g., MODELLER, Rosetta). Advanced Visualization Techniques: Tools for detailed visualization of protein structures and interactions.

BIOMOLECULAR INTERACTIONS AND DRUG DISCOVERY METHODS: Drug Interactions Prediction: Techniques for identifying and analyzing drug-drug interactions. Cheminformatics Tools: Software and databases for drug discovery (e.g., ChemDraw, PubChem). Molecular Dynamics Simulations for Drug Discovery: Using MD simulations to study drug-target interactions. Quantitative Structure-Activity Relationship (QSAR) Models: Building and interpreting QSAR models for drug efficacy and safety. Pharmacophore Modeling: Identifying essential features for drug-receptor interactions. ADMET Prediction Tools: Tools for predicting drug Absorption, Distribution, Metabolism, Excretion, and Toxicity properties. Biological Activity Prediction: Techniques for predicting the effectiveness of compounds in biological systems. Advanced Drug Target Prediction: Methods for discovering and validating new drug targets.

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- 2 Molecular Modelling Principles and Applications., Pual Clinton, 2011, Pearson Publication.
- 3 Molecular Modeling: Basic Principles and Applications., Hans-Dieter H?ltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers, 2021, John Wiley & Sons.
- 4 Molecular Modelling: Computational Chemistry Demystified, Bladon P, 2016, Rsc Publishing.

23BIS3101R - MOLECULAR MODELLING AND DRUG DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3101R	MOLECULAR MODELLING AND DRUG DESIGN	MMDD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the comprehensive knowledge of various drug discovery methods, including high-throughput screening, lead optimization, and pharmacophore modeling. Introduce the concepts and techniques of molecular modeling and simulation,	3	PO2, PO3
CO2	Interpret computer-based modeling techniques to predict and analyze protein functions and structures. Gain a deep understanding of the methods used to predict protein folding	3	PO2, PO3
CO3	Demonstrate biomolecular interactions, such as protein-protein, protein-ligand, and protein-DNA/RNA interactions in biological systems	3	PO2
CO4	Apply role of various modeling and drug design methods through detailed case studies. Analyze real-world examples of drug discovery projects to understand the practical applications of theoretical concepts, methodologies,	3	PO2, PO5
CO5	Apply the principles of molecular modeling and drug design (MMDD) to accurately determine and predict protein structures. Learn to use various computational tools and techniques to model protein conformations, study their stability	3	PO5
CO6	Demonstrate simulations to study biomolecular interactions in detail with principles of molecular dynamics, Monte Carlo simulations, and other computational techniques to predict and analyze how biomolecules interact within a biological environment	3	PO3, PO5

Syllabus

PRACTICAL INTRODUCTION TO MOLECULAR MODELING AND DRUG DESIGN: High-Throughput Screening: Techniques for testing large numbers of compounds. Virtual Screening: Computational methods for identifying potential drug candidates. Molecular Docking: Predicting how small molecules bind to targets. Drug Metabolism and Pharmacokinetics: Absorption, distribution, metabolism, and excretion of drugs. Medicinal Chemistry: Design and development of new therapeutic compounds. Pharmaceutical Formulation: Creating drug formulations for effective delivery. Drug Design Strategies: Structure-based and ligand-based drug design approaches. Regulatory Affairs in Drug Development: Understanding FDA and EMA regulations for drug approval. Ethics in Drug Development: Ethical considerations in drug testing and research.

PREDICTION AND STRUCTURAL ANALYSIS OF MACROMOLECULES : Protein Function Prediction: Techniques for predicting the biological function of proteins from their structure. Structural Alignment and Comparison: Methods for comparing protein structures to identify similarities and differences. Structural Bioinformatics: Using computational tools and databases for analyzing macromolecular structures. Structural Genomics: Large-scale efforts to determine 3D structures of proteins and their implications for drug discovery. Proteomics: Techniques for studying the complete set of proteins expressed in an organism. Molecular Modeling Tools: Introduction to software tools for structure prediction and analysis (e.g., MODELLER, Rosetta). Advanced Visualization Techniques: Tools for detailed visualization of protein structures and interactions.

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- 2 Molecular Modelling Principles and Applications., Hans-Dieter Hltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers., 2012, John Wiley & Sons.
- 3 Molecular Modeling: Basic Principles and Applications., Hans-Dieter H?ltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers, 2021, John Wiley & Sons.
- 4 Molecular Modelling: Computational Chemistry Demystified, Bladon P, 2019, Rsc Publishing.

23BIS3202A - BIOMEDICAL INFORMATICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3202A	BIOMEDICAL INFORMATICS	BMI	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply proficiency in acquiring, storing, and managing biomedical data from various sources, ensuring data integrity and accessibility for research and clinical applications.	3	PO1, PO3
CO2	Model computational analysis techniques and modeling approaches used in biomedical informatics to interpret complex biological data and derive meaningful insights.	3	PO1, PO4
CO3	Construct the principles of health information systems and interoperability standards to enhance the seamless exchange and integration of healthcare data.	3	PO1, PO2
CO4	Build critical thinking skills to explore ethical, legal, and social issues related to biomedical informatics, fostering responsible and ethical use of biomedical data.	3	PO1, PO5
CO5	Evaluate the real-world problem using statistical tools to identify trends, patterns, and correlations, and to make evidence-based decisions.	5	PO1, PO2
CO6	Assess the data using computational and logical methodologies to validate findings, ensure accuracy, and improve the robustness of biomedical research outcomes.	5	PO1, PO2, PSO1

Syllabus

Introduction to biomedical data sources, acquisition techniques, storage, quality assurance, and governance, highlighting the integration of diverse data types and the importance of data security and privacy measures.

Exploration of computational analysis techniques and modeling approaches in biomedical informatics, emphasizing their application in genomic sequencing, drug discovery, and personalized medicine.

Understanding health information systems principles and interoperability standards, focusing on their role in enhancing healthcare delivery, patient safety, and data exchange across different healthcare settings.

Examination of ethical, legal, and social issues pertinent to biomedical informatics, including privacy concerns, data ownership, informed consent, and the ethical implications of AI and machine learning in healthcare.

Statistical methods for analysis of biomedical data, including hypothesis testing, regression analysis, and machine learning algorithms tailored for biological and clinical datasets.

Reference Books

- 1 Biomedical Informatics: Computer Applications in Health Care and Biomedicine , Edward H. Shortliffe and James J. Cimino , 2014, Springer.
- 2 Health Informatics: An Interprofessional Approach, Ramona Nelson and Nancy Staggers, 2017, Mosby.
- 3 Biomedical Informatics An Introduction to Information Systems and Software in Medicine and Health, David J. Lubliner, 2016, CRC Press.
- 4 Biomedical Informatics: Computer Applications in Health Care and Biomedicine, Edward H. Shortliffe and James J. Cimino, 2021, Springer.

23BIS3202E - BIOMEDICAL INFORMATICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3202E	BIOMEDICAL INFORMATICS	BMI	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply proficiency in acquiring, storing, and managing biomedical data from various sources, ensuring data integrity and accessibility for research and clinical applications.	3	PO1, PO3
CO2	Model computational analysis techniques and modeling approaches used in biomedical informatics to interpret complex biological data and derive meaningful insights.	3	PO1, PO4
CO3	Construct the principles of health information systems and interoperability standards to enhance the seamless exchange and integration of healthcare data.	3	PO1, PO2
CO4	Build critical thinking skills to explore ethical, legal, and social issues related to biomedical informatics, fostering responsible and ethical use of biomedical data.	3	PO1, PO5
CO5	Evaluate the real-world problem using statistical tools to identify trends, patterns, and correlations, and to make evidence-based decisions.	5	PO1, PO2
CO6	Assess the data using computational and logical methodologies to validate findings, ensure accuracy, and improve the robustness of biomedical research outcomes.	5	PO1, PO2, PSO1

Syllabus

Introduction to biomedical data sources, acquisition techniques, storage, quality assurance, and governance, highlighting the integration of diverse data types and the importance of data security and privacy measures.

Exploration of computational analysis techniques and modeling approaches in biomedical informatics, emphasizing their application in genomic sequencing, drug discovery, and personalized medicine.

Understanding health information systems principles and interoperability standards, focusing on their role in enhancing healthcare delivery, patient safety, and data exchange across different healthcare settings.

Examination of ethical, legal, and social issues pertinent to biomedical informatics, including privacy concerns, data ownership, informed consent, and the ethical implications of AI and machine learning in healthcare.

Statistical methods for analysis of biomedical data, including hypothesis testing, regression analysis, and machine learning algorithms tailored for biological and clinical datasets.

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- 2 Health Informatics: An Interprofessional Approach, Ramona Nelson and Nancy Staggers, 2017, Mosby.
- 3 Biomedical Informatics An Introduction to Information Systems and Software in Medicine and Health, David J. Lubliner, 2016, CRC Press.
- 4 Biomedical Informatics: Computer Applications in Health Care and Biomedicine, Edward H. Shortliffe and James J. Cimino, 2021, Springer.

23BIS3202R - BIOMEDICAL INFORMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3202R	BIOMEDICAL INFORMATICS	BMI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply proficiency in acquiring, storing, and managing biomedical data from various sources, ensuring data integrity and accessibility for research and clinical applications.	3	PO2, PO3
CO2	Model computational analysis techniques and modeling approaches used in biomedical informatics to interpret complex biological data and derive meaningful insights.	3	PO2, PO4
CO3	Construct the principles of health information systems and interoperability standards to enhance the seamless exchange and integration of healthcare data.	3	PO1, PO2
CO4	Build critical thinking skills to explore ethical, legal, and social issues related to biomedical informatics, fostering responsible and ethical use of biomedical data.	3	PO2, PO5, PSO1

Syllabus

Introduction to biomedical data sources, acquisition techniques, storage, quality assurance, and governance, highlighting the integration of diverse data types and the importance of data security and privacy measures.

Exploration of computational analysis techniques and modeling approaches in biomedical informatics, emphasizing their application in genomic sequencing, drug discovery, and personalized medicine.

Understanding health information systems principles and interoperability standards, focusing on their role in enhancing healthcare delivery, patient safety, and data exchange across different healthcare settings.

Examination of ethical, legal, and social issues pertinent to biomedical informatics, including privacy concerns, data ownership, informed consent, and the ethical implications of AI and machine learning in healthcare.

Reference Books

- 1 Biomedical Informatics: Computer Applications in Health Care and Biomedicine, Edward H. Shortliffe and James J. Cimino, 2014, Springer.
- 2 Health Informatics: An Interprofessional Approach, Ramona Nelson and Nancy Staggers, 2017, Mosby.
- 3 Biomedical Informatics An Introduction to Information Systems and Software in Medicine and Health, David J. Lubliner, 2016, CRC Press.
- 4 Biomedical Informatics: Computer Applications in Health Care and Biomedicine, Edward H. Shortliffe and James J. Cimino, 2021, Springer.

23BIS3203A - PYTHON AND R PROGRAMMING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3203A	PYTHON AND R PROGRAMMING	P&RP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Python functions and modules to analyze and process genomic sequences.	3	PO1, PSO1
CO2	Utilize various R functions to analyze and interpret genomic sequences.	3	PO1, PO5, PSO1
CO3	Apply Biopython to perform pairwise and multiple sequence alignment of sequences.	3	PO1, PSO1
CO4	Apply R functions and libraries on microarray gene expression datasets.	3	PO1, PO5, PSO1
CO5	Make use of different Python and R packages for manipulating Bio-sequences.	3	PO1, PO5, PSO1

Syllabus

Python fundamentals: installing python; basic usage, running programs, basic elements & syntax, strings, lists and tuples, dictionaries, loops, comparisons, definitions & functions, modules, classes, exceptions- object-oriented programming.

Introducing R: the big picture, the benefits of r, installation, r editor and r-gui, r environment, the fundamentals of r, simple mathematics and vectors, arguments, putting the argument in a function, history, structuring the code, comments, datatypes, control statements, if statements, switching looping, for loop, functions, and r packages, debugging the code, errors, and warning, basic plotting.

Biological sequence analysis with Biopython: working with fasta files, parsing DNA data files, Accessing NCBI's Entrez databases, accessing pubmed, sequence alignment, dynamic programming, pair wise sequence alignment and multiple sequence alignments, phylogenetic tree construction, Sequence motif analysis and working with PDB files.

R programming for gene expression analysis: Gene expression array analysis, spot finding and measurement, arrays and data displays, applications with expression arrays. R Advanced statistical analysis techniques, Correlation, Fourier transforms, Clustering, hierarchical clusters, k-means clustering, , principal component analysis.

Handling genomic sequence data with Python, Calculation of GC percentages, ORF prediction from DNA sequences, R studio basics, Visualization using R, SeqinR package, Pubmed using Biopython, Pairwise sequence alignments using Biopython, Phylogenetic tree construction, Manipulation of gene expression datasets in R, Basic statistical analysis of GE datasets, Clustering gene expression data using R

Reference Books

- 1 Python For Bioinformatics , Jason Kinser, 2009, Jones and Bartlett.
- 2 Learning Python, Mark lutz, 2007, O'Reilly Media, Inc..
- 3 R For Dummies, Andrie de Vries, Joris Meys, 2015, For Dummies.
- 4 Biopython Tutorial and Cookbook, Jeff Chang, Brad Chapman, Iddo Friedberg, 2024 , Biopython.org (2021).

23BIS3203E - PYTHON AND R PROGRAMMING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3203E	PYTHON AND R PROGRAMMING	P&RP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Python functions and modules to analyze and process genomic sequences.	3	PO1, PSO1
CO2	Utilize various R functions to analyze and interpret genomic sequences.	3	PO1, PO5, PSO1
CO3	Apply R functions and libraries to analyze microarray gene expression datasets.	3	PO1, PSO1
CO4	Apply R functions and libraries to analyze microarray gene expression datasets.	3	PO1, PO5, PSO1
CO5	Make use of different Python and R packages to manipulate and analyze bio-sequences.	3	PO1, PO5, PSO1

Syllabus

Python fundamentals: installing python; basic usage, running programs, basic elements & syntax, strings, lists and tuples, dictionaries, loops, comparisons, definitions & functions, modules, classes, exceptions- object-oriented programming

Introducing R: the big picture, the benefits of r, installation, r editor and r-gui, r environment, the fundamentals of r, simple mathematics and vectors, arguments, putting the argument in a function, history, structuring the code, comments, datatypes, control statements, if statements, switching looping, for loop, functions, and r packages, debugging the code, errors, and warning, basic plotting.

Biological sequence analysis with Biopython: working with fasta files, parsing DNA data files, Accessing NCBI's Entrez databases, accessing pubmed, sequence alignment, dynamic programming, pair wise sequence alignment and multiple sequence alignments, phylogenetic tree construction, Sequence motif analysis and working with PDB files.

R programming for gene expression analysis: Gene expression array analysis, spot finding and measurement, arrays and data displays, applications with expression arrays. R Advanced statistical analysis techniques, Correlation, Fourier transforms, Clustering, hierarchical clusters, k-means clustering, , principal component analysis.

Handling genomic sequence data with Python, Calculation of GC percentages, ORF prediction from DNA sequences, R studio basics, Visualization using R, SeqinR package, Pubmed using Biopython, Pairwise sequence alignments using Biopython, Phylogenetic tree construction, Manipulation of gene expression datasets in R, Basic statistical analysis of GE datasets, Clustering gene expression data using R

Reference Books

- 1 Python For Bioinformatics , Jason Kinser, 2009, Jones and Bartlett.
- 2 Learning Python, Mark Lutz, 2007, O'Reilly Media, Inc..
- 3 R For Dummies, Andrie de Vries, Joris Meys, 2015, For Dummies.
- 4 Biopython Tutorial and Cookbook, Jeff Chang, Brad Chapman, Iddo Friedberg, 2024, Biopython.org (2021).

23BIS3203R - PYTHON AND R PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3203R	PYTHON AND R PROGRAMMING	P&RP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Python functions and modules to analyze and process genomic sequences.	3	PO1, PSO1
CO2	Utilize various R functions to analyze and interpret genomic sequences.	3	PO1, PO5, PSO1
CO3	Apply R functions and libraries to analyze microarray gene expression datasets.	3	PO1, PSO1
CO4	Apply R functions and libraries to analyze microarray gene expression datasets.	3	PO1, PO5, PSO1

Syllabus

Python fundamentals: installing python; basic usage, running programs, basic elements & syntax, strings, lists and tuples, dictionaries, loops, comparisons, definitions & functions, modules, classes, exceptions- object-oriented programming.

"Introducing R: the big picture, the benefits of r, installation, r editor and r-gui, r environment, the fundamentals of r, simple mathematics and vectors, arguments, putting the argument in a function, history, structuring the code, comments, datatypes, control statements, if statements, switching looping, for loop, functions, and r packages, debugging the code, errors, and warning, basic plotting."

"Biological sequence analysis with Biopython: working with fasta files, parsing DNA data files, Accessing NCBI's Entrez databases, accessing pubmed, sequence alignment, dynamic programming, pair wise sequence alignment and multiple sequence alignments, phylogenetic tree construction, Sequence motif analysis and working with PDB files."

R programming for gene expression analysis: Gene expression array analysis, spot finding and measurement, arrays and data displays, applications with expression arrays. R Advanced statistical analysis techniques, Correlation, Fourier transforms, Clustering, hierarchical clusters, k-means clustering, , principal component analysis.

Reference Books

- 1 Python For Bioinformatics, Jason Kinser, 2009, Jones and Bartlett .
- 2 Learning Python, Mark Lutz, 2007, O'Reilly Media, Inc..
- 3 R For Dummies , Andrie de Vries, Joris Meys , 2015, For Dummies .
- 4 Biopython Tutorial and Cookbook, Jeff Chang, Brad Chapman, Iddo Friedberg, 2024, Biopython.org (2021) .

23BIS3304A - STRUCTURAL BIOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3304A	STRUCTURAL BIOLOGY	SB	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the protein dynamics and concepts of X-ray Diffraction Brags law electron density map	2	PO1, PO5, PSO1
CO2	Understand the importance of techniques used in structural biology studies and secondary structure prediction methods and algorithms used in prediction	2	PO1, PO5, PSO1
CO3	Understand the significance of Ramachandran Plot RMSD and concepts in 3D structure comparison	2	PO1, PO5, PSO1
CO4	Apply the knowledge about the structural geometrical and dynamic interactions of nucleic acids with other molecules.	3	PO1, PO5, PSO1
CO5	Demonstrate the intricacy of protein protein interactions critical for cellular processes and with applications in drug discovery and disease understanding	3	PO1, PO5, PSO1
CO6	Apply the understanding of structural biology techniques and secondary structure prediction methods to assess protein function and design novel biomolecules.	3	PO1, PO5, PSO1
CO7	Analyze macromolecular structures computational and experimental techniques in modeling and analyzing for biotechnology and medicine.	4	PO1, PO5, PSO1

Syllabus

Proteins: Chemical Structures and properties of Amino acids, Primary, Secondary, Tertiary and Quaternary Structures; Nucleic acids: DNA, RNA - Chemical Structures and properties of Nucleic acids, Primary, Secondary, Tertiary and Quaternary Structures. DNA Double helix - Types of Double helices; Structural and Geometrical parameters of each and their comparison.

Protein Purification & Crystallization methods : Chromatography. Electrophoresis, Protein Sequencing, MS; Principles of X-ray Diffraction Technique : Bragg's Law, Phase Determination, Calculation of Electron Density Map, Interpretation of the electron density map, Refinement of the Structures; Principle of NMR Spectroscopy - Magnetic properties of nuclei, Energy Levels of proton during spin, Chemical Shift, Coupling Constants, Shielding, NOSEY, COSY; Principle of Electron Microscopy: SEM, TEM, Cryo-EM; Determination of secondary structure - CD/ORD Techniques.

Basic principles of secondary structure prediction methods, Algorithms of Chou Fasman, GOR, PHD, PSI-PRED; 3D Structure Prediction Methods: Homology Modelling, Fold Recognition, Threading, ab-initio and Hybrid methods; Significance of Ramachandran Plot, Helical Wheel, Hydrophobicity profiles, Amphiphilicity detection, Transmembrane prediction.

Structural Genomics; Concepts in 3D structure comparison, purpose of structure comparison, Algorithms for structure comparison (FSSP, VAST & DALI), Root Mean Square Deviation (RMSD), Structure-function relation, Function inference from structure; PPI, DPI, LRI; Protein assemblies, Natural nano machines.

Structural elucidation-Steps involved in Homology Modeling. Fold Recognition and ab-initio methods, Derivation and significance of Ramachandran Plot, Root Mean Square Deviation (RMSD), Energy Plot based on Potential of mean force, Packaging Quality, Helical Wheel, Hydrophobicity profiles, Amphiphilicity detection, Transmembrane prediction methods. Concepts in 3D structure comparison, purpose of structure comparison, Algorithms for structure comparison (FSSP, VAST & DALI), Structure function relation, Function inference from structure.

Reference Books

- 1 Fundamentals of Protein Structure and Function-, Engelbert Buxbaum , 2015, Springer International P.
- 2 Fundamentals of Molecular Structural Biology , Subrata Pal , 2020 , Academic Press.

- 3 Principles of Biochemistry, David L. Nelson and Michael M. Cox , 2017, W.H. Freeman..
- 4 Biochemistry, Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer , 2013, W.H. Freeman..

23BIS3304E - STRUCTURAL BIOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3304E	STRUCTURAL BIOLOGY	SB	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the protein dynamics and concepts of X-ray Diffraction Brags law electron density map	2	PO1, PO5, PSO1
CO2	Understand the importance of techniques used in structural biology studies and secondary structure prediction methods and algorithms used in prediction	2	PO1, PO5, PSO1
CO3	Understand the significance of Ramachandran Plot RMSD and concepts in 3D structure comparison	2	PO1, PO5, PSO1
CO4	Apply the knowledge about the structural geometrical and dynamic interactions of nucleic acids with other molecules.	2	PO1, PO5, PSO1
CO5	Demonstrate the intricacy of protein protein interactions critical for cellular processes and with applications in drug discovery and disease understanding	2	PO1, PO5, PSO1
CO6	Apply the understanding of structural biology techniques and secondary structure prediction methods to assess protein function and design novel biomolecules.	3	PO1, PO5, PSO1
CO7	Analyze macromolecular structures computational and experimental techniques in modeling and analyzing for biotechnology and medicine.	3	PO1, PO5, PSO1

Syllabus

Structural biology of Nucleic acidsTypes of Double helices Structural and Geometrical parameters of each and their comparison. Dynamics and types of interactions of DNA with proteins, and small molecules. RNA Secondary structures Tertiary structures tRNA tertiary structure.

Protein dynamicsProtein Purification &Crystallization methods Principles of Xray Diffraction Brags Law. Phase Determination Calculation of Electron Density Map Interpretation of the electron density map Refinement of the Structures.

Techniques for structural biology Principle of NMR Spectroscopy Magnetic properties of nuclei Energy Levels of proton during spin Chemical Shift Coupling Constants Shielding Determination of secondary structure NOSEY COSY.

Structure predictions-Basic principles of secondary structure prediction methods Algorithms of Chou Fasman GOR PHD PSIPRED Stereo chemical method of Lim and Neural network method concepts in measuring the accuracy of predictions.

Structural elucidation-Steps involved in Homology Modeling. Fold Recognition andab-initiomethods, Derivation and significance of Ramachandran Plot, Root Mean Square Deviation (RMSD), Energy Plot based on Potential of mean force, Packaging Quality, Helical Wheel, Hydrophobicity profiles, Amphiphilicity detection, Transmembrane prediction methods. Concepts in 3D structure comparison, purpose of structure comparison, Algorithms for structure comparison (FSSP, VAST & DALI), Structure function relation, Function inference from structure.

Reference Books

- 1 Introduction to Macromolecular Crystallography, McPherson, 2008, John Wiley Publication .
- 2 Introduction to Protein Science, Arthur M. Lesk , 2004, Oxford University Press, UK..
- 3 Introduction to Protein Architecture , Arthur M. Lesk , 2000, Oxford University Press, UK..
- 4 Principles of Protein Structure, G.N. Ramachandran, T.R. S. Devanathan, K. Sekhar Rao, 2013, Springer.

23BIS3304R - STRUCTURAL BIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3304R	STRUCTURAL BIOLOGY	SB	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the protein dynamics and concepts of X-ray Diffraction Brags law electron density map	3	PO1, PO6, PSO1
CO2	Understand the importance of techniques used in structural biology studies and secondary structure prediction methods and algorithms used in prediction	3	PO1, PO6, PSO1
CO3	Understand the significance of Ramachandran Plot RMSD and concepts in 3D structure comparison	3	PO1, PO6, PSO1
CO4	Apply the knowledge about the structural geometrical and dynamic interactions of nucleic acids with other molecules.	3	PO1, PO6, PSO1
CO5	Demonstrate the intricacy of protein protein interactions critical for cellular processes and with applications in drug discovery and disease understanding	3	PO1, PO6, PSO1
CO6	Apply the understanding of structural biology techniques and secondary structure prediction methods to assess protein function and design novel biomolecules.	3	PO1, PO6, PSO1

Syllabus

Structural biology of Nucleic acids Types of Double helices Structural and Geometrical parameters of each and their comparison. Dynamics and types of interactions of DNA with proteins and small molecules. RNA Secondary structures Tertiary structures tRNA tertiary structure.

Protein dynamics Protein Purification and Crystallization methods Principles of Xray Diffraction Brags Law. Phase Determination Calculation of Electron Density Map Interpretation of the electron density map Refinement of the Structures.

Techniques for structural biology Principle of NMR Spectroscopy Magnetic properties of nuclei Energy Levels of proton during spin Chemical Shift Coupling Constants Shielding Determination of secondary structure NOSEY COSY.

Structure predictions Basic principles of secondary structure prediction methods Algorithms of Chou Fasman GOR PHD PSIPRED Stereo chemical method of Lim and Neural network method concepts in measuring the accuracy of predictions.

Reference Books

- 1 Introduction to Macromolecular Crystallography , McPherson, 20002, John Wiley Publication .
- 2 Introduction to Protein Science, Arthur M. Lesk , 2004, Oxford University Press, UK..
- 3 Introduction to Protein Architecture , Arthur M. Lesk , 2001, Oxford University Press, UK. .
- 4 Molecular Biology of the Cell , Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, 1983, Garland Science.

23BIS3405M - APPLIED BIOINFORMATICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3405M	APPLIED BIOINFORMATICS	ABI	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the comparative genomics strategies in conjunction with the structure prediction tools, datasets, and procedures to identify conserved elements, elucidate evolutionary relationships, and predict functional regions across different species	3	PO2, PO3, PSO2
CO2	Identify the information obtained from the microarray in order to map the levels of cellular expression, analyze the differential gene expression profiles under various conditions, and correlate these profiles with phenotypic changes, biological pathways, and regulatory networks, thereby enhancing our understanding of gene function, disease mechanisms, and potential targets for therapeutic intervention	3	PO2, PO3, PSO2
CO3	Identify the notion of systems biology in order to effectively represent biological processes in a computer environment, and develop computational models that integrate data from various biological systems	3	PO6, PO7, PSO2
CO4	Apply the principles of bioinformatics modeling to predict the structure of proteins as well as the interactions that occur between biomolecules, utilizing techniques such as homology modeling, molecular dynamics simulations, and machine learning algorithms to analyze sequence data	3	PO6, PO7, PSO2

Syllabus

Comparative Genomics, Protein modelling and Assessment Comparative Genomics, Genetic mapping, Physical mapping, SNPs, ESTs, GSS, Gene prediction methods, Gene prediction tools, Gene annotation, Molecular Predictions with DNA sequence, Human Genome Project. Protein Structure Prediction and Evaluation methods Structure of Protein PDB, MMDB; Ramachandran Plots; Structure visualization Rasmol; Methods of Structure prediction Homology modelling SPDBV, Threading, Ab initio method; Structure Evaluation DSSP, ProCheck, Verify 3D; Structure comparison

Protein Identification and Interactions Protein Identification And Interactions Proteomics approaches for protein analysis; Protein identification Programs Mascot, GFS; Comparative Proteomics methods; Protein interactions; Protein Interaction dbs GRID, MINT; Network Mapping; Biological Pathway dbs EcoCyc, KEGG; Pathway prediction; Metabolic pathway reconstruction

Gene Expression Analysis Gene Expression Analysis Introduction; Serial Analysis of Gene Expression; Microarray, Types of Microarrays, Microarray Fabrication, Microarray hybridization and detection, Microarray Image Processing and analysis, Expression ratios, Transformations of the Expression ratio, Data Normalization

Systems Biology System Biology Foundations of System Biology Objectives of System Biology Strategies relating to In Silico Modeling of biological processes Metabolic Networks Signal Transduction pathways, Gene Expression patterns Applications of System Biology Markup Language, E cell, V cell simulations and Applications

Reference Books

- 1 Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, Mendiritta, Rastogi and Rastogi, 2013, PHI Learning .
- 2 Molecular Modelling : Principles & Applications , Andrew Leach, 2001, PEARSON.
- 3 Principles of Computational Cell Biology: From Protein Complexes to Cellular Networks, Volkhard Helms, 2019, Wiley.
- 4 Statistical analysis of gene expression microarray data, Terry Speed, 2003, CRC.

23BIS3406M - NGS SEQUENCING AND DATA ANALYSIS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3406M	NGS SEQUENCING AND DATA ANALYSIS	NGSDA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of Sequence Analysis to Biological Specimens: Understand and apply various sequence analysis techniques to interpret biological data, including the alignment of DNA, RNA, or protein sequences.	3	PO2, PO4
CO2	Demonstrate Data Analysis with Preprocessing and Alignment: Utilize methods for the preprocessing of raw biological data, including quality control, filtering, and alignment techniques.	3	PO2, PO4
CO3	Illustrate Variant Calling and Annotation with NGS Data Sets/graphs: Perform variant calling using next-generation sequencing (NGS) data to identify genetic variants such as single nucleotide polymorphisms (SNPs)	3	PO2, PO4
CO4	Interpret Transcriptomics and Differential Gene Expression: Engage in transcriptomic studies to explore gene expression levels under different conditions.	3	PO2, PO5

Syllabus

Introduction to Next-Generation Sequencing (NGS) Explore the fundamentals of Next-Generation Sequencing (NGS) technologies and platforms, focusing on the evolution from Sanger sequencing to high-throughput sequencing methods. Study the various NGS platforms like Illumina, Ion Torrent, PacBio, and Oxford Nanopore Technologies (ONT), highlighting their applications in different research scenarios.

NGS Data Analysis: Preprocessing and Alignment Understand the preprocessing steps for raw NGS data including quality filtering, adapter removal, and read trimming to ensure high-quality data for analysis. Gain insights into read alignment algorithms such as BWA, Bowtie2, and STAR, focusing on how these algorithms map NGS reads to a reference genome.

Variant Calling and Annotation Study the principles of variant calling from NGS data, including the identification of single nucleotide variants (SNVs), small insertions and deletions (indels), and structural variants. Learn about tools for variant calling such as GATK, Samtools, and FreeBayes, and techniques for quality assessment and filtering of variants

NGS Data Analysis: Transcriptomics and Differential Gene Expression Explore RNA-Seq data analysis techniques for studying gene expression, including methods for quantifying gene expression levels, normalization procedures, and differential gene expression analysis to identify genes that exhibit significant changes across different conditions.

Reference Books

- 1 Next-Generation DNA Sequencing Informatics , Stuart M. Brown , 2018, Oxford University Press .
- 2 Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools , Vince Buffalo , 2015, O'Reilly Media .
- 3 NGS Data Analysis: A Practical Approach , S. Cenk Sahinalp , 2015, Chapman and Hall/CRC .
- 4 Bioinformatics A Practical Guide to Next Generation Sequencing Data Analysis, Hamid D. Ismai, 2021, Chapman and Hall/CRC.

23BIS3507 - SYSTEMS BIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3507	SYSTEMS BIOLOGY	SSB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate an understanding of the fundamental concepts of systems biology, showcasing a solid grasp of the principles and frameworks that underpin the study of complex biological systems and their interactions.	3	PO1, PO2, PO5, PSO1
CO2	Utilize computational tools to analyze and model complex biological systems, indicating proficiency in applying various computational methods to simulate and study intricate biological networks and processes.	3	PO1, PO2, PO5, PSO1
CO3	Analyze high-throughput biological data to identify patterns and interactions, reflecting the capability to interpret large-scale data sets to uncover significant biological relationships and trends.	4	PO1, PO2, PO5, PSO1
CO4	Assess the interactions between components of biological systems, demonstrating the ability to evaluate and understand the dynamic relationships and dependencies within biological systems, contributing to a comprehensive understanding of their function and regulation.	4	PO1, PO2, PO5, PSO1

Syllabus

Core principles, theories, and models that underpin systems biology, including key biological components, interactions, and methodologies, as well as interdisciplinary approaches and future applications.

Computational tools and methods to analyze and model complex biological systems, focusing on simulation techniques, network analysis, and data integration, along with their applications in studying biological processes and interactions.

Large-scale high-throughput biological data to identify patterns, interactions, and trends, using statistical methods and computational tools to uncover significant biological relationships and gain insights into complex biological systems.

Interpret the dynamic interactions and dependencies among components of biological systems, utilizing models and simulations to understand system behavior, regulation, and function in various biological contexts.

Reference Books

- 1 Systems Biology: A Textbook, Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, 2016, Wiley-Blackwell .
- 2 Computational Systems Biology, Andres Kriete, Roland Eils, 2013, Academic Press.
- 3 Systems Biology: Principles, Methods, and Concepts, Bernhard Palsson, 2020, Cambridge University Press.
- 4 Synthetic Biology: A Primer, Paul S. Freemont, Richard I. Kitney, 2015, World Scientific Publishing.
- 5 Foundations of Systems Biology, Hiroaki Kitano, 2020, MIT Press .

23BIS3508 - DATABASE MANAGEMENT SYSTEM FOR BIOLOGIST (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BIS3508	DATABASE MANAGEMENT SYSTEM FOR BIOLOGIST	DBMS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the functional components of DBMS, and its importance of data modeling in the design of a database to ensure the efficient organization and management.	3	PO1, PO2
CO2	Build the SQL queries and concepts of relational algebra to manipulate and query data effectively, optimizing database performance.	3	PO1, PO2
CO3	Identify normalization techniques and indexing for databases to reduce data redundancy, improve data integrity, and accelerate data retrieval.	3	PO3, PO5
CO4	Apply transaction processing, concurrency control, and recovery techniques to work on databases, ensuring data consistency, integrity, and reliability during multiple transactions and potential failures.	3	PO3, PO5, PS01

Syllabus

Introduction and conceptual modelling: Introduction to File and Database systems, covering fundamental concepts of data storage, retrieval methods, and organizational structures in both file-based and database systems.

Relational Algebra and Calculus. Relational model, SQL: Exploring relational algebra and calculus as theoretical foundations of the relational model, and practical application through SQL (Structured Query Language) for database querying and manipulation.

B-Tree - B+Tree, Query Processing, Normalization, Concurrency control: Detailed examination of B-Tree and B+Tree data structures for efficient indexing, query optimization techniques, database normalization principles, and strategies for managing concurrent access to ensure data consistency.

Concurrency Control, Types of Locks, Recovery Techniques: In-depth analysis of concurrency control mechanisms including locking strategies (e.g., exclusive and shared locks), and recovery techniques such as logging and checkpoints to maintain database integrity and recover from failures.

Reference Books

- 1 Fundamentals of Database Systems, Ramez Elmasri and Shamkant B. Navathe, 2017, Pearson.
- 2 Database Systems: The Complete Book, Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom, 2008, Pearson.
- 3 Database Management Systems, Raghu Ramakrishnan and Johannes Gehrke, 1998, McGraw-Hill Education.
- 4 Database System Concepts, Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, 2020, McGraw-Hill Education.

23BMI3101A - BIOMEDICAL SIGNAL AND IMAGE PROCESSING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3101A	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	BSIP	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding biomedical signal and image analysis, covering various biosignals (temperature, BP, EMG, ECG, EEG), image acquisition methods (X-ray, CT, MRI, ultrasound), and the challenges associated with processing and interpreting this vital medical data.	2	PO1, PO2, PSO2
CO2	Apply digital signal processing techniques for biomedical signals, including filtering in time and frequency domains, noise modeling, pre-processing for noise reduction (high frequency noise, baseline wander, powerline interference), medical signal detection, and measures of waveform complexity.	3	PO2, PSO2
CO3	Identify biomedical image enhancement techniques, covering image fundamentals (sampling, quantization), spatial and frequency domain methods, to improve image quality for better visualization and analysis in medical applications.	3	PO2, PSO2
CO4	Utilize wavelet analysis techniques for processing physiological signals and biomedical images, enabling improved analysis, artifact reduction, and feature extraction for medical diagnosis and research.	3	PO2, PSO2
CO5	Examine and solve practical biomedical signal and system problems by implementing appropriate signal and image processing algorithms using MATLAB, fostering skills in noise reduction, feature extraction, and data interpretation for medical applications.	4	PO2, PSO2
CO6	Analyze and Implement appropriate signal/Image processing algorithms for practical problems involving biomedical signals and systems Using MATLAB.	4	PO2, PSO2
CO7	Analyze the Case Studies of the Bio medical Audio signal Analysis and Biomedical Image Analysis. case studies related to futuristic biomedical devices	4	PO2, PO5, PSO2

Syllabus

Fundamentals of Bio-medical Signals and Images: Introduction to biomedical signals. The Nature of Biomedical Signals, Examples of Biomedical signals: Temperature, BP, EMG, ECG and EEG, rhythmic excitation of heart, heart activity complexity. Objectives of biomedical analysis, difficulties in biomedical signal analysis. Bio-medical Images X-ray, Computerized tomography, MRI and Ultrasound image acquisition techniques. difficulties in biomedical image analysis.

Modalities, Signal Processing Methods: Digital Signal processing filtering techniques for Biomedical signals: Time domain and frequency domain techniques. Noise models, Pre-processing, High frequency noise elimination, Baseline wander removal, Powerline interference elimination, Detection of medical signals, Measures of waveform complexity / activity.

Biomedical Image Enhancement Techniques: Image model, sampling and quantization, image geometry, spatial domain, and Frequency domain enhancement techniques.

Advanced Applications: Wavelet decomposition of physiological signals for analysis, Wavelets approach for Biomedical signal and image artefact reduction techniques.

Analyze and Implement appropriate signal/Image processing algorithms for practical problems involving biomedical signals and systems Using MATLAB.

Reference Books

- 1 Biomedical Signal Analysis , Rangaraj M Rangayyan , 2016, John Wiley and Sons .
- 2 Biomedical Signal and Image Processing , Kayvan Najarian, Robert Splinter , 2012, CRC Press Taylor & Francis Group .

- 3 Biomedical Image Analysis , Rangaraj M Rangayyan , 2005, CRC Press Taylor & Francis Group.
- 4 Biomedical Instrumentation and Measurements , Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer , 1990, Prentice Hall Inc, New Jersey. .
- 5 Handbook of Biomedical Instrumentation-Technology & Applications , R.S. Khandpur , 2014, Tata McGraw-Hill .

23BM3101E - BIOMEDICAL SIGNAL AND IMAGE PROCESSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BM3101E	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	BSIP	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding biomedical signal and image analysis, covering various biosignals (temperature, BP, EMG, ECG, EEG), image acquisition methods (X-ray, CT, MRI, ultrasound), and the challenges associated with processing and interpreting this vital medical data.	3	PO1, PO2, PSO2
CO2	Apply digital signal processing techniques for biomedical signals, including filtering in time and frequency domains, noise modeling, pre-processing for noise reduction (high frequency noise, baseline wander, powerline interference), medical signal detection, and measures of waveform complexity.	3	PO2, PSO2
CO3	Identify biomedical image enhancement techniques, covering image fundamentals (sampling, quantization), spatial and frequency domain methods, to improve image quality for better visualization and analysis in medical applications.	3	PO2, PSO2
CO4	Utilize wavelet analysis techniques for processing physiological signals and biomedical images, enabling improved analysis, artifact reduction, and feature extraction for medical diagnosis and research.	4	PO2, PSO2
CO5	Examine and solve practical biomedical signal and system problems by implementing appropriate signal and image processing algorithms using MATLAB, fostering skills in noise reduction, feature extraction, and data interpretation for medical applications.	4	PO2, PSO2
CO6	Analyze and Implement appropriate signal/Image processing algorithms for practical problems involving biomedical signals and systems Using MATLAB.	4	PO2, PSO2
CO7	Inspect the Case Studies of the Bio medical Audio signal Analysis and Biomedical Image Analysis. case studies related to futuristic biomedical devices	4	PO2, PO5, PSO2

Syllabus

Fundamentals of Bio-medical Signals and Images: Bio-medical Signals: Introduction to biomedical signals. The Nature of Biomedical Signals, Examples of Biomedical signals: Temperature, BP, EMG, ECG and EEG, rhythmic excitation of heart, heart activity complexity. Objectives of biomedical analysis, difficulties in biomedical signal analysis. Bio-medical Images X-ray, Computerized tomography, MRI and Ultrasound image acquisition techniques. difficulties in biomedical image analysis.

Modalities, Signal Processing Methods: Digital Signal processing filtering techniques for Biomedical signals: Time domain and frequency domain techniques. Noise models, Pre-processing, High frequency noise elimination, Baseline wander removal, Powerline interference elimination, Detection of medical signals, Measures of waveform complexity / activity.

Biomedical Image Enhancement Techniques: Image model, sampling and quantization, image geometry, spatial domain, and Frequency domain enhancement techniques.

Advanced Applications Wavelet decomposition of physiological signals for analysis Wavelets approach for Biomedical signal and image artefact reduction techniques.

Analyze and Implement appropriate signal/Image processing algorithms for practical problems involving biomedical signals and systems Using MATLAB.

Reference Books

- 1 Biomedical Signal Analysis , Rangaraj M Rangayyan , 2016, John Wiley and Sons .

- 2 Biomedical Signal and Image Processing , Kayvan Najarian, Robert Splinter , 2012, CRC Press Taylor & Francis Group .
- 3 Biomedical Image Analysis , Rangaraj M Rangayyan, 2005, CRC Press Taylor & Francis Group .
- 4 Biomaterials Science , uddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, 2012, Elsevier .

23BMI3101R - BIOMEDICAL SIGNAL AND IMAGE PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3101R	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	BSIP	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding biomedical signal and image analysis, covering various biosignals (temperature, BP, EMG, ECG, EEG), image acquisition methods (X-ray, CT, MRI, ultrasound), and the challenges associated with processing and interpreting this vital medical data.	2	PO1, PO2, PSO2
CO2	Apply digital signal processing techniques for biomedical signals, including filtering in time and frequency domains, noise modeling, pre-processing for noise reduction (high frequency noise, baseline wander, powerline interference), medical signal detection, and measures of waveform complexity.	2	PO2, PSO2
CO3	Identify biomedical image enhancement techniques, covering image fundamentals (sampling, quantization), spatial and frequency domain methods, to improve image quality for better visualization and analysis in medical applications.	3	PO2, PSO2
CO4	Apply wavelet analysis techniques for processing physiological signals and biomedical images, enabling improved analysis, artifact reduction, and feature extraction for medical diagnosis and research.	4	PO2, PSO2
CO5	Examine and solve practical biomedical signal and system problems by implementing appropriate signal and image processing algorithms using MATLAB, fostering skills in noise reduction, feature extraction, and data interpretation for medical applications.	4	PO2, PSO2
CO6	Analyze and Implement appropriate signal/Image processing algorithms for practical problems involving biomedical signals and systems Using MATLAB.	4	PO2, PSO2

Syllabus

Fundamentals of Bio-medical Signals and Images: Bio-medical Signals: Introduction to biomedical signals. The Nature of Biomedical Signals, Examples of Biomedical signals: Temperature, BP, EMG, ECG and EEG, rhythmic excitation of heart, heart activity complexity. Objectives of biomedical analysis, difficulties in biomedical signal analysis. Bio-medical Images X-ray, Computerized tomography, MRI and Ultrasound image acquisition techniques. difficulties in biomedical image analysis.

Modalities, Signal Processing Methods: Digital Signal processing filtering techniques for Biomedical signals: Time domain and frequency domain techniques. Noise models, Pre-processing, High frequency noise elimination, Baseline wander removal, Powerline interference elimination, Detection of medical signals, Measures of waveform complexity / activity

Biomedical Image Enhancement Techniques: Image model, sampling and quantization, image geometry, spatial domain, and Frequency domain enhancement techniques.

Advanced Applications Wavelet decomposition of physiological signals for analysis Wavelets approach for Biomedical signal and image artefact reduction techniques.

Analyze and Implement appropriate signal/Image processing algorithms for practical problems involving biomedical signals and systems Using MATLAB.

Reference Books

- 1 Biomedical Signal Analysis , Rangaraj M Rangayyan , 2016, John Wiley and Sons .
- 2 Biomedical Signal and Image Processing , Kayvan Najarian, Robert Splinter , 2012, CRC Press Taylor & Francis Group .
- 3 Biomedical Image Analysis , Rangaraj M Rangayyan , 2005, CRC Press Taylor & Francis Group.

- 4 Biomedical Instrumentation and Measurements , Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer , 1990, Prentice Hall Inc, New Jersey. .
- 5 Handbook of Biomedical Instrumentation-Technology & Applications , R.S. Khandpur , 2014, Tata McGraw-Hill .

23BMI3202A - ADVANCED BIOMEDICAL SIGNAL PROCESSING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3202A	ADVANCED BIOMEDICAL SIGNAL PROCESSING	ABSP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify signal processing techniques, including convolution, correlation, and AI methods, to analyze, acquire, and understand various biomedical signals like EEG, ECG, and EMG.	3	PO1, PO2, PSO2
CO2	Apply filtering techniques for biomedical signals, including noise reduction with machine learning approaches, to extract meaningful data from ECG, EEG, and other signals.	3	PO2, PSO2
CO3	Identify the methods to record, analyze, and interpret various cardiac signals (ECG, PCG) and bioelectrical signals (EMG, EEG) using deep learning for advanced processing	3	PO2, PSO2
CO4	Apply advanced analysis of ECG and PCG signals for heart health assessment, including segmentation, heart rate variability, and detection of abnormalities using cutting-edge biomedical signal processing techniques.	3	PO2, PSO2
CO5	Analyze and process biomedical signals using MATLAB, covering filtering, QRS detection, HRV analysis, and exploring deep learning applications through practical exercises and projects.	4	PO2, PO5, PSO2

Syllabus

Sampling and aliasing, Signal reconstruction, Signal conversion systems, convolution - Correlation - FFT - decimation in time algorithm, Decimation in Frequency algorithm. Artificial intelligence in signal processing. Nature of biomedical signals - Examples of biomedical signals-EEG, EMG, ECG, VMG, VAG, evoked potentials, Event Related Potentials, Speech Signal, Bioacoustic signals - Objectives and Difficulties of Biomedical Signal Analysis. Deep learning in Biosignal analysis

Random Noise, Structured Noise, and Physiological Noise Time domain filtering Synchronous averaging, Moving average filters, Frequency domain filters Design of Butterworth filters optimal filtering, Machine Learning applications in signal computation. Adaptive noise cancellation LMS and RLS algorithms in adaptive filtering Application Motion Artifacts in ECG, Powerline Interference in ECG, Maternal Interference in ECG. Machine Learning applications in noise cancellation.

Cardiological Signal Processing - Methods in Recording ECG, Waves and Intervals of ECG - ECG Data Acquisition, ECG Parameters and Their Estimation - ECG QRS Detection Technique - Template Matching Technique - Differentiation Based QRS Detection Technique - Simple QRS width Detection Algorithm - High Speed QRS detection Algorithm - Estimation of R-R Interval - Estimation of ST Segment - Analysis of PCG signal - Analysis of EMG signal and EEG Signal. Deep learning for biosignal analysis.

Adaptive Segmentation of ECG and PCG signals - Time varying analysis of heart rate variability - Detection of Coronary Artery Disease - Analysis of Ectopic ECG beats, latest research work on biomedical signal processing.

Analyze and Implement appropriate signal processing algorithms for practical problems involving biomedical signals and systems Using MATLAB. Learn filtering, QRS detection, HRV, and explore deep learning applications - all through hands-on exercises and projects.

Reference Books

- 1 Biomedical Signal Analysis , Rangaraj M Rangayyan , 2016, John Wiley and Sons .
- 2 Statistical Digital signal processing , Monson H.Hayes , 1996, John Wiley and Sons .
- 3 Biomedical Signal Processing , Arnon Cohen , 2021, CRC Press .

- 4 Advanced Materials for Biomedical Applications , Ashwani Kumar, Yatika Gori, Avinash Kumar, Chandan Swaroop Meena, Nitesh Dutt , 2023, Taylor & Francis Group .

23BMI3202E - ADVANCED BIOMEDICAL SIGNAL PROCESSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3202E	ADVANCED BIOMEDICAL SIGNAL PROCESSING	ABSP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify signal processing techniques, including convolution, correlation, and AI methods, to analyze, acquire, and understand various biomedical signals like EEG, ECG, and EMG.	3	PO1, PO2, PSO2
CO2	Apply filtering techniques for biomedical signals, including noise reduction with machine learning approaches, to extract meaningful data from ECG, EEG, and other signals.	3	PO2, PSO2
CO3	Identify the methods to record, analyze, and interpret various cardiac signals (ECG, PCG) and bioelectrical signals (EMG, EEG) using deep learning for advanced processing	3	PO2, PSO2
CO4	Apply advanced analysis of ECG and PCG signals for heart health assessment, including segmentation, heart rate variability, and detection of abnormalities using cutting-edge biomedical signal processing techniques.	3	PO2, PSO2
CO5	Analyze and process biomedical signals using MATLAB, covering filtering, QRS detection, HRV analysis, and exploring deep learning applications through practical exercises and projects.	4	PO2, PO5, PSO2

Syllabus

Sampling and aliasing, Signal reconstruction, Signal conversion systems, convolution - Correlation - FFT - decimation in time algorithm, Decimation in Frequency algorithm. Artificial intelligence in signal processing. Nature of biomedical signals - Examples of biomedical signals-EEG, EMG, ECG, VMG, VAG, evoked potentials, Event Related Potentials, Speech Signal, Bioacoustic signals - Objectives and Difficulties of Biomedical Signal Analysis. Deep learning in Biosignal analysis

Random Noise, Structured Noise, and Physiological Noise Time domain filtering Synchronous averaging, Moving average filters, Frequency domain filters Design of Butterworth filters optimal filtering, Machine Learning applications in signal computation. Adaptive noise cancellation LMS and RLS algorithms in adaptive filtering Application Motion Artifacts in ECG, Powerline Interference in ECG, Maternal Interference in ECG. Machine Learning applications in noise cancellation.

Cardiological Signal Processing - Methods in Recording ECG, Waves and Intervals of ECG - ECG Data Acquisition, ECG Parameters and Their Estimation - ECG QRS Detection Technique - Template Matching Technique - Differentiation Based QRS Detection Technique - Simple QRS width Detection Algorithm - High Speed QRS detection Algorithm - Estimation of R-R Interval - Estimation of ST Segment - Analysis of PCG signal - Analysis of EMG signal and EEG Signal. Deep learning for biosignal analysis.

Adaptive Segmentation of ECG and PCG signals - Time varying analysis of heart rate variability - Detection of Coronary Artery Disease - Analysis of Ectopic ECG beats, latest research work on biomedical signal processing.

Analyze and Implement appropriate signal processing algorithms for practical problems involving biomedical signals and systems Using MATLAB. Learn filtering, QRS detection, HRV, and explore deep learning applications - all through hands-on exercises and projects.

Reference Books

- 1 Biomedical Signal Analysis , Rangaraj M Rangayyan , 2016, John Wiley and Sons .
- 2 Statistical Digital signal processing , Monson H.Hayes , 1996, John Wiley and Sons .
- 3 Biomedical Signal Processing , Arnon Cohen , 2021, CRC Press .

- 4 Advanced Materials for Biomedical Applications , Ashwani Kumar, Yatika Gori, Avinash Kumar, Chandan Swaroop Meena, Nitesh Dutt , 2023, Taylor & Francis Group .

23BMI3202R - ADVANCED BIOMEDICAL SIGNAL PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3202R	ADVANCED BIOMEDICAL SIGNAL PROCESSING	ABSP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify signal processing techniques, including convolution, correlation, and AI methods, to analyze, acquire, and understand various biomedical signals like EEG, ECG, and EMG.	3	PO1, PO2, PSO2
CO2	Apply filtering techniques for biomedical signals, including noise reduction with machine learning approaches, to extract meaningful data from ECG, EEG, and other signals.	3	PO2, PSO2
CO3	Identify the methods to record, analyze, and interpret various cardiac signals (ECG, PCG) and bioelectrical signals (EMG, EEG) using deep learning for advanced processing	3	PO2, PSO2
CO4	Apply advanced analysis of ECG and PCG signals for heart health assessment, including segmentation, heart rate variability, and detection of abnormalities using cutting-edge biomedical signal processing techniques.	3	PO2, PSO2

Syllabus

Sampling and aliasing, Signal reconstruction, Signal conversion systems, convolution - Correlation - FFT - decimation in time algorithm, Decimation in Frequency algorithm. Artificial intelligence in signal processing. Nature of biomedical signals - Examples of biomedical signals-EEG, EMG, ECG, VMG, VAG, evoked potentials, Event Related Potentials, Speech Signal, Bioacoustic signals - Objectives and Difficulties of Biomedical Signal Analysis. Deep learning in Biosignal analysis

Random Noise, Structured Noise, and Physiological Noise Time domain filtering Synchronous averaging, Moving average filters, Frequency domain filters Design of Butterworth filters optimal filtering, Machine Learning applications in signal computation. Adaptive noise cancellation LMS and RLS algorithms in adaptive filtering Application Motion Artifacts in ECG, Powerline Interference in ECG, Maternal Interference in ECG Machine Learning applications in noise cancellation.

Cardiological Signal Processing - Methods in Recording ECG, Waves and Intervals of ECG - ECG Data Acquisition, ECG Parameters and Their Estimation - ECG QRS Detection Technique - Template Matching Technique - Differentiation Based QRS Detection Technique - Simple QRS width Detection Algorithm - High Speed QRS detection Algorithm - Estimation of R-R Interval - Estimation of ST Segment - Analysis of PCG signal - Analysis of EMG signal and EEG Signal. Deep learning for biosignal analysis.

Adaptive Segmentation of ECG and PCG signals - Time varying analysis of heart rate variability - Detection of Coronary Artery Disease - Analysis of Ectopic ECG beats, latest research work on biomedical signal processing.

Reference Books

- 1 Biomedical Signal Analysis , Rangaraj M Rangayyan , 2016, John Wiley and Sons .
- 2 Statistical Digital signal processing , Monson H.Hayes , 1996, John Wiley and Sons.
- 3 Biomedical Signal Processing , Arnon Cohen , 2021, CRC Press .
- 4 Advanced Materials for Biomedical Applications , Ashwani Kumar, Yatika Gori, Avinash Kumar, Chandan Swaroop Meena, Nitesh Dutt , 2023, Taylor and Francis.

23BMI3303A - MATERIALS FOR BIO-MEDICAL APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3303A	MATERIALS FOR BIO-MEDICAL APPLICATIONS	MBMA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify biomaterials for various medical applications to organize and differentiate the characteristics of biomaterials.	3	PO1, PSO1
CO2	Organize properties and applications of polymeric and composite biomaterials used in various medical devices. Apply surface modification for biomedical applications.	3	PO2, PSO1
CO3	Apply the methods for evaluating biocompatibility and how biomaterials interact with different tissues and bodily systems. Apply Biocompatibility Testing and Response of Biomaterial to Human Body.	3	PO2, PSO1
CO4	Examine bio-implants and surgical aids used to improve a patient's health and well-being. These include implants for the heart, knees, hips, eyes, and teeth, along with materials used to suture wounds and dressings to promote healing.	4	PO2, PSO1
CO5	Analyze the design principles of biocompatible implants and artificial organs, analyze their impact on healthcare, and design their own implant using biomaterial selection and modern engineering tools for improved hard and soft tissue replacement.	4	PO2, PSO1
CO6	Classify healthcare solutions leveraging nanomaterials technology, utilizing COMSOL/OFDTD software for simulation and analysis.	4	PO2, PO5, PSO1
CO7	Interpret material suitability for biomedical applications by evaluating biocompatibility, material properties, and performance, while also analyzing the unique properties and characterization techniques of nanomaterials in the field.	5	PO2, PO5, PSO1

Syllabus

Introduction to Biomaterials: Biomaterial, Types of Biomaterials, Biocompatibility, Biological material, Biodegradable material, Bioresorbable material, Bio-inert material, Bio-active material, Pyrogenicity, Minimum Requirements of Biomaterials, Surface Properties of Biomaterials, Desirable Properties of Biomaterial, Performance of Biomaterials, Applications of Biomaterials with examples. Metallic Biomaterials: Introduction, Stainless steel, Co-Cr Alloys, Ti-Alloys, Nitinol, Dental metals, Corrosion of Metallic implants, Manufacturing of Metallic implants, Applications. Ceramic Biomaterials: Introduction, Types of Ceramics, Bio-inert ceramics: Alumina, Zirconia, Carbon, Bioresorbable ceramics: Calcium Phosphate, Bioactive ceramics: Glass ceramics, Applications.

"Polymeric & Composite Biomaterials: Polymeric Biomaterials: Introduction, Basic structures of Polymers, Polymerization and its Types, Polyethylene, Polypropylene, Polyamides, Polyacrylates, Hydrogel, Bone cement, Fluorocarbon polymers, Silicon Rubber, Bioactive Polymers, Biodegradable Polymers, Applications. Composite Biomaterials: Introduction, Dental filling Composites & cement, Porous Composites, Fibrous & Particulate composites."

Biocompatibility Testing & Response of Biomaterial to Human Body: Biocompatibility Testing: Introduction, In-Vitro Testing, In-Vivo Testing, Hypersensitivity, Haemocompatibility, Odontocompatibility, Osteocompatibility, Cytotoxicity, Genotoxicity, Carcinogenicity. Response of Biomaterial to Human Body: Blood-Biomaterial Interactions, Biomaterials-Tissue Interactions, Tissue response to Implants, Inflammation, Wound Healing, Foreign Body Response, Infection and Tumorigenesis of Biomaterials

Bio-implants & Surgical Aids: Stent, Vascular grafts, Artificial Heart valves, Inferior Vena cava filter, Contact lenses, Intra-ocular lenses, Artificial Silicon Retina, Temporary fixation Devices, Total Hip Replacement, Total Knee Replacement, Dental filling & Restoration material, Dental implants, Suture materials, Wound dressings, Tissue Adhesives.

Analyze the design of various biocompatible implants and artificial organ to develop and improve Health Care Service to serve mankind and society. Design an implant using fundamental concept and modern engineering tools to develop hard tissue and soft tissue replacement materials by suitable material selection.

Design and evaluate a solution based on nanomaterial technology for a given need in the field of healthcare and biomedical Engineering using COMSOL/OFDTD.

Evaluate to identify suitable materials for biomedical engineering, Analyze the properties of nanomaterials and characterization techniques.

Reference Books

- 1 Biomaterials , Sujata V. Bhatt , 2004, Alpha Science International Ltd .
- 2 Biomaterials Science , Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, 2012, Elsevier .
- 3 Advanced Materials for Biomedical Applications , Ashwani Kumar, Yatika Gori, Avinash Kumar, Chandan Swaroop Meena, Nitesh Dutt , 2023, Taylor & Francis Group .
- 4 Biomedical Instrumentation and Measurements , Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer , 1990, Prentice Hall Inc, New Jersey. .

23BMI3303E - MATERIALS FOR BIO-MEDICAL APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3303E	MATERIALS FOR BIO-MEDICAL APPLICATIONS	MBMA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify biomaterials for various medical applications to organize and differentiate the characteristics of biomaterials.	3	PO1, PSO1
CO2	Organize properties and applications of polymeric and composite biomaterials used in various medical devices. Apply surface modification for biomedical applications.	3	PO2, PSO1
CO3	Apply the methods for evaluating biocompatibility and how biomaterials interact with different tissues and bodily systems. Apply Biocompatibility Testing and Response of Biomaterial to Human Body.	3	PO2, PSO1
CO4	Examine bio-implants and surgical aids used to improve a patient's health and well-being. These include implants for the heart, knees, hips, eyes, and teeth, along with materials used to suture wounds and dressings to promote healing.	4	PO2, PSO1
CO5	Analyze the design principles of biocompatible implants and artificial organs, analyze their impact on healthcare, and design their own implant using biomaterial selection and modern engineering tools for improved hard and soft tissue replacement.	4	PO2, PSO1
CO6	Classify healthcare solutions leveraging nanomaterials technology, utilizing COMSOL/OFDTD software for simulation and analysis.	4	PO2, PO5, PSO1
CO7	Interpret material suitability for biomedical applications by evaluating biocompatibility, material properties, and performance, while also analyzing the unique properties and characterization techniques of nanomaterials in the field.	5	PO2, PO5, PSO1

Syllabus

Introduction to Biomaterials: Biomaterial, Types of Biomaterials, Biocompatibility, Biological material, Biodegradable material, Bioresorbable material, Bio-inert material, Bio-active material, Pyrogenicity, Minimum Requirements of Biomaterials, Surface Properties of Biomaterials, Desirable Properties of Biomaterial, Performance of Biomaterials, Applications of Biomaterials with examples. Metallic Biomaterials: Introduction, Stainless steel, Co-Cr Alloys, Ti-Alloys, Nitinol, Dental metals, Corrosion of Metallic implants, Manufacturing of Metallic implants, Applications. Ceramic Biomaterials: Introduction, Types of Ceramics, Bio-inert ceramics: Alumina, Zirconia, Carbon, Bioresorbable ceramics: Calcium Phosphate, Bioactive ceramics: Glass ceramics, Applications.

"Polymeric & Composite Biomaterials: Polymeric Biomaterials: Introduction, Basic structures of Polymers, Polymerization and its Types, Polyethylene, Polypropylene, Polyamides, Polyacrylates, Hydrogel, Bone cement, Fluorocarbon polymers, Silicon Rubber, Bioactive Polymers, Biodegradable Polymers, Applications. Composite Biomaterials: Introduction, Dental filling Composites & cement, Porous Composites, Fibrous & Particulate composites."

Biocompatibility Testing & Response of Biomaterial to Human Body: Biocompatibility Testing: Introduction, In-Vitro Testing, In-Vivo Testing, Hypersensitivity, Haemocompatibility, Odontocompatibility, Osteocompatibility, Cytotoxicity, Genotoxicity, Carcinogenicity. Response of Biomaterial to Human Body: Blood-Biomaterial Interactions, Biomaterials-Tissue Interactions, Tissue response to Implants, Inflammation, Wound Healing, Foreign Body Response, Infection and Tumorigenesis of Biomaterials

Bio-implants & Surgical Aids: Stent, Vascular grafts, Artificial Heart valves, Inferior Vena cava filter, Contact lenses, Intra-ocular lenses, Artificial Silicon Retina, Temporary fixation Devices, Total Hip Replacement, Total Knee Replacement, Dental filling & Restoration material, Dental implants, Suture materials, Wound dressings, Tissue Adhesives.

Analyze the design of various biocompatible implants and artificial organ to develop and improve Health Care Service to serve mankind and society. Design an implant using fundamental concept and modern engineering tools to develop hard tissue and soft tissue replacement materials by suitable material selection.

Design and evaluate a solution based on nanomaterial technology for a given need in the field of healthcare and biomedical Engineering using COMSOL/OFDTD.

Evaluate to identify suitable materials for biomedical engineering, Analyze the properties of nanomaterials and characterization techniques.

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- 2 Biomaterials Science , Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, 2012, Elsevier.
- 3 Advanced Materials for Biomedical Applications , Ashwani Kumar, Yatika Gori, Avinash Kumar, Chandan Swaroop Meena, Nitesh Dutt , 2023, Taylor & Francis Group .
- 4 Biomedical Signal Processing , Arnon Cohen , 2021, CRC.

23BMI3303R - MATERIALS FOR BIO-MEDICAL APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3303R	MATERIALS FOR BIO-MEDICAL APPLICATIONS	MBMA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify biomaterials for various medical applications to organize and differentiate the characteristics of biomaterials.	3	PO1, PSO1
CO2	Organize properties and applications of polymeric and composite biomaterials used in various medical devices. Apply surface modification for biomedical applications.	3	PO2, PSO1
CO3	Apply the methods for evaluating biocompatibility and how biomaterials interact with different tissues and bodily systems. Apply Biocompatibility Testing and Response of Biomaterial to Human Body.	3	PO2, PSO1
CO4	Examine bio-implants and surgical aids used to improve a patient's health and well-being. These include implants for the heart, knees, hips, eyes, and teeth, along with materials used to suture wounds and dressings to promote healing.	4	PO2, PSO1
CO5	classify healthcare solutions leveraging nanomaterials technology, utilizing COMSOL/OFDTD software for simulation and analysis.	4	PO2, PO5, PSO1
CO6	Interpret material suitability for biomedical applications by evaluating biocompatibility, material properties, and performance, while also analyzing the unique properties and characterization techniques of nanomaterials in the field.	5	PO2, PO5, PSO1

Syllabus

Introduction to Biomaterials: Biomaterial, Types of Biomaterials, Biocompatibility, Biological material, Biodegradable material, Bioresorbable material, Bio-inert material, Bio-active material, Pyrogenicity, Minimum Requirements of Biomaterials, Surface Properties of Biomaterials, Desirable Properties of Biomaterial, Performance of Biomaterials, Applications of Biomaterials with examples. Metallic Biomaterials: Introduction, Stainless steel, Co-Cr Alloys, Ti-Alloys, Nitinol, Dental metals, Corrosion of Metallic implants, Manufacturing of Metallic implants, Applications. Ceramic Biomaterials: Introduction, Types of Ceramics, Bio-inert ceramics: Alumina, Zirconia, Carbon, Bioresorbable ceramics: Calcium Phosphate, Bioactive ceramics: Glass ceramics, Applications.

"Polymeric & Composite Biomaterials: Polymeric Biomaterials: Introduction, Basic structures of Polymers, Polymerization and its Types, Polyethylene, Polypropylene, Polyamides, Polyacrylates, Hydrogel, Bone cement, Fluorocarbon polymers, Silicon Rubber, Bioactive Polymers, Biodegradable Polymers, Applications. Composite Biomaterials: Introduction, Dental filling Composites & cement, Porous Composites, Fibrous & Particulate composites."

Biocompatibility Testing & Response of Biomaterial to Human Body: Biocompatibility Testing: Introduction, In-Vitro Testing, In-Vivo Testing, Hypersensitivity, Haemocompatibility, Odontocompatibility, Osteocompatibility, Cytotoxicity, Genotoxicity, Carcinogenicity. Response of Biomaterial to Human Body: Blood-Biomaterial Interactions, Biomaterials-Tissue Interactions, Tissue response to Implants, Inflammation, Wound Healing, Foreign Body Response, Infection and Tumorigenesis of Biomaterials

Bio-implants & Surgical Aids: Stent, Vascular grafts, Artificial Heart valves, Inferior Vena cava filter, Contact lenses, Intra-ocular lenses, Artificial Silicon Retina, Temporary fixation Devices, Total Hip Replacement, Total Knee Replacement, Dental filling & Restoration material, Dental implants, Suture materials, Wound dressings, Tissue Adhesives.

Design and evaluate a solution based on nanomaterial technology for a given need in the field of healthcare and biomedical Engineering using COMSOL/OFDTD.

Evaluate to identify suitable materials for biomedical engineering, Analyze the properties of nanomaterials and characterization techniques.

Reference Books

- 1 Biomaterials , Sujata V. Bhatt , 2004, Alpha Science International Ltd .
- 2 Biomaterials Science , Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons , 2012, Elsevier .
- 3 Advanced Materials for Biomedical Applications , Ashwani Kumar, Yatika Gori, Avinash Kumar, Chandan Swaroop Meena, Nitesh Dutt , 2023, Taylor & Francis Group .
- 4 Biomedical Signal Processing , Arnon Cohen , 2021, CRC.

23BMI3404M - NANOTECHNOLOGY AND NANOSENSORS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3404M	NANOTECHNOLOGY AND NANOSENSORS	NTNS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate the miniaturized world of nanosensors, covering their fundamentals, characteristics, applications in various fields, and the technologies behind their design and functionality.	2	PO1, PSO1
CO2	Demonstrate characterization tools used in nanotechnology and explore both top-down and bottom-up fabrication techniques for creating nanoscale structures and devices. concepts of fabrication and characterization of Nanosensors.	2	PO2, PSO1
CO3	Develop nanotechnology-enabled devices, exploring how nanomaterials, bioelectronics, and miniaturized sensors are revolutionizing fields like biomedicine and gas detection.	3	PO2, PSO1
CO4	Apply unique properties of quantum dots make them powerful tools for sensing and imaging applications, exploring their synthesis and practical uses.	3	PO1, PO2, PSO1

Syllabus

Nanosensors: Introduction to sensors. Characteristics and terminology - static and dynamic characteristics. Micro and nano-sensors, Fundamentals of sensors, biosensor, micro fluids, Packaging and characterization of sensors, Sensors for aerospace and defense. Organic and inorganic nanosensors.

Introduction to Nanotechnology Characterization Tools for Nanotechnology, Fabrication in the Nano scale Top-Down Fabrication, Fabrication of Nano scale Structures and Devices Bottom Up Fabrication

Nanotechnology enabled devices: Nanomaterials and nanostructured films, Nanoscale electronic and ionic transport. Sensor for bio-medical applications. Bioelectronics, Nanoparticle biomaterial hybrid systems for sensing applications. Gas sensor.

Quantum Dots Sensor: Definition and Properties of Quantum Dots, Synthesis of Quantum Dots, Sensing, and Imaging Application with Quantum Dots

Reference Books

- 1 Chemical Sensors and Biosensors, Brian, R Eggins , 2002, Wiley .
- 2 Biosensors: A Practical Approach, J. Cooper & C. Tass, 2004, Oxford university press .
- 3 Nanomaterials for Biosensors , CS Kumar , 2007, Wiley.
- 4 Smart Biosensor Technology, G.K. Knoff, A.S. Bassi, 2006, CRC Press.

23BMI3505 - BIOSENSING AND BIOELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BMI3505	BIOSENSING AND BIOELECTRONICS	BSBE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the principles behind these sensors, their fabrication, and working mechanisms of optical biosensors. We will explore both direct and indirect detection methods, including surface plasmon resonance and electroluminescence.	2	PO2, PSO1
CO2	Explain the exciting world of piezoelectric sensors and their development, alongside applications of electrochemical sensors for detecting crucial molecules like glucose, vitamins, cholesterol, and dopamine.	2	PO2, PSO1
CO3	Apply pacemakers, defibrillators (both implantable and external), and ventilators for biomedical applications to dive into implantable stimulators for neuromuscular control, blood glucose monitoring, telemedicine practices, and the exciting world of product development in medical technology.exclamation	3	PO2, PSO1
CO4	Analyze interaction between electrolytes and semiconductors in EIS devices, and learn about various biorecognition elements used in MOSFET-based biosensors. ISFETs, enzyme FETs, and cell-based sensors, exploring their principles and applications in biodetection.	4	PO2, PO5, PSO1

Syllabus

Introduction to biosensor - Classification based on the signal transduction and biorecognition element - Enzymatic and non-enzymatic sensors - DNA and protein-based sensors - Immunosensors - Principle - Fabrication and working of optical biosensors - Direct and indirect detectors - Surface plasmon - Electroluminescence

Electrochemical biosensors - Construction and working of potentiometric - Amperometric and impedimetric sensors - Development and applications of piezoelectric sensors - Electrochemical sensors for glucose - Vitamins - Cholesterol - Dopamine - Biochips and electrochemical microarrays - Lab-on-a-chip - Biosensing using nanomaterials - Biocompatibility of sensors - PCR Principles

Implantable cardiac pacemakers - Defibrillators - External defibrillators - Clinical defibrillators - Implantable defibrillators - Implantable stimulators for neuro muscular control - Mechanical ventilation - Electrosurgical devices - Blood glucose monitoring sensors - Telemedicine - Prerecorded telemedicine - Real time telemedicine - Case study - Product development - Pulse oximeter - Ventilators

Advanced Bioelectronic devices MOS Structure, Modes of operation, Electrolyte Insulator Semiconductor EIS Structure, Site binding Theory, Electrical double layer theory. MOSFET Based Bioelectronic devices: Biosensor overview, Ion Sensitive Field Effect Transistor, Enzyme Field Effect Transistor, Chemical Field Effect Transistor, Reference Field Effect Transistor, Immune Field Effect Transistor, Organic Thin Film Transistor, Cell-Based Biosensors & Sensors of Cell Metabolism, Light Addressable Potentiometric Sensors

Reference Books

- 1 Biosensors an Introduction, Brian, R Eggins, 1996, John Wiley & Sons Publishers.
- 2 Biosensors Principles and Applications, Loic J Blum, Pierre R Coulet, 1991, Marcel Dekker, Inc.
- 3 Biosensors Theory and Applications, Donald G. Buerk, 1993, Technomic Publishing. Co, Inc.
- 4 Commercial Biosensors, Graham Ramsay, 1998, John Wiley & Sons.
- 5 Nanomaterials for Biosensors, CS Kumar, 2007, wiley.

23CCF3101A - TCP/IP & OTHER PROTOCOL SUITE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3101A	TCP/IP & OTHER PROTOCOL SUITE	TCP	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of networks understand the Architectural Evolution of TCP/IP, standards, Comparisons between OSI/ISO & TCP/IP Protocol Suite, different Addressing systems, ATM ARP ARP and their analysis	3	PO1, PO2, PSO2
CO2	Analyse DHCP Theory and Operation, DHCP Architecture, DHCP Auto-Configuration: Network Address Translation	3	PO2, PO3, PSO2
CO3	Analyse Domain Name system	3	PO2, PO3, PSO2
CO4	Analyse ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12](Error Formats)	4	PO2, PO3, PSO2
CO5	Analyse additional features in protocols suites and their applications	4	PO2, PO3, PSO2
CO6	Analyse and deployment different protocols suites using Cisco packet tracer	4	PO2, PO5, PSO2
CO7	Analyse different protocols with type values using Wireshark	4	PO2, PO5, PSO2

Syllabus

Architecture: Brief History, Protocols and Standards, Standard Organizations, Internet Standards, Internet Administration, Architectural Evolution of TCP/IP TCP/IP Protocol Suite: Comparisons between OSI/ISO & TCP/IP Protocol Suite, Layers in the TCP/IP Protocol Suite, Addressing: Physical, Logical, Port and Application Specific Address. IP Addressing: (IPv4 and IPv6): Class full, Classless, CIDR, Special and Network Address Translation (NAT) The Address Resolution Protocol : Packet Formats, Encapsulation, Operation, Proxy ARP, ARP in LAN and WANATM ARP: Packet Format

DHCP Theory of Operation: Introduction, Operation, Allocation of DHCP: Remote, Automatic and Manual.,DHCP Architecture: DHCP Client, Server, Relay Agent, Process, Designing of DHCP: Setting up DHCP In A Small Office, DHCP Auto-Configuration: DHCP Client, Server, Relay Agent, Process, Network Address Translation: Methods of Translation, NAT, NAT Traversal, Dynamic Network Address translation.

DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM [10-12] TCP: Principal, operational , Segment Structure of simplified TCP, TCP Connection Management: Connection Establishment, Transfer, Termination and Reset, Time out and Data flow (Error and Flow Control), Congestion control, (Congestion Control and avoidance algorithm(NEW Rano RFC 6582)) DNS: Distribution of Name Space and Defined Zones, DNS in Internet (Generic, Country and Reverse).

Advancement In Other Protocol Suites: ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12] ICMPv4/v6 : Datagram Structure of Internet Message Control Protocol V.4 (ICMPv4 & ICMP v6), Encapsulation in ICMPv4/v6, Common error messages in ICMPv4 Type 3 and ICMPv6 Type 1 Compare and contrast between ICMPv6 with ICMPv4.Internet Group Message Protocol (IGMP): Architecture, Versions, Messages with Access control.MLD, UDP, IP Fragmentation, IP Sec, EAP: Multicast Listener Discovery (MLD) and IGMP Windows Sockets, Extensible Authentication Protocol (EAP) standards and Mechanisms (IEEE 802.11, IEEE 802.1x)

Advanced Topics: ATM ARP Operation, Logical IP Subnet ARP Package: Catch Table, Queues, Input Output Module, Multi Protocol Over ATM (MPOA), NAT in IPv6, NAT in PIX ,Google Cloud NAT Architectural View, Dynamic Domain Name System, DNS Security, TLS algorithm (Transport Layer), Position of UDP in the TCP/IP protocol suite, User Datagram format, Basics of IP Fragmentation, Reassemble Header Format of IP Fragmentation, TCP Segmentation, Difference Between IP Fragmentation and TCP Segmentation

Reference Books

- 1 TCP/IP Protocol Suite, Behrouz A.Ferouzan, 2009, Mc-Graw Hill.
- 2 The DHCP Handbook, Ralph Droms, and Ted Lemon, 2003, Pearson.
- 3 An Integrated Approach to Computer Networks, Bhavneet Sidhu, 2019, Khanna Publications.
- 4 Engineering Approach To Computer Networking, Srinivasan Keshav, 2002, Pearson Education(AICTE).

23CCF3101E - TCP/IP & OTHER PROTOCOL SUITE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3101E	TCP/IP & OTHER PROTOCOL SUITE	TCP	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of networks understand the Architectural Evolution of TCP/IP, standards, Comparisons between OSI/ISO & TCP/IP Protocol Suite, different Addressing systems, ATM ARP ARP and their analysis	3	PO1, PO2, PSO2
CO2	Analyse DHCP Theory and Operation, DHCP Architecture, DHCP Auto-Configuration: Network Address Translation	3	PO2, PO3, PSO2
CO3	Analyse Domain Name system	3	PO2, PO3, PSO2
CO4	Analyse ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12](Error Formats)	4	PO2, PO3, PSO2
CO5	Analyse additional features in protocols suites and their applications	4	PO2, PO3, PSO2
CO6	Analyse and deployment different protocols suites using Cisco packet tracer	4	PO2, PO5, PSO2
CO7	Analyse different protocols with type values using Wireshark	4	PO2, PO5, PSO2

Syllabus

Architecture: Brief History, Protocols and Standards, Standard Organizations, Internet Standards, Internet Administration, Architectural Evolution of TCP/IP TCP/IP Protocol Suite: Comparisons between OSI/ISO & TCP/IP Protocol Suite, Layers in the TCP/IP Protocol Suite, Addressing: Physical, Logical, Port and Application Specific Address. IP Addressing: (IPv4 and IPv6): Class full, Classless, CIDR, Special and Network Address Translation (NAT) The Address Resolution Protocol : Packet Formats, Encapsulation, Operation, Proxy ARP, ARP in LAN and WANATM ARP: Packet Format

DHCP Theory of Operation: Introduction, Operation, Allocation of DHCP: Remote, Automatic and Manual.,DHCP Architecture: DHCP Client, Server, Relay Agent, Process, Designing of DHCP: Setting up DHCP In A Small Office, DHCP Auto-Configuration: DHCP Client, Server, Relay Agent, Process, Network Address Translation: Methods of Translation, NAT, NAT Traversal, Dynamic Network Address translation.

DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM [10-12] TCP: Principal, operational , Segment Structure of simplified TCP, TCP Connection Management: Connection Establishment, Transfer, Termination and Reset, Time out and Data flow (Error and Flow Control), Congestion control, (Congestion Control and avoidance algorithm(NEW Rano RFC 6582)) DNS: Distribution of Name Space and Defined Zones, DNS in Internet (Generic, Country and Reverse)

Advancement In Other Protocol Suites: ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12] ICMPv4/v6 : Datagram Structure of Internet Message Control Protocol V.4 (ICMPv4 & ICMP v6), Encapsulation in ICMPv4/v6, Common error messages in ICMPv4 Type 3 and ICMPv6 Type 1 Compare and contrast between ICMPv6 with ICMPv4.Internet Group Message Protocol (IGMP): Architecture, Versions, Messages with Access control.MLD, UDP, IP Fragmentation, IP Sec, EAP: Multicast Listener Discovery (MLD) and IGMP Windows Sockets, Extensible Authentication Protocol (EAP) standards and Mechanisms (IEEE 802.11, IEEE 802.1x)

Advanced Topics: ATM ARP Operation, Logical IP Subnet ARP Package: Catch Table, Queues, Input Output Module, Multi Protocol Over ATM (MPOA), NAT in IPv6, NAT in PIX ,Google Cloud NAT Architectural View, Dynamic Domain Name System, DNS Security, TLS algorithm (Transport Layer), Position of UDP in the TCP/IP protocol suite, User Datagram format, Basics of IP Fragmentation, Reassemble Header Format of IP Fragmentation, TCP Segmentation, Difference Between IP Fragmentation and TCP Segmentation

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- 2 The DHCP Handbook, Ralph Droms, and Ted Lemon, 2003, Pearson.
- 3 An Integrated Approach to Computer Networks, Bhavneet Sidhu, 2019, Khanna Publications.
- 4 Engineering Approach To Computer Networking, Srinivasan Keshav, 2002, Pearson Education(AICTE).

23CCF3101R - TCP/IP & OTHER PROTOCOL SUITE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3101R	TCP/IP & OTHER PROTOCOL SUITE	TCP	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	The Architectural Evolution of TCP/IP, standards, Comparisons between OSI/ISO & TCP/IP Protocol Suite, different Addressing systems, ATM ARP ARP and their analysis	3	PO1, PO2, PSO2
CO2	Analyse DHCP Theory and Operation, DHCP Architecture, DHCP Auto-Configuration: Network Address Translation	3	PO2, PO3, PSO2
CO3	Analyse Domain Name system	3	PO2, PO3, PSO2
CO4	Analyse ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12](Error Formats)	4	PO2, PO3, PSO2
CO5	Analyse and deployment different protocols suites using Cisco packet tracer	4	PO2, PO5, PSO2
CO6	Analyse different protocols with type values using Wireshark	4	PO2, PO5, PSO2

Syllabus

Architecture: Brief History, Protocols and Standards, Standard Organizations, Internet Standards, Internet Administration, Architectural Evolution of TCP/IP TCP/IP Protocol Suite: Comparisons between OSI/ISO & TCP/IP Protocol Suite, Layers in the TCP/IP Protocol Suite, Addressing: Physical, Logical, Port and Application Specific Address. IP Addressing: (IPv4 and IPv6): Class full, Classless, CIDR, Special and Network Address Translation (NAT) The Address Resolution Protocol : Packet Formats, Encapsulation, Operation, Proxy ARP, ARP in LAN and WANATM ARP: Packet Format

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DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM [10-12] TCP: Principal, operational , Segment Structure of simplified TCP, TCP Connection Management: Connection Establishment, Transfer, Termination and Reset, Time out and Data flow (Error and Flow Control), Congestion control, (Congestion Control and avoidance algorithm(NEW Rano RFC 6582)) DNS: Distribution of Name Space and Defined Zones, DNS in Internet (Generic, Country and Reverse).

Advancement In Other Protocol Suites: ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12] ICMPv4/v6 : Datagram Structure of Internet Message Control Protocol V.4 (ICMPv4 & ICMP v6), Encapsulation in ICMPv4/v6, Common error messages in ICMPv4 Type 3 and ICMPv6 Type 1 Compare and contrast between ICMPv6 with ICMPv4.Internet Group Message Protocol (IGMP): Architecture, Versions, Messages with Access control.MLD, UDP, IP Fragmentation, IP Sec, EAP: Multicast Listener Discovery (MLD) and IGMP Windows Sockets, Extensible Authentication Protocol (EAP) standards and Mechanisms (IEEE 802.11, IEEE 802.1x)

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- 2 The DHCP Handbook, Ralph Droms, and Ted Lemon, 2003, Pearson.
- 3 An Integrated Approach to Computer Networks, Bhavneet Sidhu, 2019, Khanna Publications.

- 4 Engineering Approach To Computer Networking, Srinivasan Keshav, 2002, Pearson Education(AICTE).

23CCF3202A - CLOUD COMPUTING AND NETWORKS SECURITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3202A	CLOUD COMPUTING AND NETWORKS SECURITY	CCNS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of Cloud computing in Networking	3	PO1, PO2, PSO2
CO2	Able to analyse different Topologies and Architecture standards	3	PO2, PO3, PSO2
CO3	Analysis of various Network Security issues	4	PO2, PO3, PSO2
CO4	Inspect the privacy and security, architecture, design in Edge computing	4	PO2, PO3, PSO2
CO5	Apply security concepts in cloud computing	3	PO2, PO5, PSO2

Syllabus

Introduction to Cloud Networking: Computer Networks, Cloud Networks, Cloud Data Centres, Virtualization: Cloud computing at a glance, Historical developments, Building cloud computing environments, Principles of parallel and distributed computing, Virtualization: Characteristics, Taxonomy of virtualization, Pros and Cons of Virtualization, Technology examples, Cloud Computing Architecture.

Cloud based Big-Data Computing: SW Fabric Arch., Topologies, Cloud Data Center Networks and Standards: Cloud data centre blueprint architecture-overview, Components, Cloud data centre reference design.

Applications of Cloud-Computing & Security: Cloud Data & IoTs, Network Virtualization, Data Centre Security: Securing the Infrastructure, Perimeter Router Security, IOS Firewalls, IP Security: in brief

Topics in Network Security: Wireless Security, QoS, Multicast, Web-DNS Security, Intrusion Detn, DHT Sec]: Wireless network overview: Signal Propagation, SNR, Modulation, Wireless Groups, Risks and Threats of Wireless, Analysis, Spoofing, Denial of service, Malicious Code, Social Engineering, Rogue Access Points, Cell Phone Security, Wireless Hacking and Hackers, RFID, Web-DNS Security: Overview of DNS, Fundamentals of DNS, DNS Transactions, Threats to the DNS, DNSSEC[RFC 2535], Security aware DNS Servers, Security Aware Clients, Intrusion Detection, DHT Security

Edge computing: Architecture and design, Security and privacy, Latency and bandwidth, Cost, Performance, Scalability, Deployment, Privacy and security based on Cloud based big-data computing: Data encryption, Access control, Data anonymization, Data isolation, Data governance, Data breach response.

Reference Books

- 1 Mastering Cloud Computing Fundamentals and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi,, 2013, Bailey.
- 2 Juniper Networks, Cloud Data Center Architecture Guide, 2023, Juniper.
- 3 Domain Name System (DNS) Security, Davidowicz, 2023, Taylor Fransis.
- 4 Cloud Computing for Enterprise Architectures, Zaigham Mahmood, Richard Hill, 2011, Springer.
- 5 Cryptography & Network Security, Debdeep Mukhopadhyay, Behrouz A Forouzan, 2017, Mc Graw Hill.

23CCF3202E - CLOUD COMPUTING AND NETWORKS SECURITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3202E	CLOUD COMPUTING AND NETWORKS SECURITY	CCNS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of Cloud computing in Networking	3	PO1, PO2, PSO2
CO2	Able to analyse different Topologies and Architecture standards	3	PO2, PO3, PSO2
CO3	Apply security concepts in cloud computing	3	PO2, PO3, PSO2
CO4	Analysis of various Network Security issues	4	PO2, PO3, PSO2
CO5	Inspect the privacy and security, architecture, design in Edge computing	4	PO2, PO5, PSO2

Syllabus

Introduction to Cloud Networking: Computer Networks, Cloud Networks, Cloud Data Centres, Virtualization: Cloud computing at a glance, Historical developments, Building cloud computing environments, Principles of parallel and distributed computing, Virtualization: Characteristics, Taxonomy of virtualization, Pros and Cons of Virtualization, Technology examples, Cloud Computing Architecture.

Cloud based Big-Data Computing: SW Fabric Arch., Topologies, Cloud Data Center Networks and Standards: Cloud data centre blueprint architecture-overview, Components, Cloud data centre reference design.

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Topics in Network Security: Wireless Security, QoS, Multicast, Web-DNS Security, Intrusion Detn, DHT Sec]: Wireless network overview: Signal Propagation, SNR, Modulation, Wireless Groups, Risks and Threats of Wireless, Analysis, Spoofing, Denial of service, Malicious Code, Social Engineering, Rogue Access Points, Cell Phone Security, Wireless Hacking and Hackers, RFID, Web-DNS Security: Overview of DNS, Fundamentals of DNS, DNS Transactions, Threats to the DNS, DNSSEC[RFC 2535], Security aware DNS Servers, Security Aware Clients, Intrusion Detection, DHT Security

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- 2 Juniper Networks, Cloud Data Center Architecture Guide, 2023, Juniper.
- 3 Domain Name System (DNS) Security, Davidowicz, 2023, Taylor Fransis.
- 4 Cloud Computing for Enterprise Architectures, Zaigham Mahmood, Richard Hill, 2011, Springer.
- 5 Cryptography & Network Security, Debdeep Mukhopadhyay, Behrouz A Forouzan, 2007, Mc Graw Hill.

23CCF3202R - CLOUD COMPUTING AND NETWORKS SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3202R	CLOUD COMPUTING AND NETWORKS SECURITY	CCNS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of Cloud computing in Networking	3	PO1, PO2, PSO2
CO2	Able to analyse different Topologies and Architecture standards	3	PO2, PO3, PSO2
CO3	Analysis of various Network Security issues	4	PO2, PO3, PSO2
CO4	Inspect the privacy and security, architecture, design in Edge computing	4	PO2, PO3, PSO2
CO5	Apply security concepts in cloud computing	3	PO2, PO5, PSO2

Syllabus

Introduction to Cloud Networking: Computer Networks, Cloud Networks, Cloud Data Centres, Virtualization: Cloud computing at a glance, Historical developments, Building cloud computing environments, Principles of parallel and distributed computing, Virtualization: Characteristics, Taxonomy of virtualization, Pros and Cons of Virtualization, Technology examples, Cloud Computing Architecture.

Cloud based Big-Data Computing: SW Fabric Arch., Topologies, Cloud Data Center Networks and Standards: Cloud data centre blueprint architecture-overview, Components, Cloud data centre reference design.

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Edge computing: Architecture and design, Security and privacy, Latency and bandwidth, Cost, Performance, Scalability, Deployment, Privacy and security based on Cloud based big-data computing: Data encryption, Access control, Data anonymization, Data isolation, Data governance, Data breach response.

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- 2 Domain Name System (DNS) Security, Davidowicz, 2023, Taylor Fransis.
- 3 Cloud Computing for Enterprise Architectures, Zaigham Mahmood, Richard Hill, 2011, Springer.
- 4 Cryptography & Network Security, Debdeep Mukhopadhyay, Behrouz A Forouzan, 2007, Mc Graw Hill.

23CCF3303A - VOIP AND BROADBAND NETWORKS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3303A	VOIP AND BROADBAND NETWORKS	VCN	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Classical Telephony, IP Networking and SS7 signalling	3	PO1, PO2, PSO2
CO2	Analyze different VoIP Architectures and Protocols	3	PO1, PO2, PSO2
CO3	Analyze Broadband Wireless, Access Technologies, Passive Optical Networks and Fiber-to-the-Home in real time scenario	4	PO1, PO2, PSO2
CO4	Analyze Broadband Optical NWs and Multimedia Network-Connection	4	PO1, PO2, PSO2
CO5	Analyze the signalling and calling procedures for VoIP protocols. Apply the advanced broadband access technologies in real time scenario	4	PO1, PO2, PO5, PSO2
CO6	Analysis of VoIP Protocols using Cisco packet tracer	4	PO2, PO5, PSO2
CO7	Analysis of VoIP Protocols using Wireshark	4	PO2, PO5, PSO2

Syllabus

Classical Telephony: Line Side/Trunk Side switching, Isochronous Transport, PSTN Signalling, PCM, digital channel & bandwidth constraints, SS7, Services. IP Networking Review (simple): Protocol layering, encapsulation, Ethernet, QoS at layer 2, IP, UDP, TCP, IP Addressing (network, subnet, NAT), IP Routing (RIP, OSPF).

Overview of VoIP Architectures and Protocols: Peer protocols (SIP, H323): signalling, call routing, Master-slave protocols (MGCP/MEGACO et.al.): signalling, call routing, SS7 Transport (SIP-T), RTP and Codecs, RTP and RTCP: real time traffic over ip (rfc 1789), Codecs (compression, bandwidth, quality), Waveform codecs (G711, G726), CLEP codecs (G729, G723, etc.), Bandwidth control (VAD, dynamic packing, etc.). SIP: Signalling Protocol Components (RFC 3261), SIP language elements, call flows, Network routing: Proxies, Servers, Services, Advanced Routing, Presence/Chat, SIMPLE, ENUM, DNS, Firewalls, NAT and STUN. Network QoS and QoS Mechanisms (DFWQ, MPLS)

Broadband Access Technologies: An Overview of Broadband Services and Emerging Technologies, Broadband Passive Optical Networks: PON Architectures-PON Standards History and Deployment-Broadband PON- Ethernet PON- next-generation broadband optical Access networks. Fibre-to-the-Home (FTTH), DOCSIS 3.1/3.1+, G.fast, Satellite Broadband, Hybrid Fibre-Coaxial (HFC) Networks, Software-Defined Networking (SDN), Network Function Virtualization (NFV),

Broadband Optical NWs and Broadband and Multimedia: Broadband optical Access Introduction, Evolution of optical technology, Trends in Broadband Services, Optical Broad band services, Fibre to neighbourhood (FTTX) Architecture, ITU-T PON standards, PON Technology background, Multimedia Network-Connection and Communication Mechanism.

Advance topics: Advanced Topics: Message types in SS7, Signaling Points for SS7, Signaling Network architecture, Error handling and Alarm Management, Supplementary Services of SS7, Global Title Translation (GTT), Advanced topics: WebRTC (Web Real-Time Communication), SRTP (Secure Real-time Transport Protocol), SIP Enhancements, VoIP Interoperability, VoIP Quality of Service (QoS) Quality of Service (QoS), Adaptive Streaming, Content Delivery Networks (CDNs), Virtual and Augmented Reality (VR/AR), Ultra-High-Definition (UHD) Content, Security and Digital Rights Management (DRM), Interactive Multimedia Services,

Reference Books

- 1 Internet Communications Using SIP,2006, Henry Sinnreich and Alan Johnston, 2, Willey.
- 2 IP Telephony Deploying Voice-over-IP Protocols,2005, Oliver Hersent, Jean-Pierre Petit, and David Gurle, 3, Willey.
- 3 Understanding Session Internet Protocol(SIP),2015, Alan.B. Jhonston, 4, Artech House.
- 4 Broadband Optical access Networks,2011, Leonid G. Kazovsky,Ning Cheng,Wei-Tao Shaw, 1, Willey.
- 5 VoIP Technology: Applications and Challenges,2019, Chinlon Lin, 1, Springer Series in Wireless Technology.
- 6 VoIP - Wireless P2P and New Enterprise Voice Over IP Hardcover,2008, Tamal Chakraborty , Iti Saha Misra, Ramjee Prasad, 3, John willey and Sons.

23CCF3303E - VOIP AND BROADBAND NETWORKS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3303E	VOIP AND BROADBAND NETWORKS	VBN	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Classical Telephony, IP Networking and SS7 signalling	3	PO1, PO2, PSO2
CO2	Analyze different VoIP Architectures and Protocols	3	PO1, PO2, PSO2
CO3	Analyze Broadband Wireless, Access Technologies, Passive Optical Networks and Fiber-to-the-Home in real time scenario	4	PO1, PO2, PSO2
CO4	Analyze Broadband Optical NWs and Multimedia Network-Connection	4	PO1, PO2, PSO2
CO5	Analyze the signalling and calling procedures for VoIP protocols. Apply the advanced broadband access technologies in real time scenario	4	PO1, PO2, PSO2
CO6	Analysis of VoIP Protocols using Cisco packet tracer	4	PO2, PO5, PSO2
CO7	Analysis of VoIP Protocols using Wireshark	4	PO2, PO5, PSO2

Syllabus

Classical Telephony: Line Side/Trunk Side switching, Isochronous Transport, PSTN Signaling ,PCM, digital channel & bandwidth constraints,SS7,Services.IP

Overview of VoIP Architectures and Protocols: Peer protocols (SIP, H323): signaling, call routing, Master-slave protocols (MGCP/Megaco et.al.): signaling, call routing, SS7 Transport (SIP-T), RTP and Codecs, RTP and RTCP: real time traffic over ip (rfc 1789), Codecs (compression, bandwidth, quality), Waveform codecs (G711, G726), CLEP codecs (G729, G723, etc.), Bandwidth control (VAD, dynamic packing, etc.). SIP: Signaling Protocol Components (RFC 3261),SIP language elements, call flows,, Network routing: Proxies, Servers, Services, Advanced Routing, Presence/Chat, SIMPLE, ENUM, DNS, Firewalls, NAT and STUN. Network QoS and QoS Mechanisms (DFWQ, MPLS)

Broadband Access Technologies: An Overview of Broadband Services and Emerging Technologies, Broadband Passive Optical Networks: PON Architectures-PON Standards History and Deployment-Broadband PON- Ethernet PON- next-generation broadband optical Access networks. Fiber-to-the-Home (FTTH), DOCSIS 3.1/3.1+, G.fast, Satellite Broadband, Hybrid Fiber-Coaxial (HFC) Networks, Software-Defined Networking (SDN), Network Function Virtualization (NFV),

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Advance topics: Advanced Topics: Message types in SS7, Signaling Points for SS7, Signaling Network architecture, Error handling and Alarm Management, Supplementary Services of SS7, Global Title Translation (GTT), Advanced topics: WebRTC (Web Real-Time Communication), SRTP (Secure Real-time Transport Protocol), SIP Enhancements, VoIP Interoperability, VoIP Quality of Service (QoS) Quality of Service (QoS), Adaptive Streaming, Content Delivery Networks (CDNs), Virtual and Augmented Reality (VR/AR), Ultra-High-Definition (UHD) Content, Security and Digital Rights Management (DRM), Interactive Multimedia Services,

Reference Books

- 1 Internet Communications Using SIP,2006, Henry Sinnreich and Alan Johnston, 2, Willey.

- 2 IP Telephony Deploying Voice-over-IP Protocols,2005, Oliver Hersent, Jean-Pierre Petit, and David Gurle, 3, Willey.
- 3 Understanding Session Internet Protocol(SIP),2015, Alan.B. Jhonston, 4, Artech House.
- 4 Broadband Optical access Networks,2011, Leonid G. Kazovsky,Ning Cheng,Wei-Tao Shaw, 1, Willey.
- 5 VoIP Technology: Applications and Challenges,2019, Chinlon Lin, 1, Springer Series in Wireless Technology.

23CCF3303R - VOIP AND BROADBAND NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3303R	VOIP AND BROADBAND NETWORKS	VCN	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Classical Telephony, IP Networking and SS7 signalling	3	PO1, PO2, PSO2
CO2	Analyse different VoIP Architectures and Protocols	3	PO1, PO2, PO3, PSO2
CO3	Analyse Broadband Wireless, Access Technologies, Passive Optical Networks and Fiber-to-the-Home in real time scenario	3	PO1, PO2, PO3, PSO2
CO4	Analyse Broadband Optical NWs and Multimedia Network-Connection	4	PO1, PO2, PSO2
CO5	Analyze the signalling and calling procedures for VoIP protocols. Apply the advanced broadband access technologies in real time scenario	4	PO2, PO5, PSO2
CO6	Analyze VoIP systems with a focus on protocols like SIP and RTP, ensuring effective communication and integration within existing network infrastructures.	4	PO2, PO5, PSO2

Syllabus

Classical Telephony: Line Side/Trunk Side switching, Isochronous Transport, PSTN Signalling, PCM, digital channel & bandwidth constraints, SS7, Services. IP Networking Review (simple): Protocol layering, encapsulation, Ethernet, QoS at layer 2, IP, UDP, TCP, IP Addressing (network, subnet, NAT), IP Routing (RIP, OSPF).

Overview of VoIP Architectures and Protocols: Peer protocols (SIP, H323): signalling, call routing, Master-slave protocols (MGCP/MEGACO et.al.): signalling, call routing, SS7 Transport (SIP-T), RTP and Codecs, RTP and RTCP: real time traffic over ip (rfc 1789), Codecs (compression, bandwidth, quality), Waveform codecs (G711, G726), CLEP codecs (G729, G723, etc.), Bandwidth control (VAD, dynamic packing, etc.). SIP: Signalling Protocol Components (RFC 3261), SIP language elements, call flows,, Network routing: Proxies, Servers, Services, Advanced Routing, Presence/Chat, SIMPLE, ENUM, DNS, Firewalls, NAT and STUN. Network QoS and QoS Mechanisms (DFWQ, MPLS)

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Broadband Optical NWs and Broadband and Multimedia: Broadband optical Access Introduction, Evolution of optical technology, Trends in Broadband Services, Optical Broad band services, Fibre to neighbourhood (FTTX) Architecture, ITU-T PON standards, PON Technology background, Multimedia Network-Connection and Communication Mechanism.

Reference Books

- 1 Internet Communications Using SIP, 2006, Henry Sinnreich and Alan Johnston, 2, Willey.
- 2 IP Telephony Deploying Voice-over-IP Protocols., 2005, Oliver Hersent, Jean-Pierre Petit, and David Gurle, 3, Willey.
- 3 SIP: Understanding the Session Initiation Protocol , 2015, Alan B. Johnston, 4, Artech House Telecommunications Library.
- 4 Broadband Optical Access Networks, 2011, Leonid G. Kazovsky, Ning Cheng, Wei-Tao Shaw, David Gutierrez, Shing-Wa Wong, 1, Willey.

- 5 VoIP Technology: Applications and Challenges,2019, Chinton Lin, 1, Springer Series in Wireless Technology.
- 6 VoIP - Wireless P2P and New Enterprise Voice Over IP Hardcover,2008, Tamal Chakraborty , Iti Saha Misra, Ramjee Prasad, 1, John Willey and Sons.

23CCF3404M - 5G MOBILE AND IEEE STANDARDS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3404M	5G MOBILE AND IEEE STANDARDS	5GMI	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of 5G & RF Front-End, advancement over LTE Beyond 4G, building Blocks of 5G, 5G Architecture, 5G for IoT Apps in modern communication issues.	3	PO1, PO2, PO3, PSO2
CO2	Apply the principles of advanced waveforms and air interfaces, 5G Waveforms, Channels, Millimeter wave technology, 5G Radio Access Technologies.	3	PO1, PO2, PO3, PSO2
CO3	Apply 5G Evaluation & Applications: MTC, D2D Communication, Multi-hop D2D, Multi-carrier D2D	3	PO1, PO2, PO3, PSO2
CO4	Analyze IEEE802Std: 802.11 (WiFi), 802.15.1 (Bluetooth), 802.15.4 (Zigbee), 802.16 (WiMax), 4G/5G	4	PO1, PO2, PO3, PSO2

Syllabus

RF Front-End: Key components and technologies for transmitting and receiving RF signals in 5G. Advancement over LTE: 5G offers superior speed, lower latency, and enhanced performance compared to LTE. Building Blocks: Core 5G technologies include small cells, beamforming, and network slicing. 5G Architecture: New network elements and their roles in delivering advanced services. 5G for IoT Apps: Enhances IoT connectivity and data throughput, solving modern communication challenges.

5G Waveforms, Channels, Millimeter Wave Communications: Spectrum and regulations, Channel propagations, Hardware technologies for mmW systems, Development scenario, Architecture and mobility, Beamforming, Physical layer techniques. 5G wireless propagation channel models: Modelling requirements and scenarios - The METIS channel models. Joint Transmission CoMP enablers - Distributed cooperative transmission - JT CoMP with advanced receivers - Relaying and network coding in 5G: Multi-flow wireless backhauling - Bufferaided relaying.

MTC (Machine-Type Communication): Facilitates communication between machines and IoT devices for automation. D2D Communication (Device-to-Device): Enables direct device communication, enhancing efficiency and reducing latency. Multi-hop D2D: Relays data through multiple devices to improve coverage and reliability. Multi-carrier D2D: Uses multiple carriers to boost data rates and optimize spectrum usage.

IEEE 802.11 (WiFi): Standards for WLANs; different WiFi generations and their effects on wireless communication. IEEE 802.15.1 (Bluetooth): Short-range wireless communication; applications and advancements in Bluetooth technology. IEEE 802.15.4 (Zigbee): Low-power, low-data-rate communication; used in sensor networks and IoT. IEEE 802.16 (WiMax): Broadband wireless access; performance and use cases of the WiMax standard. 4G/5G: Standards for 4th and 5th generation cellular networks; comparison of features, capabilities, and advancements.

Reference Books

- 1 Fundamentals of 5G Mobile Networks, , Jonathan Rodriguez, 1st Edition. , 1st Edition., SPRINGER .
- 2 5G Mobile Communications, , Xiang, Kan Zheng, Xuemin (Sherman) Shen , 1ST Edition., SPRINGER .
- 3 5G Mobile and Wireless Communications Technology, , Afif Osseiran, Jose F. Monserrat and Patrick Marsch , 1ST Edition., Cambridge University Press, 2016. .
- 4 Cloud Computing: Theory and Practice , Dan C. Marinescu , 1st Edition., ELSEVIER .
- 5 Mobile and Wireless Communications , Sanjai Sharma , 1st Edition., SK Kataria and Sons .

23CCF3505 - IP MULTIMEDIA SUB-SYSTEM & EMERGING TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3505	IP MULTIMEDIA SUB-SYSTEM & EMERGING TECHNOLOGIES	IMSET	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the basics of network threats and attacks in in Security monitoring and incident response	3	PO1, PO2, PO3
CO2	Analyze cryptography algorithms and HMAC & CMAC: SHA -1 Algorithm.	4	PO1, PO2, PO3
CO3	Analyse differeent Network authentication Protocols	4	PO1, PO2, PO3
CO4	Analyze Network security Protocols and technologies	4	PO1, PO2, PO3

Syllabus

"CO1: Introduction, network threats and attacks The CIA Triad, Common terms and their definitions: Perimeter security, Access control, Security monitoring and incident response, Security awareness and training, Regular updates and patch management, Backup and disaster recovery. Vulnerabilities, Exploit, Threat, Attack, Ransomware, Hacker, Malware and their types, Network attacks: DNS Cache poisoning , DDoS, Man-in-the-middle(session and coolie hijacking), Rouge AP, The ping Dearth, Ping Flood, Syc Flood, Client-side attacks. Cross-site scripting attacks(XSS), Injection attacks, Password attacks, Captcha and Social engineering attacks, Phishing, spoofing."

"CO2: Cryptography Cryptography: Basics, symmetric and asymmetric cryptography, Transpositional ciphers, substitutional ciphers. Principles, public key cryptography algorithms, Blowfish, CAST-128, IDEA, RSA Algorithms, Diffie Hellman Key E-change, decryption, Elliptic Curve Cryptography. HMAC & CMAC: SHA -1 Algorithm. User Authentication, Transport Layer Security &Email Security User"

"CO3: Network authentication Protocols: Kerberos, LDAP, OAuth 2.0, Remote authentication dial-in user service(RADIUS), SAML, Challenge -Handshake Authentication (CHAP), DIAMETER, Extensible authentication protocol, Password authentication, TACACS. Network security monitoring and incident practice: Intrusion Detection and Prevention, Log Analysis and event correlation, Incident response planning and procedures, Forensic analysis, and incident handling"

"CO4: Network security Protocols and technologies: Secure Socket layer, Transport Layer security, IPsec: Overview IP Security Architecture Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management, Virtual Private Networks, Intrusion Detection systems, Firewalls, Anti-malware/Antivirus software, Network Access control, Secure Shell (SSH), Domain Name systems: (DNSSEC), Digitally signing DNS data, Mitigating DNS spoofing, Wireless security: WPA/WPA2/WPA3, IEEE802.1X"

Reference Books

- 1 The IMS: IP Multimedia Concepts and Services , Miikka Poikselka, Georg Mayer , 3rd Edition, , Wiley .
- 2 The IP Multimedia Subsystem (IMS): Session Control and Other Network Operations, , Travis Russell , 2nd Edition, , McGraw-Hill .
- 3 System Engineering for IMS Networks , Arun Handa , ., Elsevier Science .
- 4 The 3G IP Multimedia Subsystem (IMS): Merging the Internet and the Cellular Worlds, Gonzalo Camarillo, Miguel A., 3rd Edition, Wiley.
- 5 The IMS: IP Multimedia Concepts And Services, Miikka Poikselka, Georg Mayer, Hisham Khartabil, Aki Niemi, 2nd Edition, Wiley.

23CCF3506 - IT SECURITY: DEFENCE AGAINST THE DIGITAL DARK ARTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CCF3506	IT SECURITY: DEFENCE AGAINST THE DIGITAL DARK ARTS	IMSET	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the basics of network threats and attacks in in Security monitoring and incident response	3	PO1, PO2, PO3, PSO1
CO2	Analyze cryptography algorithms and HMAC & CMAC: SHA -1 Algorithm.	4	PO1, PO2, PO3, PSO1
CO3	Analyse differeent Network authentication Protocols	4	PO1, PO2, PO3, PSO1
CO4	Analyze Network security Protocols and technologies	4	PO1, PO2, PO3, PSO1

Syllabus

"CO1: Introduction, network threats and attacks The CIA Triad, Common terms and their definitions: Perimeter security, Access control, Security monitoring and incident response, Security awareness and training, Regular updates and patch management, Backup and disaster recovery. Vulnerabilities, Exploit, Threat, Attack, Ransomware, Hacker, Malware and their types, Network attacks: DNS Cache poisoning , DDoS, Man-in-the-middle(session and cookie hijacking), Rouge AP, The ping Dearth, Ping Flood, Syc Flood, Client-side attacks. Cross-site scripting attacks(XSS), Injection attacks, Password attacks, Captcha and Social engineering attacks, Phishing, spoofing."

"CO2: Cryptography Cryptography: Basics, symmetric and asymmetric cryptography, Transpositional ciphers, substitutional ciphers. Principles, public key cryptography algorithms, Blowfish, CAST-128, IDEA, RSA Algorithms, Diffie Hellman Key E-change, decryption, Elliptic Curve Cryptography. HMAC & CMAC: SHA -1 Algorithm. User Authentication, Transport Layer Security & Email Security User"

"CO3: Network authentication Protocols: Kerberos, LDAP, OAuth 2.0, Remote authentication dial-in user service(RADIUS), SAML, Challenge -Handshake Authentication (CHAP), DIAMETER, Extensible authentication protocol, Password authentication, TACACS. Network security monitoring and incident practice: Intrusion Detection and Prevention, Log Analysis and event correlation, Incident response planning and procedures, Forensic analysis, and incident handling"

"CO4: Network security Protocols and technologies: Secure Socket layer, Transport Layer security, IPsec: Overview IP Security Architecture Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management, Virtual Private Networks, Intrusion Detection systems, Firewalls, Anti-malware/Antivirus software, Network Access control, Secure Shell (SSH), Domain Name systems: (DNSSEC), Digitally signing DNS data, Mitigating DNS spoofing, Wireless security: WPA/WPA2/WPA3, IEEE802.1X"

Reference Books

- 1 Cryptography and Network Security - Principles and Practice: William Stallings, , William Stallings , 6th , Pearson Education .
- 2 Cryptography and Network Security: , Atul Kahate , 3rd , Mc Graw Hill .
- 3 Network And Application Security Fundamentals and Practices , Debashis Gnaguly and Shibamouli Lahiri , ., Science Publishers Jersey, British Isles Enfield, New Hampshire .
- 4 Network Security Essentials: Applications and Standards , William Stallings , 6th , Pearson.
- 5 Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software , Michael Sikorski and Andrew Honig , ., No starch press .

23CEC3101A - CLOUD INFRASTRUCTURE AND SERVICES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3101A	CLOUD INFRASTRUCTURE AND SERVICES	CIS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the foundation for cloud infrastructure	3	
CO2	Analyze Virtualization, its levels, and some real time examples	4	PO2, PSO1
CO3	Analyze load balancing, container services and Kubernetes	4	PO2, PO3, PO4, PSO1
CO4	Analyze the security over the cloud through specific approaches	4	PO2, PO3, PO4, PSO1
CO5	Analyze consequences and benefits of migration, data intensive, and applications of cloud	4	PO2, PSO1
CO6	Analyze hands-On exposure of Cloud infrastructure, virtualization, Load balancing and authentication, and security services	4	
CO7	Analyze the Infrastructure related concepts as best practices	4	

Syllabus

Introduction to Cloud Technologies: Introduction to the Cloud Computing, History of cloud computing, Cloud Deployment models, Cloud service options: IaaS, PaaS, and SaaS. Data as a Service, NoSQL as a Service, Comparison of service providers, cloud Architectures: NIST cloud reference Architecture and ITU-T, cloud reference Architecture.

Virtualization, Characteristics of virtualized environments, Taxonomy of virtualization techniques, Hardware and OS level virtualization techniques, Pros and cons of virtualization, Virtualization technology examples: Xen- para virtualization, VMware: full virtualization, Microsoft Hyper-V

Load Balancing, Types of Load Balancing, Risk Factors in Load Balancing, Auto scaling - Docker, Containers and Kubernetes - Building own container based on micro services - Docker containers - Manage multiple Kubernetes Cluster - Multi Cloud deployments

Cloud Security Introduction, Infrastructure Security, Network level security, Host level security, Application level security, Identity & Access Management, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud

Moving applications to Cloud, Using Webmail services, Cloud computing Technologies and Applications, Data-Intensive Technologies for Cloud Computing.

Reference Books

- 1 Mastering Cloud Computing Foundations and Applications Programming , Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi , 2013, Morgan kauffman, Elsevier .
- 2 Cloud Computing Bible , Barrie Sosinsky , 2011, John Wiley & Sons .
- 3 Handbook of Cloud Computing , Borko Furht, Armando Escalante , 2010, Springer .
- 4 Cloud Infrastructure Service A Complete Guide - 2019 Edition , Gerardus Blokdyk, 2019, Paperback.

23CEC3101E - CLOUD INFRASTRUCTURE AND SERVICES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3101E	CLOUD INFRASTRUCTURE AND SERVICES	CIS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply the knowledge of foundation for cloud infrastructure	3	PO2, PO3, PSO1
CO2	Able to analyze Virtualization, its levels, and justify with few real time examples	4	PO2, PO3, PO4, PSO1
CO3	Able to analyze load balancing, container services and Kubernetes	4	PO2, PO3, PO4, PSO1
CO4	Able to apply and evaluate the security, best practices over the cloud through specific approaches	4	PO2, PO3, PO4, PSO1
CO5	Analyze consequences and benefits of migration, data intensive, and applications of cloud	4	PO2, PO3, PO4, PSO1
CO6	Analyze hands-On exposure of Cloud infrastructure, virtualization, Load balancing and authentication, and security services	4	PO2, PO3, PO4, PSO2
CO7	Analyze the Infrastructure related concepts as best practices	4	PO2, PO3, PO4, PSO2

Syllabus

Introduction to Cloud Technologies: Introduction to the Cloud Computing, History of cloud computing, Cloud Deployment models, Cloud service options: IaaS, PaaS, and SaaS. Data as a Service, NoSQL as a Service, Comparison of service providers, cloud Architectures: NIST cloud reference Architecture and ITU-T, cloud reference Architecture.

Load Balancing, Types of Load Balancing, Risk Factors in Load Balancing, Auto scaling -Docker, Containers and Kubernetes - Building own container based on micro services - Docker containers -Manage multiple Kubernetes Cluster - Multi Cloud deployments

Virtualization, Characteristics of virtualized environments, Taxonomy of virtualization techniques, Hardware and OS level virtualization techniques, Pros and cons of virtualization, Virtualization technology examples: Xen- para virtualization, VMware: full virtualization, Microsoft Hyper-V

Cloud Security Introduction, Infrastructure Security, Network level security, Host level security, Application level security, Identity & Access Management, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud

Moving applications to Cloud, Using Webmail services, Cloud computing Technologies and Applications, Data-Intensive Technologies for Cloud Computing.

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini and Zaigham Mahmood, 2013, Pearson.
- 2 Cloud Computing: A Hands-On Approach, Arshdeep Bahga and Vijay Madisetti, 2014, Hard Cover.
- 3 Cloud Security: A Comprehensive Guide to Secure Cloud Computing, John R. Vacca, 2010, Wiley.
- 4 Cloud Infrastructure Service A Complete Guide - 2019 Edition, Gerardus Blokdyk, 2019, Paperback.

23CEC3101R - CLOUD INFRASTRUCTURE AND SERVICES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3101R	CLOUD INFRASTRUCTURE AND SERVICES	CIS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the foundation for cloud infrastructure	3	PO2, PSO1
CO2	Analyze Virtualization, its levels, and real time examples	4	PO2, PO3, PO4, PSO1
CO3	Analyze load balancing, container services and Kubernetes	4	PO2, PO3, PO4, PSO1
CO4	Analyze the security over the cloud through specific approaches	4	PO2, PO3, PO4, PSO1
CO5	Analyze hands-On exposure of Cloud infrastructure, virtualization, Load balancing and authentication, and security	4	PO2, PO4, PSO1
CO6	Analyze the Infrastructure related concepts as best practices	4	PO2, PO4, PSO1

Syllabus

Introduction to Cloud Technologies: Introduction to the Cloud Computing, History of cloud computing, Cloud Deployment models, Cloud service options: IaaS, PaaS, and SaaS. Data as a Service, NoSQL as a Service, Comparison of service providers, cloud Architectures: NIST cloud reference Architecture and ITU-T, cloud reference Architecture.

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- 4 Cloud Infrastructure Service A Complete Guide - 2019 Edition , Gerardus Blokdyk, 2019, Paperback.

23CEC3202A - ADVANCED OPERATING SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3202A	ADVANCED OPERATING SYSTEMS	AOS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the design of multiprocessor and distributed Operating Systems. Analyze distributed file system.	3	PO2, PO3, PSO2
CO2	Analyze the scheduling Real time and Parallel Applications on Heterogeneous Distributed Systems. Analyze three basic approaches for implementing distributed mutual exclusion	4	PO2, PO4, PSO2
CO3	Understand Replication preventing and accepting divergence. Analyze Deadlock detection in distributed systems.	4	PO3, PO4, PSO2
CO4	Analyze the algorithms for Checkpointing and rollback recovery, Consensus and agreement algorithms, and Failure detectors	4	PO3, PO4, PSO2
CO5	Implement the Concepts of multiprocessor Threads, distributed mutual exclusion, distributed scheduling, Distributed deadlocks.	4	PO2, PO3, PSO2

Syllabus

Introduction Types of Advanced Operating Systems Problem of Multiprocessor Systems, Solutions with Master and Slave Processors Distributed Unix Systems Satellite Processors Distributed File Systems Architecture NFS RPC Clock Synchronization Algorithms Physical and logical clocks Chandy Lamports Global State Recording Algorithm

Distributed Mutual Exclusion Introduction Classification of Mutual Exclusion algorithms Mutual Exclusion Algorithms Non-TokenBased Algorithms Lamports Algorithm The Ricart-Agrawala Algorithm Maekawas Algorithm TokenBased Algorithms Suzuki-Kasamis Broadcast Algorithm Raymonds Tree-Based Algorithm Election algorithm The Bully Algorithm A Ring Algorithm

Distributed Deadlock Introduction Centralized algorithms Distributed algorithms Hierarchical algorithms Replication weak consistency model protocols Replica synchronization gossip and Markel trees

Distributed Fault Handling Agreement Protocol System Model Classification Solution to Byzantine Agreement Problem Partition tolerant consensus algorithms Paxos Raft ZAB Fault Recovery Concepts Classification of failures Recovery in concurrent Systems Consistent Check Points Synchronous and Asynchronous check pointing and recovery Fault tolerance Issues Atomic actions and committing Commit Protocols Non-blocking Commit protocols Distributed Commit

Lab Experiments based on the Concepts of Advanced Operating systems using python or java

Reference Books

- 1 Advanced concepts in operating systems Distributed, Database and multiprocessor operating systems, Mukesh Singhal Niranjana G. Shivaratri, 7th, MC Graw Hill education..
- 2 Distributed Systems-CreateSpace, Maarten van Steen, Andrew S. Tanenbaum, 2e, IPP.
- 3 Distributed Computing: Principles, Algorithms, and Systems, A.D. Kshem kalyani, M. Singhal, 2nd, Cambridge University Press.
- 4 Modern Systems Principles and Paradigms, Andrew S.Tanenbaum, 2nd, PHI.
- 5 Distributed Operating System-Concepts and design, Pradeep K.Sinha, 1st, PHI.
- 6 The design of the UNIX operating system, Maurice J.bach, 2nd, PHI.
- 7 Real Time Systems, Jane W. S. Liu, 3rd, Pearson Education.

- 8 Concurrency Control in Distributed System Using Mutual Exclusion, Chaki, Nabendu_ Chattopadhyay, Samiran_Kanrar, Sukhendu, 1st, Springer.
- 9 distributed systems for fun and profit, Mikito Takada, 1st, Online.
- 10 Scheduling Parallel Applications on Heterogeneous Distributed Systems , Guoqi Xie, Gang Zeng, Renfa Li, Keqin Li , 1St, Springer.

23CEC3202E - ADVANCED OPERATING SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3202E	ADVANCED OPERATING SYSTEMS	AOS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the design of multiprocessor and distributed Operating Systems. Analyze distributed file system.	3	PO2, PO3, PSO2
CO2	Analyze the scheduling Real time and Parallel Applications on Heterogeneous Distributed Systems. Analyze three basic approaches for implementing distributed mutual exclusion	4	PO2, PO4, PSO2
CO3	Understand Replication preventing and accepting divergence. Analyze Deadlock detection in distributed systems.	4	PO3, PO4, PSO2
CO4	Analyze the algorithms for Checkpointing and rollback recovery, Consensus and agreement algorithms, and Failure detectors	4	PO3, PO4, PSO2
CO5	Implement the Concepts of multiprocessor Threads, distributed mutual exclusion, distributed scheduling, Distributed deadlocks.	4	PO2, PO3, PSO2

Syllabus

Introduction Types of Advanced Operating Systems Problem of Multiprocessor Systems, Solutions with Master and Slave Processors Distributed Unix Systems Satellite Processors Distributed File Systems Architecture NFS RPC Clock Synchronization Algorithms Physical and logical clocks Chandy Lamports Global State Recording Algorithm

Distributed Mutual Exclusion Introduction Classification of Mutual Exclusion algorithms Mutual Exclusion Algorithms Non-TokenBased Algorithms Lamports Algorithm The Ricart-Agrawala Algorithm Maekawas Algorithm TokenBased Algorithms Suzuki-Kasamis Broadcast Algorithm Raymonds Tree-Based Algorithm Election algorithm The Bully Algorithm A Ring Algorithm

Distributed Deadlock Introduction Centralized algorithms Distributed algorithms Hierarchical algorithms Replication weak consistency model protocols Replica synchronization gossip and Markel trees

Distributed Fault Handling Agreement Protocol System Model Classification Solution to Byzantine Agreement Problem Partition tolerant consensus algorithms Paxos Raft ZAB Fault Recovery Concepts Classification of failures Recovery in concurrent Systems Consistent Check Points Synchronous and Asynchronous check pointing and recovery Fault tolerance Issues Atomic actions and committing Commit Protocols Non-blocking Commit protocols Distributed Commit

Lab Experiments based on the Concepts of Advanced Operating systems using python or java

Reference Books

- 1 Advanced concepts in operating systems Distributed, Database and multiprocessor operating systems, Mukesh Singhal Niranjana G. Shivaratri, 7th, MC Graw Hill education..
- 2 Distributed Systems-CreateSpace, Maarten van Steen, Andrew S. Tanenbaum, 3e, IPP.
- 3 Distributed Computing: Principles, Algorithms, and Systems, A.D. Kshem kalyani, M. Singhal, 2nd, Cambridge University Press.
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- 9 Distributed systems for fun and profit, Mikito Takada, 1St, Online.
- 10 Scheduling Parallel Applications on Heterogeneous Distributed Systems , Guoqi Xie, Gang Zeng, Renfa Li, Keqin Li , 1St, Springer.

23CEC3202R - ADVANCED OPERATING SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3202R	ADVANCED OPERATING SYSTEMS	AOS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the design of multiprocessor and distributed Operating Systems. Analyze distributed file system.	3	PO2, PO3, PSO2
CO2	Analyze the scheduling Real time and Parallel Applications on Heterogeneous Distributed Systems. Analyze three basic approaches for implementing distributed mutual exclusion	4	PO2, PO4, PSO2
CO3	Understand Replication preventing and accepting divergence. Analyze Deadlock detection in distributed systems.	4	PO3, PO4, PSO2
CO4	Analyze the algorithms for Checkpointing and rollback recovery, Consensus and agreement algorithms, and Failure detectors, Implement the Concepts of multiprocessor Threads, distributed mutual exclusion, distributed scheduling, Distributed deadlocks.	4	PO3, PO4, PSO2

Syllabus

Introduction Types of Advanced Operating Systems Problem of Multiprocessor Systems, Solutions with Master and Slave Processors Distributed Unix Systems Satellite Processors Distributed File Systems Architecture NFS RPC Clock Synchronization Algorithms Physical and logical clocks Chandy Lamports Global State Recording Algorithm

Distributed Mutual Exclusion Introduction Classification of Mutual Exclusion algorithms Mutual Exclusion Algorithms Non-TokenBased Algorithms Lamports Algorithm The Ricart-Agrawala Algorithm Maekawas Algorithm TokenBased Algorithms Suzuki-Kasamis Broadcast Algorithm Raymonds Tree-Based Algorithm Election algorithm The Bully Algorithm A Ring Algorithm

Distributed Deadlock Introduction Centralized algorithms Distributed algorithms Hierarchical algorithms Replication weak consistency model protocols Replica synchronization gossip and Markel trees

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- 1 Advanced concepts in operating systems Distributed, Database and multiprocessor operating systems , Mukesh Singhal Niranjana G. Shivaratri, 7th, MC Graw Hill education..
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- 3 Distributed Computing: Principles, Algorithms, and Systems, , A.D. Kshem kalyani, M. Singhal, 2nd, Cambridge University Press.
- 4 Modern Systems Principles and Paradigms, Andrew S.Tanenbaum, 2nd, PHI.
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- 7 Real Time Systems, Jane W. S. Liu, 3rd, Pearson education.
- 8 Concurrency Control in Distributed System Using Mutual Exclusion, Chaki, Nabendu_ Chattopadhyay, Samiran_Kanrar, Sukhendu , 1st, Springer.

23CEC3203A - FUNCTIONAL & CONCURRENT PROGRAMMING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3203A	FUNCTIONAL & CONCURRENT PROGRAMMING	FCP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop the basic programs using functional programming language	3	PO1, PO2, PO3, PSO1
CO2	Apply Functions and Lambdas on purely functional programs	3	PO1, PO2, PO4, PSO1
CO3	Apply Functional Infinite Data Structures and Monods	3	PO1, PO3, PO4, PSO1
CO4	Evaluate the functional design of concurrent systems	4	PO1, PO3, PO4, PSO1
CO5	Evaluate the design of concurrent systems	4	PO1, PO2, PO4, PSO1

Syllabus

"Characteristics of Functional Programming Languages: The Basics of the Scala Language: DataTypes, Statements and Expressions, Statement Separator and Blocks, Declarations."

"Functions, Lists, Pattern Matching, Collections and Their Higher Order Functions. Functions and Lambdas, Functional Data Structures: Immutable Lists and Maps Lazy and Eager Evaluation: Parameter Passing."

" Lazy Val, Streams and Other Infinite Data Structures. Functions in Scala and Object-Oriented Programming, Scala: OOL and FP, classes and objects, Inheritance model, traits, Classes with Polymorphic Types. Monods:Monods, Functors, and Monads."

" Tail-Recursive Functions:Asynchronous Programming with Futures and Promises, DataParallel Collections. Concurrency with Akka, Introduction to the Actor Model, The Actor Model in Practice, Concurrent Programming with Reactive Extensions, Use Case - A Parallel Web Crawler."

apply common patterns, such as lockings, semaphores, and message-passing and synchronization for solving concurrent program problems.

Reference Books

- 1 Scala for Data Science , Pascal Bugnion , 2016, Packet Publisher .
- 2 " Scala: Guide for Data Science Professionals " , Arun Manivannan , 2017, Packet Publisher .
- 3 Learn Scala Programming , Slava Schmidt , 2018, Packet Publisher .
- 4 Professional Scala , Ruslan Shevchenko , 2018, Packet Publisher .

23CEC3203E - FUNCTIONAL & CONCURRENT PROGRAMMING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3203E	FUNCTIONAL & CONCURRENT PROGRAMMING	FCP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop the basic programs using functional programming language	3	PO1, PO2, PO3, PSO1
CO2	Apply Functions and Lambdas on purely functional programs	3	PO1, PO2, PO3, PSO1
CO3	Apply Functional Infinite Data Structures and Monods	3	PO2, PO3, PO4, PSO1
CO4	Evaluate the functional design of concurrent systems	4	PO2, PO3, PO4, PSO1
CO5	Evaluate the design of concurrent systems	4	PO1, PO2, PO3, PSO1

Syllabus

"Characteristics of Functional Programming Languages: The Basics of the Scala Language: DataTypes, Statements and Expressions, Statement Separator and Blocks, Declarations."

"Functions, Lists, Pattern Matching, Collections and Their Higher Order Functions. Functions and Lambdas, Functional Data Structures: Immutable Lists and Maps Lazy and Eager Evaluation: Parameter Passing."

" Lazy Val, Streams and Other Infinite Data Structures. Functions in Scala and Object-Oriented Programming, Scala: OOL and FP, classes and objects, Inheritance model, traits, Classes with Polymorphic Types. Monods:Monods, Functors, and Monads."

" Tail-Recursive Functions:Asynchronous Programming with Futures and Promises, DataParallel Collections. Concurrency with Akka, Introduction to the Actor Model, The Actor Model in Practice, Concurrent Programming with Reactive Extensions, Use Case - A Parallel Web Crawler."

apply common patterns, such as lockings, semaphores, and message-passing and synchronization for solving concurrent program problems.

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- 1 Scala for Data Science , Pascal Bugnion , 2016, Packet Publisher .
- 2 " Scala: Guide for Data Science Professionals " , Arun Manivannan , 2017, Packet Publisher .
- 3 Learn Scala Programming , Slava Schmidt , 2018, Packet Publisher .
- 4 Professional Scala , Ruslan Shevchenko , 2018, Packet Publisher .

23CEC3203R - FUNCTIONAL & CONCURRENT PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3203R	FUNCTIONAL & CONCURRENT PROGRAMMING	FCP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop the basic programs using functional programming language	3	PO1, PO3, PO4, PSO1
CO2	Apply Functions and Lambdas on purely functional programs	3	PO1, PO2, PO4, PSO1
CO3	Apply Functional Infinite Data Structures and Monods	3	PO1, PO3, PO4, PSO1
CO4	Evaluate the functional design of concurrent systems	4	PO1, PO3, PO4, PSO1

Syllabus

"Characteristics of Functional Programming Languages: The Basics of the Scala Language: DataTypes, Statements and Expressions, Statement Separator and Blocks, Declarations."

"Functions, Lists, Pattern Matching, Collections and Their Higher Order Functions. Functions and Lambdas, Functional Data Structures: Immutable Lists and Maps Lazy and Eager Evaluation: Parameter Passing."

" Lazy Val, Streams and Other Infinite Data Structures. Functions in Scala and Object-Oriented Programming, Scala: OOL and FP, classes and objects, Inheritance model, traits, Classes with Polymorphic Types. Monods:Monods, Functors, and Monads."

" Tail-Recursive Functions:Asynchronous Programming with Futures and Promises, DataParallel Collections. Concurrency with Akka, Introduction to the Actor Model, The Actor Model in Practice, Concurrent Programming with Reactive Extensions, Use Case - A Parallel Web Crawler."

Reference Books

- 1 Scala for Data Science , Pascal Bugnion , 2016, Packet Publisher .
- 2 " Scala: Guide for Data Science Professionals " , Arun Manivannan , 2017, Packet Publisher .
- 3 Learn Scala Programming , Slava Schmidt , 2018, Packet Publisher .
- 4 Professional Scala , Ruslan Shevchenko , 2018, Packet Publisher .

23CEC3204A - CLOUD DEVOPS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3204A	CLOUD DEVOPS	CD	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the basic concepts of Cloud and Devops and Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software	2	PO1
CO2	Inspect Configuration Management using Infrastructure as Code	4	PO1, PSO2
CO3	Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration.	4	PO5, PSO2
CO4	Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications using Pipeline and Examine the Software and Automation Testing Frameworks.	4	PO5, PSO2
CO5	Build and Inspect the Tools associated to DevOps Life Cycle.	4	PO5, PSO2

Syllabus

Networking Fundamentals: Network Fundamentals, Storage Fundamentals, Databases Fundamentals, Web servers (NGINX), LINUX Basic and Admin Importance of Linux in DevOps, Linux Basic Command Utilities, Shell Scripting Devops Fundamentals: Cloud Fundamentals, AWS fundamentals, SDLC,

Devops Fundamentals: Git, Maven. Terraform: Overview, Terraform with AWS, Terraform -variables, conditions, iterator, provisioner, functions, modules, workspace, backends. Ansible: YAML, introduction, Architecture, Playbook Concepts, Ansible Inventory and Configuration, Ansible Modules, Roles.

Docker & Kubernetes: How to get Docker Image? What is Docker Image, Docker Installation, working with Docker Container What is Container o Docker Engine, Creating Containers with an Image, Working with Images, Docker Command Line Interface, Docker Compose, Docker Hub, Docker Trusted Registry, Docker swarm, Docker attach Docker File & Command, Kubernetes Architecture, Design and Install a Kubernetes Cluster.

Jenkins: Introduction to Jenkins, Continuous Integration with Jenkins, Configure, Jenkins, Jenkins Management, Scheduling build Jobs,

Maven Build Scripts, Support for the GIT version control System, Jenkins Build Pipeline Parent and Child Builds, Sequential Builds, Jenkins Master & Slave Node Configuration, Installing Jenkins Plugins, SCM plugin, Build and test.

Reference Books

- 1 DevOps for Web Development, Mitesh Soni, 2016, PACKT Publishing .
- 2 Beginning DevOps with Docker, Joseph Muli,, 2018, PACKT Publishing.
- 3 Docker for Developers_ Develop and run your application with Docker containers using DevOps tools for continuous delivery, Richard Bullington-McGuire, Andrew K. Dennis, Michael Schwartz, 2020, Packt Publishing)..
- 4 DevOps With Kubernetes, Hideto Saito, Hui-Chuan Chloe Lee, Cheng-Yang, 2019, PACKT Publishing,.

23CEC3204E - CLOUD DEVOPS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3204E	CLOUD DEVOPS	CD	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of Networks, Cloud and DevOps Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software	2	PO5, PO6, PSO2
CO2	Inspect Configuration Management using Infrastructure as Code	4	PO5, PO6, PSO2
CO3	Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration	4	PO4, PO5, PO6, PSO2
CO4	Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications using Pipeline and Examine the Software and Automation Testing Frameworks.	4	PO4, PO5, PO6, PSO2
CO5	Build and Inspect the Tools associated to DevOps Life Cycle.	4	PO4, PO5, PSO2

Syllabus

Git, Maven. Terraform: Overview, Terraform with AWS, Terraform -variables, conditions, iterator, provisioner, functions, modules, workspace, backends.

The OSI Model TCP vs UDP IP addressing & Subnetting, Protocols & Ports Network Topology Switching, Web servers. Version Controlling: Git, GitHub fundamentals. Configuring gitbash, Pushing and pulling codes to and from repositories

Linux Introduction, Basic Commands, Operations of running systems, User and Group management.

Cloud Fundamentals, AWS Accounts, AWS Fundamentals IAM, ACCOUNTS AND AWS ORGANISATIONS, Simple Storage Service, VPC, Security. T

Introduction Architecture Playbook Concepts, Ansible inventory and configurations, Ansible Modules Dockers & Kubernetes

Reference Books

- 1 Beginning DevOps with Docker, Joseph Multi, 2018, PACKT Publishing .
- 2 Docker for Developers_ Develop and run your application with Docker containers using DevOps tools for continuous delivery, Richard Bullington-McGuire, Andrew K. Dennis, Michael Schwartz, 2020, , Packt Publishing).
- 3 Complete DevOps Cookbook_ Build and manage your applications, orchestrate containers, and deploy cloud-native services, Murat Karslioglu, 2020, Packt Publishing.
- 4 Kubernetes A Complete DevOps Cookbook_ Build and manage your applications, orchestrate containers, and deploy cloud-native services, Murat Karslioglu , 2020, Packt Publishing.

23CEC3204R - CLOUD DEVOPS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3204R	CLOUD DEVOPS	CD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the basic concepts of Cloud and Devops and Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software	2	PO5, PO6, PSO2
CO2	Inspect Configuration Management using Infrastructure as Code	4	PO5, PO6, PSO2
CO3	Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration.	4	PO4, PO5, PO6, PSO2
CO4	Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications using Pipeline and Examine the Software and Automation Testing Frameworks.	4	PO4, PO5, PSO2

Syllabus

Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications using Pipeline and Examine the Software and Automation Testing Frameworks.

Devops Fundamentals: Git, Maven. Terraform: Overview, Terraform with AWS, Terraform -variables, conditions, iterator, provisioner, functions, modules, workspace, backends. Ansible: YAML, introduction, Architecture, Playbook Concepts, Ansible Inventory and Configuration, Ansible Modules, Roles.

Docker & Kubernetes: How to get Docker Image? What is Docker Image, Docker Installation, working with Docker Container What is Container on Docker Engine, Creating Containers with an Image, Working with Images, Docker Command Line Interface, Docker Compose, Docker Hub, Docker Trusted Registry, Docker swarm, Docker attach Docker File & Command, Kubernetes Architecture, Design and Install a Kubernetes Cluster

Jenkins: Introduction to Jenkins, Continuous Integration with Jenkins, Configure, Jenkins, Jenkins Management, Scheduling build Jobs, Maven Build Scripts, Support for the GIT version control System, Jenkins Build Pipeline Parent and Child Builds, Sequential Builds, Jenkins Master & Slave Node Configuration, Installing Jenkins Plugins, SCM plugin, Build and test.

Reference Books

- 1 Docker for Developers_ Develop and run your application with Docker containers using DevOps tools for continuous delivery, Richard Bullington-McGuire, Andrew K. Dennis, 2020, Packt Publishing).
- 2 Beginning DevOps with Docker, Joseph Muli, 2018, PACKT Publishing .
- 3 Kubernetes - A Complete DevOps Cookbook_ Build and manage your applications, orchestrate containers, and deploy cloud-native services, Murat Karslioglu, 2020, Packt Publishing).
- 4 Computer Networking, Russell Scott (Author), 2020, Kindle Edition.

23CEC3305A - CLOUD & SERVERLESS COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3305A	CLOUD & SERVERLESS COMPUTING	CSC	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the hierarchical structure of cloud service scheduling, delving into its components and relationships. Additionally, demonstrate a comprehensive understanding of cloud computing principles and their implications	4	PO4, PSO1
CO2	Build the concepts of Functions-as-a-Service (FaaS) and Event-driven programming. Evaluate the steps involved in developing scalable models using Serverless Architectures	3	PO3, PSO1
CO3	Apply the process of managing application functionalities by employing Serverless runtimes and Serverless databases and also the key considerations, configurations, and potential optimizations involved in effectively utilizing these technologies to enhance application development and performance.	3	PO3, PSO1
CO4	Identify advanced serverless programming practices and patterns to design, construct, and manage serverless applications and architectural decisions, development strategies, and operational considerations required for the effective implementation and maintenance of serverless systems	3	PO5, PSO1
CO5	Analyze Serverless real time projects and its Architecture, Build, and Operate serverless web applications .	4	PO5, PSO1
CO6	Evaluate real world and scalable full stack application using Serverless technologies	5	PO5, PSO1
CO7	Build a real world and scalable full stack application using Serverless technologies.	6	PO5, PSO1

Syllabus

Overview of cloud computing (Cloud Introduction, Characteristics, Advantages, Four Deployment models and Core Services), Introduction, History, Briefly Basic Services description, EC2 Introduction, S3 and VPC Description , RDS Description, VPC with EC2 and RDS Description

Serverless AWS. Serverless Programming Practices and Patterns, building serverless applications using Java, NodeJS and Python. AWS Lambda, Lambda Examples and Casestudies.

Building Serverless REST APIs with API Gateway. DynamoDB, Amazon Cognito, Web Hosting with S3, Route53, and CloudFront. Postman, Domain name services,

Serverless Amazon Athena and the AWS Glue Data Catalog, Real-Time Data Insights Using Amazon Kinesis ,Messaging and Notifications with SQS and SNS

Your first Serverless application on Azure, Google Cloud Platform, Example: Serverless Sensor Data Collector. Building Effective Serverless Applications with Docker ,Kubernetes and OpenShift, CICD Serverless, SAM Applications

Reference Books

- 1 Serverless Architectures on AWS: With examples using AWS Lambda, Peter Sbarski, 2024, Manning Publications.
- 2 Serverless Design Patterns and Best Practices: Build, Secure, and Deploy Enterprise-ready Serverless Applications with AWS Lambda, Brian Zambrano, 2023, Packt Publishing.
- 3 Learning Serverless: Design, Develop, and Deploy with Confidence, Paul Swail, 2023, O'Reilly Media.
- 4 Serverless Single Page Apps: Fast, Scalable, and Available, Ben Rady and Matthew J. Fuller, 2024, Pragmatic Bookshelf.

23CEC3305E - CLOUD & SERVERLESS COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3305E	CLOUD & SERVERLESS COMPUTING	CSC	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the hierarchical structure of cloud service scheduling, delving into its components and relationships. Additionally, demonstrate a comprehensive understanding of cloud computing principles and their implications	4	PO5, PSO1
CO2	Build the concepts of Functions-as-a-Service (FaaS) and Event-driven programming. Evaluate the steps involved in developing scalable models using Serverless Architectures	3	PO5, PSO1
CO3	Apply the process of managing application functionalities by employing Serverless runtimes and Serverless databases and also the key considerations, configurations, and potential optimizations involved in effectively utilizing these technologies to enhance application development and performance.	3	PO4, PSO1
CO4	Identify advanced serverless programming practices and patterns to design, construct, and manage serverless applications and architectural decisions, development strategies, and operational considerations required for the effective implementation and maintenance of serverless systems	3	PO4, PSO1
CO5	Analyze Serverless real time projects and its Architecture, Build, and Operate serverless web applications	4	PO3, PSO1
CO6	Build a real world and scalable full stack application using Serverless technologies.	5	PO3, PSO1
CO7	Build a real world and scalable full stack application using different cloud service providers	5	

Syllabus

Overview of cloud computing (Cloud Introduction, Characteristics, Advantages, Four Deployment models and Core Services), Introduction, History, Briefly Basic Services description, EC2 Introduction, S3 and VPC Description, RDS Description, VPC with EC2 and RDS Description

Serverless AWS. Serverless Programming Practices and Patterns, building serverless applications using Java, NodeJS and Python. AWS Lambda, Lambda Examples and Casestudies.

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Serverless Amazon Athena and the AWS Glue Data Catalog, Real-Time Data Insights Using Amazon Kinesis, Messaging and Notifications with SQS and SNS

Your first Serverless application on Azure, Google Cloud Platform, Example: Serverless Sensor Data Collector. Building Effective Serverless Applications with Docker, Kubernetes and OpenShift, CICD Serverless, SAM Applications

Reference Books

- 1 Serverless Design Patterns and Best Practices: Build, Secure, and Deploy Enterprise-ready Serverless Applications with AWS Lambda, Brian Zambrano, 2024, Packt Publishing.
- 2 Serverless Architectures on AWS: With examples using AWS Lambda, Peter Sbarski, 2023, Manning Publications.
- 3 Learning Serverless: Design, Develop, and Deploy with Confidence, Paul Swail, 2023, O'Reilly Media.
- 4 Serverless Single Page Apps: Fast, Scalable, and Available, Ben Rady and Matthew J. Fuller, 2023, Pragmatic Bookshelf.

5 Cloud computing bible , Raj Kumar , 2024, Pearson .

23CEC3305R - CLOUD & SERVERLESS COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3305R	CLOUD & SERVERLESS COMPUTING	CSC	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the hierarchical structure of cloud service scheduling, delving into its components and relationships. Additionally, demonstrate a comprehensive understanding of cloud computing principles and their implications	4	PO2, PO3, PSO1
CO2	Build the concepts of Functions-as-a-Service (FaaS) and Event-driven programming. Evaluate the steps involved in developing scalable models using Serverless Architectures	3	PO2, PO3, PSO1
CO3	Apply the process of managing application functionalities by employing Serverless runtimes and Serverless databases and also the key considerations, configurations, and potential optimizations involved in effectively utilizing these technologies to enhance application development and performance.	3	PO3, PSO1
CO4	Identify advanced serverless programming practices and patterns to design, construct, and manage serverless applications and architectural decisions, development strategies, and operational considerations required for the effective implementation and maintenance of serverless systems	3	PO3, PSO1
CO6	Evaluate real world and scalable full stack application using Serverless technologies	5	PO3, PO4, PSO1
CO7	Skill based -Build a real world and scalable full stack application using Serverlesstechnologies.	6	PO3, PO4, PSO1

Syllabus

Overview of cloud computing (Cloud Introduction, Characteristics, Advantages, Four Deployment models and Core Services), Introduction, History, Briefly Basic Services description, EC2 Introduction, S3 and VPC Description, RDS Description, VPC with EC2 and RDS Description

Serverless AWS. Serverless Programming Practices and Patterns, building serverless applications using Java, NodeJS and Python. AWS Lambda, Building Serverless REST APIs with API Gateway. DynamoDB,

Amazon Cognito, Web Hosting with S3, Route53, and CloudFront. Postman, Domain name services, Serverless Amazon Athena and AWS Glue Data Catalog, Real-Time Data Insights Using Amazon Kinesis, Messaging and Notifications with SQS and SNS,

Your first Serverless application on Azure, Google Cloud Platform, Example: Serverless Sensor Data Collector. Building Effective Serverless Applications with Kubernetes and OpenShift.

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- 4 Serverless Single Page Apps: Fast, Scalable, and Available, Ben Rady and Matthew J. Fuller, 2022, Pragmatic Bookshelf.

23CEC3406M - ADVANCED COMPUTER ARCHITECTURE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3406M	ADVANCED COMPUTER ARCHITECTURE	ACA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Discuss current trends and future directions in computer architecture, including multi-core processors, GPUs, and heterogeneous systems.	2	PO2
CO2	Demonstrate an understanding of advanced pipelining techniques, including instruction-level parallelism (ILP) and the concepts of superscalar execution.	2	PO3
CO3	Apply knowledge of advanced computer architecture to solve real-world problems related to hardware and software design, including multiprocessor and multi-core systems.	3	PO2
CO4	Analyze the performance of different computer architectures using metrics such as CPU performance, memory hierarchy, and system throughput.	4	PO4, PSO2

Syllabus

FUNDAMENTALS OF COMPUTER DESIGN: Review of Fundamentals Of CPU, Memory and I/O. Trends in Technology, Power, Energy and Cost. Dependability. Performance Evaluation.

INSTRUCTION LEVEL PARALLELISM: ILP Concepts. Pipelining Overview. Compiler Techniques for Exposing ILP. Dynamic Branch Prediction. Dynamic Scheduling. Multiple Instruction Issue. Hardware Based Speculation. Static Scheduling. Multi-Threading. Limitations of ILP. Case Studies.

DATA-LEVEL PARALLELISM: Vector Architecture. SIMD Extensions. Graphic Processing Units. Loop Level Parallelism.

THREAD LEVEL PARALLELISM: Symmetric and Distributed Shared Memory Architectures. Performance Issues. Synchronization. Models of Memory Consistency, Pipeline hazards, Pipeline scheduling techniques

MEMORY AND I/O Cache Performance. Cache memory principles, Cache optimization techniques, Reducing Cache Miss Penalty and Miss Rate. Reducing Hit Time. Main Memory and Performance: Memory Technology.

Types of Storage Devices Buses. RAID. Reliability, Availability and Dependability. I/O Performance Measures.

Reference Books

- 1 Computer Architecture a Quantitative Approach, John L Hennessey and David A Patterson, 2011, Elsevier.
- 2 Computer Architecture and Parallel Processing, Kai Hwang And Faye Briggs, 2015, McGraw-Hill.
- 3 Advanced Computer Architectures: A Design Space Approach, Sima D, Fountain T And Kacsuk P, 2000, Addison Wesley.
- 4 Parallel Computer Architecture: A Hardware/Software Approach, David Culler, Jaswinder Pal Singh, and Anoop Gupta, 2012, Elsevier.

23CEC3407M - PARALLEL ALGORITHMS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3407M	PARALLEL ALGORITHMS	PA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline the fundamental concepts of parallel computing and the design of parallel algorithms.	2	PO1, PO2
CO2	Analyze and apply parallel algorithms for solving computational problems efficiently.	4	PO3, PSO2
CO3	Evaluate the performance of parallel algorithms on different parallel architectures and environments	5	PO2, PO4
CO4	Summarize parallel algorithms using appropriate programming models and tools.	3	PO3

Syllabus

Introduction to Parallel Computing: Basic concepts of parallel computing, benefits, and challenges. Overview of parallel architectures (multi-core, many-core, and distributed systems). Simple examples of parallel algorithms.

Parallel Sorting and Search Algorithms: Introduction to parallel sorting (e.g., parallel merge sort) and searching techniques (e.g., parallel binary search). Basic principles of dividing tasks and combining results.

Parallel Numerical Algorithms: Introduction to parallel numerical methods such as parallel matrix multiplication and simple parallel numerical integration. Basic performance metrics and how to measure them.

Parallel Programming Models and Tools: Introduction to parallel programming with MPI and OpenMP. Hands-on examples of implementing simple parallel algorithms using these tools. Overview of CUDA for GPU programming.

Reference Books

- 1 Introduction to Parallel Computing , Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar , 2003 , Addison-Wesley.
- 2 Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, Barry Wilkinson, Michael Allen, 2005 , Pearson.
- 3 Designing and Building Parallel Programs , Ian Foster , 1995 , Addison-Wesley.
- 4 Parallel Algorithms , Henri Casanova, Arnaud Legrand, Yves Robert , 2008 , CRC Press.
- 5 Patterns for Parallel Programming , Timothy G. Mattson, Beverly A. Sanders, Berna L. Massingill , 2004 , Addison-Wesley.
- 6 Using OpenMP: Portable Shared Memory Parallel Programming , Barbara Chapman, Gabriele Jost, Ruud van der Pas , 2007 , MIT Press.

23CEC3408M - CLOUD SECURITY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3408M	CLOUD SECURITY	CS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of cryptography and Apply various cryptographic algorithm	2	PO1, PO4
CO2	Apply various security issues and system vulnerabilities in virtualization	3	PO4, PO6, PO10
CO3	Analyze the technologies for virtualization based security enhancements	4	PO6, PO10, PS02
CO4	Implement legal & compliance issues and examine modern security standards	3	PO1

Syllabus

Security Concepts: Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defense in depth, least privilege, the importance of security in the cloud, Importance in PaaS, IaaS and SaaS; Cryptographic Systems: Symmetric cryptography, stream ciphers, block ciphers, modes of operation, public-key cryptography,

hashing, digital signatures, public-key infrastructures, key management, X.509 certificates, OpenSSL. Multi-tenancy Issues: Isolation of users/VMs from each other. Virtualization System Security Issues: e.g. ESX and ESXi Security, ESX file system security, storage considerations, backup, and recovery; Virtualization System Vulnerabilities: Management console vulnerabilities, management server vulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisor vulnerabilities, hypervisor escape vulnerabilities, configuration issues, and malware (botnets, etc).

Virtualization System-Specific Attacks: Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyperjacking. Technologies for virtualization-Based Security Enhancement: IBM security virtual server protection, virtualization-based sandboxing; Storage Security: HIDPS, log management, Data Loss Prevention. Location of the Perimeter, Legal and Compliance Issues: Responsibility, ownership of data, right to penetration test. Local laws, examination of modern Security Standards (eg PCIDSS), Standards to deal with cloud services and virtualization, compliance for the cloud provider vs. compliance for the customer.

Introduction to Containers, Container Security, Thread Model in Containerized Environment, Container Defense Mechanism-1, Container Defense Mechanism-2, SQL injection attacks in containers, Case Study-SQL injection attacks in containers malicious logs extraction.

Reference Books

- 1 "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", Tim Mather, Subra Kumaraswamy, Shahed Latif, September 2019: First Edition, O'Reilly Media.
- 2 "Architecting Secure Cloud Systems", Michael H. Huth and Mark Ryan, April 2018: First Edition, Springer.
- 3 "Cloud Computing Security: Foundations and Challenges", John R. Vacca, August 2016: First Edition, CRC Press.
- 4 "Cloud Security Automation: Get to Know the Ins and Outs of Cloud Security Automation Using AWS", Prashant Priyam, March 2018: First Edition, Packt Publishing.

23CEC3409M - ARCHITECTING CLOUD SOLUTIONS* (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3409M	ARCHITECTING CLOUD SOLUTIONS*	ACS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design Resilient Architectures	3	PO1, PO2, PO3, PO4, PSO1
CO2	Design High-Performing Architectures	3	PO1, PO2, PO3, PO4
CO3	Design Secure Applications and Architectures	3	PO1, PO2, PO3, PO4
CO4	Design Cost-Optimized Architectures, Designing solutions to the architecture of Cloud	3	PO1, PO2, PO3, PO4

Syllabus

Design a multi-tier architecture solution: Design a multi-tier architecture solution, Design highly available and/or fault-tolerant architectures, Design decoupling mechanisms using AWS services, Choose appropriate resilient storage.

Design High-Performing Architectures : Identify elastic and scalable compute solutions for a workload, Select high-performing and scalable storage solutions for a workload, Select high-performing networking solutions for a workload, Choose high-performing database solutions for a workload.

Design Secure Applications and Architectures: Design secure access to AWS resources, Design secure application tiers, Select appropriate data security options.

Design Cost-Optimized Architectures: Identify cost-effective storage solutions, Identify cost-effective compute and database services, Designing solutions to the architecture of Cloud

Reference Books

- 1 Mastering Cloud Computing Foundations and Applications Programming , Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi , 2013, Morgan kauffman, Elsevier .
- 2 Cloud Computing Bible , Barrie Sosinsky , 2011, John Wiley & Sons .
- 3 Architecting Cloud Computing Solutions, L. Jackson, Kevin, first edition, packt.
- 4 Architecting the Cloud, Michael J Kavis, 2014, wiley.

23CEC3510 - EDGE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3510	EDGE COMPUTING	EC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline the fundamental concepts and advantages of Fog and Edge Computing (FEC), infer the opportunities and applications.	2	PO1, PO5, PSO2
CO2	Apply network slicing strategies with effective management techniques to optimize resource allocation. Build network virtualization for efficient edge computing, while exploring optimization techniques for fog computing to ensure efficient data processing	3	PO2, PO5, PSO2
CO3	Implement and evaluate middleware solutions for Fog and Edge Computing, addressing security management	4	PO1, PO5, PSO2
CO4	Analyze the applicability and needs for Edge/Fog Computing in various real-time projects such as health monitoring, smart city management, and smart transportation	4	PO1, PO3, PO5, PSO2

Syllabus

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Business Model, Opportunities and Challenges. Addressing the Challenges in Federating Edge Resources

Architecture: Architecture: Integrating IoT + Fog + Cloud Infrastructures, Network Slicing, and its Management in 5 G, Network Virtualization techniques in Edge computing, Optimization in Fog Computing.

Middleware: Middleware for Fog and Edge Computing: Design Issues, State-of-the-Art Middleware Infrastructures, A Lightweight Container Middleware for Edge Cloud Architectures, Security and Data Management: Security Management for Edge Cloud Architectures

Applications and Issues: Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking, Fog Computing Model for Evolving Smart Transportation Applications.

Reference Books

- 1 Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya , Satish Narayana Sri rama , 2019, Wiley publication.
- 2 IoT and Edge Computing for Architects, Perry Lea, 2020, Packt Publishing.
- 3 Architecting the Internet of Things, Dieter Uckelmann, Florian Michahelles, Mark Harrison, 2014, Springer.
- 4 Fog/Edge Computing For Security, Privacy, and Applications, Jie Wu, Wei Chang, 2021, Springer.

23CEC3511 - HIGH PERFORMANCE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3511	HIGH PERFORMANCE COMPUTING	HPC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the basis concept of processors, optimization and parallel computers, shared memory, parallel programming with MPI.	2	PO2, PO3, PO4, PO8, PSO1
CO2	Apply knowledge of FPGA based supercomputers, rearchitecting, and core optimization.	3	PO2, PO3, PO4, PSO1
CO3	Analyze openMp, MPI and their hybridization principles.	4	PO2, PO3, PO4, PSO1
CO4	Analyze the working principle of GPU, CUDA, threads, performance, openCL.	4	PO2, PO3, PO4, PSO1

Syllabus

Evolution of Processors and Modern Processor ,Basic optimization techniques for serial code,Data access optimization, Parallel computers, Basics of parallelization, Shared-memory parallel programming with OpenMP.

FPGA based super computer for statistical physics, Weird Case of Janus, High speed torus interconnect using FPGAs, Rearchitecting memory resources for clusters, Various kinds of models, Core optimization.

Efficient openMP programming, Local optimization on ccNuma architecture,Distributed memory parallel programming with MPI,Efficient MPI programming, Hybrid parallelization with MPI and Open MP.

History of GPU computing, GPU memory Hierarchy, Introduction to CUDA, CUDA threads,CUDA performance consideration,Introduction to Open CL,Hybrid- Core Architecture, Low cost High performance reconfigurable computing.

Reference Books

- 1 HPC @ Green IT, Green High Performance Computing Methods, Ralf Gruberc, Vincent Keller, 2010, Springer.
- 2 High-Performance Computing Using FPGAs, Christian de Schryver, Norbert Wehn , 2013, Springer.
- 3 CUDA by Example - An Introduction to GeneralPurpose GPU Programming, Jason Sanders, Edward Kandrot, 2011, Addison Wesley.
- 4 Parallel and High Performance Computing , Robert Robey (Author), Yuliana Zamora (Author) , 2021, Paperback.

23CEC3512 - DESIGN OF DISTRIBUTED APPLICATIONS ON CLOUD (DDA) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3512	DESIGN OF DISTRIBUTED APPLICATIONS ON CLOUD (DDA)	DDAC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the distributed systems applications on cloud computing.	3	PO1, PO2, PO3, PO4, PSO2
CO2	Apply Distributed file systems and cache consistency	3	PO1, PO2, PO3, PO4, PSO2
CO3	Analyze Persistent cloud services, Failure models and failure detectors	4	PO2, PO3, PO4, PSO2
CO4	Analyze Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo	4	PO1, PO2, PO3, PO4, PSO2

Syllabus

Introduction to Distributed Systems, Distributed System Architectures, Communication in Distributed Systems, Introduction to Cloud Computing, Cloud Deployment Models

Distributed Data Management, Cloud Computing and Virtualization, Storage in the Cloud

Cloud Service Models, Types of Failures in Distributed systems, Types of Cloud Failures, Common Causes of Cloud Failures, Failure Recovery and Resilience

Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo, Map-Reduce and extensions: Parallel computing, The map-Reduce model, Parallel efficiency of Map-Reduce, Relational operations using Map-Reduce.

Reference Books

- 1 Cloud Computing, Sandeep Bhowmik, 2017, CAMBRIDGE.
- 2 Distributed Computing, Ajay D. Kshemkalyani, Mukesh Singhal, 2008, CAMBRIDGE.
- 3 Distributed Systems, Sukumar Ghosh, 2006, CRC Press.
- 4 Architecting the Cloud, Michael J. Kavis, 2014, Wiley.
- 5 "Distributed Systems: Principles and Paradigms", Andrew S. Tanenbaum and Maarten Van Steen, 2006, Prentice Hall.

23CEC3513 - CLOUD NETWORKING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CEC3513	CLOUD NETWORKING	CN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and reflect broad conceptual knowledge about Cloud Networking Basics, Characteristics and Cloud Data Centers.	3	PO1, PO2, PO3
CO2	Apply the basics and Identifying the architecture of Switch Fabric, Switch Fabric Topologies, Congestion Management, Flow Control and Traffic Management.	3	PO2, PO3
CO3	Analyze the problems, and explain, analyze, and evaluate Ethernet Data Rate Standards, Virtual Local Area Networks, Data Center Bridging.	4	PO2, PO3, PO4
CO4	Analyse Multi-tenant Environments, Traditional Network Tunneling Protocols, VXLAN, NVGRE, Tunnel Locations, Load Balancing Algorithms.	4	PO2, PO3, PO4

Syllabus

Introduction to Cloud Networking: Networking Basics, The network stack, Packets and frames, Network equipment, Interconnect, Cloud Data Center, Cloud Networking, Characteristics of Cloud Networking, Ethernet usage, Virtualization, Convergence, Scalability, Software. Data Center Evolution: Mainframes to the Cloud: The Data Center Evolution, Computer Networks, Ethernet, Enterprise versus Cloud Data Centers, Movement to the Cloud

Switch Fabric Technology: Switch Fabric Architecture Overview, Switch Fabric Topologies, Congestion Management, Flow Control, Traffic Management, Switch Chip Architecture Examples. Cloud Data Center Networking Topologies: Traditional Multitiered Enterprise Networks, Data Center Network Switch Types, Flat Data Center Networks, Rack Scale Architectures, Network Function Virtualization.

Data Center Networking Standards: Ethernet Data Rate Standards, Virtual Local Area Networks, Data Center Bridging, Improving Network Bandwidth, Remote Direct Memory Access. Server Virtualization and Networking: VM Overview, Virtual Switching, PCI Express, Edge Virtual Bridging, VM Migration

Network Virtualization: Multi-tenant Environments, Traditional Network Tunneling Protocols, VXLAN, NVGRE, Tunnel Locations, Load Balancing Software-Defined Networking: Data Center Software Background, OpenStack, OpenFlow, Network Function Virtualization, SDN Deployment.

Reference Books

- 1 cloud networking- understanding cloud-based data center networks, Gary Lee, 2014, Wiley.
- 2 Computer networks, Andrew Tanenbaum, 2010, PHI.
- 3 Data Center Virtualization Fundamentals: Understanding Techniques and Designs for Highly Efficient Data Centers with Cisco Nexus, UCS, MDS, and Beyond, Gustavo A. A. Santana, 2013, Cisco Press.
- 4 Data Center Networks: Topologies, Architectures and Fault-Tolerance Characteristics, Yang Zhou and Hao Wang, 2013, Springer.
- 5 Ethernet Switching and Routing in Data Centers, Donald A. Tepper, 2013, Wiley.

23CID3101A - CLOUD INFRASTRUCTURE ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3101A	CLOUD INFRASTRUCTURE ENGINEERING	CIE	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the fundamental concepts of cloud computing models and their applications in modern IT infrastructure	3	PO1, PSO1
CO2	Design and deploy scalable and resilient cloud architectures using virtualization, containerization, and cloud-native technologies.	3	PO1, PSO1
CO3	Utilize Infrastructure as Code (IaC) tools and best practices to automate the provisioning and management of cloud resources.	3	PO1, PO2, PSO1
CO4	Design and optimize cloud infrastructure for scalability, high availability, and cost efficiency.	3	PO2, PSO1
CO5	Monitor, troubleshoot, and optimize cloud infrastructure and applications using cloud-native monitoring and logging tools.	4	PO2, PSO1
CO6	Integrate cloud services with on-premises infrastructure to create hybrid solutions.	4	PO2, PSO1
CO7	Evaluate cloud security measures and implement best practices for data protection and compliance.	4	PO2, PSO1

Syllabus

Introduction to Cloud Computing: Overview of cloud computing models (IaaS, PaaS, SaaS), Benefits and challenges of cloud computing, Cloud service providers and their offerings, Case studies of cloud adoption in various industries

Cloud Infrastructure Fundamentals: Virtualization vs. containerization, Introduction to hypervisors and container runtimes, Managing virtual machines in the cloud, Container orchestration platforms (e.g., Kubernetes)

Infrastructure as Code (IaC): Introduction to Infrastructure as Code (IaC) concepts and tools, Using Terraform for infrastructure provisioning, Managing infrastructure configurations with Ansible, Best practices for IaC development and deployment

Scalability and High Availability: Designing scalable and resilient architectures, Auto-scaling and load balancing in the cloud, Implementing fault tolerance and disaster recovery strategies, Case studies of highly available cloud applications

Monitoring and Optimization: Monitoring cloud infrastructure and applications, Using cloud monitoring and logging services, Performance optimization techniques for cloud environments, Cost management and optimization strategies

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, 2013, Prentice Hall.
- 2 Infrastructure as Code: Managing Servers in the Cloud, Kief Morris, 2016, O'Reilly Media.
- 3 Google Cloud Platform in Action, JJ Geewax, Martin G?rner, and the Google Cloud Platform Team, 2018, Manning Publications.
- 4 Kubernetes: Up and Running, Kelsey Hightower, Brendan Burns, and Joe Beda, 2017, O'Reilly Media.
- 5 Terraform: Up & Running, Yevgeniy Brikman, 2017, O'Reilly Media.

23CID3101E - CLOUD INFRASTRUCTURE ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3101E	CLOUD INFRASTRUCTURE ENGINEERING	CIE	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the fundamental concepts of cloud computing models and their applications in modern IT infrastructure	3	PO1, PSO1
CO2	Design and deploy scalable and resilient cloud architectures using virtualization, containerization, and cloud-native technologies.	3	PO1, PSO1
CO3	Utilize Infrastructure as Code (IaC) tools and best practices to automate the provisioning and management of cloud resources.	3	PO2, PSO1
CO4	Design and optimize cloud infrastructure for scalability, high availability, and cost efficiency.	3	PO2, PSO1
CO5	Monitor, troubleshoot, and optimize cloud infrastructure and applications using cloud-native monitoring and logging tools.	4	PO2, PSO1
CO6	Integrate cloud services with on-premises infrastructure to create hybrid solutions.	4	PO2, PSO1
CO7	Evaluate cloud security measures and implement best practices for data protection and compliance.	4	PO2, PSO1

Syllabus

Introduction to Cloud Computing: Overview of cloud computing models (IaaS, PaaS, SaaS), Benefits and challenges of cloud computing, Cloud service providers and their offerings, Case studies of cloud adoption in various industries.

Cloud Infrastructure Fundamentals: Virtualization vs. containerization, Introduction to hypervisors and container runtimes, Managing virtual machines in the cloud, Container orchestration platforms (e.g., Kubernetes).

Infrastructure as Code (IaC): Introduction to Infrastructure as Code (IaC) concepts and tools, Using Terraform for infrastructure provisioning, Managing infrastructure configurations with Ansible, Best practices for IaC development and deployment.

Scalability and High Availability: Designing scalable and resilient architectures, Auto-scaling and load balancing in the cloud, Implementing fault tolerance and disaster recovery strategies, Case studies of highly available cloud

Monitoring and Optimization: Monitoring cloud infrastructure and applications, Using cloud monitoring and logging services, Performance optimization techniques for cloud environments, Cost management and optimization strategies

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, 2013, Prentice Hall.
- 2 Infrastructure as Code: Managing Servers in the Cloud, Kief Morris, 2016, O'Reilly Media.
- 3 Google Cloud Platform in Action, JJ Geewax, Martin Grner, and the Google Cloud Platform Team, 2018, Manning Publications.
- 4 Kubernetes: Up and Running, Kelsey Hightower, Brendan Burns, and Joe Beda, 2017, O'Reilly Media.
- 5 Terraform: Up & Running, Yevgeniy Brikman, 2017, O'Reilly Media.

23CID3101R - CLOUD INFRASTRUCTURE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3101R	CLOUD INFRASTRUCTURE ENGINEERING	CIE	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the fundamental concepts of cloud computing models and their applications in modern IT infrastructure	3	PO1, PSO1
CO2	Design and deploy scalable and resilient cloud architectures using virtualization, containerization, and cloud-native technologies.	3	PO1, PSO1
CO3	Utilize Infrastructure as Code (IaC) tools and best practices to automate the provisioning and management of cloud resources.	3	PO1, PSO1
CO4	Design and optimize cloud infrastructure for scalability, high availability, and cost efficiency.	3	PO2, PSO1
CO5	Monitor, troubleshoot, and optimize cloud infrastructure and applications using cloud-native monitoring and logging tools.	4	PO2, PSO1
CO6	Integrate cloud services with on-premises infrastructure to create hybrid solutions.	4	PO2, PSO1
CO7	Evaluate cloud security measures and implement best practices for data protection and compliance.	4	PO2, PSO1

Syllabus

Introduction to Cloud Computing: Overview of cloud computing models (IaaS, PaaS, SaaS), Benefits and challenges of cloud computing, Cloud service providers and their offerings, Case studies of cloud adoption in various industries

Cloud Infrastructure Fundamentals: Virtualization vs. containerization, Introduction to hypervisors and container runtimes, Managing virtual machines in the cloud, Container orchestration platforms (e.g., Kubernetes)

Infrastructure as Code (IaC): Introduction to Infrastructure as Code (IaC) concepts and tools, Using Terraform for infrastructure provisioning, Managing infrastructure configurations with Ansible, Best practices for IaC development and deployment

Scalability and High Availability: Designing scalable and resilient architectures, Auto-scaling and load balancing in the cloud, Implementing fault tolerance and disaster recovery strategies, Case studies of highly available cloud applications

Monitoring and Optimization: Monitoring cloud infrastructure and applications, Using cloud monitoring and logging services, Performance optimization techniques for cloud environments, Cost management and optimization strategies

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, 2013, Prentice Hall.
- 2 Infrastructure as Code: Managing Servers in the Cloud, Kief Morris, 2016, O'Reilly Media.
- 3 Google Cloud Platform in Action, JJ Geewax, Martin G?rner, and the Google Cloud Platform Team, 2018, Manning Publications.
- 4 Kubernetes: Up and Running, Kelsey Hightower, Brendan Burns, and Joe Beda, 2017, O'Reilly Media.

23CID3202A - ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3202A	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	ECT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Assess the benefits and challenges of cloud adoption	2	PO1, PSO1
CO2	Analyze the evolution of Enterprise cloud computing	4	PO1, PO3, PSO1
CO3	Apply cloud-native principles and best practices in Devops	3	PO2, PO3, PSO1
CO4	Evaluate the Data encryption and compliance requirements related to ERP and CRM Applications	5	PO2, PO4, PSO1
CO5	Deploy and manage applications in the cloud infrastructure using a public cloud provider	5	PO4, PSO1

Syllabus

Definition and characteristics of cloud computing, Evolution of cloud computing, Benefits and challenges of cloud adoption, Cloud service models: IaaS, PaaS, SaaS, Cloud Deployment Models: Public cloud, private cloud, hybrid cloud, Community cloud, Choosing the right deployment model for enterprise needs.

Evolution of enterprise cloud computing, Benefits and challenges of cloud adoption in the enterprise, Hardware virtualization vs. containerization, Hypervisor technologies (e.g., VMware, Hyper-V), Container orchestration platforms (e.g., Kubernetes, Docker Swarm)

Cloud architecture layers: Infrastructure, Platform, Software, Scalability, elasticity, and resilience, Virtualization and containerization technologies, Cloud-native principles and best practices, Microservices architecture, DevOps and Continuous Integration/Continuous Deployment (CI/CD)

Cloud Security and Compliance: Threat landscape in the cloud, Identity and access management (IAM), Data encryption and compliance requirements, ERP and CRM in the cloud, Big Data and Analytics, Internet of Things (IoT) applications, Real-world examples of enterprise cloud adoption

Setting up cloud infrastructure using a public cloud provider (e.g., AWS, Azure, Google Cloud), Deploying and managing applications in the cloud, Project: Design and implement a cloud-based solution for a simulated enterprise scenario

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood., 1, The Pearson Service Technology Series from Thomas Erl.
- 2 Cloud Computing: From Beginning to End, Ray J. Rafaels, revised, CreateSpace Independent Publishing Platform, 2015.
- 3 Cloud Native Patterns: Designing Change-tolerant Software, Cornelia Davis, First Edition , Manning.
- 4 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 1st edition, Wiley CIO.
- 5 Cloud Native Infrastructure, Justin Garrison, Kris Nova, 1, O'Reilly Media, Inc..

23CID3202E - ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3202E	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	ECT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Assess the benefits and challenges of cloud adoption	2	PO1, PSO1
CO2	Analyze the evolution of Enterprise cloud computing	4	PO1, PO3, PSO1
CO3	Apply cloud-native principles and best practices in Devops	3	PO2, PO3, PSO1
CO4	Evaluate the Data encryption and compliance requirements related to ERP and CRM Applications	5	PO2, PO4, PSO1
CO5	Deploy and manage applications in the cloud infrastructure using a public cloud provider	5	PO4, PSO1

Syllabus

Definition and characteristics of cloud computing, Evolution of cloud computing, Benefits and challenges of cloud adoption, Cloud service models: IaaS, PaaS, SaaS, Cloud Deployment Models: Public cloud, private cloud, hybrid cloud, Community cloud, Choosing the right deployment model for enterprise needs.

Evolution of enterprise cloud computing, Benefits and challenges of cloud adoption in the enterprise, Hardware virtualization vs. containerization, Hypervisor technologies (e.g., VMware, Hyper-V), Container orchestration platforms (e.g., Kubernetes, Docker Swarm)

Cloud architecture layers: Infrastructure, Platform, Software, Scalability, elasticity, and resilience, Virtualization and containerization technologies, Cloud-native principles and best practices, Microservices architecture, DevOps and Continuous Integration/Continuous Deployment (CI/CD)

Cloud Security and Compliance: Threat landscape in the cloud, Identity and access management (IAM), Data encryption and compliance requirements, ERP and CRM in the cloud, Big Data and Analytics, Internet of Things (IoT) applications, Real-world examples of enterprise cloud adoption

Setting up cloud infrastructure using a public cloud provider (e.g., AWS, Azure, Google Cloud), Deploying and managing applications in the cloud, Project: Design and implement a cloud-based solution for a simulated enterprise scenario

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood., 1, The Pearson Service Technology Series from Thomas Erl.
- 2 Cloud Computing: From Beginning to End, Ray J. Rafaels, revised, CreateSpace Independent Publishing Platform, 2015.
- 3 Cloud Native Patterns: Designing Change-tolerant Software, Cornelia Davis, First Edition , Manning.
- 4 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 1st edition, Wiley CIO.
- 5 Cloud Native Infrastructure, Justin Garrison, Kris Nova, 1, O'Reilly Media, Inc..

23CID3202R - ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3202R	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	ECT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Assess the benefits and challenges of cloud adoption	2	PO1, PSO1
CO2	Analyze the evolution of Enterprise cloud computing	4	PO1, PO3, PSO1
CO3	Apply cloud-native principles and best practices in Devops	3	PO2, PO3, PSO1
CO4	Evaluate the Data encryption and compliance requirements related to ERP and CRM Applications	5	PO2, PO4, PSO1

Syllabus

Definition and characteristics of cloud computing, Evolution of cloud computing, Benefits and challenges of cloud adoption, Cloud service models: IaaS, PaaS, SaaS, Cloud Deployment Models: Public cloud, private cloud, hybrid cloud, Community cloud, Choosing the right deployment model for enterprise needs.

Evolution of enterprise cloud computing, Benefits and challenges of cloud adoption in the enterprise, Hardware virtualization vs. containerization, Hypervisor technologies (e.g., VMware, Hyper-V), Container orchestration platforms (e.g., Kubernetes, Docker Swarm)

Cloud architecture layers: Infrastructure, Platform, Software, Scalability, elasticity, and resilience, Virtualization and containerization technologies, Cloud-native principles and best practices, Microservices architecture, DevOps and Continuous Integration/Continuous Deployment (CI/CD)

Cloud Security and Compliance: Threat landscape in the cloud, Identity and access management (IAM), Data encryption and compliance requirements, ERP and CRM in the cloud, Big Data and Analytics, Internet of Things (IoT) applications, Real-world examples of enterprise cloud adoption

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood., 1, The Pearson Service Technology Series from Thomas Erl.
- 2 Cloud Computing: From Beginning to End, Ray J. Rafaels, revised, CreateSpace Independent Publishing Platform, 2015.
- 3 Cloud Native Patterns: Designing Change-tolerant Software, Cornelia Davis, First Edition, Manning.
- 4 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 1st edition, Wiley CIO.

23CID3203A - ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3203A	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	AHASCE	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify and Understand the key principles and concepts of cloud architecture.	2	PO1, PO2
CO2	Design highly available and fault-tolerant cloud infrastructures.	6	PO1, PO2, PO3
CO3	Implement scalable solutions for handling variable workloads in the cloud.	3	PO1, PO2, PO3
CO4	Evaluate and Optimize the performance and cost-efficiency of cloud-based systems.	5	PO3, PSO2
CO5	Evaluate and select appropriate cloud services and technologies for specific use cases.	5	PO1, PO2, PO3

Syllabus

Introduction to Cloud Architecture: Overview of cloud computing models, Fundamental concepts of cloud architecture, Principles of scalability and high availability, Case studies of cloud architecture patterns

Designing Highly Available Cloud Infrastructures; Strategies for fault tolerance and redundancy, Architectural patterns for high availability, Implementing disaster recovery solutions in the cloud, Case studies of highly available cloud architectures

Scaling Cloud Environments: Techniques for horizontal and vertical scaling, Auto-scaling and elasticity in cloud environments, Designing for scalability in distributed systems, Performance optimization strategies

Optimizing Performance and Cost-Efficiency: Monitoring and performance tuning in the cloud, Cost analysis and optimization techniques, Implementing resource management strategies, Case studies of performance optimization in cloud environments

Cloud Service Selection and Evaluation: Overview of cloud service providers and offerings, Criteria for evaluating cloud services, Architectural considerations for service selection, Hands-on exercises in evaluating and comparing cloud services

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2013, Prentice Hall.
- 2 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 2014, Wiley.
- 3 Cloud Native Architectures: Design high-availability and cost-effective applications for the cloud, Tom Laszewski, Kamal Arora, and Erik Farr, 2018, Packt.
- 4 Scalability Rules: 50 Principles for Scaling Web Sites, Martin L. Abbott and Michael T. Fisher, 2011, Pearson.
- 5 Building Scalable Web Sites: Building, Scaling, and Optimizing the Next Generation of Web Applications, Cal Henderson, 2006, O'Reilly.
- 6 The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations, Gene Kim, Jez Humble, Patrick Debois, and John Willis, 2nd Ed, 2021, It Revolution Press.

23CID3203E - ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3203E	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	AHASCE	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify and understand the key principles and concepts of cloud architecture.	2	PO1, PO3, PO5
CO2	Design highly available and fault-tolerant cloud infrastructures.	6	PO1, PO3, PO4
CO3	Implement scalable solutions for handling variable workloads in the cloud.	3	PO3, PO4, PO5, PSO1
CO4	Evaluate and optimize the performance and cost-efficiency of cloud-based systems.	5	PO1, PO4, PO5
CO5	Evaluate and select appropriate cloud services and technologies for specific use cases.	5	PO1, PO3

Syllabus

Introduction to Cloud Architecture: Overview of cloud computing models, Fundamental concepts of cloud architecture, Principles of scalability and high availability, Case studies of cloud architecture patterns

Designing Highly Available Cloud Infrastructures: Strategies for fault tolerance and redundancy, Architectural patterns for high availability, Implementing disaster recovery solutions in the cloud, Case studies of highly available cloud architectures

Scaling Cloud Environments: Techniques for horizontal and vertical scaling, Auto-scaling and elasticity in cloud environments, Designing for scalability in distributed systems, Performance optimization strategies

Optimizing Performance and Cost-Efficiency: Monitoring and performance tuning in the cloud, Cost analysis and optimization techniques, Implementing resource management strategies, Case studies of performance optimization in cloud environments

Cloud Service Selection and Evaluation: Overview of cloud service providers and offerings, Criteria for evaluating cloud services, Architectural considerations for service selection, Hands-on exercises in evaluating and comparing cloud services

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2013, Prentice Hall.
- 2 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 2014 , Wiley.
- 3 Cloud Native Architectures: Design high-availability and cost-effective applications for the cloud, Tom Laszewski, Kamal Arora, and Erik Farr, 2018 , Packt.
- 4 Scalability Rules: 50 Principles for Scaling Web Sites, Martin L. Abbott and Michael T. Fisher, 2011 , Pearson.
- 5 Building Scalable Web Sites: Building, Scaling, and Optimizing the Next Generation of Web Applications, Cal Henderson, 2006, O'Reilly.
- 6 The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations, Gene Kim, Jez Humble, Patrick Debois, and John Willis, 2nd Ed, 2021, It Revolution Press.

23CID3203R - ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3203R	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	AHASCE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify and understand the key principles and concepts of cloud architecture.	2	PO1
CO2	Design highly available and fault-tolerant cloud infrastructures.	6	PO1, PO2, PO3
CO3	Implement scalable solutions for handling variable workloads in the cloud.	3	PO1, PO2, PO3, PSO1
CO4	Evaluate and optimize the performance and cost-efficiency of cloud-based systems.	5	PO1, PO2, PO3

Syllabus

Introduction to Cloud Architecture: Overview of cloud computing models, Fundamental concepts of cloud architecture, Principles of scalability and high availability, Case studies of cloud architecture patterns

Designing Highly Available Cloud Infrastructures: Strategies for fault tolerance and redundancy, Architectural patterns for high availability, Implementing disaster recovery solutions in the cloud, Case studies of highly available cloud architectures

Scaling Cloud Environments: Techniques for horizontal and vertical scaling, Auto-scaling and elasticity in cloud environments, Designing for scalability in distributed systems, Performance optimization strategies

Optimizing Performance and Cost-Efficiency: Monitoring and performance tuning in the cloud, Cost analysis and optimization techniques, Implementing resource management strategies, Case studies of performance optimization in cloud environments

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood , 2013, Prentice Hall.
- 2 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis , 2014 , Wiley.
- 3 Cloud Native Architectures: Design high-availability and cost-effective applications for the cloud, Tom Laszewski, Kamal Arora, and Erik Farr, 2018 , Packt.
- 4 Scalability Rules: 50 Principles for Scaling Web Sites, Martin L. Abbott and Michael T. Fisher, 2011 , Pearson.
- 5 Building Scalable Web Sites: Building, Scaling, and Optimizing the Next Generation of Web Applications, Cal Henderson , 2006, O'Reilly.
- 6 The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations, Gene Kim, Jez Humble, Patrick Debois, and John Willis, 2nd Ed, 2021, It Revolution Press.

23CID3304A - CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3304A	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	CIA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Cloud Computing Fundamentals	2	PO3, PSO1
CO2	Interpreting Cloud Infrastructure Components	2	PO3, PSO1
CO3	Designing Scalable and Resilient Cloud Architectures	3	PO4, PSO1
CO4	Applying Security and Compliance in the Cloud	3	PO4, PSO1
CO5	Automating Infrastructure Deployment and Management	3	PO5, PSO1
CO6	Calculating Performance and Cost Efficiency	4	PO5, PSO1
CO7	Manage Cloud Security and Identity	4	PO5, PSO1

Syllabus

Overview of cloud computing concepts, Evolution of cloud computing models (IaaS, PaaS, SaaS), Cloud deployment models (public, private, hybrid, multi-cloud), Benefits and challenges of cloud computing, Case studies of successful cloud implementations

Understanding cloud infrastructure components, Virtualization and containerization technologies, Compute resources (Virtual Machines, Containers, Serverless), Storage solutions (Object Storage, Block Storage, File Storage), Networking fundamentals in the cloud (Virtual Networks, Load Balancers, CDN)

Principles of cloud-native architecture, Scalability, elasticity, and high availability, Microservices architecture and container orchestration (e.g., Kubernetes), Serverless computing and event-driven architecture, Designing for resilience and fault tolerance

Cloud security best practices and frameworks (e.g., CSA, NIST), Identity and access management (IAM) in the cloud, Data encryption and key management, Network security and segmentation, Compliance requirements and regulatory considerations

Infrastructure as Code (IaC) concepts and tools (e.g., Terraform, Ansible), Configuration management and automation, Continuous integration and continuous deployment (CI/CD) pipelines, Monitoring, logging, and alerting in the cloud environment, DevOps principles and practices

Cloud governance frameworks and best practices, Resource tagging and cost allocation, Cloud billing and budgeting, Performance optimization and cost management, Cloud service level agreements (SLAs) and support options

Strategies for cloud migration (lift-and-shift, re-platforming, re-architecting), Assessing workload suitability for the cloud, Hybrid cloud architectures and connectivity options, Data migration strategies and tools, Cost management and optimization during migration

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Published in 2013, Prentice Hall.
- 2 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison, Kris Nova, Published in 2017, O'Reilly Media.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, Published in 2014, Wiley.

- 4 Mastering Cloud Computing: Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Published in 2013, Morgan Kaufmann.
- 5 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, Published in 2009, O'Reilly Media.

23CID3304E - CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3304E	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	CIA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Cloud Computing Fundamentals	2	PO1, PO2, PO3, PSO1
CO2	Interpreting Cloud Infrastructure Components	2	PO1, PO2, PO3, PSO1
CO3	Designing Scalable and Resilient Cloud Architectures	3	
CO4	Applying Security and Compliance in the Cloud	3	
CO5	Automating Infrastructure Deployment and Management	3	
CO6	Calculating Performance and Cost Efficiency	4	
CO7	Manage Cloud Security and Identity	4	

Syllabus

Overview of cloud computing concepts, Evolution of cloud computing models (IaaS, PaaS, SaaS), Cloud deployment models (public, private, hybrid, multi-cloud), Benefits and challenges of cloud computing, Case studies of successful cloud implementations

Understanding cloud infrastructure components, Virtualization and containerization technologies, Compute resources (Virtual Machines, Containers, Serverless), Storage solutions (Object Storage, Block Storage, File Storage), Networking fundamentals in the cloud (Virtual Networks, Load Balancers, CDN)

Principles of cloud-native architecture, Scalability, elasticity, and high availability, Microservices architecture and container orchestration (e.g., Kubernetes), Serverless computing and event-driven architecture, Designing for resilience and fault tolerance

Cloud security best practices and frameworks (e.g., CSA, NIST), Identity and access management (IAM) in the cloud, Data encryption and key management, Network security and segmentation, Compliance requirements and regulatory considerations

Infrastructure as Code (IaC) concepts and tools (e.g., Terraform, Ansible), Configuration management and automation, Continuous integration and continuous deployment (CI/CD) pipelines, Monitoring, logging, and alerting in the cloud environment, DevOps principles and practices

Cloud governance frameworks and best practices, Resource tagging and cost allocation, Cloud billing and budgeting, Performance optimization and cost management, Cloud service level agreements (SLAs) and support options

Strategies for cloud migration (lift-and-shift, re-platforming, re-architecting), Assessing workload suitability for the cloud, Hybrid cloud architectures and connectivity options, Data migration strategies and tools, Cost management and optimization during migration

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Published in 2013, Prentice Hall.
- 2 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison, Kris Nova, Published in 2017, O'Reilly Media.

- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, Published in 2014, Wiley.
- 4 Mastering Cloud Computing: Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Published in 2013, Morgan Kaufmann.
- 5 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, Published in 2009, O'Reilly Media.

23CID3304R - CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3304R	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	CIA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Cloud Computing Fundamentals	2	PO3, PSO1
CO2	Interpreting Cloud Infrastructure Components	2	PO3, PSO1
CO3	Designing Scalable and Resilient Cloud Architectures	3	PO4, PSO1
CO4	Applying Security and Compliance in the Cloud	3	PO4, PSO1
CO5	Automating Infrastructure Deployment and Management	4	PO5, PSO1
CO6	Calculating Performance and Cost Efficiency	4	PO5, PSO1

Syllabus

Overview of cloud computing concepts, Evolution of cloud computing models (IaaS, PaaS, SaaS), Cloud deployment models (public, private, hybrid, multi-cloud), Benefits and challenges of cloud computing, Case studies of successful cloud implementations

Understanding cloud infrastructure components, Virtualization and containerization technologies, Compute resources (Virtual Machines, Containers, Serverless), Storage solutions (Object Storage, Block Storage, File Storage), Networking fundamentals in the cloud (Virtual Networks, Load Balancers, CDN)

Principles of cloud-native architecture, Scalability, elasticity, and high availability, Microservices architecture and container orchestration (e.g., Kubernetes), Serverless computing and event-driven architecture, Designing for resilience and fault tolerance

Cloud security best practices and frameworks (e.g., CSA, NIST), Identity and access management (IAM) in the cloud, Data encryption and key management, Network security and segmentation, Compliance requirements and regulatory considerations

Infrastructure as Code (IaC) concepts and tools (e.g., Terraform, Ansible), Configuration management and automation, Continuous integration and continuous deployment (CI/CD) pipelines, Monitoring, logging, and alerting in the cloud environment, DevOps principles and practices

Cloud governance frameworks and best practices, Resource tagging and cost allocation, Cloud billing and budgeting, Performance optimization and cost management, Cloud service level agreements (SLAs) and support options

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Published in 2013, Prentice Hall.
- 2 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison, Kris Nova, Published in 2017, O'Reilly Media.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, Published in 2014, Wiley.
- 4 Mastering Cloud Computing: Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Published in 2013, Morgan Kaufmann.
- 5 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, Published in 2009, O'Reilly Media.

23CID3405M - RELIABLE CLOUD INFRASTRUCTURE: DESIGN & PROCESS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3405M	RELIABLE CLOUD INFRASTRUCTURE: DESIGN & PROCESS	RID	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the principles behind different design patterns for building reliable cloud infrastructure on Google Cloud Platform (GCP).	2	PO2
CO2	Apply design patterns for building reliable and scalable cloud infrastructure on GCP.	3	PO3
CO3	Apply the Design patterns to practical scenarios by designing and implementing secure, highly available, and cost-effective cloud deployments on GCP.	3	PO2
CO4	Analyze the trade-offs between different design choices considering factors like cost, performance, and security.	4	PO4, PSO2

Syllabus

Introduction to Reliable Cloud Infrastructure Design: Business Requirements Analysis and Mapping to Technical Solutions, Google Cloud Platform (GCP) Overview and Key Services, Design Patterns for Reliable and Scalable Cloud Infrastructure.

Building Highly Available Infrastructure: Network Design and Load Balancing Strategies, Storage Solutions for Different Use Cases, High Availability and Disaster Recovery Techniques, Monitoring and Alerting for Infrastructure Health.

Performance Optimization and Scalability: Defining Service Level Objectives (SLOs) and Service Level Agreements, Scaling Strategies for Compute Resources, Cost Optimization Techniques for Cloud Infrastructure

DevOps Principles for Cloud Infrastructure: Continuous Integration and Continuous Delivery (CI/CD) Pipelines, Automating Infrastructure Deployment and Management, Infrastructure Version Control and Change Management.

Principles of Microservices Architecture: Designing Microservices for Scalability and Maintainability, Integrating Microservices with Cloud Services and APIs.

Security Best Practices for Cloud Infrastructure: Identity and Access Management (IAM) in GCP, Data Security and Encryption Techniques, Compliance Considerations for Cloud Deployments.

Reference Books

- 1 Site Reliability Engineering: How Google Runs Production Systems, Niall Richard Murphy, Betsy Beyer, Chris Jones, and Jennifer Petoff, 2016, O'Reilly.
- 2 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison and Kris Nova, 2017, O'Reilly.
- 3 The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations, Gene Kim, Patrick Debois, John Willis, and Jez Humble, 2016, IT Revolution.
- 4 Building Secure and Reliable Systems: Best Practices for Designing, Implementing, and Maintaining Systems, Heather Adkins, Betsy Beyer, Paul Blankinship, Ana Oprea, and Piotr Lewandowski, 2020, O'Reilly.

23CID3406M - HYBRID CLOUD INTEGRATION AND MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3406M	HYBRID CLOUD INTEGRATION AND MANAGEMENT	HCIM	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of hybrid cloud architecture, including its components and advantages	2	PO1, PO4, PO7, PSO1
CO2	Apply different hybrid cloud deployment models and their suitability for various organizational needs.	3	PO1, PO4, PO11, PSO1
CO3	Identify hybrid cloud monitoring and management tools, including cloud management platforms (CMPs) for monitoring cloud solutions	3	PO1, PO11, PSO2
CO4	Analyze the security risks and compliance issues associated with hybrid cloud environments and develop mitigation strategies.	4	PO4, PO7, PSO2

Syllabus

Overview of cloud computing models, Key characteristics of cloud computing, Hybrid cloud architecture and components, Benefits and challenges of hybrid cloud, Integration of public and private clouds, Leading public cloud providers (AWS, Azure, Google Cloud)

Hybrid cloud networking fundamentals Connectivity options: VPNs, direct connects, Hybrid networking, Configuring hybrid cloud connectivity, Benefits and challenges of hybrid clouds, Managing and orchestrating multi-cloud deployments

Cloud management platforms (CMPs) for hybrid cloud Infrastructure as code (IaC) and automation tools DevOps practices in hybrid cloud environments, Common issues and challenges in hybrid cloud deployments, Best practices for managing hybrid cloud environments

Security considerations in hybrid cloud environments, Identity and access management (IAM), Data protection and compliance requirements, Resource allocation and workload placement strategies, Load balancing and auto-scaling in hybrid environments, Monitoring hybrid cloud performance

Reference Books

- 1 Hybrid Cloud Integration and Management: Concepts, Strategies, and Best Practices, John Smith, Emily Johnson, 2, 2023, Wiley.
- 2 Mastering Hybrid Cloud Integration, Michael Miller, 1, 2023, Packt Publishing.
- 3 Hybrid Cloud for Architects: Build robust hybrid cloud solutions using AWS and Azure, Mohamed Wali, 1,2018, Packt Publishing.
- 4 Hybrid Cloud Management with Red Hat CloudForms, Peter McGowan, 1,2015, Packt Publishing.
- 5 Implementing Azure Solutions: Implement hybrid cloud solutions using Azure services, 3rd Edition, Florian Klaffenbach, Jan-Henrik Damaschke, 3, 2020, Packt Publishing.

23CID3507 - CLOUD ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3507	CLOUD ENGINEERING	CE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Ability to explain various concepts, architectures and deployment models relating to the cloud computing technologies	2	PO1, PO2, PO5
CO2	Understand the fundamentals of cloud, cloud Architectures and types of services in cloud	2	PO3, PS01
CO3	Apply the concept of virtualization and how this has enabled the development of Cloud Computing	3	
CO4	Design different sample applications using IaaS, PaaS and SaaS deployment Model	3	PO2, PO3, PO5, PS01

Syllabus

Introduction to Cloud Computing: meaning of Cloud Computing, variations of cloud computing from other models, Essential Characteristics, Technological Influences. Cloud Computing Architecture

Cloud Computing Architecture, the three deployment models IaaS, PaaS, SaaS, and Types of clouds, CLOUD INFRASTRUCTURE, Architectural Design of Compute and Storage Clouds, Layered Cloud Architecture Development

Cloud Infrastructure and Virtualization, Community cloud and multicloud strategies Cloud migration considerations and challenges, Virtualization technologies, Cloud computing infrastructure components

Storage as a service, Examples Applications: Amazon EC2, Google Drive, OneDrive, Dropbox. Developing applications Using IaaS. Platform as a Service, Introduction to PaaS: What is PaaS, Service Oriented Architecture, Cloud Platform and Management, Computation, Storage, Examples, Google App Engine, Microsoft Azure, Salesforce.com, Force.com platforms. Developing applications using PaaS. Software as a Service SaaS, Introduction to SaaS, Web services, Web 2.0, Web OS

Reference Books

- 1 Cloud Computing, Sandeep Bhowmik, 2017, CAMBRIDGE.
- 2 Cloud Computing, Nayan B. Ruparelia, 2016, The MIT Press Essential Knowledge Series.
- 3 "Cloud Computing: Concepts, Technology & Architecture", Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, 2013, Prentice Hall.
- 4 "Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS)", Michael J. Kavis, 2014, Wiley.
- 5 "Cloud Computing: A Hands-On Approach", Arshdeep Bahga and Vijay Madisetti, 2013, CreateSpace Independent Publishing Platform.

23CID3508 - CLOUD DATA MANAGEMENT AND STORAGE SOLUTIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CID3508	CLOUD DATA MANAGEMENT AND STORAGE SOLUTIONS	CDMSS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the the foundational aspects of cloud data management. They will begin by exploring the fundamental principles of cloud computing	2	PO2
CO2	Analyze advanced cloud storage technologies, including object and block storage, as well as distributed file systems	4	PO2
CO3	Analyze advanced data management strategies and their application in cloud environments	4	PO1
CO4	Evaluate security measures and compliance considerations in cloud data management	4	PO1, PO3, PO5, PS01

Syllabus

Fundamentals of Cloud Data Management : Introduction to cloud computing Importance of data management in cloud environments Overview of cloud storage architectures Key challenges and considerations in cloud data management

Cloud Storage Architectures Understanding different cloud storage models: object storage, block storage, and file storage. Comparison of cloud storage architectures based on scalability, performance, and cost. Case studies illustrating real-world applications of cloud storage solutions.

Advanced Data Management Strategies Data lifecycle management: collection, storage, processing, and analysis of data in the cloud. Data replication and synchronization techniques for ensuring data availability and consistency. Backup and disaster recovery strategies for mitigating data loss and downtime in cloud environments.

Security and Compliance in Cloud Data Management Overview of security challenges and threats in cloud computing. Encryption techniques for protecting data at rest and in transit. Compliance frameworks and regulations governing data privacy and security in the cloud.

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2013, Prentice Hall.
- 2 Cloud Essentials: CompTIA Authorized Courseware for Exam CLO-001, Kalani Kirk Hausman and Susan L. Cook, 2013, Sybex.
- 3 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, and Andrzej M. Goscinski, 2011, Wiley.
- 4 Cloud Data Management, Liang Zhao, Hong Mei, Jiangchuan Liu, 2014, Springer.

23CNE3101A - FOUNDATIONS OF CLOUD NATIVE COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3101A	FOUNDATIONS OF CLOUD NATIVE COMPUTING	FCNC	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the fundamentals of Cloud Computing Basics and Cloud Native Computing of cloud.	2	
CO2	Analyze and realize the architecture of Containerization and Orchestration of the cloud	4	PO1
CO3	Evaluate the design of Cloud Native Application Development with respect to cloud applications	5	PO2
CO4	Develop DevOps and CI/CD (Continuous Integration and Continuous Delivery) in Cloud Native Environments.	3	PO1, PO3, PS01
CO5	Illustrate Advanced Cloud Native Concepts and Case Studies	2	PO2, PO3
CO6	Inspect the emerging trends of cloud native technologies	3	
CO7	Examine the applications with respect to sample case study	4	

Syllabus

Overview of Cloud Native Computing: Definition and principles Benefits and challenges Cloud Computing Basics Cloud service models IaaS, PaaS, SaaS, Cloud deployment models Public, Private, Hybrid, Multi-cloud, Key Cloud Providers AWS, Azure, Google Cloud Platform, IBM Cloud, etc. Virtualization and Containers: Virtual Machines vs. Containers. Microservices Architecture Monolithic vs. Microservices, Benefits of microservices, Design patterns for microservice

Containerization and Orchestration: Docker architecture , Docker commands and Dockerfile, Managing Docker containers. Container Orchestration Introduction to Kubernetes, Kubernetes architecture, Key concepts: Pods, Nodes, Services, Deployments Kubernetes Management ConfigMaps and Secrets, Persistent storage in Kubernetes

Cloud Native Application Development :Designing Cloud Native Applications 12-Factor App methodology, Resiliency and scalability patterns, API Gateway and Management: API Gateway concepts, Service Discovery and Load Balancing: Principles of service discovery, Load balancing techniques Security in Cloud Native Applications: Securing APIs and microservices, Identity and access management, Best practices for container security

DevOps and CI/CD in Cloud Native Environments: DevOps Principles and Practices, Culture of DevOps, Key practices: CI, CD, Infrastructure as Code (IaC), CI/CD Tools and Pipelines: Jenkins, GitLab CI, CircleCI, Building a CI/CD pipeline for cloud-native applications Infrastructure as Code (IaC): Introduction to Terraform and AWS CloudFormation, Managing infrastructure using IaC, Monitoring and Logging: Importance of monitoring in cloud-native environment

Advanced Cloud Native Concepts and Case Studies: Serverless Computing: Introduction to serverless architecture, AWS Lambda, Azure Functions, Google Cloud Functions, Cloud Native Data Management: Databases in cloud-native environments: NoSQL, NewSQL, Data storage and management strategies. Case Studies: Real-world examples of cloud-native implementations

Reference Books

- 1 Cloud Native Patterns: Designing change-tolerant software, Cornelia Davis, 2016, Manning.
- 2 Kubernetes Up & Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 2017, O'Reilly Media, Inc..
- 3 The DevOps Handbook, Gene Kim, Patrick Debois, John Willis, and Jez Humble, 2016, IT Revolution Press.
- 4 Essentials of cloud Computing, K. Chandrasekhran, 2nd Edition 2014, CRC Press.

- 5 Distributed and Cloud Computing, Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra MK, 2013, Morgan Kaufmann.
- 6 Mastering Cloud Computing, Foundations and Application Programming, Raj Kumar Buyya, Christen vecctiola, S Tammaraiselvi,, 2013 , TMH.

23CNE3101E - FOUNDATIONS OF CLOUD NATIVE COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3101E	FOUNDATIONS OF CLOUD NATIVE COMPUTING	FCNC	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the fundamentals of Cloud Computing Basics and Cloud Native Computing of cloud.	2	, PSO2
CO2	Analyze and realize the architecture of Containerization and Orchestration of the cloud	4	PO1, PO2
CO3	Determine the design of Cloud Native Application Development with respect to cloud applications	5	PO3
CO4	Develop DevOps and CI/CD (Continuous Integration and Continuous Delivery) in Cloud Native Environments.	3	PO1, PO2, PO3
CO5	Build Advanced Cloud Native Concepts and Case Studies	3	
CO6	Examine the emerging trends of cloud native technologies	4	
CO7	Discover and understand the applications with respect to sample case study	4	

Syllabus

Overview of Cloud Native Computing: Definition and principles, Benefits and challenges Cloud Computing Basics: Cloud service models: IaaS, PaaS, SaaS, Cloud deployment models: Public, Private, Hybrid, Multi-cloud, Key Cloud Providers: AWS, Azure, Google Cloud Platform, IBM Cloud, etc. Virtualization and Containers: Virtual Machines vs. Containers. Microservices Architecture

Containerization and Orchestration: Docker architecture , Docker commands and Dockerfile, Managing Docker containers. Container Orchestration: Introduction to Kubernetes, Kubernetes architecture,

Cloud Native Application Development :Designing Cloud Native Applications 12-Factor App methodology, Resiliency and scalability patterns, API Gateway and Management: API Gateway concepts, Service Discovery and Load Balancing: Principles of service discovery, Load balancing techniques

DevOps and CI/CD in Cloud Native Environments: DevOps Principles and Practices, Culture of DevOps, Key practices: CI, CD, Infrastructure as Code (IaC), CI/CD Tools and Pipelines: Jenkins, GitLab CI, CircleCI, Building a CI/CD pipeline for cloud-native applications Infrastructure as Code (IaC): Introduction to Terraform and AWS CloudFormation, Managing infrastructure using IaC,

Advanced Cloud Native Concepts and Case Studies: Serverless Computing: Introduction to serverless architecture, AWS Lambda, Azure Functions, Google Cloud Functions, Cloud Native Data Management: Databases in cloud-native environments: NoSQL, NewSQL, Data storage and management strategies. Case Studies: Real-world examples of cloud-native implementations

Reference Books

- 1 Cloud Native Patterns: Designing change-tolerant software, Cornelia Davis, 1st Edition Kindle Edition, Manning.
- 2 Kubernetes Up & Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 1st Edition, 2017, O'Reilly Media, Inc.
- 3 The DevOps Handbook, Gene Kim, Patrick Debois, John Willis, and Jez Humble, 1st Edition, 2016, IT Revolution Press.
- 4 Essentials of cloud Computing, K. Chandrasekhran, 2nd Edition 2014, CRC Press.

- 5 Distributed and Cloud Computing, Kai Hwang, Geoffry C. Fox, Jack J. Dongarra MK, 2nd Edition 2013, Morgan Kaufmann.

23CNE3101R - FOUNDATIONS OF CLOUD NATIVE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3101R	FOUNDATIONS OF CLOUD NATIVE COMPUTING	FCNC	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the fundamentals of Cloud Computing Basics and Cloud Native Computing of cloud.	2	PO1
CO2	Discover the architecture of Containerization and Orchestration of the cloud	4	PO2
CO3	Determine the design of Cloud Native Application Development with respect to cloud applications	5	PO3
CO4	Discover DevOps and CI/CD (Continuous Integration and Continuous Delivery) in Cloud Native Environments.	3	PO1, PO2, PO3, PSO1
CO5	Build Advanced Cloud Native Concepts and Case Studies	3	
CO6	Develop the emerging trends of cloud native technologies	3	

Syllabus

Overview of Cloud Native Computing: Definition and principles, Benefits and challenges Cloud Computing Basics: Cloud service models: IaaS, PaaS, SaaS, Cloud deployment models: Public, Private, Hybrid, Multi-cloud, Key Cloud Providers: AWS, Azure, Google Cloud Platform, IBM Cloud, etc. Virtualization and Containers: Virtual Machines vs. Containers. Microservices Architecture Monolithic vs. Microservices, Benefits of microservices, Design patterns for microservice

Containerization and Orchestration: Docker architecture , Docker commands and Dockerfile, Managing Docker containers. Container Orchestration: Introduction to Kubernetes, Kubernetes architecture, Key concepts: Pods, Nodes, Services, Deployments Kubernetes Management ConfigMaps and Secrets, Persistent storage in Kubernetes

Cloud Native Application Development :Designing Cloud Native Applications 12-Factor App methodology, Resiliency and scalability patterns, API Gateway and Management: API Gateway concepts, Service Discovery and Load Balancing: Principles of service discovery, Load balancing techniques Security in Cloud Native Applications: Securing APIs and microservices, Identity and access management, Best practices for container security

DevOps and CI/CD in Cloud Native Environments: DevOps Principles and Practices, Culture of DevOps, Key practices: CI, CD, Infrastructure as Code (IaC), CI/CD Tools and Pipelines: Jenkins, GitLab CI, CircleCI, Building a CI/CD pipeline for cloud-native applications Infrastructure as Code (IaC): Introduction to Terraform and AWS CloudFormation, Managing infrastructure using IaC, Monitoring and Logging: Importance of monitoring in cloud-native environment

Reference Books

- 1 Cloud Native Patterns: Designing change-tolerant software, Cornelia Davis, 1st Edition Kindle Edition, Manning.
- 2 Kubernetes Up & Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 1st Edition, 2017, O'Reilly Media, Inc.
- 3 The DevOps Handbook, Gene Kim, Patrick Debois, John Willis, and Jez Humble, 1st Edition, 2016, IT Revolution Press.
- 4 Essentials of cloud Computing, K. Chandrasekhran, 2nd Edition 2014, CRC Press.
- 5 Distributed and Cloud Computing, Kai Hwang, Geoffry C. Fox, Jack J. Dongarra MK, 2nd Edition 2013, Morgan Kaufmann.
- 6 Mastering Cloud Computing, Foundations and Application Programming, Raj Kumar Buyya, Christen vecctiola, S Tammaraiselvi, 2nd Edition 2013 , TMH.

23CNE3202A - CLOUD NATIVE APPLICATION DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3202A	CLOUD NATIVE APPLICATION DEVELOPMENT	CNAD	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Getting Started with IBM Cloud	3	PO3, PO4, PSO1, PSO2
CO2	IBM Cloud CLI and Tools	4	PO3, PO4, PSO1, PSO2
CO3	DevOps on IBM Cloud	4	PO3, PO4, PSO1, PSO2
CO4	REST Architecture and Watson APIs	4	PO3, PO4, PSO1, PSO2
CO5	Data Services in IBM Cloud	5	PO3, PO4, PSO1, PSO2
CO6	Practicals on IBM Cloud for Developing Cloud Native Applications	5	PO3, PO4, PSO1, PSO2

Syllabus

Getting Started with IBM Cloud IBM Cloud Overview Building in the IBM Cloud Creating and Managing an IBM Cloud Application Managing Your IBM Cloud Users and Resources

IBM Cloud CLI and Tools Introduction to Node.js Using the Command Line Interface (CLI) IBM Cloud Developer Tools for Visual Studio Code

DevOps on IBM Cloud Overview of IBM Cloud Continuous Delivery Web IDE (Edit Code) Source Code Management (Git Repo) and Issue Tracker Build and Deploy Automated Delivery Pipeline

REST Architecture and Watson APIs Introduction to Representational State Transfer (REST) JavaScript Object Notation (JSON) Using REST APIs with Watson AI Services

Introduction to Data Services in IBM Cloud Overview of Database Services in IBM Cloud Getting Started with IBM Cloudant

Practicals on IBM Cloud for Developing Cloud Native Applications

Reference Books

- 1 Essentials of Application Development on IBM Cloud, ibm, 1, IBM.
- 2 IBM Worklight Mobile Application Development Essentials, ibm, 1, ibm.
- 3 IBM Cloud Private Application Developer's Guide, Apple, 1, Apple.
- 4 IBM Cloud A Complete Guide, IBM, 2019 Edition, IBM.

23CNE3202E - CLOUD NATIVE APPLICATION DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3202E	CLOUD NATIVE APPLICATION DEVELOPMENT	CNAD	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Application Design and Build	3	PO3, PO4, PSO1, PSO2
CO2	Application Deployment	3	PO3, PO4, PSO1, PSO2
CO3	Application Observability and Maintenance	3	PO3, PO4, PSO1, PSO2
CO4	Application Environment, Configuration and Security	4	PO3, PO4, PSO1, PSO2
CO5	Services and Networking	4	PO3, PO4, PSO1, PSO2
CO6	Apply practicals based on application resources and use Kubernetes core primitives to create/migrate, configure, expose and observe scalable applications.	5	PO3, PO4, PSO1, PSO2

Syllabus

Kubernetes: Introduction and Core Concepts, Storage and Networking, Scaling workloads, Pods and Schedulers.

Kubernetes: Cluster Architecture, Installation & Configuration, Cluster and Networking Troubleshooting Techniques.

Kubernetes: primitives to implement common deployment strategies, Helm package manager to deploy existing packages Customize, Implement probes and health checks Use built-in CLI tools to monitor Kubernetes applications, container logs Debugging in Kubernetes

Security Applications: authentication, authorization and admission control, requests, limits, quotas, ConfigMaps, ConfigMaps .

Kubernetes: NetworkPolicies, Provide and troubleshoot access to applications via services, Analyze Ingress rules to expose applications.

Reference Books

- 1 Essentials of Application Development on IBM Cloud, IBM, 1st, IBM.
- 2 IBM Cloud Private Application Developer's Guide, Ahmed Azraq, 1st, Apple.
- 3 Essentials of Application Development on IBM Cloud, ibm, 1st, IBM.
- 4 IBM Cloud A Complete Guide, IBM, 2019 Edition, IBM.

23CNE3202R - CLOUD NATIVE APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3202R	CLOUD NATIVE APPLICATION DEVELOPMENT	CNAD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Application Design and Build	3	PO3, PO4, PSO1, PSO2
CO2	Application Deployment	3	PO3, PO4, PSO1, PSO2
CO3	Application Observability and Maintenance	3	PO3, PO4, PSO1, PSO2
CO4	Application Environment, Configuration and Security	4	PO3, PO4, PSO1, PSO2
CO5	Services and Networking	4	PO3, PO4, PSO1, PSO2
CO6	Apply practicals based on application resources and use Kubernetes core primitives to create/migrate, configure, expose and observe scalable applications.	5	PO3, PO4, PSO1, PSO2

Syllabus

Kubernetes: Introduction and Core Concepts, Storage and Networking, Scaling workloads, Pods and Schedulers.

Kubernetes: Cluster Architecture, Installation & Configuration, Cluster and Networking Troubleshooting Techniques.

Kubernetes: primitives to implement common deployment strategies, Helm package manager to deploy existing packages Customize, Implement probes and health checks Use built-in CLI tools to monitor Kubernetes applications, container logs Debugging in Kubernetes

Security Applications: authentication, authorization and admission control, requests, limits, quotas, ConfigMaps, ConfigMaps .

Kubernetes: NetworkPolicies, Provide and troubleshoot access to applications via services, Analyze Ingress rules to expose applications.

Reference Books

- 1 Certified Kubernetes Application Developer (CKAD) Study Guide., Benjamin Muschko, 1st, O'REILLY.
- 2 Essentials of Application Development on IBM Cloud, IBM , 1ST, ibm.
- 3 IBM Cloud Private Application Developer's Guide, Apple, 1st, Apple.
- 4 IBM Cloud A Complete Guide, IBM, 2019 Edition, IBM.

23CNE3203A - CLOUD NATIVE DESIGN PROCESS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3203A	CLOUD NATIVE DESIGN PROCESS	CNDP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the Cloud Native Principles	2	PO1, PO9, PO12
CO2	Analyse the Proficiency in cloud Native Technologies	4	PO1, PO4, PS02
CO3	Implement the Cloud Native Applications	4	PO4, PO9
CO4	Understanding of Devops and Continuous Delivery	2	PO4, PO12
CO5	Apply the Knowledge of Security and Compliance in Cloud-Native Environments	3	

Syllabus

Introduction to Cloud-Native Applications: cloud-native principles and benefits, Cloud Native Architecture, Comparison with traditional Monolithic Applications, Microservices Architecture, Docker and containerization, Building and managing Docker containers, Docker networking and storage, Container orchestration with Docker Swarm

Introduction to Kubernetes, Overview of Kubernetes architecture, Pods, Deployments, ReplicaSets, Deploying applications with Kubernetes, Managing Kubernetes clusters, Scaling and self-healing with Kubernetes

Microservices Architecture-Designing Microservices, Principles and patterns, Communication between microservices, Service Mesh-Introduction to service mesh, Traffic management, security, and observability with service mesh

Continuous Integration and Continuous Deployment (CI/CD)-CI/CD Principles, Importance and benefits of CI/CD, Tools and frameworks, Implementing CI/CD Pipelines, Setting up CI pipelines, Automating deployment with CD pipelines, Blue-green deployments, canary releases, Rollbacks and version control

Security in Cloud Native Applications-Security Principles, Cloud-native security challenges, Security best practices, Implementing Security, Monitoring Cloud Native Applications, Implementing Observability, Logging, metrics, and tracing, Integrating monitoring solutions with Kubernetes

Reference Books

- 1 "Cloud Native Patterns: Designing change-tolerant software", Cornelia Davis, May 2019: First Edition, Manning Publications.
- 2 "Kubernetes Patterns: Reusable Elements for Designing Cloud-Native Applications", Bilgin Ibryam and Roland Hu, April 2019: First Edition, O'Reilly Media.
- 3 "Cloud Native Transformation: Practical Patterns for Innovation", Pini Reznik, Jamie Dobson, and Michelle Gienow, January 2020: First Edition, O'Reilly Media.
- 4 "Cloud Native Java: Designing Resilient Systems with Spring Boot, Spring Cloud, and Cloud Foundry", Josh Long and Kenny Bastani, October 2017: First Edition, O'Reilly Media.

23CNE3203E - CLOUD NATIVE DESIGN PROCESS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3203E	CLOUD NATIVE DESIGN PROCESS	CNDP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the Cloud Native Principles	2	PO1, PO9, PO12
CO2	Analyse and apply the Proficiency in cloud Native Technologies	4	PO1, PO4, PS02
CO3	Implement the Cloud Native Applications	4	PO4, PO9
CO4	Understanding of Devops and Continuous Delivery	2	PO4, PO12
CO5	Apply the Knowledge of Security and Compliance in Cloud-Native Environments	3	

Syllabus

Introduction to Cloud-Native Applications: cloud-native principles and benefits, Cloud Native Architecture, Comparison with traditional Monolithic Applications, Microservices Architecture, Docker and containerization, Building and managing Docker containers, Docker networking and storage, Container orchestration with Docker Swarm

Introduction to Kubernetes, Overview of Kubernetes architecture, Pods, Deployments, ReplicaSets, Deploying applications with Kubernetes, Managing Kubernetes clusters, Scaling and self-healing with Kubernetes

Microservices Architecture-Designing Microservices, Principles and patterns, Communication between microservices, Service Mesh-Introduction to service mesh, Traffic management, security, and observability with service mesh

Continuous Integration and Continuous Deployment (CI/CD)-CI/CD Principles, Importance and benefits of CI/CD, Tools and frameworks, Implementing CI/CD Pipelines, Setting up CI pipelines, Automating deployment with CD pipelines, Blue-green deployments, canary releases, Rollbacks and version control

Security in Cloud Native Applications-Security Principles, Cloud-native security challenges, Security best practices, Implementing Security, Monitoring Cloud Native Applications, Implementing Observability, Logging, metrics, and tracing, Integrating monitoring solutions with Kubernetes

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- 1 "Cloud Native Patterns: Designing change-tolerant software", Cornelia Davis, May 2019: First Edition, Manning Publications.
- 2 "Kubernetes Patterns: Reusable Elements for Designing Cloud-Native Applications", Bilgin Ibryam and Roland Hu?, April 2019: First Edition, O'Reilly Media.
- 3 "Cloud Native Transformation: Practical Patterns for Innovation", Pini Reznik, Jamie Dobson, and Michelle Gienow, January 2020: First Edition, O'Reilly Media.
- 4 "Cloud Native Java: Designing Resilient Systems with Spring Boot, Spring Cloud, and Cloud Foundry", Josh Long and Kenny Bastani, October 2017: First Edition, O'Reilly Media.

23CNE3203R - CLOUD NATIVE DESIGN PROCESS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3203R	CLOUD NATIVE DESIGN PROCESS	CNDP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the Cloud Native Principles	2	PO1, PO9, PO12
CO2	Analyse the Proficiency in cloud Native Technologies	4	PO1, PO4, PS02
CO3	Implement the Cloud Native Applications	4	PO4, PO9
CO4	Understanding of Devops and Continuous Delivery	2	PO4, PO12

Syllabus

Introduction to Cloud-Native Applications: cloud-native principles and benefits, Cloud Native Architecture, Comparison with traditional Monolithic Applications, Microservices Architecture, Docker and containerization, Building and managing Docker containers, Docker networking and storage, Container orchestration with Docker Swarm

Introduction to Kubernetes, Overview of Kubernetes architecture, Pods, Deployments, ReplicaSets, Deploying applications with Kubernetes, Managing Kubernetes clusters, Scaling and self-healing with Kubernetes

Microservices Architecture-Designing Microservices, Principles and patterns, Communication between microservices, Service Mesh-Introduction to service mesh, Traffic management, security, and observability with service mesh

Continuous Integration and Continuous Deployment (CI/CD)-CI/CD Principles, Importance and benefits of CI/CD, Tools and frameworks, Implementing CI/CD Pipelines, Setting up CI pipelines, Automating deployment with CD pipelines, Blue-green deployments, canary releases, Rollbacks and version control

Reference Books

- 1 "Cloud Native Patterns: Designing change-tolerant software", Cornelia Davis, May 2019: First Edition, Manning Publications.
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- 4 "Cloud Native Java: Designing Resilient Systems with Spring Boot, Spring Cloud, and Cloud Foundry", Josh Long and Kenny Bastani, October 2017: First Edition, O'Reilly Media.

23CNE3304A - SOFTWARE ENGINEERING FOR CLOUD COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3304A	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	SEC	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Organize core concepts of cloud computing, including its history, characteristics, advantages, and challenges.	3	PO1
CO2	Identify the different cloud service models (IaaS, PaaS, SaaS) and discuss their suitability for various applications. U	3	PO2
CO3	Analyze and apply cloud programming models to develop software solutions on the cloud.	4	PO4
CO4	Compare security risks in cloud computing environments and implement appropriate security measures, including identity and access management, data encryption, and compliance with regulatory frameworks.	4	PO3
CO5	Determine cloud platforms and services from major providers such as AWS, Azure, and Google Cloud, including infrastructure as code (IaC), storage, databases, and monitoring tools.	5	PO4, PSO1
CO6	Compare software applications that leverage cloud resources for scalability, elasticity, and fault tolerance.	5	PO3, PO4, PSO1
CO7	Distinguish various cloud infrastructures based on managing load balancing using cloud provider tools and APIs.	5	PO4, PSO1

Syllabus

Introduction to Cloud Computing Definition and characteristics of cloud computing Cloud service models: IaaS, PaaS, SaaS Cloud deployment models: public, private, hybrid Benefits and challenges of cloud computing for software engineering

Software Engineering Methodologies for the Cloud Traditional vs. cloud-based software development processes Agile methodologies in cloud environments DevOps culture and practices Continuous Integration/Continuous Deployment (CI/CD)

Cloud-Native Application Development Microservices architecture Containerization with Docker Orchestration with Kubernetes Serverless computing

Cloud Security and Compliance Security challenges in cloud computing Identity and access management Data encryption and privacy Compliance frameworks (e.g., GDPR, HIPAA) in the cloud

Cloud Platforms and Services Overview of major cloud providers (AWS, Azure, Google Cloud) Infrastructure as Code (IaC) with tools like Terraform Cloud storage, databases, and messaging services Monitoring and logging in cloud

Reference Books

- 1 Cloud Native: Using Containers, Functions, and Data to Build Next-Generation Applications, Boris Scholl, Trent Swanson, and Peter Jausovec, 2009, TMH.
- 2 Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Jez Humble and David Farley, 2017, Pearson.
- 3 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, 2013, Prentice Hall.
- 4 Software Engineering for Cloud Computing: Principles and Practices, Durgesh Kumar Mishra, Malaya Kumar Nayak, and Anuradha Tomar, 2019, CRC Press.

23CNE3304E - SOFTWARE ENGINEERING FOR CLOUD COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3304E	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	SEC	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply design principles for scalability, fault tolerance, elasticity, and cost optimization in cloud applications.	3	PO1
CO2	Build containerization technologies like Docker and Kubernetes.	3	PO1, PO2
CO3	Compare familiarity with a specific cloud platform (e.g., AWS, Azure, GCP) and its core services.	4	PO2, PO3
CO4	Distinguish software applications leveraging cloud-based resources.	4	PO3, PO4, PSO1
CO5	Determine basic cloud monitoring and logging practices.	5	PO3, PO4, PSO1
CO6	Explore best practices for scalability, reliability, and performance optimization in cloud environments	5	PO4, PSO1
CO7	Compare DevOps practices for continuous integration, deployment, and monitoring in cloud-based software development	5	PO4

Syllabus

Introduction to cloud computing: Definition, deployment models (IaaS, PaaS, SaaS), service models, benefits and challenges. Cloud architecture: Understanding core components, virtualization, containers, and serverless computing. Cloud security: Identity and access management (IAM), encryption, compliance considerations.

Software Development for the Cloud: Designing for the cloud: Scalability, fault tolerance, elasticity, and cost optimization principles. Infrastructure as Code (IaC): Tools like Terraform and CloudFormation for automating infrastructure provisioning. Containerization: Docker and Kubernetes for building, deploying, and managing containerized applications. DevOps for Cloud: CI/CD pipelines and automation practices for continuous integration and delivery in the cloud.

Popular Cloud Platforms: In-depth exploration of a specific cloud platform (e.g., AWS, Azure, Google Cloud Platform). Learning the platform's core services (compute, storage, databases, networking). Hands-on labs to deploy, manage, and scale applications on the chosen platform.

Serverless computing: Exploring platforms like AWS Lambda and Azure Functions. Cloud microservices architecture: Building and deploying distributed applications.

To learn strategies for ensuring reliability and fault tolerance in cloud-based software systems, including redundancy, failover mechanisms, and disaster recovery planning

To comprehend security principles and best practices for cloud computing environments, including identity and access management (IAM), data encryption, network security, and compliance standards

To develop skills in DevOps practices for cloud-based software development, including continuous integration (CI), continuous deployment (CD), infrastructure as code (IaC), and automated testing

To guide how to monitor and analyze cloud-based applications for performance optimization, utilizing tools for logging, monitoring, and performance testing.

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture , Thomas Erl and Ricardo PuttiniThis, 2019, The Pearson Service Technology Series from Thomas Erl.

- 2 Building Microservices: Designing Fine-Grained Systems, Sam Newman , 2020, Oreily.
- 3 AWS: The Complete Certified Cloud Practitioner Guide, Alan Gaffney, 2021, Pearson.
- 4 Software Architecture Patterns for Serverless Systems: Architecting for innovation with events, autonomous services, and micro frontends, John Gilbert, 2021, O'Reilly Media.

23CNE3304R - SOFTWARE ENGINEERING FOR CLOUD COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3304R	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	SEC	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain basic software related Infrastructure as Code (IaC) concepts and tools.	2	PO1
CO2	Identify DevOps practices and CI/CD pipelines in the context of cloud development.	3	PO2
CO3	Build various containerized applications.	3	PO3, PSO2
CO4	Analyse design principles for scalability, fault tolerance, elasticity, and cost optimization in cloud applications.	4	PO4
CO5	Categorize basic cloud monitoring and logging practices.	4	PO4
CO6	Compare various strategies for ensuring reliability and fault tolerance in cloud-based software systems, including redundancy, failover mechanisms, and disaster recovery planning	4	PO4
CO7	Distinguish security principles and best practices for cloud computing environments, including identity and access management (IAM)	4	PO4

Syllabus

Introduction to Cloud Computing Overview of cloud computing concepts and models Cloud service models: IaaS, PaaS, SaaS Cloud deployment models: public, private, hybrid Benefits and challenges of cloud computing for software engineering

Cloud-Native Architecture Principles of cloud-native architecture Microservices architecture and its advantages Containerization technologies: Docker and Kubernetes

Designing Cloud-Native Applications Principles of cloud-native application design Microservices architecture and its benefits for cloud applications Containerization with Docker and container orchestration with Kubernetes Serverless computing and its advantages for cloud-based applications Best practices for designing resilient, scalable, and fault-tolerant cloud-native applications

Cloud Application Development Choosing the right programming languages and frameworks for cloud development Developing and deploying applications on major cloud platforms (AWS, Azure, Google Cloud) Integrating cloud services and APIs into applications Testing strategies for cloud applications: unit testing, integration testing, and end-to-end testing Continuous integration and continuous deployment (CI/CD) pipelines for cloud applications

Data Management in the Cloud Overview of cloud databases: relational, NoSQL, and NewSQL databases Data storage options in the cloud: object storage, block storage, and file storage Data security and compliance considerations in cloud environments Big data and analytics services in the cloud: Hadoop, Spark, and data warehousing solutions Data governance and data lifecycle management in cloud computing

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2018, Prentice hall.
- 2 Software Engineering: A Practitioner's Approach, Roger S. Pressman and Bruce Maxim, 1987, Mc Graw Hill.
- 3 Software Engineering for Internet Applications, Eve M. Andersson and Philip Greenspun, 2021, MIT Press.
- 4 Cloud Computing Patterns: Fundamentals to Design, Build, and Manage Cloud Applications, Christoph Fehling, Frank Leymann, Ralph Retter, Walter Schupeck, and Peter Arbitter, 2020, Springer.

23CNE3405M - SERVERLESS COMPUTING AND EVENT-DRIVEN ARCHITECTURES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3405M	SERVERLESS COMPUTING AND EVENT-DRIVEN ARCHITECTURES	SCEDA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify the core concepts of cloud computing, its benefits, deployment models, and describe essential services like EC2, S3, RDS, and VPC.	3	PO4, PSO1
CO2	Build Functions-as-a-Service (FaaS) and Event-driven programming. Evaluate the steps involved in developing scalable models using Serverless Architectures	3	PO4, PSO1
CO3	Identify the process of managing application functionalities by employing Serverless runtimes and Serverless databases. Analyze the key considerations, configurations, and potential optimizations involved in effectively utilizing these technologies to enhance application development and performance.	3	PO3, PSO1
CO4	Develop advanced serverless programming practices and patterns to design, construct, and manage serverless applications and apply the architectural decisions, development strategies, and operational considerations required for the effective implementation and maintenance of serverless systems	3	PO3, PSO1

Syllabus

Overview of cloud computing (Cloud Introduction, Characteristics, Advantages, Four Deployment models and Core Services), Introduction, History, Briefly Basic Services description, EC2 Introduction, S3 and VPC Description , RDS Description, VPC with EC2 and RDS Description

Serverless AWS. Serverless Programming Practices and Patterns, building serverless applications using Java,NodeJS and Python. AWS Lambda, Lambda Examples and Casestudies.

Building Serverless REST APIs with API Gateway. DynamoDB, Amazon Cognito, Web Hosting with S3, Route53, and CloudFront. Postman, Domain name services,

Serverless Amazon Athena and the AWS Glue Data Catalog, Real-Time Data Insights Using Amazon Kinesis ,Messaging and Notifications with SQS and SNS

Reference Books

- 1 Serverless Design Patterns and Best Practices: Build, Secure, and Deploy Enterprise-ready Serverless Applications with AWS Lambda, Brian Zambrano, 2023, Packt Publishing.
- 2 Serverless Architectures on AWS: With examples using AWS Lambda, Peter Sbarski, 2024, Manning Publications.
- 3 Programming AWS Lambda: Build and Deploy Serverless Applications with JavaScript and Python, John Chapin and Mike Roberts, 2024, O'Reilly Media.
- 4 Serverless Single Page Apps: Fast, Scalable, and Available, Ben Rady and Matthew J. Fuller, 2023, Pragmatic Bookshelf.
- 5 Building Serverless Applications with Google Cloud Run: Design and Deploy Production-Ready Applications, Wietse Venema, 2023, Packt Publishing.

23CNE3406M - CLOUD NATIVE SOFTWARE ARCHITECTURES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3406M	CLOUD NATIVE SOFTWARE ARCHITECTURES	CNSA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding of Cloud-Native Concepts	2	PO1, PO2, PO3, PO4, PSO1
CO2	Proficiency in Cloud-Native Tools and Technologies	3	PO1, PO2, PO3, PSO1
CO3	Ability to Design and Implement Cloud-Native Solutions	4	PO1, PO2, PO3, PO4, PSO1
CO4	Critical Analysis of Cloud-Native Architectures	5	PO1, PO2, PO3, PSO1

Syllabus

Overview of cloud computing and its evolution Introduction to cloud-native architecture principles Characteristics and benefits of cloud-native applications Challenges and considerations in adopting cloud-native approaches

Principles of microservices architecture Decomposition strategies for monolithic applications Design patterns and best practices for microservices Communication and coordination between microservices

Introduction to containerization with Docker Creating Docker images and containers Orchestration with Kubernetes Deploying and scaling containerized applications

Principles of CI/CD and automated testing Setting up CI/CD pipelines with Jenkins or GitLab CI Automating software build, test, and deployment processes Infrastructure as Code (IaC) for provisioning and managing cloud resources

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Rajkumar Buyya, S. Thamarai Selvi, and Arun Kumar Sangaiah, 2022, Wiley India.
- 2 The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations, Gene Kim, Patrick Debois, John Willis, and Jez Humble, 2016, IT Revolution .
- 3 Building Microservices: Designing Fine-Grained Systems, Sam Newman, 2014, O'Reilly Media.
- 4 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, O'Reilly Media, 2017, Justin Garrison, Kris Nova.
- 5 Cloud Computing: A Hands-On Approach, Arshdeep Bahga and Vijay Madiseti , 2013, CreateSpace Independent Publishing Platform.

23CNE3507 - CLOUD NATIVE NETWORKING AND STORAGE SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3507	CLOUD NATIVE NETWORKING AND STORAGE SYSTEMS	CNNSS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding and reflect broad conceptual knowledge about Cloud Networking Basics, Characteristics and Cloud Data Centers.	3	PO1, PO2, PO3, PO4, PSO1
CO2	Understanding the basics and Identifying the architecture of Switch Fabric, Switch Fabric Topologies, Congestion Management, Flow Control and Traffic Management.	3	PO1, PO2, PO3, PO4, PSO1
CO3	Identify problems, and explain, analyze, and evaluate Ethernet Data Rate Standards, Virtual Local Area Networks, Data Center Bridging.	3	PO1, PO2, PO3, PO4, PSO1
CO4	Understand and Analyse Multi-tenant Environments, Traditional Network Tunneling Protocols, VXLAN, NVGRE, Tunnel Locations, Load Balancing Algorithms. Understand and analyse the storage systems	3	PO1, PO2, PO3, PO4, PSO1

Syllabus

Introduction to Cloud Networking: Networking Basics, The network stack, Packets and frames, Network equipment, Interconnect, Cloud Data Center, Cloud Networking, Characteristics of Cloud Networking, Ethernet usage, Virtualization, Convergence, Scalability, Software. Data Center Evolution: Mainframes to the Cloud: The Data Center Evolution, Computer Networks, Ethernet, Enterprise versus Cloud Data Centers, Movement to the Cloud

Switch Fabric Technology: Switch Fabric Architecture Overview, Switch Fabric Topologies, Congestion Management, Flow Control, Traffic Management, Switch Chip Architecture Examples. Cloud Data Center Networking Topologies: Traditional Multitiered Enterprise Networks, Data Center Network Switch Types, Flat Data Center Networks, Rack Scale Architectures, Network Function Virtualization

Data Center Networking Standards: Ethernet Data Rate Standards, Virtual Local Area Networks, Data Center Bridging, Improving Network Bandwidth, Remote Direct Memory Access. Server Virtualization and Networking: VM Overview, Virtual Switching, PCI Express, Edge Virtual Bridging, VM Migration.

Network Virtualization: Multi-tenant Environments, Traditional Network Tunneling Protocols, VXLAN, NVGRE, Tunnel Locations, Load Balancing Software-Defined Networking: Data Center Software Background, OpenStack, OpenFlow, Network Function Virtualization, SDN Deployment..Introduction to Storage Systems,Storage media, Storage access mechanisms, Storage Protocols,Communication Protocols for Networked Storage Systems,Types of Storage Devices and Systems, Long-term Storage,Storage Interfaces and Device Drivers,Storage Filesystem Design,Storage Reliability, Performance, Security.

Reference Books

- 1 Cloud Networking Understanding Cloud-based Data Center Networks, Gary Lee, 2014, Elsevier.
- 2 Storage Systems: Organization, Performance, Coding, Reliability, and Their Data Processing, Alexander Thomasian , first edition, Morgan Kaufmann.
- 3 Cloud Native Data Center Networking: Architecture, Protocols, and Tools , Dinesh Dutt, first edition, Shroff/O'Reilly.
- 4 Cloud Native Architecture And Design A Handbook For Modern Day Architecture And Design With Enterprise Grade Examples, Goniwada S R, 2022, Apress.

23CNE3508 - CLOUD INFRASTRUCTURE AND VIRTUALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNE3508	CLOUD INFRASTRUCTURE AND VIRTUALIZATION	CIAV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarizing the fundamentals of cloud concepts.	2	PO2, PO3, PO4, PSO1
CO2	Determining the knowledge of virtualization through different virtualization tools	3	PO2, PO3, PO4, PSO1
CO3	Applying economic considerations to launch businesses online.	3	PO2, PO3, PO4, PSO1
CO4	Integrating your private cloud as per business needs.	3	PO2, PO3, PO4, PSO1

Syllabus

Introduction to Cloud, Cloud Service Models

Cloud Deployment Models, Introduction to Hypervisor, Introduction to Virtualization

Virtualization on IT Assets

Installation and Configuration ,Practical Approach and Experiments , Resource Management in Cloud ,Security in private Cloud

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, 1, Prentice Hall.
- 2 Virtualization Essentials, Matthew Portnoy, 2, Sybex.
- 3 Mastering VMware vSphere 7, Nick Marshall, Mike Brown, G. Blair Fritz, 1, Sybex.
- 4 Kubernetes: Up and Running" Kelsey Hightower, Brendan Burns, Joe Beda, 2, O'Reilly Media.

23CNS3101A - INTRODUCTION TO CLOUD NATIVE COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3101A	INTRODUCTION TO CLOUD NATIVE COMPUTING	ITCNC	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Introduction to Cloud Native Computing	2	PO1, PO5, PSO1
CO2	Understand the concept of Containerization with Docker	2	PO1, PO5, PSO2
CO3	Apply Container Orchestration with Kubernetes	3	PO2, PO5, PSO1
CO4	Apply Microservices Architecture to container orchestration	3	PO2, PO5, PSO2
CO5	Integrating Cloud-Native Applications	3	PO3, PO5, PSO2
CO6	Analyzing and Mashing Cloud-Native Applications	4	PO1, PO5, PSO1
CO7	Analyzing DevOps Practices in Cloud-Native Environments	4	PO1, PO5, PSO1

Syllabus

Introduction to Cloud Native Computing Overview of cloud-native architecture Characteristics and benefits of cloud-native applications

Containerization with Docker Introduction to Docker containers Dockerfile and Docker images Docker Compose for multi-container applications

Container Orchestration with Kubernetes Introduction to Kubernetes Pods, Deployments, and Services Kubernetes architecture and components

Microservices Architecture Principles of microservices Communication patterns between microservices Benefits and challenges of microservices

Applying Cloud-Native Applications Design considerations for cloud-native applications Implementing microservices with Spring Boot or Flask Testing strategies for cloud-native applications

Reference Books

- 1 Cloud Native Patterns Designing Change tolerant Software, Cornelia Davis, 1st edition (2019), O Reilly Media.
- 2 Kubernetes Up and Running Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 2nd edition (2020), O Reilly Media.
- 3 Designing Change tolerant Software, Cornelia Davis, 2019, O Reilly Media.
- 4 Dive into the Future of Infrastructure, Joe Beda, third edition September 6, 2022, O Reilly Media.
- 5 Essentials of Cloud Computing, Brendan Burns, 2023, O Reilly Media.

23CNS3101E - INTRODUCTION TO CLOUD NATIVE COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3101E	INTRODUCTION TO CLOUD NATIVE COMPUTING	ITCNC	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Introduction to Cloud Native Computing	2	PO1, PO5, PSO1
CO2	Understand the concept of Containerization with Docker	2	PO2, PO5, PSO2
CO3	Apply Container Orchestration with Kubernetes	3	PO2, PO5, PSO2
CO4	Apply Microservices Architecture to container orchestration	3	PO1, PO5, PSO1
CO5	Integrating Cloud-Native Applications	3	PO1
CO6	Analyzing and Mashing Cloud-Native Applications	4	PO1
CO7	Analyzing DevOps Practices in Cloud-Native Environments	4	PO1

Syllabus

Introduction to Cloud Native Computing Overview of cloud-native architecture Characteristics and benefits of cloud-native applications

Containerization with Docker Introduction to Docker containers Dockerfile and Docker images Docker Compose for multi-container applications

Container Orchestration with Kubernetes Introduction to Kubernetes Pods, Deployments, and Services Kubernetes architecture and components

Microservices Architecture Principles of microservices Communication patterns between microservices Benefits and challenges of microservices

Applying Cloud-Native Applications Design considerations for cloud-native applications Implementing microservices with Spring Boot or Flask Testing strategies for cloud-native applications

Reference Books

- 1 Cloud Native Patterns: Designing Change-tolerant Software, Cornelia Davis, 2019, O'Reilly Media.
- 2 Kubernetes: Up and Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 2020, O'Reilly Media.
- 3 Designing Change-tolerant Software, Cornelia Davis, 2019, O'Reilly Media.
- 4 Dive into the Future of Infrastructure, Brendan Burns,, 2020, O'Reilly Media.
- 5 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison, Kris Nova, 2018, O'Reilly Media.

23CNS3101R - INTRODUCTION TO CLOUD NATIVE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3101R	INTRODUCTION TO CLOUD NATIVE COMPUTING	ITCNC	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Introduction to Cloud Native Computing	2	PO1, PO5, PSO1
CO2	Understand the concept of Containerization with Docker	2	PO2, PO5, PSO1
CO3	Apply Container Orchestration with Kubernetes	3	PO1, PO5, PSO2
CO4	Apply Microservices Architecture to container orchestration	3	PO2, PO5, PSO2
CO5	Integrating Cloud-Native Applications	3	PO1, PO5, PSO1
CO6	Analyzing and Mashing Cloud-Native Applications	4	PO5, PSO2

Syllabus

Introduction to Cloud Native Computing Overview of cloud-native architecture Characteristics and benefits of cloud-native applications

Containerization with Docker Introduction to Docker containers Dockerfile and Docker images Docker Compose for multi-container applications

Container Orchestration with Kubernetes Introduction to Kubernetes Pods, Deployments, and Services Kubernetes architecture and components

Microservices Architecture Principles of microservices Communication patterns between microservices Benefits and challenges of microservices

Reference Books

- 1 Cloud Native Patterns Designing Change-tolerant Software, Cornelia Davis, 2019, O Reilly Media.
- 2 Kubernetes Up and Running Dive into the Future of Infrastructure, kelsey Hightower Brendan Burns and Joe Beda, 2020, O Reilly Media.
- 3 Designing Change tolerant Software, Cornelia Davis, 2019, O Reilly Media.
- 4 Dive into the Future of Infrastructure, Brendan Burns, and Joe Beda, 2020, O Reilly Media.
- 5 Essentials of Cloud Computing, Brendan Burns, 2023, O Reilly Media.

23CNS3202A - FUNDAMENTALS OF CLOUD SECURITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3202A	FUNDAMENTALS OF CLOUD SECURITY	FOCS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate compute services in cloud computing and its significance for security.	2	PO1, PSO1
CO2	Identify the security controls to implement IAM for monitoring and auditing cloud deployment.	3	PO1, PO3
CO3	Examine the effectiveness of different security architectures and strategies for cloud environments.	4	PO4
CO4	Analyze about different compliance frameworks and their implications for cloud security.	4	PO5
CO5	Determine the strengths and weaknesses of managing security in multi cloud environment	5	PO5

Syllabus

Introduction to Cloud Security, Cloud Service, Cloud Deployment Models, why we need security, What is the shared responsibility model. Securing Compute Services, Technical requirements securing VMs, Securing managed Database services, securing container, Securing serverless as a service Securing Storage Services, securing object storage, securing block storage, securing file storage, securing the CSI.

Securing Networking Services, securing virtual networking, Securing DNS services, Securing CDN services, Securing VPN services, Securing DDOS protection services, Securing WAF services, Effective Strategies to Implement IAM Solutions, Failing to manage identities, securing cloud-based IAM services, Security Directory services, Configuring MFA, Monitoring and Auditing Your Cloud Environments

Applying Encryption in Cloud Services, Introduction to encryption, Best practices for deploying KMSes, Best practices for deploying secrets management services, Best practices for using encryption in transit, Best practices for using encryption at rest, Understanding Common Security Threats to Cloud Services, The MITRE ATT&CK, Framework, Detecting and mitigating data breach, Detecting and mitigating misconfigurations in cloud services.

Handling Compliance and Regulation, Compliance and the shared responsibility model, Introduction to compliance with regulatory requirements and industry best practices, What are the common ISO standards related to cloud computing, SOC report, CSA STAR program, PCI DSS, GDPR, HIPAA, Engaging with Cloud Providers, Data Privacy and Sovereignty, Migration Capabilities, Authentication, Conducting penetration testing in cloud environments.

Advanced Use of Cloud Services, Managing Hybrid Clouds, Hybrid cloud strategy, Compute services for hybrid cloud environments, Managing Multi Cloud Environments, Data security in multi-cloud environments, Cost management in multi cloud environments, Cloud Security Posture Management (CSPM) Security in Large-Scale Environments, managing governance and policies at a large scale, Automation using IaC, Security in large-scale cloud environments

Reference Books

- 1 Cloud Security A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz and Russell Dean Vines, 2010, Wiley Publishing, Inc..
- 2 Cloud Security for dummies, Lawrence Miller, 2021, Oracle.
- 3 Cloud Security Handbook Find out how to effectively secure cloud environments, Eyal Estrin, 2022, Packt.
- 4 Handbook of Cloud Computing, Borko Furht Armando Escalante, 2010, Springer.
- 5 The Definitive Guide to Cloud Computing, Dan Sullivan, 2010, Real Time Publishers.

23CNS3202E - FUNDAMENTALS OF CLOUD SECURITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3202E	FUNDAMENTALS OF CLOUD SECURITY	FOCS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate compute services in cloud computing and its significance for security.	2	PO1, PSO1
CO2	Identify security controls to implement IAM for monitoring and auditing cloud deployment.	3	PO1, PO3
CO3	Examine the effectiveness of different security architectures and strategies for cloud environments.	4	PO4
CO4	Analyze about different compliance frameworks and their implications for cloud security.	4	PO5
CO5	Determine the strengths and weaknesses of managing security in multi cloud environment	5	PO5

Syllabus

Introduction to Cloud Security, Cloud Service, Cloud Deployment Models, why we need security, What is the shared responsibility model. Securing Compute Services, Technical requirements securing VMs, Securing managed Database services, securing container, Securing serverless as a service Securing Storage Services, securing object storage, securing block storage, securing file storage, securing the CSI

Securing Networking Services, Securing virtual networking, Securing DNS services, Securing CDN services, Securing VPN services, Effective Strategies to Implement IAM Solutions, Securing AWS IAM, Auditing AWS IAM, Securing AWS, Monitoring and Auditing Your Cloud Environments

3 Applying Encryption in Cloud Services, Introduction to encryption, Best practices for deploying KMSes, Best practices for deploying secrets management services, Best practices for using encryption in transit, Best practices for using encryption at rest, Understanding Common Security Threats to Cloud Services, The MITRE ATT&CK, Framework, Detecting and mitigating data breach, Detecting and mitigating misconfigurations in cloud services.

Handling Compliance and Regulation, Compliance and the shared responsibility model, Introduction to compliance with regulatory requirements and industry best practices, What are the common ISO standards related to cloud computing, SOC report, CSA STAR program, PCI DSS, GDPR, HIPAA, Engaging with Cloud Providers, Data Privacy and Sovereignty, Migration Capabilities, Authentication, Conducting penetration testing in cloud environments.

Advanced Use of Cloud Services, Managing Hybrid Clouds, Hybrid cloud strategy, Compute services for hybrid cloud environments, Managing Multi Cloud Environments, Data security in multi-cloud environments, Cost management in multi cloud environments, Cloud Security Posture Management (CSPM) Security in Large-Scale Environments, managing governance and policies at a large scale, Automation using IaC, Security in large-scale cloud environments

Reference Books

- 1 Cloud Security A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz and Russell Dean Vines, 2010, Wiley Publishing, Inc..
- 2 Cloud Security for dummies, Lawrence Miller, 2021, Oracle.
- 3 Cloud Security Handbook Find out how to effectively secure cloud environments, Eyal Estrin, 2022, Packt.
- 4 Handbook of Cloud Computing, Borko Furht ? Armando Escalante, 2010, Springer.
- 5 The Definitive Guide to Cloud Computing, Dan Sullivan, 2010, Realtime publishers.

23CNS3202R - FUNDAMENTALS OF CLOUD SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3202R	FUNDAMENTALS OF CLOUD SECURITY	FOCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate compute services in cloud computing and its significance for security.	2	PO1, PSO1
CO2	Identify the security controls to implement IAM for monitoring and auditing cloud deployment.	3	PO1, PO3
CO3	Examine the effectiveness of different security architectures and strategies for cloud environments.	4	PO4
CO4	Analyze about different compliance frameworks and their implications for cloud security	4	PO5

Syllabus

Introduction to Cloud Security, Cloud Service, Cloud Deployment Models, why we need security, What is the shared responsibility model. Securing Compute Services, Technical requirements securing VMs, Securing managed Database services, securing container, Securing serverless as a service Securing Storage Services, securing object storage, securing block storage, securing file storage, securing the CSI

Securing Networking Services, Securing virtual networking, Securing DNS services, Securing CDN services, Securing VPN services, Effective Strategies to Implement IAM Solutions, Securing AWS IAM, Auditing AWS IAM, Securing AWS, Monitoring and Auditing Your Cloud Environments

Applying Encryption in Cloud Services, Introduction to encryption, Best practices for deploying KMSes, Best practices for deploying secrets management services, Best practices for using encryption in transit, Best practices for using encryption at rest, Understanding Common Security Threats to Cloud Services, The MITRE ATT&CK, Framework, Detecting and mitigating data breach, Detecting and mitigating misconfigurations in cloud services.

Handling Compliance and Regulation, Compliance and the shared responsibility model, Introduction to compliance with regulatory requirements and industry best practices, What are the common ISO standards related to cloud computing, SOC report, CSA STAR program, PCI DSS, GDPR, HIPAA, Engaging with Cloud Providers, Data Privacy and Sovereignty, Migration Capabilities, Authentication, Conducting penetration testing in cloud environments.

Reference Books

- 1 Cloud Security A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz and Russell Dean Vines, 2010, Wiley Publishing, Inc..
- 2 Cloud Security for dummies, Lawrence Miller, 2021, Oracle.
- 3 Cloud Security Handbook Find out how to effectively secure cloud environments, Eyal Estrin, 2022, Packt.
- 4 Handbook of Cloud Computing, Borko Furht ? Armando Escalante Editors, 2010, Springer.
- 5 The Definitive Guide to Cloud Computing, Dan Sullivan, 2010, Real Time Publisher.

23CNS3303A - CONTAINER SECURITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3303A	CONTAINER SECURITY	CTSY	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Containerization and Security	2	PO1, PO5, PSO1
CO2	Understand Container Image Security, Container Runtime Security	2	PO3, PO5
CO3	Apply Container Orchestration Security	3	PO2, PO5
CO4	Apply Network Security for Containers	3	PO2, PO5, PSO2
CO5	Apply the concept of Identity and Access Management, Monitoring and Logging	3	PO1, PO5
CO6	Analyzing Security in Continuous Integration/Continuous Deployment (CI/CD)	4	PO3, PO5, PSO1
CO7	Analyzing Compliance and Governance for container security	4	PO2, PO5

Syllabus

Overview of container technology Benefits and challenges of containerization Security considerations in containerized environments

Image composition and vulnerability management Secure image registries and scanning tools Best practices for building and managing secure container images Container Runtime Security Container isolation mechanisms Securing container runtimes (e.g., Docker, containerd) Runtime monitoring and protection

Container orchestration platforms (e.g., Kubernetes) Securing Kubernetes clusters Network security and access control in container orchestrators

Container network models and architecture Network segmentation and isolation techniques Container firewalling and network policies. Integrating security into CI/CD pipelines Automated security testing and validation Infrastructure as code (IaC) security considerations

Authentication and authorization in container environments Role-based access control (RBAC) for containers Secrets management and secure communication Monitoring and Logging Container monitoring tools and practices Log management and analysis for containers Security event detection and response, Regulatory compliance requirements for containerized environments Auditing and compliance monitoring Security standards and frameworks (e.g., CIS benchmarks)

Reference Books

- 1 Container Security Fundamental Technology Concepts that Protect Containerized Applications, Liz Rice, 2017, O Reilly Media.
- 2 Kubernetes Security Operating Kubernetes Clusters and Applications Safely, Liz Rice, 2019, Nigel Poulton (self-published).
- 3 Fundamental Technology Concepts that Protect Containerized Applications, Liz Rice, 2017, O Reilly Media.
- 4 Operating Kubernetes Clusters and Applications Safely, Liz Rice, 2019, Nigel Poulton (self-published).
- 5 Docker Security Quick Reference, Liz Rice, 2018, O Reilly Media.

23CNS3303E - CONTAINER SECURITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3303E	CONTAINER SECURITY	CTSY	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Containerization and Security	2	PO1, PO5, PSO1
CO2	Understand Container Image Security, Container Runtime Security	2	PO2, PO5
CO3	Apply Container Orchestration Security	3	PO3, PO5, PSO2
CO4	Apply Network Security for Containers	3	PO2, PO5
CO5	Apply Network Security for Containers	3	
CO6	Analyzing Security in Continuous Integration/Continuous Deployment (CI/CD)	4	
CO7	Analyzing Compliance and Governance for container security	4	

Syllabus

Overview of container technology Benefits and challenges of containerization Security considerations in containerized environments

Image composition and vulnerability management Secure image registries and scanning tools Best practices for building and managing secure container images Container Runtime Security Container isolation mechanisms Securing container runtimes (e.g., Docker, containerd) Runtime monitoring and protection

Container orchestration platforms (e.g., Kubernetes) Securing Kubernetes clusters Network security and access control in container orchestrators

Container network models and architecture Network segmentation and isolation techniques Container firewalling and network policies. Integrating security into CI/CD pipelines Automated security testing and validation Infrastructure as code (IaC) security considerations

Authentication and authorization in container environments Role-based access control (RBAC) for containers Secrets management and secure communication Monitoring and Logging Container monitoring tools and practices Log management and analysis for containers Security event detection and response, Regulatory compliance requirements for containerized environments Auditing and compliance monitoring Security standards and frameworks (e.g., CIS benchmarks)

Reference Books

- 1 Container Security Fundamental Technology Concepts that Protect Containerized Applications, Liz Rice, 2019, O Reilly Media.
- 2 Kubernetes Security: Operating Kubernetes Clusters and Applications Safely, Liz Rice, 2017, Nigel Poulton (self-published).
- 3 Fundamental Technology Concepts that Protect Containerized Applications, Liz Rice, 2018, O Reilly Media.
- 4 Kubernetes Clusters and Applications Safely, Liz Rice, 2020, Nigel Poulton.
- 5 Docker Security Quick Reference, Liz Rice, 2018, O Reilly Media.

23CNS3303R - CONTAINER SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3303R	CONTAINER SECURITY	CTSY	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Containerization and Security	2	PO1, PO5, PSO1
CO2	Understand Container Image Security, Container Runtime Security	2	PO3, PO5
CO3	Apply Container Orchestration Security	3	PO2, PO5, PSO2
CO4	Apply Network Security for Containers	3	PO2, PO5
CO5	Apply the concept of Identity and Access Management, Monitoring and Logging	3	PO1, PO5
CO6	Analyzing Security in Continuous Integration/Continuous Deployment (CI/CD)	4	PO3, PO5, PSO1

Syllabus

Overview of container technology Benefits and challenges of containerization Security considerations in containerized environments

Image composition and vulnerability management Secure image registries and scanning tools Best practices for building and managing secure container images Container Runtime Security Container isolation mechanisms Securing container runtimes (e.g., Docker, containerd) Runtime monitoring and protection

Container orchestration platforms (e.g., Kubernetes) Securing Kubernetes clusters Network security and access control in container orchestrators, Integrating security into CI/CD pipelines Automated security testing and validation Infrastructure as code (IaC) security considerations

Container network models and architecture Network segmentation and isolation techniques Container firewalling and network policies, Authentication and authorization in container environments Role-based access control (RBAC) for containers Secrets management and secure communication Monitoring and Logging Container monitoring tools and practices Log management and analysis for containers Security event detection and response

Reference Books

- 1 Container Security: Fundamental Technology Concepts that Protect Containerized Applications, Liz Rice, 2019, O'Reilly Media.
- 2 Kubernetes Security Operating Kubernetes Clusters and Applications Safely, Liz Rice, 2020, Nigel Poulton (self-published).
- 3 Fundamental Technology Concepts that Protect Containerized Applications, Liz Rice, 2019, O'Reilly Media.
- 4 Operating Kubernetes Clusters and Applications Safely, Liz Rice, 2020, Nigel Poulton.
- 5 Docker Security Quick Reference, Liz Rice, 2020, O'Reilly Media.

23CNS3404M - MICROSERVICES SECURITY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3404M	MICROSERVICES SECURITY	MSS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying security challenges in various applications	3	PO1, PSO1
CO2	Apply authentications by implementing different mechanisms	3	PO1, PO2
CO3	Applying protocols for microservices and various controls to be implemented for data encryption	3	PO2, PO3
CO4	Analyzing various anomalies and incident responses in security monitoring	4	PO3, PSO1

Syllabus

Overview of microservices architecture, Security challenges in microservices-based applications, Principles of defense-in-depth security, Identifying security threats and vulnerabilities, Threat modeling techniques for microservices, Risk assessment and mitigation strategies

Introduction to authentication mechanisms, Single sign-on (SSO) and OAuth for microservices, Implementing authentication using JWT (JSON Web Tokens), Role-based access control (RBAC) in microservices, Attribute-based access control (ABAC), Implementing authorization policies with API gateways

Secure Communication Protocols for Microservices, Transport Layer Security (TLS) and Encryption, Service Meshes for Enhanced Security, Practical Implementation of Secure Communication, Data Protection Strategies for Microservices, Data Encryption and Tokenization, Secure Storage and Access Controls, Compliance Requirements and Data Governance

Proactive Monitoring of Microservices Security, Identifying Anomalies and Security Incidents, Incident Response Strategies and Playbooks, Continuous Improvement in Security Monitoring, Exploring, Emerging Trends in Microservices Security, Future Challenges and Opportunities, Blockchain and Decentralized Identity, Quantum-Safe Cryptography and Post-Quantum Security

Reference Books

- 1 Microservices, IoT, and Azure: Leveraging DevOps and Microservice Architecture to Deliver SaaS Solutions, Bob Familiar and Brian Johnson, 2015, APRESS.
- 2 Blockchain Basics, Daniel Drescher, 2017, APRESS.
- 3 Quantum Computing for Computer Scientists, Noson S. Yanofsky and Mirco A. Mannucci, 2008, UNIVERSITY PRESS.
- 4 Microservices Security in Action, Wajjakkara Kankanamge Anthony Nuwan Dias, Prabath Siriwardena, August 2020, Manning Publications.

23CNS3405M - INFRASTRUCTURE AS CODE SECURITY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3405M	INFRASTRUCTURE AS CODE SECURITY	ISACS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify the fundamental principles of Infrastructure as Code (IaC) and its importance in modern IT infrastructure management.	3	PO3, PO4, PO6, PSO1
CO2	Analyze and describe the various security vulnerabilities and threats specific to Infrastructure as Code.	4	PO3, PO4, PO6, PSO1
CO3	Analyze security best practices and methodologies for creating secure Infrastructure as Code deployments.	4	PO3, PO4, PO6, PSO1
CO4	Analyze and recommend improvements to existing Infrastructure as Code implementations for enhanced security and compliance.	4	PO3, PO4, PO6, PSO1

Syllabus

Introduction to IaC and its evolution, Importance of IaC in automation and scalability, Key concepts: declarative vs. imperative approaches, Overview of popular IaC tools (Terraform, Integration of IaC in DevOps practices, Ansible, Puppet, Chef),

Common security vulnerabilities in IaC (e.g., hard-coded secrets, improper configurations), Threat modeling for IaC environments, Real-world examples of IaC security incidents, Impact of insecure IaC on overall system security

Best practices for secure IaC development, Implementation of security controls in IaC, Role-based access control (RBAC) and principle of least privilege, Techniques for secret management in IaC

Assessment of existing IaC implementations for security flaws, Conducting security audits and compliance checks, Remediation strategies for identified issues, Policy-as-code for enforcing security standards

Reference Books

- 1 Infrastructure as Code: Managing Servers in the Cloud, Kief Morris, 1st (2016) and 2nd (2020), O'Reilly Media.
- 2 Terraform: Up & Running: Writing Infrastructure as Code, Yevgeniy Brikman, 3rd (2022), O'Reilly Media.
- 3 Infrastructure as Code (IaC) Cookbook, Stephane Jourdan and Pierre Pomes, 1st (2020), Packt Publishing.
- 4 Continuous Delivery and DevOps: A Quickstart Guide, Paul Swartout, 2nd (2018), Packt Publishing.

23CNS3406M - IDENTITY AND ACCESS MANAGEMENT IN CLOUD NATIVE ENVIRONMENTS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3406M	IDENTITY AND ACCESS MANAGEMENT IN CLOUD NATIVE ENVIRONMENTS	IAMCNE	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the core concepts and principles of IAM in cloud-native environments.	2	PO3, PSO2
CO2	Understand IAM policies and role-based access control (RBAC) models.	2	PO3, PO5, PSO2
CO3	Understand and implement secure authentication and authorization mechanisms	3	PO3, PSO2
CO4	Manage identities across multiple platforms and services. Ensure compliance and security through logging, monitoring, and incident response.	4	PO3, PO5, PSO2

Syllabus

Overview of IAM, Definitions and Concepts, Differences between traditional and cloud-native IAM Importance of IAM in Cloud Computing, IAM Architecture and Components, Users, Groups, Roles, and Policies, Authentication vs. Authorization. IAM Standards and Protocols OAuth 2.0, OpenID Connect, SAML, LDAP and Kerberos, Challenges in IAM for Cloud-Native Environments, Scalability, Flexibility, Security and Case Studies with Real-world IAM implementations.

IAM Solutions for Cloud Providers, AWS Identity and Access Management, IAM Users, Groups, Zero Trust Architecture, Roles, Policies, AWS Organizations and Service Control Policies (SCP), AWS SSO and AWS Cognito, Azure Identity and Access Management, Azure Active Directory (AD), Role-Based Access Control (RBAC) in Azure. Google Cloud Identity and Access Management, Cloud IAM Policies and Roles, Google Identity Platform, IAM and Organization Policies. Comparative Analysis, Choosing the Right IAM Solution.

Implementing IAM in Cloud-Native Applications, IAM Integration in Microservices, Securing Service-to-Service Communication, API Gateway and IAM Integration, IAM in Kubernetes Environments, RBAC in Kubernetes, Kubernetes Authentication and Authorization. IAM for Serverless Architectures, Managing Access for AWS Lambda, Azure Functions, Google Cloud Functions, Best Practices for Serverless IAM. Automation and IAM, Using Infrastructure as Code (IaC) for IAM, Integrating IAM in CI/CD Pipelines.

Security Best Practices for IAM, IAM Policy Design, Principles of Least Privilege, Policy Development and Testing. Identity Federation and SSO, Federation Concepts and Implementation, SSO Integration with Cloud Services. IAM Monitoring and Auditing, Logging and Monitoring IAM Activities, Implementing Auditing and Compliance Checks. Incident Response and IAM, Detecting and Responding to IAM Breaches, Case Studies on IAM Security Incidents. Emerging Trends in IAM, Zero Trust Security Model, Identity as the New Perimeter. Advanced IAM Topics and Future Directions, IAM for Hybrid and Multi-Cloud Environments, IAM and DevSecOps, Integrating Security into DevOps Practices, Identity Management for IoT and Edge Computing, IAM Challenges and Solutions in IoT, Using ML for IAM Threat Detection

Reference Books

- 1 Cloud Native Applications with Docker and Kubernetes: Design and Build Cloud Architecture and Applications with Microservices, EMQ, and Multi-Site Configurations, Jonathan Bartlett, 2022 published , Apress, 2022.
- 2 Active Directory Administration Cookbook: Proven solutions to everyday identity and authentication challenges for both on-premises and the cloud, Sander Berkouwer, 2nd Edition, Packt Publishing.
- 3 Okta Administration: Up and Running: Implement enterprise-grade identity and access management for on-premises and cloud apps., Lovisa Stenb?cken Stjernl?f, HenkJan de Vries, 2022 published, Packt Publishing.
- 4 Practical Spring Cloud Function: Developing Cloud-Native Functions for Multi-Cloud and Hybrid-Cloud Environments , Banu Parasuraman, 1st Edition , Apress.

23CNS3407M - NETWORK SECURITY IN CLOUD NATIVE ARCHITECTURES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3407M	NETWORK SECURITY IN CLOUD NATIVE ARCHITECTURES	NSCNA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Comprehensive understanding of cloud native architectures, including containerization, microservices, and orchestration tools such as Kubernetes.	2	PO3, PO5, PSO2
CO2	To implement security best practices specific to cloud native environments, ensuring the integrity, confidentiality, and availability of services.	2	PO3, PO5, PSO2
CO3	Identify and mitigate common security threats and vulnerabilities in cloud native architectures, utilizing monitoring, logging, and alerting tools effectively.	3	PO3, PSO2
CO4	Acquire the skills to secure containerized applications, including understanding container isolation, image security, and runtime protection. To implement the regulatory and compliance requirements related to cloud native environments and how to implement governance policies to meet these standards	3	PO3, PSO2

Syllabus

Introduction to Cloud Native Architectures, Overview of Cloud Native Concepts, Definition and benefits of cloud native, Key components: containers, microservices, DevOps, and CI/CD. Containerization and Orchestration, Introduction to Docker and Kubernetes, Basic container operations and orchestration fundamentals. Microservices Security Challenges, Security implications of microservices architecture, Service mesh and API security.

Security Fundamentals in Cloud Native Environments, Identity and Access Management (IAM), IAM principles and practices in cloud native architectures, Role-based access control (RBAC) in Kubernetes. Network Security, Securing service communications, Network policies and segmentation. Data Security and Encryption, Data-at-rest and data-in-transit encryption methods, Secrets management.

Threat Detection and Incident Response, Monitoring and Logging, zero trust based cloud security, Implementing monitoring and logging in cloud native environments, Tools: Prometheus, Grafana, Fluentd, and Elasticsearch. Vulnerability Management, Scanning and patching vulnerabilities in containers and clusters, Tools for vulnerability management (e.g., Clair, Trivy). Incident Response, Building an incident response plan for cloud native environments, Case studies of real-world incidents and response strategies

Advanced Security Strategies and Compliance, Advanced Security Tools and Techniques, Service meshes (e.g., Istio) and their role in security, Policy enforcement with Open Policy Agent (OPA). Compliance and Governance, Overview of compliance frameworks (e.g., GDPR, HIPAA), Implementing governance policies in cloud native setups. a Capstone Project: Designing and implementing a secure cloud native application with Peer reviews and presentations

Reference Books

- 1 Kubernetes Security: Operating Kubernetes Clusters and Applications Safely, Liz Rice, First Edition, 2018, O'Reilly, 2018.
- 2 Cloud Native Security: Patterns and Practices, Chris Binnie, First Edition, 2021, Wiley, 2021.
- 3 Kubernetes Up & Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, first edition , 2017, O'Reilly.
- 4 Practical Cloud Security: A Guide for Secure Design and Deployment, Chris Dots, Second Edition, 2023 , O'Reilly.

23CNS3508 - MONITORING AND LOGGING FOR CLOUD NATIVE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3508	MONITORING AND LOGGING FOR CLOUD NATIVE SECURITY	MLCNS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the importance of monitoring and logging in cloud-native security	2	PO1, PO5, PSO1, PSO2
CO2	Implement monitoring infrastructure using cloud-native tools and services	2	PO2, PO5, PSO2
CO3	Analyze log data to identify patterns, anomalies, and potential security threats	3	PO3, PO5, PSO1
CO4	Design comprehensive monitoring and logging architectures tailored to specific cloud-native security requirements	4	PO3, PO5, PSO2

Syllabus

Introduction to Cloud Native Security Monitoring and Logging: Overview of cloud-native security principles Importance of monitoring and logging in cloud-native environments Fundamentals of log management and real-time alerting Key concepts and terminologies in security monitoring and logging

Cloud-Native Monitoring Infrastructure: Understanding cloud-native monitoring architectures Selection and implementation of monitoring tools and services Configuring logging solutions for cloud-native applications Best practices for instrumenting applications and services for monitoring

Log Analysis and Threat Detection: Techniques for log analysis and interpretation Identifying patterns, anomalies, and potential security threats in log data Real-time alerting based on security criteria and detection rules Integration of machine learning and AI for advanced threat detection

Incident Response and Forensic Investigation: Developing incident response strategies leveraging monitoring and logging data Forensic analysis of security incidents using log data Creating incident response playbooks for cloud-native environments Continuous improvement and optimization of monitoring and logging practices

Reference Books

- 1 Monitoring and Logging in the Cloud, Scott Lowe, Nathaniel Avery, Mike Preston, 1st Edition, O'Reilly Media.
- 2 Cloud Native Security Monitoring and Logging: A Practical Guide to Monitoring and Securing Cloud-Native Applications, Abhay Bhargav, Rashmi Nanda, 1st Edition, Packt Publishing.
- 3 Cloud Security Monitoring and Logging Handbook, Ankur Tyagi, Navneet Mehra, 1st Edition, Apress.
- 4 Monitoring and Logging Best Practices: A Comprehensive Guide for Cloud-Native Environments, Mark Smith, 1st Edition, Wiley.

23CNS3509 - COMPLIANCE AND GOVERNANCE IN CLOUD NATIVE ENVIRONMENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3509	COMPLIANCE AND GOVERNANCE IN CLOUD NATIVE ENVIRONMENTS	CGCNE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand cloud provider tools for activity logging and basic governance controls	2	PO1, PO5
CO2	Apply Infrastructure as Code and Compliance as Code tools for automated governance.	3	PO2, PSO2
CO3	Demonstrate the effectiveness of different governance frameworks for a specific cloud-native project.	3	PO5, PSO2
CO4	Compare and contrast cloud provider tools for security and compliance automation.	4	PO1, PSO2

Syllabus

Importance of activity logging in the cloud, various cloud activity log types, principles of cloud governance, essential governance controls using cloud provider tools

The core principles of IaC and CaC, integrity security practices into IaC pipelines, implement CaC rules to enforce security and compliance requirements, Leverage automation tools to streamline governance processes.

The importance of governance frameworks in cloud-native deployments, understand popular cloud governance frameworks like CCM, NIST cyber security framework, CSA, CCF,

Compare and contrast cloud provider tools for security and compliance automation, understand popular cloud provider tools for security automation like AWS security hub, Azure sentinel, GCP cloud IDS

Reference Books

- 1 Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Timothy Mather, Elizabeth McCarthy, and Shanling Shao, 1st Edition, Wiley publishing, Inc.
- 2 Compliance as Code: Infrastructure Automation for Security and Governance, Angie Chakravarty, 2nd Edition, O'Reilly Media, Inc..
- 3 Cloud Governance: Basics and practice, Meredith Stein, Steven Mezzio, Vincent Campitelli, 1st Edition, De Gruyter.
- 4 Cloud Native Security, Chris Binnie, Rory McCune, 1st Edition, O'Reilly Media, Inc..
- 5 Cloud Native Patterns: Designing Change-tolerant Software, Cornelia Davis, 1st Edition, Manning, Inc.

23CNS3510 - SERVERLESS SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3510	SERVERLESS SECURITY	SLSY	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of serverless computing and its security implications	2	PO1, PO5, PSO1
CO2	Identify common security risks and vulnerabilities in serverless architectures.	2	PO2, PO5
CO3	Apply security best practices in designing, developing, and deploying serverless applications.	3	PO2, PO5
CO4	Apply authentication, authorization, and data protection mechanisms in serverless environments.	3	PO1, PO5, PSO2

Syllabus

Introduction to Serverless Computing and Security Overview of serverless architectures Security challenges and considerations

Authentication and Authorization in Serverless Environments Identity and access management Role-based access control (RBAC) API security

Data Protection and Privacy Encryption techniques Key management Compliance requirements (GDPR, HIPAA, etc.) Secure Development Practices for Serverless Applications Secure coding principles OWASP Top 10 vulnerabilities in serverless environments Static code analysis and code review

Monitoring, Logging, and Incident Response Importance of logging and monitoring Real-time threat detection Incident response strategies Security Tools and Services for Serverless Applications Serverless-specific security tools Third-party security services Integration with DevSecOps pipelines

Reference Books

- 1 Security in Serverless Computing Principles and Practices, John Doe, 2018, XYZ Publications.
- 2 Serverless Security Understand Assess and Implement Secure and Reliable Applications in AWS Microsoft Azure and Google Cloud, Miguel A. Calles, 2019, Apress.
- 3 Serverless Architectures on AWS, Peter Sbarski and Yan Cui, 2020, Manning Publications.
- 4 Software Architecture Patterns for Serverless Systems, John Gilbert, 2019, Packt Publishing.
- 5 Security and Microservice Architecture on AWS, Gaurav Raje, 2021, Packt Publishing.

23CNS3511 - CLOUD NATIVE SECURITY TOOLS AND SOLUTIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3511	CLOUD NATIVE SECURITY TOOLS AND SOLUTIONS	CNSTAS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of cloud-native security and the shared responsibility model.	2	PO3, PO4, PO6, PSO1
CO2	Identify and describe the functionalities of key cloud-native security tools and solutions.	3	PO3, PO4, PO6, PSO1
CO3	Analyze and assess security risks and mitigation strategies in cloud-native environments.	4	PO3, PO4, PO6, PSO2
CO4	Analyze and design secure cloud-native architectures using industry best practices and frameworks.	4	PO3, PO4, PO6, PSO2

Syllabus

Introduction to cloud-native security concepts, Overview of cloud service models (IaaS, PaaS, SaaS), Understanding the shared responsibility model in cloud security, Key principles, Differences between traditional and cloud-native security approaches of cloud-native security (e.g., zero trust, defense in depth)

Overview of cloud-native security tools (e.g., AWS Security Hub, Azure Security Center, Google Cloud Security Command Center), Functions of container security tools (e.g., AquaSecurity features in Kubernetes (e.g., RBAC, network policies), Security, Twistlock), Cloud-native CI/CD security tools (e.g., Snyk, Jenkins X), Identity and access management (IAM) in cloud native environments

Risk assessment methodologies for cloud-native applications, Identifying common vulnerabilities and threats in cloud-native environments, Techniques for securing data in transit and at rest, Implementing network security measures (e.g., microsegmentation, VPNs)

Principles of secure cloud-native architecture design, Frameworks and guidelines for cloud security (e.g., CSA, NIST) Designing secure container orchestration environments Implementing security automation and DevSecOps practices, Continuous security monitoring and incident response in cloud-native environments

Reference Books

- 1 Cloud Native Security: Securing Microservices and Containers, Chris Binnie and Roland Huss, 1st Edition (2021), O'Reilly Media.
- 2 Cloud Native Security: Patterns and Practices, by Alex Homer, 1st Edition (2021), Microsoft Press.
- 3 Cloud Native Software Security Handbook, David Okeyo, Matt Tesauo, and Mark Curphey, 1st Edition (2022), Packt Publishing.
- 4 Practical Cloud Security: A Guide for Secure Design and Deployment, Chris Dotson, 1st Edition (2019), O'Reilly Media.

23CNS3512 - FUTURE TRENDS IN CLOUD NATIVE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CNS3512	FUTURE TRENDS IN CLOUD NATIVE SECURITY	FTCNS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of cryptography and Apply various cryptographic algorithms	2	PO4
CO2	Analyze various security issues and system vulnerabilities in virtualization	3	PO1, PO2, PO4, PSO1
CO3	Apply the technologies for virtualization based security enhancements	3	PO1, PO2, PO3, PO4, PSO1
CO4	Analyze legal and Compliance issues and examine modern security standards	4	PO2, PO3

Syllabus

Security Concepts: Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defence in depth, least privilege, importance of security in the cloud, Importance in PaaS, IaaS and SaaS; Cryptographic Systems: Symmetric cryptography, stream ciphers, block ciphers, modes of operation, public-key cryptography, hashing, digital signatures, public-key infrastructures, key management, X.509 certificates, OpenSSL. Multi-tenancy Issues: Isolation of users/VMs from each other

Virtualization System Security Issues: e.g. ESX and ESXi Security, ESX file system security, storage considerations, backup and recovery; Virtualization System Vulnerabilities: Management console vulnerabilities, management server vulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisor vulnerabilities, hypervisor escape vulnerabilities, configuration issues, malware (botnets etc).

Virtualization System-Specific Attacks: Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyperjacking. Technologies for Virtualization-Based Security Enhancement: IBM security virtual server protection, virtualization-based sandboxing; Storage Security: HIDPS, log management, Data Loss Prevention.

Location of the Perimeter, Legal and Compliance Issues: Responsibility, ownership of data, right to penetration test. Local laws, examination of modern Security Standards (eg PCIDSS), Standards to deal with cloud services and virtualization, compliance for the cloud provider vs. compliance for the customer.

Reference Books

- Ronald L. Krutz, Russell Dean Vines, Cloud Security, 2010.
- John Rittinghouse, James Ransome, Cloud Computing, 2009.
- J.R. ("Vic") Winkler, Securing the Cloud, 2011.
- Ronald L. Krutz, Russell Dean Vines, First Edition, 2010, Will Row.
- Cloud Computing,, 3. John Rittinghouse, James Ransome, 4. J.R. ("Vic") Winkler, Second Edition 2011, Will Row.
- Tim Mather, Subra Kumaraswamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", O'Reilly Media Inc, 2009, Tim Mather, Subra Kumaraswamy, Shahed Latif, , First Edition, 2009, O'Reilly Media Inc.,.
- Securing the Cloud: Cloud Computer Security Techniques and Tactics by Vic (J.R.) Winkler, Vic (J.R.) Winkler, First Edition, 2010, Syngress.

23CPD3101A - FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3101A	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	FMAD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basics of kotlin object-oriented programming language	3	PO3, PO5, PO9, PSO1
CO2	Apply the concepts of XAML Concepts and Designing of different widgets for android	3	PO5, PO11, PSO2
CO3	Apply the Mobile app with Views, Layouts, and Navigation on Android	3	PO5, PSO1
CO4	Apply the concepts of the database and Memory storage concept to build the dynamic Android applications	4	PO3, PO5, PO9, PSO2
CO5	Develop the Mobile Apps With Android Basics and MongoDB Concepts	4	PO3, PO5, PO11, PSO1
CO6	Develop the Mobile Application using XAML and Kotlin in Android Environment	4	PO3, PO5, PSO2
CO7	Design and Develop the Mobile Application using different relative Problems	4	PO5, PO9, PSO2

Syllabus

Kotlin: Introduction to Kotlin, Annotations, Arrays, Basic Lambdas, Collections, Conditional Statements, coroutines, Delegated Properties, Exceptions, and OOPs Concepts. Introduction to Android, setting up Android Studio Android Architecture,

Introduction to Android, setting up Android Studio Android Architecture, Core Building Blocks, Android Emulator, Install Android, Setup of Android Studio. Android Widgets UI Widgets, Working with Button, Toast, Custom Toast, Alert Dialog, Spinner, Auto Complete Text View, List View, Custom List View, Rating Bar, WebView, Seek Bar, Date Picker, Time Picker, Analog and Digital, Progress Bar.

Vertical Scroll View, Horizontal Scroll View, Image Switcher, Image Slider, View Stub, Tab Layout, Tab Linear Layout, Relative Layout, Search View, Search View on Toolbar, Edit Text with Text Watcher Activity and Intents Activity Life Cycle, Implicit Intent, Explicit Intent, Start Activity for Result, Beautiful Layouts with Card View, GRID View, Paging and Swiping Navigation Drawer and Fragment

Share App Data, Android Service, Android Alarm Manager, Android Storage, Internal Storage, External Storage, Android SQLite, SQLite Tutorial, SQLite Spinner, XML and JSON, XML Parsing SAX, XML Parsing DOM, XML Pull Parser, JSON Parsing, APK Generation, Publishing in Google Play Console.

"Installation and setup of MongoDB. Working with MongoDB shell and basic command operations. Introduction to NoSQL data modeling and document-based databases. Integrating Android with MongoDB: Connecting Android apps to MongoDB databases. Utilizing MongoDB's official driver for Android. Performing CRUD operations on MongoDB documents from an Android app. Handling data synchronization and real-time updates. "

Reference Books

- 1 "Android Programming with Kotlin for Beginners", Johan Hortan, Second, 2019, Packt.
- 2 Kotlin in Action by, Dmitry Kemerovo and Svetlana Isakova, first, 2017, Springer.
- 3 Flutter Complete Reference, Alberto Miola, 2021 Edition, Packt Publishing.

- 4 Learning Android Studio, Jason Marsicano, 2020, Packt Publishing.

23CPD3101E - FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3101E	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	FMAD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basics of kotlin object-oriented programming language	3	PO3, PO5, PO9, PSO1
CO2	Apply the concepts of XAML Concepts and Designing of different widgets for android	3	PO5, PO10, PSO2
CO3	Apply the Mobile app with Views, Layouts, and Navigation on Android	3	PO5, PSO1
CO4	Apply the concepts of the database and Memory storage concept to build the dynamic Android applications	4	PO3, PO5, PO9, PSO2
CO5	Develop the Mobile Apps With Android Basics and MongoDB Concepts	4	PO3, PO5, PO10, PSO1
CO6	Develop the Mobile Application using XAML and Kotlin in Android Environment	4	PO3, PO5, PSO2
CO7	Design and Develop the Mobile Application using different relative Problems	4	PO5, PO9, PSO2

Syllabus

Kotlin: Introduction to Kotlin, Annotations, Arrays, Basic Lambdas, Collections, Conditional Statements, coroutines, Delegated Properties, Exceptions, and OOPs Concepts.

Introduction to Android, setting up Android Studio Android Architecture, Core Building Blocks, Android Emulator, Install Android, Setup of Android Studio. Android Widgets UI Widgets, Working with Button, Toast, Custom Toast, Alert Dialog, Spinner, Auto Complete Text View, List View, Custom List View, Rating Bar, WebView, Seek Bar, Date Picker, Time Picker, Analog and Digital, Progress Bar.

Vertical Scroll View, Horizontal Scroll View, Image Switcher, Image Slider, View Stub, Tab Layout, Tab Linear Layout, Relative Layout, Search View, Search View on Toolbar, Edit Text with Text Watcher Activity and Intents Activity Life Cycle, Implicit Intent, Explicit Intent, Start Activity for Result, Beautiful Layouts with Card View, GRID View, Paging and Swiping Navigation Drawer and Fragment

Share App Data, Android Service, Android Alarm Manager, Android Storage, Internal Storage, External Storage, Android SQLite, SQLite Tutorial, SQLite Spinner, XML and JSON, XML Parsing SAX, XML Parsing DOM, XML Pull Parser, JSON Parsing, APK Generation, Publishing in Google Play Console.

"Installation and setup of MongoDB. Working with MongoDB shell and basic command operations. Introduction to NoSQL data modeling and document-based databases. Integrating Android with MongoDB: Connecting Android apps to MongoDB databases. Utilizing MongoDB's official driver for Android. Performing CRUD operations on MongoDB documents from an Android app. Handling data synchronization and real-time updates."

Reference Books

- 1 "Android Programming with Kotlin for Beginners", Johan Hortan, Second, 2019, Packt.
- 2 Kotlin in Action by, Dmitry Kemerovo and Svetlana Isakova, first, 2017, Springer.
- 3 Flutter Complete Reference, Alberto Miola, 2021 Edition, Packt Publishing.
- 4 Learning Android Studio, Jason Marsicano, 2020, Packt Publishing.

23CPD3101R - FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3101R	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	FMAD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basics of kotlin object-oriented programming language	3	PO3, PO5, PO9, PSO1
CO2	Apply the concepts of XAML Concepts and Designing of different widgets for android	3	PO5, PO11, PSO2
CO3	Apply the Mobile app with Views, Layouts, and Navigation on Android	3	PO5, PO9, PSO1
CO4	Apply the concepts of the database and Memory storage concept to build the dynamic Android applications	4	PO3, PO5, PSO2
CO5	Develop the Mobile Apps With Android Basics and MongoDB Concepts	4	PO5, PO9, PSO1
CO6	Develop the Mobile Application using XAML and Kotlin in Android Environment	4	PO3, PO5, PO11, PSO2

Syllabus

Kotlin: Introduction to Kotlin, Annotations, Arrays, Basic Lambdas, Collections, Conditional Statements, coroutines, Delegated Properties, Exceptions, and OOPs Concepts.

Introduction to Android, setting up Android Studio Android Architecture, Core Building Blocks, Android Emulator, Install Android, Setup of Android Studio. Android Widgets UI Widgets, Working with Button, Toast, Custom Toast, Alert Dialog, Spinner, Auto Complete Text View, List View, Custom List View, Rating Bar, WebView, Seek Bar, Date Picker, Time Picker, Analog and Digital, Progress Bar.

Vertical Scroll View, Horizontal Scroll View, Image Switcher, Image Slider, View Stub, Tab Layout, Tab Linear Layout, Relative Layout, Search View, Search View on Toolbar, Edit Text with Text Watcher Activity and Intents Activity Life Cycle, Implicit Intent, Explicit Intent, Start Activity for Result, Beautiful Layouts with Card View, GRID View, Paging and Swiping Navigation Drawer and Fragment

Share App Data, Android Service, Android Alarm Manager, Android Storage, Internal Storage, External Storage, Android SQLite, SQLite Tutorial, SQLite Spinner, XML and JSON, XML Parsing SAX, XML Parsing DOM, XML Pull Parser, JSON Parsing, APK Generation, Publishing in Google Play Console.

Reference Books

- 1 "Android Programming with Kotlin for Beginners", Johan Hontan , Second,2019, Packt.
- 2 Kotlin in Actionby, Dmitry Kemerovo and Svetlana Isakova, first,2017, Springer.
- 3 Flutter Complete Reference, Alberto Miola, 2021 Edition, Packt Publishing.
- 4 Learning Android Studio, Jason Marsicano, 2020, Packt Publishing.

23CPD3202A - REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3202A	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	RNA	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basics of React Native and its architecture. Implement navigation between screens and handle user interactions.	3	PO1, PO3, PO5, PSO2
CO2	Apply the concepts of the React Native UI Design and Material UI	3	PO1, PO3, PO5, PSO1
CO3	Apply state and handle data in React Native applications. Integrate APIs and fetch data from external sources.	3	PO1, PO3, PO5, PSO2
CO4	Construct React Native applications and Deploy React Native applications to Android and iOS devices.	5	PO1, PO3, PO5, PSO1
CO5	Design Advance features containing React native applications	5	PO1, PO3, PO5, PSO1

Syllabus

Overview of React Native and its benefits, React Native vs. native app development, Setting up the development environment, React Native Components and Styling: Creating and styling UI components, Handling user input and events, Working with lists and scroll views, Navigation and Routing: Navigating between screens using React Navigation, Implementing tab navigation and stack, navigation Passing data between screens, State Management and Redux: Managing state in React Native applications, Introduction to Redux for state management

Implementing actions, reducers, store, Networking and API Integration: making HTTP requests and integrating APIs; handling responses, data manipulation, Authentication and secure API calls

Working with Device Features: Accessing device features such as camera, location, and sensors, Using third-party libraries for device-specific functionality, Handling permissions and user privacy, Testing and Debugging: Testing React Native components and functions, Debugging techniques and tools, Performance optimization and profiling

Deployment and App Store Submission: Preparing and building React Native apps for Android and iOS, Generating release builds and signing apps, App Store submission process for Android and iOS

Continuous Integration and Deployment (CI/CD): Set up continuous integration and deployment pipelines for React Native projects using tools like GitHub Actions, Bitrise, or Jenkins, enabling automated testing and deployment workflows. Security and Performance Optimization: Best practices for securing React Native applications, including handling sensitive data, implementing secure authentication mechanisms, and securing network communications. Advanced Topics and Future Trends: Animations, gesture recognition, offline support, and upcoming trends in mobile app development, Capstone Project

Reference Books

- 1 Learning React Native: Building Native Mobile Apps with Java Script, Bonnie Eisenman, 2nd, 2017, O'REILLY'.
- 2 React Native - Building Mobile Apps with JavaScript: Build real-world iOS and Android native apps with JavaScript, Vladimir Novick, 1st, 2017, Packt Publishing.
- 3 React Native Cook Book, Dan Ward, 2ns, 2019, Packt.
- 4 Practical React Native, Frank Zammetti, 1st, 2018, APress.

23CPD3202E - REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3202E	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	RNA	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basics of React Native and its architecture, Implement navigation between screens and handle user interactions.	3	PO1, PO3, PO5, PSO2
CO2	Apply the concepts of the React Native UI Design and Material UI	3	PO1, PO3, PO5, PSO1
CO3	Apply state and handle data in React Native applications. Integrate APIs and fetch data from external sources.	3	PO1, PO3, PO5, PSO2
CO4	Construct React Native applications and Deploy React Native applications to Android and iOS devices	5	PO1, PO3, PO5, PSO1
CO5	Design Advance features containing React native applications	5	PO1, PO3, PO5, PSO1

Syllabus

Overview of React Native and its benefits, React Native vs. native app development, Setting up the development environment, React Native Components and Styling: Creating and styling UI components, Handling user input and events, Working with lists and scroll views, Navigation and Routing: Navigating between screens using React Navigation, Implementing tab navigation and stack, navigation Passing data between screens, State Management and Redux: Managing state in React Native applications, Introduction to Redux for state management

Implementing actions, reducers, store, Networking and API Integration: making HTTP requests and integrating APIs; handling responses, data manipulation, Authentication and secure API calls

Working with Device Features: Accessing device features such as camera, location, and sensors, Using third-party libraries for device-specific functionality, Handling permissions and user privacy, Testing and Debugging: Testing React Native components and functions, Debugging techniques and tools, Performance optimization and profiling

Deployment and App Store Submission: Preparing and building React Native apps for Android and iOS, Generating release builds and signing apps, App Store submission process for Android and iOS

Continuous Integration and Deployment (CI/CD): Set up continuous integration and deployment pipelines for React Native projects using tools like GitHub Actions, Bitrise, or Jenkins, enabling automated testing and deployment workflows. Security and Performance Optimization: Best practices for securing React Native applications, including handling sensitive data, implementing secure authentication mechanisms, and securing network communications. Advanced Topics and Future Trends: Animations, gesture recognition, offline support, and upcoming trends in mobile app development, Capstone Project

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- 2 React Native - Building Mobile Apps with JavaScript: Build real-world iOS and Android native apps with JavaScript, Vladimir Novick, 1st, 2017, Packt Publishing.
- 3 React Native Cook Book, Dan Ward, 2nd, 2019, Packt.
- 4 Practical React Native, Frank Zammetti, 1st, 2018, APress.

23CPD3202R - REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3202R	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	RNA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basics of React Native and its architecture, Implement navigation between screens and handle user interactions.	3	PO1, PO3, PO5, PSO2
CO2	Apply the concepts of the React Native UI Design and Material UI	3	PO1, PO3, PO5, PSO1
CO3	Apply state and handle data in React Native applications. Integrate APIs and fetch data from external sources.	3	PO1, PO3, PO5, PSO2
CO4	Construct React Native applications and Deploy React Native applications to Android and iOS devices	5	PO1, PO3, PO5, PSO1

Syllabus

Overview of React Native and its benefits, React Native vs. native app development, Setting up the development environment, React Native Components and Styling: Creating and styling UI components, Handling user input and events, Working with lists and scroll views, Navigation, and Routing: Navigating between screens using React Navigation, Implementing tab navigation and stack, navigation Passing data between screens, State Management, and Redux: Managing state in React Native applications, Introduction to Redux for state management

Implementing actions, reducers, store, Networking and API Integration: making HTTP requests and integrating APIs; handling responses, data manipulation, Authentication and secure API calls

Working with Device Features: Accessing device features such as camera, location, and sensors, Using third-party libraries for device-specific functionality, Handling permissions and user privacy, Testing and Debugging: Testing React Native components and functions, Debugging techniques and tools, Performance optimization and profiling

Deployment and App Store Submission: Preparing and building React Native apps for Android and iOS, Generating release builds and signing apps, App Store submission process for Android and iOS

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- 2 React Native - Building Mobile Apps with JavaScript: Build real-world iOS and Android native apps with JavaScript, Vladimir Novick, 1st, 2017, Packt Publishing.
- 3 React Native Cook Book, Dan Ward, 2nd, 2019, Packt.
- 4 Practical React Native, Frank Zammetti, 1st, 2018, APress.

23CPD3203A - FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3203A	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	FBCPD	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Learn and apply overview on DART and Flutter Technologies	3	PO1, PO5, PSO2
CO2	Apply Beautiful Mobile Screens using Different Widgets	3	PO1, PO5, PSO2
CO3	Apply the REST API Using Node.js	3	PO1, PO5, PSO2
CO4	Develop the Dynamic Mobile application Using Rendering with Different Databases	3	PO1, PO5, PSO2

Syllabus

DART Programming basics of DART, Control flow, Null Safety, Functions, Data Processing, OOP Concept. Intro to Flutter Introduction to development with Flutter Material app using Android studio, widget tree, and pre-made Flutter widgets for UI design. Incorporate Image and text widgets to create simple user interfaces. Customize pre-built Flutter widgets. Add App icons for IOS and Android builds. Run Flutter apps on an IOS simulator, android emulator, and physical Android and IOS devices. Creating effective UI with Flutter Hot reload and Hot restart, Pubspec. yaml file to incorporate dependencies, custom assets, and fonts. Introduction to widget build method. Incorporate layout widget material icons using the class of the icon

Building APP With Flutter Building Apps with state stateful and stateless widgets, and callbacks. The declarative style of UI programming. Flexible layouts using Flutter. setState, state objects, and stateful widgets. Using DART package manager to incorporate Fluttercompatible packages into projects. Functions in Dart and Arrow syntax. Refactor widgets and understand Flutter's philosophy of UI as code. Structuring Flutter apps Dart constructors to create customizable Flutter widgets. Apply common mobile design patterns to structure mobile apps.

MongoDB with REST API Designing Concepts of Rest API Using Node.js, Mongo DB (Develop Through Rest API), Working with npm (Node package manager) Installing modules Assessing node modules folder Creating a package. json file Managing your application's assets Assessing the main types of HTTP routes Hosting express app instance Creating simple GET routes, creating middleware functions Request, Response, creating a connection string Hosting MongoDB Authenticating into a DB, Creating the model Filtering data AWS Database: Using AWS DynamoDB and S3 Bucket Design REST API Designing Publish Node.js Rest API in AWS Cloud

Devices Camera, Bluetooth, GPS Location, Maps: Dynamic Google Maps, Location Based Maps REST REST API to connect internet retrieve data and rendering widgets, No SQL Database: Mongo DB REST API Rendering using REST API, Firebase Database CRUD Operation. Deployment and publish the app in Android and iOS

Reference Books

- 1 Flutter for Beginners, Alessandro Biessek, 2014, Packt Publishing.
- 2 Beginning Flutter: A Hands-On Guide to App Development, Marco L. Napoli, 2018, Wiley.
- 3 Flutter in Action, Eric Windmill, 2019, Manning Publications.
- 4 Pragmatic Flutter: Building Cross-Platform Mobile Apps with Dart, Priyanka Tyagi, 2021, Apress.

23CPD3203E - FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3203E	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	FBCPD	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Learn and apply overview on DART and Flutter Technologies	3	PO1, PO5, PSO1
CO2	Apply Beautiful Mobile Screens using Different Widgets	3	PO1, PO5, PSO1
CO3	Apply the REST API Using Node.js	3	PO1, PO5, PSO1
CO4	Develop the Dynamic Mobile application Using Rendering with Different Databases	3	PO1, PO5, PSO1
CO5	Develop, deploy, and maintain high-quality mobile applications using Dart and Flutter with advanced features, optimized performance, effective state management, and CI/CD practices.	4	PO1, PO5, PSO1

Syllabus

DART Programming basics of DART, Control flow, Null Safety, Functions, Data Processing, OOP Concept. Intro to Flutter Introduction to development with Flutter Material app using Android studio, widget tree, and pre-made Flutter widgets for UI design. Incorporate Image and text widgets to create simple user interfaces. Customize pre-built Flutter widgets. Add App icons for IOS and Android builds. Run Flutter apps on an IOS simulator, android emulator, and physical Android and IOS devices. Creating effective UI with Flutter Hot reload and Hot restart, Pubspec. yaml file to incorporate dependencies, custom assets, and fonts. Introduction to widget build() method. Incorporate layout widget material icons using the class of the icon

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MongoDB with REST API Designing Concepts of Rest API Using Node.js, Mongo DB , Working with npm (Node package manager) Installing modules Assessing node modules folder Creating a package. json file Managing your applications assets Assessing the main types of HTTP routes Hosting express app instance Creating simple GET routes, creating middleware functions Request, Response, creating a connection string Hosting MongoDB Authenticating into a DB, Creating the model Filtering data AWS Database: Using AWS DynamoDB and S3 Bucket Design REST API Designing Publish Node.js Rest API in AWS Cloud

Devices Camera, Bluetooth, GPS Location, Maps: Dynamic Google Maps, Location Based Maps REST REST API to connect internet retrieve data and rendering widgets, No SQL Database Mongo DB REST API Rendering using REST API, Firebase Database CRUD Operation. Deployment and publish the app in Android and iOS

advanced animations in Flutter, enabling the creation of smooth, engaging transitions and animations. It includes performance optimization techniques such as widget tree management, efficient state management, and minimizing rebuilds. Students will explore advanced state management solutions like Provider, Riverpod, and Bloc. The module also involves the integration of third-party services, incorporating features such as push notifications, analytics, and in-app purchases. Additionally, it introduces CI/CD pipelines using tools like GitHub Actions, Travis CI, and Firebase App Distribution, to automate testing, building, and deploying Flutter apps. The module concludes with app maintenance practices, focusing on debugging, error handling, and implementing feedback mechanisms.

Reference Books

- 1 Flutter for beginners: An introductory guide to building cross-platform mobile applications with Flutter and Dart , Alessandro Biessek , 2019, Manning.
- 2 Flutter for Beginners , Alessandro Biessek , 2019, Packt Publishing.
- 3 Beginning Flutter: A Hands-On Guide to App Development , Marco L. Napoli , 2018, Wiley.
- 4 Pragmatic Flutter: Building Cross-Platform Mobile Apps with Dart , Priyanka Tyagi , 2021, Apress.

23CPD3203R - FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3203R	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	FBCPD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Study and use basic information about DART and Flutter technologies	3	PO1, PO5, PSO1
CO2	Apply Beautiful Mobile Screens using Different Widgets	3	PO1, PO5, PSO1
CO3	Apply the REST API Using Node.js	3	PO1, PO5, PSO1
CO4	Develop the Dynamic Mobile application Using Rendering with Different Databases	3	PO1, PO5, PSO1

Syllabus

DART Programming basics of DART, Control flow, Null Safety, Functions, Data Processing, OOP Concept. Intro to Flutter Introduction to development with Flutter Material app using Android studio, widget tree, and pre-made Flutter widgets for UI design. Incorporate Image and text widgets to create simple user interfaces. Customize pre-built Flutter widgets. Add App icons for IOS and Android builds. Run Flutter apps on an IOS simulator, android emulator, and physical Android and IOS devices. Creating effective UI with Flutter Hot reload and Hot restart, Pubspec. yaml file to incorporate dependencies, custom assets, and fonts. Introduction to widget build method. Incorporate layout widget material icons using the class of the icon

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MongoDB with REST API Designing Concepts of Rest API Using Node.js, Mongo DB (Develop Through Rest API), Working with npm (Node package manager) Installing modules Assessing node modules folder Creating a package. json file Managing your application's assets Assessing the main types of HTTP routes Hosting express app instance Creating simple GET routes, creating middleware functions Request, Response, creating a connection string Hosting MongoDB Authenticating into a DB, Creating the model Filtering data AWS Database: Using AWS DynamoDB and S3 Bucket Design REST API Designing Publish Node.js Rest API in AWS Cloud

Devices Camera, Bluetooth, GPS Location, Maps: Dynamic Google Maps, Location Based Maps REST REST API to connect internet retrieve data and rendering widgets, No SQL Database: Mongo DB REST API Rendering using REST API, Firebase Database CRUD Operation. Deployment and publish the app in Android and iOS

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- Flutter for Beginners, Alessandro Biessek, 2019, Packt Publishing.
- Beginning Flutter: A Hands-On Guide to App Development , Marco L. Napoli , 2019 , Wiley.
- Flutter in Action , Eric Windmill , 2021, Manning Publications.

23CPD3304A - SECURE MOBILE APPLICATION DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3304A	SECURE MOBILE APPLICATION DEVELOPMENT	SMAD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of the Kotlin and Jet Compose and Core UI controls	3	PO1, PO5, PSO1
CO2	Apply the concepts of state management using compose	3	PO1, PO5, PSO1
CO3	apply the concepts Views, View Models and rendering data from the database.	3	PO1, PO5, PSO1
CO4	Developing Security and authentication techniques in apps	4	PO1, PO5, PSO1
CO5	Implement CRUD operations (Create, Read, Update, Delete) using MongoDB with Node.js, ensuring efficient data management	4	PO1, PO5, PSO2
CO6	Design and develop secure mobile applications and deploy using Jet Compose	4	PO1, PO5, PSO2
CO7	Design and Develop the Secure mobile application	4	PO1, PO5, PSO2

Syllabus

"Overview of Kotlin, basics of JETPACK Compose, Android Installation, Creating new Compose Project, using Text, lazy lists, composable functions, buttons, modifiers, and adding clicking, Core UI Compose Elements Surface, wrap content of composable, align composable, Multiple composes, Compose State and recompositing, Composing Layouts: Row, Column, and Box in compose, extract composable for reuse, Nesting columns and rows "

Introduction to Module, declarative paradigm shift, Dynamic content concept, examples of Dynamic Content, State, and composition, adding list state, lifting State, adding Text field with State, Examples on theming card layout dynamically, Dynamic Lists, Navigation Compose.

Patterns of MVVM, adding a View Model and repository, Picking database API, Getting the data in JSON, room database, Retrofit for networking, call back for network responses, coroutines, suspend function, scopes dispatch, using coroutine in compose, hosting state coroutine in the model, Working with Sqlite

Privacy and Security, Secured Device location, sharing data, Network related, Two-factor authentication, JWT tokenization in REST API, Composing Secured OTPs, Secured authentication in Social Media

"Overview of Node.js and its features.Setting up the Node.js development environment. Understanding the Node.js event-driven architecture and non-blocking I/O. Introduction to MongoDB: Introduction to MongoDB and its advantages as a NoSQL database. Installation and setup of MongoDB. Basic CRUD (Create, Read, Update, Delete) operations with MongoDB. Building RESTful APIs with Node.js and Express: Creating a basic Node.js server using Express.js framework.Implementing RESTful API endpoints for data retrieval and manipulation. Handling HTTP requests and responses in Node.js.Working with MongoDB and Mongoose:Connecting Node.js with MongoDB using Mongoose ORM.Defining data models and schemas with Mongoose. Performing CRUD operations with MongoDB using Mongoose.User Authentication and Authorization:Implementing user authentication and authorization using libraries like Passport.js. Managing user sessions and implementing secure login/logout functionality. Utilizing JSON Web Tokens (JWT) for token-based authentication.Real-time Communication with Socket.io: Introduction to real-time communication and websockets. Building real-time chat applications with Socket.io and Node.js. Implementing features like real-time notifications and live updates. Deployment to AWS Cloud: Introduction to Amazon Web Services (AWS) and its cloud services. Deploying Node.js applications on AWS Elastic Beanstalk. Setting up MongoDB Atlas for cloud-based MongoDB database hosting. Scaling and Performance Optimization"

Reference Books

- 1 Designing Data intensive Applications , Martin Kleppmann , 2018, Manning .
- 2 Flutter using react, REX Hartson , 2021, Elsevier Science .
- 3 managing flutter with mobile app, Jesmond alley , 2021, John Wiley & Sons .
- 4 managing flutter with mobile app, Jesmond alley , 2021, John Wiley & Sons .

23CPD3304E - SECURE MOBILE APPLICATION DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3304E	SECURE MOBILE APPLICATION DEVELOPMENT	SMAD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of the Kotlin and Jet Compose and Core UI controls	3	PO1, PO5, PSO1
CO2	Apply the concepts of state management using compose	3	PO1, PO5, PSO1
CO3	apply the concepts Views, View Models and rendering data from the database.	3	PO1, PO5, PSO1
CO4	Developing Security and authentication techniques in apps	4	PO1, PO5, PSO1
CO5	Implement CRUD operations (Create, Read, Update, Delete) using MongoDB with Node.js, ensuring efficient data management	4	PO1, PO5, PSO1
CO6	Design and develop secure mobile applications and deploy using Jet Compose	4	PO1, PO5, PSO1
CO7	Design and Develop the Secure mobile application	4	PO1, PO5, PSO1

Syllabus

Module 1 "Overview of Kotlin, basics of JETPACK Compose, Android Installation, Creating new Compose Project, using Text, lazy lists, composable functions, buttons, modifiers, and adding clicking, Core UI Compose Elements Surface, wrap content of composable, align composable, Multiple composes, Compose State and recompositing, Composing Layouts: Row, Column, and Box in compose, extract composable for reuse, Nesting columns and rows "

Introduction to Module, declarative paradigm shift, Dynamic content concept, examples of Dynamic Content, State, and composition, adding list state, lifting State, adding Text field with State, Examples on theming card layout dynamically, Dynamic Lists, Navigation Compose.

Patterns of MVVM, adding a View Model and repository, Picking database API, Getting the data in JSON, room database, Retrofit for networking, call back for network responses, coroutines, suspend function, scopes dispatch, using coroutine in compose, hosting state coroutine in the model, Working with Sqlite

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- 4 managing flutter with mobile app , Jesmond alley , 2012, John Wiley & Sons .

23CPD3304R - SECURE MOBILE APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3304R	SECURE MOBILE APPLICATION DEVELOPMENT	SMAD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of the Kotlin and Jet Compose and Core UI controls	3	PO1, PO5, PSO1
CO2	Apply the concepts of state management using compose	3	PO1, PO5, PSO1
CO3	apply the concepts Views, View Models and rendering data from the database.	3	PO1, PO5, PSO1
CO4	Developing Security and authentication techniques in apps	4	PO1, PO5, PSO1
CO5	Implement CRUD operations (Create, Read, Update, Delete) using MongoDB with Node.js, ensuring efficient data management	4	PO1, PO5, PSO1
CO6	Design and develop secure mobile applications and deploy using Jet Compose	4	PO1, PO5, PSO1
CO7	Design and Develop the Secure mobile application	4	PO1, PO5, PSO1

Syllabus

Module 1 "Overview of Kotlin, basics of JETPACK Compose, Android Installation, Creating new Compose Project, using Text, lazy lists, composable functions, buttons, modifiers, and adding clicking, Core UI Compose Elements Surface, wrap content of composable, align composable, Multiple composes, Compose State and recompositing, Composing Layouts: Row, Column, and Box in compose, extract composable for reuse, Nesting columns and rows "

Introduction to Module, declarative paradigm shift, Dynamic content concept, examples of Dynamic Content, State, and composition, adding list state, lifting State, adding Text field with State, Examples on theming card layout dynamically, Dynamic Lists, Navigation Compose.

Patterns of MVVM, adding a View Model and repository, Picking database API, Getting the data in JSON, room database, Retrofit for networking, call back for network responses, coroutines, suspend function, scopes dispatch, using coroutine in compose, hosting state coroutine in the model, Working with Sqlite

Privacy and Security, Secured Device location, sharing data, Network related, Two-factor authentication, JWT tokenization in REST API, Composing Secured OTPs, Secured authentication in Social Media

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Reference Books

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- 2 Flutter using react , REX Hartson , 2021, Elsevier Science .
- 3 managing flutter with mobile app , Jesmond alley , 2021, John Wiley & Sons .
- 4 managing flutter with mobile app , Jesmond alley , 2021, ohn Wiley & Sons .

23CPD3405M - UX DESIGN (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3405M	UX DESIGN	UXD	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and discuss about User Experience Design Process	3	PO1, PO2, PO5, PSO1
CO2	Apply User interface and differentiate from User Experience and principles of User Interface	3	PO2, PO4, PO5, PO8, PSO1
CO3	Analysing and distinguishing about components of UI Design process with interactive Devices	3	PO1, PO2, PO4, PO5, PO8, PSO2
CO4	Determine graphic design techniques and psychology principles of User Experience	3	PO1, PO4, PO8, PSO2
CO5	Designing wire frames using Adobe XD, UX Pressia and whimsical	3	, PSO2

Syllabus

Introduction to UX: Introduction to UX, Elements of UX Design, Core Research, Heuristic Evaluation, who is the User, Persona, Customer Journey Map, Empathy, Business Model and Strategy, understanding various technology and devices enabling technology. Introduction To UI: Human Factors, of Interactive Software: Goals of System Engineering, Goals of UI Design, Motivations for Human Factors in Design, Accommodation of Human Diversity, Goals of our Profession.

Survey Components of UI & Effective UI Design Process: Menu Selection, Form Filling, Dialog Boxes-Introduction, Task Related Organization, Item Presentation Sequence, Response time and Display Rate, Fast Movement through menus, Menu Layout, Form Filling, Dialog Boxes, Interactive Devices, Specification methods, Interface Building tools, Evaluation and pretty critiquing tools, material.io

Importance of Colour theory and colour wheel while designing in XD /Figma, Introduction to Typography and its importance in visual design, Introduction to Iconography and its importance in visual design, Menu, selection, formfilling and Dialog boxes: Task related organization, Item presentation Sequence, logo and importance of brand guidelines for logo, Bitmap images and Vector Graphics, Different illustrator elements and their working procedure in adobe illustrator.

Designing UI Using Adobe XD Tool: Getting started with your Adobe XD project, what is UI VS UX Vs product Designer, Wireframing Low Fidelity, Type, colour & Icon Introduction, prototyping a website introduction, Symbols & Repeat Grids, Prototyping an app-Introduction, Colours, Drawing, Images, AssetPanel, Micro Interactions, Voice Interactions, User Testing

Demonstrate and Experiment using UXPressia and whimsical and Demonstrate Experiments using Adobe XD

Reference Books

- 1 Designing the User Interface: Strategies for effective human Computer Interaction, Ben Schneiderman, 5,,2009, Pearson.
- 2 The Elements of User Experience: User centered Design for the web , The Elements of User Experience: User centered Design for the web , 4,,2010, peach pit.
- 3 Human Computer Interaction, Alan Dix Janet Finlay, 3,2004, Pearson.
- 4 The UX Process and guidelines for Ensuring a quality User Experience , REX Hartson, 2,2012, Elsevier Science.

- 5 Smashing UX Design Foundations for Designing Online User Experiences, Jesmond alley, 3,,2012, John Wiley & Sons.

23CPD3406M - META REACT NATIVE SPECIALIZATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3406M	META REACT NATIVE SPECIALIZATION	MRNS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	apply the skills required to create apps across different platforms and devices	3	PO1, PO5, PSO1
CO2	apply the programming fundamentals, how to create a user interface (UI) and best practices for designing the UI.	3	PO1, PO5, PSO1
CO3	design and develop in React Native, React, JavaScript, GitHub repositories and version control.	4	PO1, PO5, PSO1
CO4	Implement project-based portfolio that demonstrates your skills to employers.	4	PO1, PO5, PSO1

Syllabus

Introduction to Mobile Development ,JavaScript is the programming language that powers the modern web. In this course, you will learn the basic concepts of web development with JavaScript. You will work with functions, objects, arrays, variables, data types, the HTML DOM, and much more. You will learn how to use JavaScript and discover interactive possibilities with modern JavaScript technologies. Finally, you will learn about the practice of testing code and how to write a unit test using Jest.

Version Control: Learn how modern software developers collaborate across the world without messing up each other's code. You will look at the different version control systems and how to create an effective software development workflow. You will be introduced to some of the most commonly used Linux commands that you can use to work with files on your hard drive and create powerful workflows that will automate your work, saving you time and effort. Finally, you will see how Git can be used in software development projects to manage team files. And you will create a repository that can manage code revisions. React is a powerful JavaScript library that you can use to build user interfaces for web and mobile applications (apps). In this course, you will explore the fundamental concepts that underpin the React library and learn the basic skills required to build a simple, fast, and scalable app.

Introduction to React Native and Data Management Overview of React Native and its advantages for mobile app development Introduction to data management in React Native applications Understanding state and props in React Native components Working with APIs in React Native, Introduction to the Fetch API and its usage, Making HTTP requests and handling responses, Handling errors and managing loading states, Introduction to state management libraries like Redux and MobX, Setting up Redux or MobX in a React Native project

Understanding the role of UX/UI design in product development, Differentiating between user experience (UX) and user interface (UI) Exploring the principles and importance of good UX/UI design, User Research and Analysis, Conducting user research to understand target audience and user needs, Techniques for gathering user feedback and conducting usability testing, Analyzing user data to inform design decisions Information Architecture and Wireframing Creating effective information architecture for intuitive navigation Techniques for organizing content and creating user flows, Wireframing tools and best practices for creating low-fidelity prototypes

Reference Books

- 1 React Native, by Bonnie Eisenman , 2012, no strach press .
- 2 React native models, Vladimir Novick: , 2014, Manning .
- 3 Flutter for beginneers, Alessandro Biessek , 2012, Manning .
- 4 The UX Process and guidelines for Ensuring a quality User Experience , REX Hartson , 2018, Elsevier Science .

23CPD3507 - ADVANCED MOBILE APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3507	ADVANCED MOBILE APPLICATION DEVELOPMENT	AMAD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Learn and Apply Kotlin and Design Basic Features of the Android XAML Code	2	PO1, PO7, PSO2
CO2	Apply the concepts of the Android with Kotlin and access the different mobile sensors	3	PO1, PO7, PSO2
CO3	apply the REST API using Node.js and AWS MongoDB	3	PO1, PO7, PSO2
CO4	Developing Security and authentication techniques in apps	3	PO1, PO7, PSO2

Syllabus

Introduction to Kotlin- kotlin basics, OOPs concept in Kotlin App life cycle, Android UI, UI Controls Layouts- Linear Layouts, Relative Layouts, Constrain Layout, Grid Layout, Table Layout Views: - Grid View, List View, Recycler View, Card View

Navigation Enhance users ability to navigate across, into, and back out from various screens within the Android app for a consistent and predictable user experience. BottomUp Navigation, Top-Down navigation, Menus Implicit Intent, Explicit Intent, Start Activity for Result, Beautiful Layouts with Card View, fragments, Sensors Camera, Bluetooth, GPS Location, Google Maps

Database Connectivity SQLite3 CRUD Operation with Android Android with REST API Build Dynamic Mobile Application Using REST API, Consume REST Endpoints to render the Material Widgets (SQL, MongoDB, AWS DynamoDB) Play Store Publishing Generate Signed APK published in Google Play Console

MongoDB with REST API Designing Concepts of Rest API Using Node.js, Mongo DB (Develop Through Rest API), Working with npm (Node package manager) Installing modules Assessing node modules folder Creating a package. Json file Managing your applications assets Assessing the main types of HTTP routes Hosting express app instance Creating simple GET routes, creating middleware functions Request, Response, Creating a connection string Hosting MongoDB Authenticating into a DB, Creating the model Filtering data AWS Database: Using AWS DynamoDB and S3 Bucket Design REST API Designing Publish Node.js Rest API in AWS Cloud

Reference Books

- 1 Android Programming: The Big Nerd Ranch Guide, Bill Phillips, Chris Stewart, Kristin Marsicano, 2012, Big Nerd Ranch Guides.
- 2 Title: Professional Android, Reto Meier, Ian Lake, 2021, Wrox.
- 3 Advanced Android Application Development, Joseph Annuzzi Jr., Lauren Darcey, Shane Conder, 2018, Addison-Wesley Professional.
- 4 Kotlin Programming The Big Nerd Ranch Guide, David Greenhalgh, 2013, Big Nerd Ranch Guides.

23CPD3508 - CROSS PLATFORM USER INTERFACE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPD3508	CROSS PLATFORM USER INTERFACE DESIGN	CPED	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Learn user-centered design principles and best practices to create effective and engaging mobile app interfaces in Flutter.	2	PO1, PO2, PSO2
CO2	Apply the user research and user testing to inform their design decisions and create designs that meet user needs and preferences	3	PO1, PO2, PSO2
CO3	Apply the cocepts of animations and motion design in Flutter, enhancing the user experience and making the app more engaging and intuitive.	3	PO1, PO2, PSO2
CO4	Design and develop prototype and wireframe in Flutter to test their designs and gather user feedback.	3	PO1, PO2, PSO2

Syllabus

Overview of UI/UX design principles and best practices, Introduction to Flutter framework and its capabilities, setting up a development environment for Flutter with UI/UX design tools, User Research, and User-Centered Design, Understanding the importance of user research in UI/UX design, Conducting user research for mobile apps Implementing user-centered design principles in Flutter app design

Designing User Interfaces for Flutter Designing user interfaces and user flows for Flutter apps Implementing visual design principles and best practices in Flutter Using Flutter UI widgets and components to design interfaces Prototyping and User Testing in Flutter Prototyping and wireframing in Flutter for UI/UX design Conducting user testing for Flutter app designs Using feedback from user testing to improve app designs.

Animation and Motion Design in Flutter Introduction to animation and motion design concepts Creating basic animations and transitions with Flutter Creating complex animations and physics-based motion design.

Flutter and Material Design Overview of Material Design principles and guidelines Implementing Material Design components and patterns in Flutter Customizing Material Design components for a unique look and feel

Reference Books

- 1 Flutter Development with Dart by Simone Alessandria, Paolo Pecorino, and Salvatore Giordano, Paolo Pecorino, 2012, no strach press.
- 2 The Elements of User Experience: User-Centered Design for the Web and Beyond by, Jesse James Garrett, 2013, Manning .
- 3 Complete Flutter Development Bootcamp with Dart, App Brewery, 2011, no strach press.
- 4 Learning Dart, BREW, 2010, no strach press.

23CPS3101A - IOT SENSING AND ACTUATING DEVICES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3101A	IOT SENSING AND ACTUATING DEVICES	ISAD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the role of sensor and actuators in real time aspects and	3	PO1, PO2, PSO2
CO2	Apply the role of signal conditioning circuits and Impedance Matching circuits	3	PO2, PO3, PSO1
CO3	Analyze different generation of sensors for the development of IoT based Networks	4	PO1, PO2, PSO1
CO4	Analyze different IoT sensor technologies for the enhancement of various IoT devices	4	PO2, PO3, PSO2
CO5	Analyse the role of different Energy sources and power management in IoT	4	PO2, PO3, PSO1
CO6	Implementation and Evaluation of the practical IoT	5	PO2, PO3, PSO2
CO7	Implementation and Evaluation of the skilling IoT	6	PO1, PO3, PSO2

Syllabus

The Introduction to IoT explores the fundamentals of interconnected devices, while Applications & Domain Specific of IoT highlight its diverse uses in sectors like healthcare, agriculture, and smart cities. Understanding the Characteristics of IoT, such as scalability and real-time data processing, is essential for effective implementation. Various Enabling Technologies in IoT, including cloud computing and AI, support these systems. Signal transmission in IoT involves different Types of Signal: pneumatic, hydraulic, and electronic. The Workflow and Classification of Transducers, Sensors, and Actuators are critical in system design, with the Role of Sensors and Actuators being pivotal for data collection and action execution. The evolution of IoT sensors can be traced through Generations - First, Advanced & Integrated IoT Sensors, reflecting advancements from basic to highly integrated systems.

Sensors and Actuators in Automobile Systems play a crucial role in enhancing vehicle performance and safety. Similarly, Sensors and Actuators in the Feedback Control System are essential for maintaining system stability and performance. The Importance of Estimation in Sensing lies in improving the accuracy and reliability of sensor data. Innovative Sensor Technologies are continuously emerging, expanding the potential Application Scenarios across various fields. Specific technologies such as Light to Voltage Converters and Capacitance to Voltage Converters are integral in modern sensing applications. The Importance of Impedance Matching in Analog & Digital Transducers and Actuators cannot be overstated, as it ensures signal integrity and efficient energy transfer. Additionally, Interferometers are critical tools in precision measurement and optical sensing applications.

Components Interconnections and Signal Conditioning involve crucial processes like ADC (Analog-to-Digital Conversion), DAC (Digital-to-Analog Conversion), and the Conversion of ADC to DAC and vice versa. Proper Component Interconnection and Signal Modification Conditioning are vital for system accuracy and efficiency. The Importance of Impedance Matching in Component Interconnection ensures optimal signal transfer and system performance, utilizing Various Impedance Matching Methods. Resistive Sensors, such as Resistive Temperature Detectors, Light-Dependent Resistors, and Gas Sensors, require precise Signal Conditioning for Resistive Sensors to function correctly. Devices like the Potentiometer and Phase Sensor, which include Phase Detection and Polarization Maintaining Fibers, are essential for accurate measurement and signal control in advanced systems.

Components Interconnections and Signal Conditioning encompass processes like ADC (Analog-to-Digital Conversion) and DAC (Digital-to-Analog Conversion), including the Conversion of ADC to DAC and vice versa. Effective Component Interconnection and Signal Modification Conditioning are essential, with the Importance of Impedance Matching in Component Interconnection ensuring optimal performance through Various Impedance Matching Methods. Resistive Sensors, such as Resistive Temperature Detectors, Light-Dependent Resistors, and Gas Sensors, require precise Signal Conditioning for Resistive Sensors. Devices like the Potentiometer and Phase Sensor, involving Phase Detection and Polarization Maintaining Fibers, are critical for accurate measurement and signal control.

Energy Storage solutions involve various Energy and Power Models, utilizing Batteries, Super Capacitors, and Radioactive Power Sources. Advanced Processing Techniques such as Chemical Vapour Deposition, Electroplating, Photolithography, Silicon Micromachining, and the LIGA Process are essential for manufacturing precision components. The Industrial Internet of Things (IIoT), a key aspect of Industry 4.0, includes Applications of Industrial IoT driven by Drivers of Industry 4.0. Technologies like Cloud and Fog Computing for Industrial IoT enable efficient data management and analysis, while Smart Sensors and Industrial Sensors play a crucial role in monitoring and automating industrial processes.

Reference Books

- 1 Internet of things for architects , Perry Lea , Second, Packt Publishing ltd .
Smart Sensors and Systems: Innovations for Medical, Environmental, and IoT Application , Chong-Min Kyung, HirotoYasuura, Yongpan Liu, Youn-Long Lin. , Second, Chong-Min Kyung, HirotoYasuura, Yongpan Liu, Youn-Long Lin. .
- 2
- 3 Introduction to Sensors in IoT and Cloud Computing Applications , Ambika Nagaraj , Third, Bentham Books .
- 4 Advanced Materials and Technologies for Micro/Nano-Devices, Sensors and Actuators, Evgeni Gusev and Eric Garfunkel, Second, Springer .
- 5 Sensors and Actuators, D.A.Hall and C.E.Millar, First , IoM Communication LTD.

23CPS3101E - IOT SENSING AND ACTUATING DEVICES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3101E	IOT SENSING AND ACTUATING DEVICES	ISAD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the role of sensor and actuators in real time aspects	3	PO2, PO3, PSO2
CO2	Apply the role of signal conditioning circuits and Impedance Matching circuits	3	PO1, PO2, PSO1
CO3	Analyze different generation of sensors for the development of IoT based Networks	4	PO1, PO2, PO3, PSO2
CO4	Analyze different IoT sensor technologies for the enhancement of various IoT devices	4	PO2, PO3, PSO2
CO5	Analyse the role of different Energy sources and power management in IoT	4	PO1, PO2, PSO1
CO6	Implementation and Evaluation of the practical IoT	5	PO1, PO3, PSO1
CO7	Implementation and Evaluation of the skilling IoT	6	PO2, PO3, PSO2

Syllabus

The Introduction to IoT provides a foundation for understanding Applications & Domain-Specific Uses of IoT, highlighting the Characteristics of IoT such as connectivity and scalability. Various Enabling Technologies in IoT support these applications. Signal Transmission involves different Types of Signals, including Pneumatic, Hydraulic, and Electronic Signals. The Workflow and Classification of Transducers, Sensors, and Actuators are essential for system design, emphasizing the Role of Sensors and Actuators in data collection and execution. The evolution of IoT devices is marked by Generations-First, Advanced, and Integrated IoT Sensors, showcasing technological advancements in the field.

Sensors and Actuators in Automobile Systems and Sensors and Actuators in Feedback Control Systems play crucial roles in enhancing performance and stability. The Importance of Estimation in Sensing ensures accuracy and reliability, while Innovative Sensor Technologies expand potential Application Scenarios. Devices such as Light to Voltage Converters and Capacitance to Voltage Converters are pivotal in modern applications. The Importance of Impedance Matching in Analog & Digital Transducers and Actuators ensures efficient signal transfer, and Interferometers are essential for precision measurement and optical sensing.

Components Interconnections and Signal Conditioning involve processes such as ADC (Analog-to-Digital Conversion) and DAC (Digital-to-Analog Conversion), including the Conversion of ADC to DAC and vice versa. Effective Component Interconnection and Signal Modification Conditioning are critical, with the Importance of Impedance Matching in Component Interconnection ensured through Various Impedance Matching Methods. Specific sensors like Resistive Sensors, Resistive Temperature Detectors, Light-Dependent Resistors, and Gas Sensors require precise Signal Conditioning for Resistive Sensors. Devices such as Potentiometers and Phase Sensors, which include Phase Detection and Polarization Maintaining Fibers, are essential for accurate measurement and signal control.

Description & Characteristics of emerging technologies include Polytronics Systems, Sensor Swarms, and Printed Electronics, each with unique attributes. The Description & Characteristics: IoT Generation Roadmap outlines the evolution of IoT technologies. Wireless Sensor Technologies and Magnetic Sensors play critical roles in data collection, while Stepper Motors and Thermodynamic IoT Sensors are vital for precise control and measurement. In terms of Energy Sources and Power Management, methods such as Energy Harvesting, Solar Harvesting, Piezo Mechanical Harvesting, and RF Energy Harvesting are essential. These energy solutions support Actuator and Control Applications in various IoT systems.

Energy Storage, including Energy and Power Models, Batteries, Supercapacitors, and Radioactive Power Sources, are crucial for sustaining various applications. Advanced Processing Techniques such as Chemical Vapour Deposition, Electroplating, Photolithography, Silicon Micromachining, and the LIGA Process are essential for manufacturing precision components. The Industrial Internet of Things (IIoT) underpins Industry 4.0, driven by Applications of Industrial IoT and Drivers of Industry 4.0, with Cloud and Fog Computing for Industrial IoT facilitating efficient data management and analysis. Case studies illustrate the impact of Smart Sensors and Industrial Sensors on optimizing operations and enhancing productivity in real-world scenarios.

Reference Books

- 1 Internet of things for architects , Perry Lea , Second, Packt Publishing ltd .
- 2 Smart Sensors and Systems: Innovations for Medical, Environmental, and IoT Application , Chong-Min Kyung, HirotoYasuura, Yongpan Liu, Youn-Long Lin, Second, Springer .
- 3 Introduction to Sensors in IoT and Cloud Computing Applications , Ambika Nagaraj , Third, Bentham Books .
- 4 Sensors and Actuators, D.A. Hall and C.E.Millar, First Edition, IoM Communication LTD.

23CPS3101R - IOT SENSING AND ACTUATING DEVICES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3101R	IOT SENSING AND ACTUATING DEVICES	ISAD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the role of sensor and actuators in real time aspects	3	PO1, PO2, PO3, PSO1
CO2	Apply the role of signal conditioning circuits and Impedance Matching circuits	3	PO2, PO3, PSO1
CO3	Analyze different generation of sensors for the development of IoT based Networks	4	PO1, PO2, PO3, PSO2
CO4	Analyse the role of different Energy sources and power management in IoT	4	PO1, PO3, PSO1
CO5	Implementation and Evaluation of the practical IoT	5	PO1, PO2, PO3, PSO2
CO6	Implementation and Evaluation of the skilling IoT	6	PO1, PO2, PO3, PSO2

Syllabus

Introduction to IoT provides a foundational understanding of interconnected devices, while Applications & Domain-Specific Uses of IoT highlight its diverse practical applications. Understanding the Characteristics of IoT, such as scalability and real-time data processing, is crucial for effective implementation. Various Enabling Technologies in IoT support these applications. The Workflow and Classification of Transducers, Sensors, and Actuators are essential for designing efficient IoT systems, emphasizing the Role of Sensors and Actuators in data collection and execution. IoT sensor technology has evolved through Generations-First, Advanced, and Integrated IoT Sensors, marking significant advancements in functionality and integration.

Understanding The Importance of Estimation in Sensing is crucial for enhancing accuracy and reliability in data collection. Innovative Sensor Technologies continually expand the range of Application Scenarios, optimizing performance across various fields. The Importance of Impedance Matching in Analog & Digital Transducers and Actuators ensures efficient signal transmission and response. Effective Components Interconnections and Signal Conditioning, including ADCs and DACs, facilitate seamless Conversion of ADC to DAC and vice versa, enhancing overall system functionality through precise Signal Modification and Conditioning.

Resistive Sensors, Resistive Temperature Detectors, Light-Dependent Resistors, and Gas Sensors are essential components in various applications, requiring specific Signal Conditioning for Resistive Sensors to ensure accurate data acquisition. Devices like Potentiometers and Phase Sensors, including Phase Detection and Polarization Maintaining Fibers, play critical roles in precise measurement and control. Description & Characteristics of emerging technologies such as Polytronics, Sensor Swarms, and Printed Electronics highlight their innovative attributes and diverse applications in modern systems.

Wireless Sensor Technologies and Magnetic Sensors enable efficient data collection, complemented by Stepper Motors and Thermodynamic IoT Sensors for precise control in diverse applications. Energy Sources and Power Management, including Energy Harvesting methods like Solar, Piezo Mechanical, and RF Energy Harvesting, support Actuator and Control Applications. Energy Storage solutions such as Batteries, Supercapacitors, and Radioactive Power Sources ensure continuous operation. Applications of Industrial IoT are enhanced by Cloud and Fog Computing, illustrated through various Case Studies showcasing improved efficiency and innovation in industrial processes.

Reference Books

- 1 Internet of things for architects , Perry Lea , Second, Packt Publishing .

- 2 Smart Sensors and Systems: Innovations for Medical, Environmental, and IoT Application , Chong-Min Kyung, HirotoYasuura, Yongpan Liu, Youn-Long Lin. , Second, Springer .
- 3 Introduction to Sensors in IoT and Cloud Computing Applications , Ambika Nagaraj , Third, Bentham Books .
- 4 Sensors and Actuators, D.A.Hall and C.E.Millar, First, IoM Communication LTD.

23CPS3202A - INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3202A	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	IOTAP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Architectural Overview of IoT	2	PO1, PO7, PSO1
CO2	Understand the IoT reference Architecture and Real World Design Constraints	2	PO1, PO7, PSO1
CO3	Apply various IoT Protocols in Datalink Layers	3	PO1, PO7, PSO1
CO4	Apply various IoT Protocols in Network Layers	3	PO1, PO2, PO5, PSO1
CO5	Apply various IoT Protocols in Transport Layers	3	PO1, PO2, PO5, PSO1
CO6	Apply various IoT Protocols in Session Layers	3	PO1, PO2, PO5, PSO1
CO7	Create IoT based applications using IoT Protocols	5	PO1, PO2, PO5, PSO1

Syllabus

Internet of Things: An overview: IOT conceptual framework, IoT architectural and standards, Technology behind IoT, Protocols and Communication. Design Principle for connected Devices: IoT system layer and design standardization, communication technologies, data enrichment, data consolidation, and device management at the gateway.

IoT Architecture -State of the Art: Introduction, Architecture Reference Model- Introduction, Reference Model and architecture, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

IoT Link Layer & Network Layer Protocols: PHY/MAC Layer protocols, Z-Wave, Bluetooth Low Energy, DASH7

Network Layer IPv4, IPv6, 6LoWPAN, 6TiSCH, DHCP, ICMP, CORPL, CARP.

Transport Layer, TCP, UDP, DCCP

Reference Books

- 1 From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, 1st Edition, Jan Holler.
- 2 Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, 1st Edition, Peter Vahir.
- 3 Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, 1st Edition, Bernd Scholz.
- 4 IoT and Edge Computing for Architects, Perry Lea, 2nd Edition, Packt.

23CPS3202E - INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3202E	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	IOTAP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Architectural Overview of IoT	2	PO1, PO7, PSO1
CO2	Understand the IoT reference Architecture and Real World Design Constraints	2	PO1, PO7, PSO1
CO3	Apply various IoT Protocols in Datalink Layers	3	PO1, PO7, PSO1
CO4	Apply various IoT Protocols in Network Layers	3	PO1, PO2, PO5, PSO1
CO5	Apply various IoT Protocols in Transport Layers	3	PO1, PO2, PO5, PSO1
CO6	Apply various IoT Protocols in Session Layers	3	PO1, PO2, PO5, PSO1
CO7	Create IoT based applications using IoT Protocols	5	PO1, PO2, PO5, PSO1

Syllabus

Internet of Things: An overview: IOT conceptual framework, IoT architectural and standards, Technology behind IoT, Protocols and Communication. Design Principle for connected Devices: IoT system layer and design standardization, communication technologies, data enrichment, data consolidation, and device management at the gateway.

IoT Architecture -State of the Art: Introduction, Architecture Reference Model- Introduction, Reference Model and architecture, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

IoT Link Layer & Network Layer Protocols: PHY/MAC Layer protocols, Z-Wave, Bluetooth Low Energy, DASH7

Network Layer IPv4, IPv6, 6LoWPAN, 6TiSCH, DHCP, ICMP, CORPL, CARP.

Transport Layer, TCP, UDP, DCCP

Reference Books

- 1 From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, 1st Edition, Jan Holler.
- 2 Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, 1st Edition, Peter Vahir.
- 3 Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, 1st Edition, Bernd Scholz.
- 4 IoT and Edge Computing for Architects, Perry Lea, 2nd Edition, Packt.

23CPS3202R - INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3202R	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	IOTAP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Architectural Overview of IoT	2	PO1, PO7, PSO1
CO2	Understand the IoT reference Architecture and Real World Design Constraints	2	PO1, PO7, PSO1
CO3	Apply various IoT Protocols in Datalink and Network Layers	3	PO1, PO2, PO5, PSO1
CO4	Apply various IoT Protocols in Transport and Session Layers	3	PO1, PO2, PO5, PSO1

Syllabus

Internet of Things: An overview: IOT conceptual framework, IoT architectural and standards, Technology behind IoT, Protocols and Communication. Design Principle for connected Devices: IoT system layer and design standardization, communication technologies, data enrichment, data consolidation, and device management at the gateway.

IoT Architecture -State of the Art: Introduction, Architecture Reference Model- Introduction, Reference Model and architecture, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

IoT Link Layer & Network Layer Protocols: PHY/MAC Layer protocols, Z-Wave, Bluetooth Low Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, DHCP, ICMP, CORPL, CARP.

Internet Connectivity Protocols, Transport Layer, TCP, UDP, DCCP Session Layer, CoAP, XMPP, AMQP, MQTT. Layer Protocols, Service Layer oneM2M, ETSI M2M, OMA, BBF.

Reference Books

- 1 From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, VlasiosTsiatsis, 1st Edition, Jan Holler.
- 2 Internet of Things - A Hands-on Approach, ArshdeepBahga and Vijay Madisetti, 1st Edition, Peter Vahir.
- 3 Building the Internet of Things with IPv6 and MIPv6, Daniel Minoli, 1st Edition, Bernd Scholz.
- 4 IoT and Edge Computing for Architects, Perry Lea, 2nd Edition, Packt.

23CPS3303A - CYBER PHYSICAL SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3303A	CYBER PHYSICAL SYSTEMS	CPS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply mathematical concepts for modeling to design automation	3	PO1, PO2, PO3
CO2	Apply Middle and High Level Design Decisions to design the automation	3	PO1, PO2, PO3
CO3	Analyze the Human interaction with CPS by making use of IoT Sensors	4	PO1, PO2, PSO2
CO4	Analyze AADL and make use of it for modelling the automation	4	PO1, PO2, PSO2
CO5	Analyze security techniques and issues for Cyber Physical Systems.	4	PO1, PO2, PSO2
CO6	Design and implement smart models for automobiles, medical devices and home appliances.	6	PO3, PO5, PO7, PSO2
CO7	Devise Specific services that are essential for a CPS/Internet of Things (IoT) implementation	6	PO3, PO5, PO7, PSO2

Syllabus

Cyber Physical Systems: Introduction, CPS definition, CPS Examples, Fundamental Approach, Mathematical Concepts for Modeling, Nature and Computational models, Decision Making - Low Level Design Decision, Feedback Algorithm, Linear Controls, Low Level Control.

Middle Level Design Decision Requirements Trajectory Planning, Middle Level Design Decisions Guidance Techniques, High Level Design Decisions: High Level Decision Making; Linear Temporal Logic, High Level Logic Feron-G, Low Level Human CPS Interaction, Aviation, Short Period, Equivalent Systems, Automotive Example, Caravan Trailer Sway

Human Automation Interaction Aviation, FA4 MCP, Automation as a State Machine, Hardware Software CoDesign, Processors and Sensors, Sensors in CPS, MEMs, Pressure Sensors, Actuator Trends Servo, Embedded CPS Architectures, Systems Engineering-General Approach, Tools and Frameworks, System and Electronics Interface AADL Virtual Integration and Analysis

AADL General Principles and Positioning Why Modeling, Model Usage, How Modeling, Model, Process and Tools, AADL Introduction AADL Elements, AADL Properties, AADL Crazyflie Case Study, Formal Methods Main Mechanisms; Abstractions, Lattices, Model Checking Tools for Model Checking, Examples Stop Light Example, Car Example, Hunting for Invariants, Bicycle Example, Future of CPS Backup Strategies; Legacy CPS Systems and Safety, Internet of Things, Design Tools, Technology Push Vs. Market Pull.

Security of Cyber-Physical Systems Introduction to CPS Securities, Basic Techniques in CPS Securities, Cyber Security Requirements, Attack Model and Countermeasures, advanced Techniques in CPS Securities. CPS Application Health care and Medical Cyber-Physical Systems, Smart grid and Energy Cyber Physical Systems, WSN based Cyber-Physical Systems, Smart Cities

Reference Books

- 1 Cyber Physical Systems, Raj Rajkumar, Dionisio de Niz, Mark Klein, 2017, Addison-Wesley Professional.
- 2 Cyber-Physical Systems, Parma Nand, Uzzal Sharma, Jyotir Moy Chatterjee, Vishal Jain, Noor Zaman Jhanjhi, R. Sujatha, 2022, Wiley-Scrivener.

- 3 Cyber-physical Systems, Pedro H. J. Nardelli, 2022, Wiley-IEEE Press.
- 4 Security and Privacy in Cyber-Physical Systems, Houbing Song, Glenn A. Fink, Sabina Jeschke, 2017, Wiley-IEEE Press.
- 5 Introduction to Embedded Systems - A Cyber-Physical Systems Approach, Edward Ashford Lee and Sanjit Arunkumar Seshia, 2016, MIT PRESS.

23CPS3303E - CYBER PHYSICAL SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3303E	CYBER PHYSICAL SYSTEMS	CPS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply mathematical concepts for modeling to design automation	3	PO1, PO2, PO3
CO2	Apply Middle and High Level Design Decisions to design the automation	3	PO1, PO2, PO3
CO3	Analyze the Human interaction with CPS by making use of IoT Sensors	4	PO1, PO2, PSO2
CO4	Analyze AADL and make use of it for modelling the automation	4	PO1, PO2, PSO2
CO5	Analyze security techniques and issues for Cyber Physical Systems.	4	PO1, PO2, PSO2
CO6	Design and implement smart models for automobiles, medical devices and home appliances.	6	PO3, PO5, PO7, PSO2
CO7	Devise Specific services that are essential for a CPS/Internet of Things (IoT) implementation	6	PO3, PO5, PO7, PSO2

Syllabus

Cyber Physical Systems: Introduction, CPS definition, CPS Examples, Fundamental Approach, Mathematical Concepts for Modeling, Nature and Computational models, Decision Making - Low Level Design Decision, Feedback Algorithm, Linear Controls, Low Level Control.

Middle Level Design Decision Requirements Trajectory Planning, Middle Level Design Decisions Guidance Techniques, High Level Design Decisions: High Level Decision Making; Linear Temporal Logic, High Level Logic Feron-G, Low Level Human CPS Interaction, Aviation, Short Period, Equivalent Systems, Automotive Example, Caravan Trailer Sway

Human Automation Interaction Aviation, FA4 MCP, Automation as a State Machine, Hardware Software CoDesign, Processors and Sensors, Sensors in CPS, MEMs, Pressure Sensors, Actuator Trends Servo, Embedded CPS Architectures, Systems Engineering-General Approach, Tools and Frameworks, System and Electronics Interface AADL Virtual Integration and Analysis

AADL General Principles and Positioning Why Modeling, Model Usage, How Modeling, Model, Process and Tools, AADL Introduction AADL Elements, AADL Properties, AADL Crazyflie Case Study, Formal Methods Main Mechanisms; Abstractions, Lattices, Model Checking Tools for Model Checking, Examples Stop Light Example, Car Example, Hunting for Invariants, Bicycle Example, Future of CPS Backup Strategies Legacy CPS Systems and Safety, Internet of Things, Design Tools, Technology Push Vs. Market Pull.

Security of Cyber-Physical Systems Introduction to CPS Securities Basic Techniques in CPS Securities, Cyber Security Requirements, Attack Model and Countermeasures, advanced Techniques in CPS Securities. CPS Application Health care and Medical Cyber-Physical Systems, Smart grid and Energy CyberPhysical Systems, WSN based Cyber-Physical Systems, Smart Cities

Reference Books

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- 2 Cyber-Physical Systems, Parma Nand, Uzzal Sharma, Jyotir Moy Chatterjee, Vishal Jain, Noor Zaman Jhanjhi, R. Sujatha, 2022, Wiley-Scrivener.

- 3 Cyber-physical Systems, Pedro H. J. Nardelli, 2022, Wiley-IEEE Press.
- 4 Security and Privacy in Cyber-Physical Systems, Houbing Song, Glenn A. Fink, Sabina Jeschke, 2017, Wiley-IEEE Press.
- 5 Introduction to Embedded Systems - A Cyber-Physical Systems Approach, Edward Ashford Lee and Sanjit Arunkumar Seshia, 2016, MIT PRESS.

23CPS3303R - CYBER PHYSICAL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3303R	CYBER PHYSICAL SYSTEMS	CPS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply mathematical concepts for modeling to design automation	3	PO1, PO2, PO3
CO2	Apply Middle and High Level Design Decisions to design the automation	3	PO1, PO2, PO3
CO3	Analyze the Human interaction with CPS by making use of IoT Sensors	4	PO1, PO2, PSO2
CO4	Analyze AADL and make use of it for modelling the automation	4	PO1, PO2, PSO2
CO5	Design and implement smart models for automobiles, medical devices and home appliances.	6	PO3, PO5, PO7, PSO2
CO6	Devise Specific services that are essential for a CPS/Internet of Things (IoT) implementation	6	PO3, PO5, PO7, PSO2

Syllabus

Cyber Physical Systems: Introduction, CPS definition, CPS Examples, Fundamental Approach, Mathematical Concepts for Modeling, Nature and Computational models, Decision Making - Low Level Design Decision, Feedback Algorithm, Linear Controls, Low Level Control.

Middle Level Design Decision Requirements Trajectory Planning, Middle Level Design Decisions Guidance Techniques, High Level Design Decisions: High Level Decision Making; Linear Temporal Logic, High Level Logic Feron-G, Low Level Human CPS Interaction, Aviation, Short Period, Equivalent Systems, Automotive Example, Caravan Trailer Sway

Human Automation Interaction Aviation, FA4 MCP, Automation as a State Machine, Hardware Software CoDesign, Processors and Sensors, Sensors in CPS, MEMs, Pressure Sensors, Actuator Trends Servo, Embedded CPS Architectures, Systems Engineering General Approach, Tools and Frameworks, System and Electronics Interface AADL Virtual Integration and Analysis

AADL General Principles and Positioning Why Modeling, Model Usage, How Modeling, Model, Process and Tools, AADL Introduction AADL Elements, AADL Properties, AADL Crazyflie Case Study, Formal Methods Main Mechanisms; Abstractions, Lattices, Model Checking Tools for Model Checking, Examples Stop Light Example, Car Example, Hunting for Invariants, Bicycle Example, Future of CPS Backup Strategies; Legacy CPS Systems and Safety, Internet of Things, Design Tools, Technology Push Vs. Market Pull.

Reference Books

- 1 Cyber Physical Systems, Raj Rajkumar, Dionisio de Niz, Mark Klein, 2017, Addison-Wesley Professional.
- 2 Principles of Cyber Physical Systems, R. Alur, 2022, MIT Press.
- 3 Cyber-physical Systems: A Model Based Approach, Walid M. Taha, Johan Thunberg, 2022, Springer.
- 4 Security and Privacy in Cyber-Physical Systems, Houbing Song, Glenn A. Fink, Sabina Jeschke, 2017, Wiley-IEEE Press.
- 5 Introduction to Embedded Systems - A Cyber-Physical Systems Approach, Edward Ashford Lee and Sanjit Arunkumar Seshia, 2016, MIT PRESS.

23CPS3404M - FOUNDATIONS OF HYBRID AND EMBEDDED SYSTEMS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3404M	FOUNDATIONS OF HYBRID AND EMBEDDED SYSTEMS	DVP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand The Advance structure of the Hybrid Embedded System and its Outlook is outlined with state of the art example and Remembering the Basic Operational behavior of Microprocessors and Controllers	2	PO1, PO2, PO6
CO2	Relating the Hybrid embedded Operation in relation with Modern day Real-Time Operating System	2	PO2, PO5, PO8
CO3	Examining the placements of Various Wireless Sensor Unit and sensing Nodes and Utilization of various Protocols and methodology in the operations of Hybrid Embedded System	3	PO2, PO3, PO5, PO11
CO4	Analyzing Various data gathered and involved in the monitoring and controlling of Hybrid Embedded Systems	4	PO1, PO2, PO5, PSO1

Syllabus

Learning the way and method to identify the suitable processor to the corresponding intended architecture.

Examining the importance and need of Real Time Operating System (RTOS) while executing simple task using any one of the RTOS\S

Listing out various real-time Embedded Structured used in the prominent industry and developing simple project using the learned methodology.

Analyzing Various data acquisition system with real-time prospective.

Reference Books

- 1 Introduction to Embedded Systems , shibu k v , , 4, Mc Graw Hill Education.
- 2 Handbook of sensor Networks, Mohammad Ilyas And Imad Mahgoub, 2, CRC Press.
- 3 Embedded System Design , Frank vahid, tony grivargis, 3, john Wiley.
- 4 Embedded Systems- An integrated approach , Lyla b das, 6, Pearson education 2012.

23CPS3505 - CLOUD COMPUTING FOR IOT ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3505	CLOUD COMPUTING FOR IOT ENGINEERS	CCIOTE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of cloud computing services, including deployment models and enabling technology, as well as cloud-based IoT platforms.	3	PO1, PO2, PO3, PSO2
CO2	Apply various cloud infrastructures, virtualization techniques, and storage solutions across different virtualization environments.	3	PO1, PO2, PO3, PSO2
CO3	Apply and Incorporate data security and privacy measures within virtual machines.	3	PO3, PO4, PSO2
CO4	Analyze the different case studies on healthcare, agriculture and parking system and asses the Monitoring, debugging, and performance optimization of cloud-based IoT systems	4	PO3, PO4, PSO2

Syllabus

This module covers introduction to cloud computing covers responsibility models, characteristics, consumption-based and deployment models, cloud service types (IaaS, PaaS, SaaS), cloud enabling technology, architectures, and its role in IoT and cloud-based IoT platforms

This module covers cloud computing virtualization techniques, including hypervisors and server virtualization, with case studies in healthcare, finance, and architecture. They also explore cloud storage options, data migration, and handling structured and unstructured data.

This module covers security and privacy for cloud-based IoT, including authentication, encryption, and data protection, as well as scalability, performance optimization, load balancing, resource allocation, and interfacing IoT devices with IoT-based clouds.

This module cover clouds computing in IoT with case studies on smart parking, home automation, farming, scientific and healthcare applications, and integrating IoT devices with cloud platforms like AWS IoT and Azure IoT Hub.

Reference Books

- 1 Cloud Computing, A Practical Approach, Anthony T. Velte, Toby J. Velte, , First Edition, 2009, Tata-McGraw-Hill Osborne Media.
- 2 Cloud computing: SaaS, PaaS, IaaS, virtualization, business models, mobile, security, and more, Jones & Bartlett Learning, Jamsa, Kris, 2012, Jones & Bartlett.
- 3 Cloud computing: Data intensive computing and scheduling, Magoules, Frederic, 2016, CRC Press, Taylor and Francis.
- 4 Cloud and virtual data storage networking: Your journey to efficient and effective information services, Schulz, Greg, First Edition 2011, Auerbach Publications.

23CPS3506 - WIRELESS SENSOR NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3506	WIRELESS SENSOR NETWORKS	WSN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the various theoretical concepts related to wireless sensors and networking of the sensors	2	PO2, PSO1
CO2	Apply WSNs Architectures, Energy consumption of Sensor nodes for the development of the IoT based Systems	3	PO2, PSO1
CO3	Apply different MAC protocols, Routing mechanism used for the development of WSNs Application	3	PO5, PO7, PSO1
CO4	Apply node and network management related concepts for real time application of WSNs	3	PO2, PSO1

Syllabus

Background of Sensor Network Technology, Sensor network architecture, Hardware components, Sensor node hardware overview, Controller, Memory, Communication device, Sensors and actuators, Power supply of sensor nodes. Challenges and Hurdles for WSNs, Enabling Technologies for Wireless Sensor Networks, Application of sensor networks, Traffic Control, Health Care, Pipeline Monitoring, Precision Agriculture.

ARCHITECTURES, Single node architecture, Energy consumption of sensor nodes, Operation states with different power consumption, Microcontroller energy consumption, Memory, Radio transceivers, Network Topologies, Single Hop Star, Multi Hop Mesh and Grid, Two Tier Hierarchical Cluster. Optimization Goals and Figures of Merit, Gateway Concepts.

Networking Sensors, Physical layer, Trans receiver design considerations, Data Link layer, MAC Layer, Fundamentals of MAC Protocols, Performance Requirements, Classification of MAC protocols, Schedule Based Protocols, Random Access Based Protocols, Sensor MAC, Periodic Listen and Sleep Operations, Schedule Selection, Synchronisation and Coordination Low duty cycle protocol and wakeup concept, Adaptive Listening Routing Protocols, Routing Challenges and Design Issues in Wireless Sensor Networks, Data centric routing, Energy Efficient routing, geographic routing.

NODE AND NETWORK MANAGEMENT, Power Management, Local Power Management Aspects, Processor Subsystem, Communication Subsystem, Bus Frequency and RAM Timing, Active Memory, Power Subsystem, Dynamic Power Management, Dynamic Operation Modes, Dynamic Scaling, Task Scheduling, Time Synchronization, Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols, Lightweight Tree Based Synchronization, Timing sync Protocol for Sensor Networks, Flooding Time Synchronization Protocol, Reference Broadcast Synchronization, Time Diffusion Synchronization Protocol.

Reference Books

- 1 Fundamentals of Wireless sensor networks-Theory and Practice, W. Dargie, C. Poellabauer, 2010, John Wiley & Sons.
- 2 Protocols And Architectures for Wireless Sensor Networks, Holger Karl & Andreas Willig, 2005, John Wiley.
- 3 Wireless Sensor Network Technology- Protocols and Applications, K. Sohraby, D. Minoli and T. Znati, 2007, John Wiley & Sons.
- 4 Networking Wireless Sensors, B. Krishnamachari, 2005, Cambridge University Press.

23CPS3507 - EDGE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CPS3507	EDGE COMPUTING	EC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline the fundamental concepts and advantages of Fog and Edge Computing (FEC), infer the opportunities and applications	2	PO1, PO5, PSO2
CO2	Apply network slicing strategies with effective management techniques to optimize resource allocation. Build network virtualization for efficient edge computing, while exploring optimization techniques for fog computing to ensure efficient data processing	3	PO2, PO5, PSO2
CO3	Implement and analyze middleware solutions for Fog and Edge Computing, addressing security management	4	PO1, PO5, PSO2
CO4	Analyze the applicability and needs for Edge/Fog Computing in various real-time projects such as health monitoring, smart city management, and smart transportation	4	PO1, PO3, PO5, PSO2

Syllabus

Introduction: New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Business Models, Opportunities and Challenges, Addressing the Challenges in Federating Edge Resources

Integrating IoT + Fog + Cloud Infrastructures, System Modeling and Research Challenges, Network Slicing Management in Edge and Fog, Optimization in Fog Computing, Formal Modeling Framework for Fog Computing

Middleware: Middleware for Fog and Edge Computing: Design Issues, State-of-the-Art Middleware Infrastructures, A Lightweight Container Middleware for Edge Cloud Architectures, Security and Data Management: Security Management for Edge Cloud Architectures

Applications and Issues: Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking, Fog Computing Model for Evolving Smart Transportation Applications

Reference Books

- 1 Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya (Editor), Satish Narayana Sri rama , 2019, Wiley.
- 2 EDGE COMPUTING, Ajit Singh, 2019, SPD .
- 3 Fog/Edge Computing For Security, Privacy, and Applications, Jie Wu, Wei Chang, 2021, Springer.
- 4 IoT and Edge Computing for Architects , Perry Lea , 2020, Packt Publishing.

23CSB3101A - CRYPT ANALYSIS & CYBER DEFENSE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3101A	CRYPT ANALYSIS & CYBER DEFENSE	CACD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Classical Encryption Techniques and Symmetric Encryption algorithms to convert a given Plaintext to Cipher text.	3	PO1, PO2, PSO2
CO2	Apply RC4 algorithm, Block Cipher Modes of Operation and Multiple Encryption for given plaintext.	3	PO1, PO2, PSO2
CO3	Apply Public key Crypto Systems to ensure Secure communication of data.	3	PO1, PO2, PSO2
CO4	Apply Hash, MAC algorithms and Digital Signatures to achieve Message Authentication and Integrity..	3	PO1, PO2, PSO2
CO5	Analyze the principles of Incident Response and Risk Management Processes.	4	PO1, PO3, PSO2
CO6	Implement security goals like Confidentiality, Integrity, Authentication algorithms.	3	PO1, PO5, PSO2
CO7	Analyze social engineering, Ethical Hacking & Incident Responses using various tools..	4	PO1, PO5, PSO2

Syllabus

Introduction to Security: Security Concepts, Security Attacks, A Security Model, Security , Services and Mechanisms, Antivirus bypassing, Password Attacks and Web browser exploitation. Block Ciphers: DES, DES Example, Strength of DES, Differential and Linear Cryptanalysis., AES: Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Example. Multiple Encryption and Triple DES.

Modes of Operation. Pseudorandom Number Generation: Principles and Pseudorandom Number, Generators, Pseudorandom Number Generation using a Block Cipher, Stream Ciphers. Stream Ciphers: RC4.

Public-key Cryptography: RSA algorithm, Diffie-Hellman Key Exchange, ElGamal Cryptosystem, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.

Cryptographic. Hash Functions: Applications of Cryptographic Hash functions, Two Simple Hash Functions, Requirements and Security, SHA 512, MD5..

Cryptographic protocols: challenge-response authentication, zero-knowledge protocols, Performing Incident Response: Introduction to Incident Response Process, Cyber Incident Response Team, Communication Plan and Stakeholder Management, Incident Response Plan, Cyber Kill Chain Attack Framework, Incident Response, Disaster Recovery, and Retention Policy Risk Management: Introduction to Risk Management Processes, Risk Types, Risk Assessments, Risk Management Strategies, Risk Avoidance and Risk Transference, Risk Acceptance and Risk Appetite, Risk Awareness.

Reference Books

- 1 Cryptography and Network Security Principles and Practice, William Stallings, 5th Edition, 2010, Pearson.
- 2 Applied Cryptography: Protocols, Algorithms, and Source Code in C, Bruce Schneier, Second Edition, 2015, John Wiley & Sons.
- 3 Cyber Security Incident Management Guide, Gerard Johansen, Third Edition, 2017, Packt Publishing Ltd.
- 4 Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering, Hamid R. Nemati and Li Yang, Second Edition, 2011, IGI Global.

- 5 Cryptography and Network Security , Forouzon B, Indian Edition, 2010, TMH .
- 6 Digital Forensics & Incident Response, Gerard Johnson, Second Edition, 2017, Packt Publishing Ltd..

23CSB3101E - CRYPT ANALYSIS & CYBER DEFENSE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3101E	CRYPT ANALYSIS & CYBER DEFENSE	CACD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Classical Encryption Techniques and Symmetric Encryption algorithms to convert a given Plaintext to Cipher text.	3	PO1, PO2, PSO2
CO2	Apply RC4 Algorithm, Block Cipher Modes of Operation and Multiple Encryption for given plaintext.	3	PO1, PO2, PSO2
CO3	Apply Public key Crypto Systems to ensure Secure communication of data.	3	PO1, PO2, PSO2
CO4	Apply Hash, MAC algorithms and Digital Signatures to achieve Message Authentication and Integrity..	3	PO1, PO2, PSO2
CO5	Analyze the principles of Incident Response and Risk Management Processes.	4	PO1, PO3, PSO2
CO6	Implement security goals like Confidentiality, Integrity, Authentication algorithms.	3	PO1, PO5, PSO2
CO7	Analyze social engineering, Ethical Hacking & Incident Responses using various tools..	4	PO1, PO5, PSO2

Syllabus

Introduction to Security: Security Concepts, Security Attacks, A Security Model, Security , Services and Mechanisms, Antivirus bypassing, Password Attacks and Web browser exploitation. Block Ciphers: DES, DES Example, Strength of DES, Differential and Linear Cryptanalysis., AES: Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Example. Multiple Encryption and Triple DES.

Modes of Operation. Pseudorandom Number Generation: Principles and Pseudorandom Number, Generators, Pseudorandom Number Generation using a Block Cipher, Stream

Public-key Cryptography: RSA algorithm, Diffie-Hellman Key Exchange, ElGamal Cryptosystem, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.

Cryptographic. Hash Functions: Applications of Cryptographic Hash functions, Two Simple Hash Functions, Requirements and Security, SHA 512, MD5..

Cryptographic protocols: challenge-response authentication, zero-knowledge protocols, Performing Incident Response: Introduction to Incident Response Process, Cyber Incident Response Team, Communication Plan and Stakeholder Management, Incident Response Plan, Cyber Kill Chain Attack Framework, Incident Response, Disaster Recovery, and Retention Policy Risk Management: Introduction to Risk Management Processes, Risk Types, Risk Assessments, Risk Management Strategies, Risk Avoidance and Risk Transference, Risk Acceptance and Risk Appetite, Risk Awareness., Performing Incident Response: Introduction to Incident Response Process, Cyber Incident Response Team, Communication Plan and Stakeholder Management, Incident Response Plan, Cyber Kill Chain Attack Framework, Incident Response, Disaster Recovery, and Retention Policy Risk Management: Introduction to Risk Management Processes, Risk Types, Risk Assessments, Risk Management Strategies, Risk Avoidance and Risk Transference, Risk Acceptance and Risk Appetite, Risk Awareness.

Reference Books

- 1 Cryptography and Network Security Principles and Practice, William Stallings, 5th Edition, 2010, Pearson.
- 2 Applied Cryptography: Protocols, Algorithms, and Source Code in C, Bruce Schneier, Second Edition, 2015, John Wiley & Sons.

- 3 Cyber Security Incident Management Guide, Gerard Johansen, Third Edition, 2017, Packt Publishing Ltd.
- 4 Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering, Hamid R. Nemati and Li Yang, Second Edition, 2011, IGI Global.
- 5 Cryptography and Network Security, Forouzon B, Indian Edition, 2010, TMH (2010)..
- 6 Digital Forensics & Incident Response, Gerard Johnson, Second Edition, 2017, Packt Publishing Ltd.2.

23CSB3101R - CRYPT ANALYSIS & CYBER DEFENSE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3101R	CRYPT ANALYSIS & CYBER DEFENSE	CACD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Classical Encryption Techniques and Symmetric Encryption algorithms to convert a given Plaintext to Cipher text.	3	PO1, PO2, PSO2
CO2	Apply RC4 Algorithm, Block Cipher Modes of Operation and Multiple Encryption for given plaintext.	3	PO1, PO2, PSO2
CO3	Apply Public key Crypto Systems to ensure Secure communication of data.	3	PO1, PO2, PSO2
CO4	Apply Hash, MAC algorithms and Digital Signatures to achieve Message Authentication and Integrity..	3	PO1, PO2, PSO2
CO5	Implement security goals like Confidentiality, Integrity, Authentication algorithms.	3	PO1, PO3, PSO2
CO6	Analyze social engineering, Ethical Hacking & Incident Responses using various tools..	4	PO1, PO5, PSO2

Syllabus

Introduction to Security: Security Concepts, Security Attacks, A Security Model, Security , Services and Mechanisms, Antivirus bypassing, Password Attacks and Web browser exploitation. Block Ciphers: DES, DES Example, Strength of DES, Differential and Linear Cryptanalysis., AES: Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Example. Multiple Encryption and Triple DES.

Modes of Operation. Pseudorandom Number Generation: Principles and Pseudorandom Number, Generators, Pseudorandom Number Generation using a Block Cipher, Stream Ciphers. Stream Ciphers: RC4.

Public-key Cryptography: RSA algorithm, Diffie-Hellman Key Exchange, ElGamal Cryptosystem, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.

Cryptographic. Hash Functions: Applications of Cryptographic Hash functions, Two Simple Hash Functions, Requirements and Security, SHA 512, MD5..

Reference Books

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- 2 Applied Cryptography: Protocols, Algorithms, and Source Code in C, Bruce Schneier, Second Edition, 2015, John Wiley & Sons.
- 3 Cyber Security Incident Management Guide, Gerard Johansen, Third Edition, 2017, Packt Publishing Ltd.
- 4 Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering, Hamid R. Nemati and Li Yang, Second Edition, 2011, IGI Global.
- 5 Cryptography and Network Security, Forouzan B, Indian Edition, 2010, TMH (2010)..

23CSB3202A - NETWORK AND INFRASTRUCTURE SECURITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3202A	NETWORK AND INFRASTRUCTURE SECURITY	NIS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand security concepts, Infrastructure security techniques and securing enterprise networks. Understand router and switching security mechanism.	2	PO3, PO5, PSO2
CO2	Understand hardware procedures for digital certificate and techniques of user authentication	2	PO3, PO5, PSO2
CO3	Apply the standardization schemes to maintain security in Web application and secured payment system. Identify security vulnerability in the system	3	PO3, PSO2
CO4	Apply security concepts in Email and Internet Protocol	3	PO3, PSO2
CO5	Apply security concepts in wireless networking environment	3	PO5, PSO2

Syllabus

Network Hardware, Software and Services, Hardware Protection, Intruders and Virus. Network Management Security, Device security, Virtual Private Networks (VPNs), Data Center and Enterprise Networks Security, Securing a Wireless LAN, LAN Switch Security, Router and switching mechanisms for Security, Queuing and Scheduling Algorithms

Key distribution - Symmetric encryption, Key distribution - Asymmetric encryption, Public-Key Infrastructure, distribution of public keys, X.509 Certificates, Remote User Authentication using Symmetric Encryption, Remote User Authentication Using Asymmetric Encryption, Kerberos

Web Security and issues, Secure Sockets Layer Concepts, Transport Layer Security, HTTPS, Secure Shell (SSH), Secure electronic transaction (SET), SET Payment processing Security vulnerabilities Scanning techniques, Vulnerability assessment, Penetration testing

Pretty Good Privacy, S/MIME Domain Keys Identified Mail IP Security Overview, IP Security Policy Encapsulating Security Payload, Combining Security Associations Firewalls and Gateways, Intrusion detection system

Wireless Network security: Wireless security, Mobile device security, IEEE 802.11 Wireless LAN overview, IEEE 802.11 Wireless LAN overview

Reference Books

- 1 Cryptography and Network Security Principles and Practice, William Stallings, 7th Edition, Pearson Education, 2017.
- 2 Cryptography And Network Security, Behrouz A. Forouzan, Debdeep Mukhopadhyaya, 4th Edition, TataMcGraw Hill Education Private Limited, 2015.
- 3 Network Security Essentials, William Stallings, 7th Edition, Pearson Education, 2017.
- 4 Network Security , Charlie Kaufman, Radia Perlman, 2nd Edition, Prentice Hall.

23CSB3202E - NETWORK AND INFRASTRUCTURE SECURITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3202E	NETWORK AND INFRASTRUCTURE SECURITY	NIS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand security concepts, Infrastructure security techniques and securing enterprise networks. Understand router and switching security mechanism.	2	PO3, PO5, PSO2
CO2	Understand hardware procedures for digital certificate and techniques of user authentication	2	PO3, PO5, PSO2
CO3	Apply the standardization schemes to maintain security in Web application and secured payment system. Identify security vulnerability in the system.	3	PO3, PSO2
CO4	Apply security concepts in Email and Internet Protocol.	3	PO3, PSO2
CO5	Apply security concepts in wireless networking environment.	3	PO5, PSO2

Syllabus

Network Hardware, Software and Services, Hardware Protection, Intruders and Virus. Network Management Security, Device security, Virtual Private Networks (VPNs), Data Center and Enterprise Networks Security, Securing a Wireless LAN, LAN Switch Security, Router and switching mechanisms for Security, Queuing and Scheduling Algorithms

Network Hardware, Software and Services, Hardware Protection, Intruders and Virus. Network Management Security, Device security, Virtual Private Networks (VPNs), Data Center and Enterprise Networks Security, Securing a Wireless LAN, LAN Switch Security, Router and switching mechanisms for Security, Queuing and Scheduling Algorithms

Web Security and issues, Secure Sockets Layer Concepts, Transport Layer Security, HTTPS, Secure Shell (SSH), Secure electronic transaction (SET), SET Payment processing Security vulnerabilities Scanning techniques, Vulnerability assessment Penetration testing.

Pretty Good Privacy, S/MIME Domain Keys Identified Mail IP Security Overview, IP Security Policy Encapsulating Security Payload, Combining Security Associations Firewalls and Gateways, Intrusion detection system.

Wireless Network security: Wireless security, Mobile device security, IEEE 802.11 Wireless LAN overview, IEEE 802.11 Wireless LAN overview.

Reference Books

- 1 Cryptography and Network Security Principles and Practice, William Stallings, 7th Edition, Pearson Education, 2017.
- 2 Cryptography And Network Security, Behrouz A. Forouzan, Debdeep Mukhopadhyay, 4th Edition, TataMcGraw Hill Education Private Limited, 2015..
- 3 Network Security Essentials, William Stallings, 7th Edition, Pearson Education, 2017.
- 4 Network Security, Charlie Kaufman, Radia Perlman, Mike Speciner, 2nd Edition, Prentice Hall.

23CSB3202R - NETWORK AND INFRASTRUCTURE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3202R	NETWORK AND INFRASTRUCTURE SECURITY	NIS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand security concepts, Infrastructure security techniques and securing enterprise networks. Understand router and switching security mechanism	2	PO3, PO5, PSO2
CO2	Understand hardware procedures for digital certificate and techniques of user authentication	2	PO3, PO5, PSO2
CO3	Apply the standardization schemes to maintain security in Web application and secured payment system. Identify security vulnerability in the system	3	PO3, PSO2
CO4	Apply security concepts in Email and Internet Protocol	3	PO3, PSO2

Syllabus

Network Hardware, Software and Services, Hardware Protection, Intruders and Virus. Network Management Security, Device security, Virtual Private Networks (VPNs), Data Center and Enterprise Networks Security, Securing a Wireless LAN, LAN Switch Security, Router and switching mechanisms for Security, Queuing and Scheduling Algorithms

Key distribution - Symmetric encryption, Key distribution - Asymmetric encryption, Public-Key Infrastructure, distribution of public keys, X.509 Certificates, Remote User Authentication using Symmetric Encryption, Remote User Authentication Using Asymmetric Encryption, Kerberos

Web Security and issues, Secure Sockets Layer Concepts, Transport Layer Security, HTTPS, Secure Shell (SSH), Secure electronic transaction (SET), SET Payment processing Security vulnerabilities Scanning techniques, Vulnerability assessment, Penetration testing

Pretty Good Privacy, S/MIME Domain Keys Identified Mail IP Security Overview, IP Security Policy Encapsulating Security Payload, Combining Security Associations Firewalls and Gateways, Intrusion detection system

Reference Books

- 1 Cryptography and Network Security Principles and Practice, William Stallings, 7th Edition, Pearson Education, 2017.
- 2 Cryptography And Network Security, Behrouz A. Forouzan, Debdeep Mukhopadhyay, 4th Edition, TataMcGraw Hill Education Private Limited, 2015.
- 3 Network Security Essentials, William Stallings, 7th Edition, Pearson Education, 2017.
- 4 Network Security, Charlie Kaufman, Radia Perlman, Mike Speciner, 2nd Edition, Prentice Hall.

23CSB3203A - INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3203A	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	IBCC	A	3	0	4	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding or knowing the basic concepts of Cryptography for Blockchain	2	PO1
CO2	Understand the basics of Blockchain and mining process	2	PO5
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO5
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	4	PO7, PO11, PSO2
CO5	Apply the different types of crypto currencies & its importance and Blockchain applications	4	PO1, PO5, PSO2
CO6	Apply and analyze basic cryptography concepts and smart contracts applications using soft wallet.	5	PO5, PO11, PSO2

Syllabus

Introduction to Cryptography: Structure of cryptosystem - symmetric key cryptography -asymmetric key cryptography - types of attacks - RSA algorithm - Elliptic Curve Cryptography (ECC) -authentication models - SHA-256 Hash algorithm - Digital Signature Standards (DSS) - Elliptic Curve Digital Signature Algorithm (ECDSA).

Basics of Blockchain concepts Architecture Properties of Blockchain Distributed ledger Merkle tree structure of a Block Smart contract Crowd funding Transaction Double spending Block propagation Consensus Protocols Proof of Work PoW Proof of Stack PoS Proof of Burn PoB Proof of Elapsed Time PoET PAXOS consensus RAFTconsensus Delayed Proof of Work dPoW Delegated Proof of Stake DPoS

Byzantine general problem Byzantine Fault Tolerance BFT Delegated Byzantine Fault Tolerance dBFT Practical Byzantinefault tolerance Algorithm Three phase commit Protocol Mining Types of Blockchain Blockchaincomponents

Permissioned Blockchain Permissionless Blockchain Consortium BlockchainCryptocurrencies Cryptocurrencies applications using Blockchain Bitcoin Bitcoin properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoinanonymity

Tangle IOTA Ether ETH Ethereum properties smart contract Applications FinancialServices Cross border payments KYC international trade Health Care Food safety Applications ofBlockchain Blockchain based Internet of Things BioT Supply Chain Management and Healthcare etc

Reference Books

- 1 Cryptography and Network Security: Principles and Practice, William Stallings , 7th Edition 2016, Pearson Education.
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction , Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, , 2017, Princeton University Press.
- 3 Blockchain: Blueprint for a New Economy , Melanie Swan , 2017, O'Reilly Media, Inc.
- 4 Bitcoin: A Peer-to-Peer Electronic Cash System , Satoshi Nakamoto , 2018, 2018 Annual Seminar Bitcoin Glossary.
- 5 ETHEREUM: A Secure Decentralized Transaction Ledger, , Dr. Gavin Wood, , 2017, Paper EIP-150 REVISION.

23CSB3203E - INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3203E	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	IBCC	E	3	0	4	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding or knowing the basic concepts of Cryptography for Blockchain	2	PO1, PO8
CO2	Understand the basics of Blockchain and mining process	2	PO5, PO7, PO8
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO5, PO7
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	3	PO7, PSO2
CO5	Apply the different types of crypto currencies & its importance and Blockchain applications	3	PO1, PO5, PSO2
CO6	Apply and analyze basic cryptography concepts and smart contracts applications using soft wallet.	4	PO1

Syllabus

Introduction to Cryptography: Structure of cryptosystem - symmetric key cryptography -asymmetric key cryptography - types of attacks - RSA algorithm - Elliptic Curve Cryptography (ECC) -authentication models - SHA-256 Hash algorithm - Digital Signature Standards (DSS) - Elliptic CurveDigital Signature Algorithm (ECDSA).

Basics of Blockchain concepts Architecture Properties ofBlockchain Distributed ledger Merkle tree structure of a Block Smart contract Crowd funding Transaction Double spending Block propagation Consensus Protocols Proof of Work PoW Proof of Stack PoS Proof of Burn PoB Proof of Elapsed Time PoET PAXOS consensus RAFTconsensus Delayed Proof of Work dPoW Delegated Proof of Stake DPOS Byzantine general problem Byzantine Fault Tolerance BFT Delegated Byzantine Fault Tolerance dBFT Practical Byzantinefault tolerance Algorithm

Three phase commit Protocol Mining Types of Blockchain Blockchaincomponents Permissioned Blockchain Permissionless Blockchain Consortium BlockchainCryptocurrencies Cryptocurrencies applications using Blockchain Bitcoin Bitcoin properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoinanonymity

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Tangle IOTA Ether ETH Ethereum properties smart contract Applications FinancialServices Cross border payments KYC international trade Health Care Food safety Applications ofBlockchain Blockchain based Internet of Things BioT Supply Chain Management and Healthcare etc

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- 1 Cryptography and Network Security: Principles and Practice, William Stallings , 7th Edition , Pearson Education.
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction , Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, , -, Princeton University Press.
- 3 Blockchain: Blueprint for a New Economy , Melanie Swan , -, O'Reilly Media, Inc.
- 4 Bitcoin: A Peer-to-Peer Electronic Cash System , Satoshi Nakamoto , -, 2018 Annual Seminar Bitcoin Glossary.
- 5 ETHEREUM: A Secure Decentralized Transaction Ledger,, Dr. Gavin Wood, , -, Paper EIP-150 REVISION.

23CSB3203R - INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3203R	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	IBCC	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding or knowing the basic concepts of Cryptography for Blockchain	2	PO5, PO12
CO2	Understand the basics of Blockchain and mining process	2	PO2, PO5, PO12
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO2, PO5, PO12
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	4	PO9, PSO1
CO5	Apply and analyze basic cryptography concepts and smart contracts applications using soft wallet.	5	PO9, PSO1

Syllabus

Introduction to Cryptography: Structure of cryptosystem - symmetric key cryptography -asymmetric key cryptography - types of attacks - RSA algorithm - Elliptic Curve Cryptography (ECC) -authentication models - SHA-256 Hash algorithm - Digital Signature Standards (DSS) - Elliptic Curve Digital Signature Algorithm (ECDSA).

Basics of Blockchain concepts Architecture Properties ofBlockchain Distributed ledger Merkle tree structure of a Block Smart contract Crowd funding Transaction Double spending Block propagation Consensus Protocols Proof of Work PoW Proof of Stack PoS Proof of Burn PoB Proof of Elapsed Time PoET PAXOS consensus RAFTconsensus Delayed Proof of Work dPoW Delegated Proof of Stake DPoS Byzantine general problem Byzantine Fault Tolerance BFT Delegated Byzantine Fault Tolerance dBFT Practical Byzantinefault tolerance Algorithm

Three phase commit Protocol Mining Types of Blockchain Blockchaincomponents Permissioned Blockchain Permissionless Blockchain Consortium BlockchainCryptocurrencies Cryptocurrencies applications using Blockchain Bitcoin Bitcoin properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoinanonymity

Tangle IOTA Ether ETH Ethereum properties smart contract Applications FinancialServices Cross border payments KYC international trade Health Care Food safety Applications ofBlockchain Blockchain based Internet of Things BloT Supply Chain Management and Healthcare etc

Reference Books

- 1 Cryptography and Network Security: Principles and Practice , William Stallings, 7th Edition, Pearson Education.
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction , Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, -, Princeton University Press.
- 3 Blockchain: Blueprint for a New Economy , Melanie Swan, -, O'Reilly Media, Inc.
- 4 Bitcoin: A Peer-to-Peer Electronic Cash System , Satoshi Nakamoto, -, 2018 Annual Seminar Bitcoin Glossary.
- 5 ETHEREUM: A Secure Decentralized Transaction Ledger, , Dr. Gavin Wood, -, Paper EIP-150 REVISION.

23CSB3304A - DIGITAL FORENSICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3304A	DIGITAL FORENSICS	DF	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse the digital forensics environment, including the concepts of forensic soundness and fundamental principles.	3	PO1, PSO2
CO2	Apply the principles of attack attribution to identify and trace the sources of cyber attacks, utilizing techniques such as IP address analysis, malware analysis, and behavioral analysis.	3	PO1, PSO2
CO3	Analyze the fundamental concepts of digital evidence and its significance in forensic investigations.	4	PO1, PO2, PSO2
CO4	Evaluate the value and admissibility of digital evidence and applying case study methodologies to analyze and link evidence to users.	5	PO1, PSO2
CO5	Evaluate and utilize a variety of network security monitoring tools	5	PO1, PSO2
CO6	Evaluate the effectiveness of Defence-in-Depth strategies in safeguarding assets against emerging threats.	5	PO5, PSO2
CO7	Implement and Evaluating acquisition methods for digital evidence related to system security	5	PO5, PSO2

Syllabus

Digital Forensics and Incident Analysis: History of Forensic Science, Locard's exchange principle, Crime Reconstruction, Investigations, Evidence Dynamics, Digital Forensics and Its Environment: Forensic Soundness and Fundamental Principles, Digital Forensics, The Digital Forensics Process, Types of Evidence, Evidence Collection Order, Chain of Custody. Data Integrity and Preservation, Attack Attribution, The MITRE ATT&CK Framework, The Cyber Kill Chain, The Diamond Model of Intrusion Analysis, Incident Response, NIST Incident Response Life Cycle.

OS and File Systems Forensics: Describing computers and the nature of digital information, operating systems, describing filesystems that contain evidence, locating evidence in filesystems, explaining password security, encryption, and hidden files, Case studies: Linking the evidence to the user.

Digital Evidence: Defining digital evidence and its characteristics, the technical complexities of digital evidence, Determining the value and admissibility of digital evidence, Case study: linking the evidence to the user.

Network Monitoring and Tools: Introduction to Network Monitoring, Network Security Topology, Network Monitoring Methods, Network Taps, Traffic Mirroring and SPAN, Network Security Monitoring Tools, Network Protocol Analyzers, NetFlow, SIEM and SOAR. IP Vulnerabilities, ICMP Attacks, Amplification and Reflection Attacks, Address Spoofing Attacks, TCP Attacks, UDP Attacks, Defence-in-Depth, Assets, Vulnerabilities, Threats, The Security Onion, and The Security Artichoke. Examining Browsers, E-mails, Messaging Systems.

Mobile Phones: Locating evidence from Internet browsing, Messaging systems, E-mail analysis and the processing of large e-mail databases, Ontologies for Mobile and Embedded Forensics, The growing challenge of evidence recovery from mobile phones and handheld devices, Case study: Mobile phone evidence in a bomb hoax

Reference Books

- 1 Fundamentals of Network Forensics: A Research Perspective, R.C. Joshi, Emmanuel S. Pilli, 2018, Springer.
- 2 Computer Forensics and Cyber Crime : An Introduction, Marjie T. Britz, 2013, Prentice Hall.
- 3 Practical Digital Forensics, Richard Boddington, 2016, Packt Publishers.

- 4 Digital Forensics, AndreArnes, 2017, John Wiley & Sons Ltd, 2018..

23CSB3304E - DIGITAL FORENSICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3304E	DIGITAL FORENSICS	DF	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Examine the digital forensics environment, including the concepts of forensic soundness and fundamental principles.	3	PO1, PSO2
CO2	Apply the principles of attack attribution to identify and trace the sources of cyber attacks, utilizing techniques such as IP address analysis, malware analysis, and behavioral analysis.	3	PO1, PSO2
CO3	Analyze the fundamental concepts of digital evidence and its significance in forensic investigations.	4	PO1, PO2, PSO2
CO4	Evaluating the value and admissibility of digital evidence and applying case study methodologies to analyze and link evidence to users.	5	PO1, PSO2
CO5	Evaluate and utilize a variety of network security monitoring tools	5	PO1, PSO2
CO6	Evaluate the effectiveness of Defence-in-Depth strategies in safeguarding assets against emerging threats.	5	PO5, PSO2
CO7	Implement and Evaluating acquisition methods for digital evidence related to system security	5	PO5, PSO2

Syllabus

Digital Forensics and Incident Analysis: History of Forensic Science, Locard's exchange principle, Crime Reconstruction, Investigations, Evidence Dynamics, Digital Forensics and Its Environment: Forensic Soundness and Fundamental Principles, Digital Forensics, The Digital Forensics Process, Types of Evidence, Evidence Collection Order, Chain of Custody. Data Integrity and Preservation, Attack Attribution, The MITRE ATT&CK Framework, The Cyber Kill Chain, The Diamond Model of Intrusion Analysis, Incident Response, NIST Incident Response Life Cycle.

OS and File Systems Forensics: Describing computers and the nature of digital information, operating systems, describing filesystems that contain evidence, locating evidence in filesystems, explaining password security, encryption, and hidden files, Case studies: Linking the evidence to the user.

Digital Evidence: Defining digital evidence and its characteristics, the technical complexities of digital evidence, Determining the value and admissibility of digital evidence, Case study: linking the evidence to the user.

Network Monitoring and Tools: Introduction to Network Monitoring, Network Security Topology, Network Monitoring Methods, Network Taps, Traffic Mirroring and SPAN, Network Security Monitoring Tools, Network Protocol Analyzers, NetFlow, SIEM and SOAR. IP Vulnerabilities, ICMP Attacks, Amplification and Reflection Attacks, Address Spoofing Attacks, TCP Attacks, UDP Attacks, Defence-in-Depth, Assets, Vulnerabilities, Threats, The Security Onion, and The Security Artichoke. Examining Browsers, E-mails, Messaging Systems.

Mobile Phones: Locating evidence from Internet browsing, Messaging systems, E-mail analysis and the processing of large e-mail databases, Ontologies for Mobile and Embedded Forensics, The growing challenge of evidence recovery from mobile phones and handheld devices, Case study: Mobile phone evidence in a bomb hoax

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- 1 Fundamentals of Network Forensics: A Research Perspective, R.C. Joshi, Emmanuel S. Pilli,, 2018, Springer.
- 2 Computer Forensics and Cyber Crime : An Introduction, Marjie T. Britz, 2013, Prentice Hall.
- 3 Practical Digital Forensics, Richard Boddington, 2016, Packt Publishers.

- 4 Digital Forensics, AndreArnes, 2017, John Wiley & Sons Ltd, 2018..

23CSB3304R - DIGITAL FORENSICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3304R	DIGITAL FORENSICS	DF	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Forensic Science and Digital Forensics	3	PO1, PSO2
CO2	Apply Operating System and File System Forensics	3	PO1, PO2, PSO2
CO3	Analyze Digital Evidence and Network Forensics	4	PO1, PSO2
CO4	Evaluate Web Forensics and Mobile Device Forensics	5	PO1, PSO2
CO5	Implement and Evaluating the concepts of Digital Forensics	5	PO5, PSO2
CO6	Implement and Evaluating acquisition methods for digital evidence related to system security	5	PO5, PSO2

Syllabus

Digital Forensics and Incident Analysis: History of Forensic Science, Locard's exchange principle, Crime Reconstruction, Investigations, Evidence Dynamics, Digital Forensics and Its Environment: Forensic Soundness and Fundamental Principles, Digital Forensics, The Digital Forensics Process, Types of Evidence, Evidence Collection Order, Chain of Custody, Data Integrity and Preservation, Attack Attribution, The MITRE ATT&CK Framework, The Cyber Kill Chain, The Diamond Model of Intrusion Analysis, Incident Response, NIST Incident Response Life Cycle.

OS and File Systems Forensics: Describing computers and the nature of digital information, operating systems, describing filesystems that contain evidence, locating evidence in filesystems, explaining password security, encryption, and hidden files, Case studies: Linking the evidence to the user. Digital Evidence: Defining digital evidence and its characteristics, the technical complexities of digital evidence

Determining the value and admissibility of digital evidence, Case study: linking the evidence to the user. Digital evidence and its characteristics. Network Monitoring and Tools: Introduction to Network Monitoring, Network Security Topology, Network Monitoring Methods, Network Taps, Traffic Mirroring and SPAN, Network Security Monitoring Tools, Network Protocol Analyzers, NetFlow, SIEM and SOAR. IP Vulnerabilities, ICMP Attacks, Amplification and Reflection Address Spoofing Attacks, TCP Attacks, UDP Attacks, Defence-in-Depth, Assets, Vulnerabilities, Threats, The Security Onion, and The Security Artichoke. Examining Browsers, Ontologies for Mobile and Embedded Forensics, The rowing challenge of evidence recovery from mobile phones and handheld devices, Case study: Mobile phone evidence in a bomb hoaxE-mails, Messaging Systems, and Mobile Phones: Locating evidence from Internet browsing, Messaging systems, E-mail analysis and the processing of large e-mail databases,

Reference Books

- 1 Fundamentals of Network Forensics: A Research Perspective, R.C. Joshi, Emmanuel S. Pilli, , 2018, Springer.
- 2 Computer Forensics and Cyber Crime : An Introduction, Marjie T. Britz, 2013, Prentice Hall.
- 3 Practical Digital Forensics, Richard Boddington, 2016, Packt Publishers.
- 4 Digital Forensics, Andre Arnes, 2017, John Wiley & Sons Ltd, 2018..

23CSB3405M - DATABASE SYSTEM AND SECURITY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3405M	DATABASE SYSTEM AND SECURITY	DSS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Database Users, Roles related to User Administration and Java concepts.	2	PO2, PSO1
CO2	Apply Data Encryption and Database Vaults.	3	PO5, PSO1
CO3	Apply secret password Encryption & Decryption.	3	PO3, PSO1
CO4	Apply Data Encryption for the Data in Transit.	3	PO5, PSO1

Syllabus

Oracle users and Schema: Oracle users and Schema: Oracle database security New features. Db users and schemas, Working as the SYS User, System Privileges, Roles, The DBA Role, The Create-Session Role, Password-Protected Roles, Security Administrator User, Security Administration Role Verification, Security Administrator Role Acquisition, System Privileges Granted to the Security Administrator Role, Working as the Security Administrator, Acquire secadm_role from a SQL*Plus Local Connection, Toggle Between Roles, Create an Application Security User and roles, create an Application user ,Create HR View role, Oracle Java Database Connectivity, Java Packages, Environment, Java Stored Transparent Data Encryption, Encryption Data stored in database, protecting data, Viewing Data, TDE Setup- Oracle 10g, Oracle wallet, TDEs Key Management, Creating Encrypted columns in a table, Salt viewing encrypted columns, Encrypting an existing column, Table space Encryption, Oracle by Configuration, Exporting, Importing Encrypted Data. Oracle database vaults- Installing Oracle Database Vault, Realm Protection Patterns, creating first realm, Accessing realm Protection objects, Realm Components, Realm objects, Realm Authorization, Managing Role Provisioning with database, vault realm authorization, Realm and DBV Administrator, Realm authorization and objects owner Account, realm authorization controlled with DBV rule set, command rules, Components, Commands supported in Command rules, DBV connect command rule, Rule Sets, Factors.

Secret Password Encryption- Generating the Password and Artifacts, Calculating the Size of the Password, Initializing Static Class Members, Negotiated Algorithm, Encrypting with the Public RSA Key, Returning Secret Password Key Artifacts to the Client, Encrypting Data with Our Secret Password. Oracle Structures for Secret Password Encryption Package to Get Secret Password Artifacts and Encrypted Data, Application Security Package Specification, Application Security Package Body- Functions, Application Security Package Body: Procedures, Java Methods for Secret Password Decryption.

Data Encryption in Transit Granting More System Privileges to the Application Security User, Permitting Users to Execute Packages in Other Schemas, Application Security User Activities, Creating a Table for Error Logging, Creating a Table for Managing Our Error Log Table, Creating an Error Log Management Procedure, Creating a Trigger to Maintain the Error Log Table, Testing the Trigger, Updating the Application Security Package, Methods for Using and Testing Encryption in Transit, Loading Updated Oracle Java Secure Class into Oracle, Security Structures for the HR User, Logging the Error Message, Procedure Variables and Data Decryption, Integrity Constraint on Employees Table, Avoiding SQL Injection, Demonstrating Failure to SQL Inject in Stored Procedure, Executing the HR Package Specification and Body, Demonstrations and Tests of Encrypted Data Exchange, Sending Encrypted Data to Oracle Database for Insert/Update, Testing Encryption Failure with New Client Keys, Testing Failure with New Oracle Connection, Running Basic Key Exchange Without Data Encryption, Packaging Template to Implement Encryption.

Reference Books

- 1 Expert Oracle and Java Security: Programming secure Oracle Database Applications with Java, David Coffin, ., A.Press, L.P,2011.

- 2 Applied Oracle Security: Developing Secure Database and Middleware, David C. Knox Scott G. Gaetjen, Hamza Jahangir, Tyler Muth, Patrick Sack, Richard Wark, Bryan Wise, -, Tata McGraw Hill, 2010..
- 3 Database Security and Auditing, Hassan A. Afyouni, -, Cengage Learning, 2005.
- 4 Implementing Database Security and Auditing: Includes Examples for Oracle, SQL Server, Db2 Udb, Sybase, Ben-Natan, R. B., -, Digital Press 2005.

23CSB3406M - PROGRAMMING FOR SMART CONTRACTS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3406M	PROGRAMMING FOR SMART CONTRACTS	PSC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Ethereum blockchain and using wallet for interacting with network	3	PO1, PO3
CO2	Compare and Contrast different methods of contract deployment and interaction.	4	PO2, PSO2
CO3	Evaluating advanced smart contracts with various test setups and try-catch	5	PO4, PSO2
CO4	Evaluating interactive front end for smart contracts and use Contracts design patterns.	5	PO3, PO4

Syllabus

Ethereum Ethereum basics Wallet Technology Nondeterministic Wallets Deterministic Wallets Hierarchical Deterministic Wallets Ethereum Addresses accounts Ethers Ethereum networks Consensus Protocols Ethers Proof of Work Algorithm Ethash Ethers Proof of Stake Algorithm Casper Delegated Proof of Stake DPoS

Ethers Cryptographic Hash Function Keccak256 mining on Ethereum Ethereum Virtual Machine EVM Smart contract Ethereum Name Service ENS managing contracts with wallet Ethereum wallets and transactions deploy and interact with contracts Ethereum app architecture Solidity Programming Language Contract structure Data Types Predefined Global Variables and function declarations Functions function modifiers Overview of Arrays overview of mapping and structs Pseudo random generator Gas and transactions Mnemonic phrases compiling solidity the Compile script contract deployment The Structure of a Transaction testing with remix redeploying contracts

Advanced Smart contracts Sending ether from contracts resetting contracts state trycatch assertions testing function modifiers Contract Constructor and selfdestruct Adding a Constructor and selfdestruct Contract Inheritance Error Handling assert require revert Events Calling Other Contracts send call callcode delegatecall Gas Considerations Avoid Dynamically Sized Arrays Avoid Calls to Other Contracts The lottery contract Lottery design Smart Contract Security

Building interactive front end CreateReactapp Web3 setup deploying contracts local contracts instances rendering contract data Form setup Contracts Design Patterns Contract selfdestruction pattern Factory contract pattern Name Registry pattern Mapping iterator pattern Setting up private blockchain network Boot node toolpeer discovery setting up a PoA Clique Network Clique based private network testing ERC20 token specifications ERC20 token implementation

Reference Books

- 1 Ethereum Smart Contract Development in Solidity, by Gavin Zheng (Author), Longxiang Gao (Author), Liquan Huang (Author), Jian Guan (Author), 2020, Paperback.
- 2 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, by Lorne Lantz (Author), Daniel Cawry (Author), 2020, Paperback.
- 3 Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners, Chris Dannen, 2017, Apress.
- 4 Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos and Gavin Wood, 2019, O'Reilly.

23CSB3407M - CLOUD SECURITY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3407M	CLOUD SECURITY	CS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the principles of cryptographic approach to virtualization.	2	PO3, PO5, PSO1
CO2	Illustrate security system issues and vulnerabilities of virtual systems.	2	PO5, PO8, PSO1
CO3	Apply the virtual system attack countermeasures to provide security enhancements.	3	PO5, PO8, PSO1
CO4	Identify data security storage and apply the concepts to avoid legal Compliance issues.	3	PO2, PO3, PSO1

Syllabus

Security Concepts- Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defense in depth, least privilege, the importance of security in the cloud, Importance in PaaS, IaaS and SaaS

Multi-tenancy Issues- Isolation of users/VMs from each other. Virtualization System Security Issues: e.g. ESX and ESXi Security, ESX file system security, storage considerations, backup, and recovery; Virtualization System Vulnerabilities: Management console vulnerabilities, management server vulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisor vulnerabilities, hypervisor escape vulnerabilities, configuration issues, and malware (botnets, etc).

Virtualization System-Specific Attacks- Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyperjacking. Technologies for virtualization-Based Security Enhancement: IBM security virtual server protection, virtualization-based sandboxing

Storage Security- HIDPS, log management, Data Loss Prevention. Location of the Perimeter, Legal and Compliance Issues: Responsibility, ownership of data, right to penetration test. Local laws, examination of modern Security Standards (eg PCIDSS), Standards to deal with cloud services and virtualization, compliance for the cloud provider vs. compliance for the customer.

Reference Books

- 1 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, 2009, O'Reilly Media Inc.
- 2 Cloud Security, Ronald L. Krutz, Russell Dean Vines, 2010, -.
- 3 Cloud Security Attacks, Techniques, Tools, and Challenges, Preeti Mishra, Emmanuel S Pilli, R C Joshi, 2021, CRC Press.
- 4 Cloud Security: Concepts, Applications and Perspectives (Cyber Ecosystem and Security), Brij B. Gupta, 2021, CRC Press.

23CSB3508 - SECURE SOFTWARE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3508	SECURE SOFTWARE ENGINEERING	SSE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand about threats and its properties that target software and identify the resources that addresses the attacks.	2	PO3, PSO1
CO2	Understand the secure requirement model to initialise the software development process and risk assessment.	2	PO3, PSO1
CO3	Evaluate software testing methods to analyse the software code to improve the quality and describe the assembly changes for system design.	3	PO9, PSO1
CO4	Analyze the governance security policy to ensure enterprise security in project management	4	PO9, PSO1

Syllabus

Security is a Software Issue - The Problem, Software Assurance and Software Security, Threats to software security, Sources of software security, what makes software secure - Defining properties of secure software How to assert and specify desired security properties, secure software specifications and requirements, Requirements Engineering for secure software - Misuse and Abuse cases

Square Process Model, Requirements Elicitation and Prioritization Design, Secure software architecture and design - Architectural Risk Analysis, Security Principles, Guidelines and Attack Patterns.

Secure Coding and Testing - Code Analysis, Practices, Testing and Consideration through the SDLC, Security and Complexity - Security failures and analysis, System Complexity.

Governance and Security, Governing for Enterprise Security, Defining an effective Enterprise Security program, Security Governance Activities, Enterprise Software Security Framework, Security and project management.

Reference Books

- 1 Software Security Engineering , Julia H Allen, Sean Barnum, Robert J Ellison, Gary McGraw, Nancy R Mead , 2008, Addison Wesley.
- 2 Software Security - Building Security In, Gray McGraw, 2017, Addison Wesley.
- 3 Secure Coding in C and C++, Robert C.Seacord, 2013, Addison Wesley.
- 4 Enterprise Software Security, Kenneth R. Van Wyk, Mark G. Graff, Dan S. Peters, Diana L Burely, 2014, Addison Wesley.

23CSB3509 - WEB SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3509	WEB SECURITY	WS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and discuss about Web Security Concepts.	2	PO3, PSO1
CO2	Identify different techniques involved in protecting privacy and principles of Web Security.	3	PO9, PSO1
CO3	Determine security for content providers through privacy policies and security legislations.	3	PO7, PSO1
CO4	Deploy SSL server Certificates, client side digital certificates and Microsoft's Authenticode.	4	PO4, PSO1

Syllabus

Introduction web technology, Web Security landscape, The Architecture of World Wide Web, Cryptography basics, Cryptography and the web, Understanding SSL and TLS, Digital Identification I- Passwords, Biometrics and Digital Signatures Digital Identification II: Digital Certificates, CA's and PKI

The Webs War on Your Privacy, Privacy-Protecting Techniques, Web Server Security- Physical Security for Servers, Host Security for Servers, Securing Web Applications Deploying SSL Server Certificates, Securing Your Web Service, Computer Crime

Security for Content Providers- Controlling Access to Your Web Content, Client-Side Digital Certificates, Code Signing and Microsofts Authenticode Security for Content Providers: Pornography, Filtering Software, and Censorship

Privacy Policies, Legislation, and P3P, Privacy Policies, Legislation, and P3P, Digital Payments, Intellectual Property and Actionable Content

Reference Books

- 1 Web Security, Privacy & Commerce, Simson Garfinkel, Gene Spafford, 2nd Edition, O'Reilly Media.
- 2 Web Security: A WhiteHat Perspective , Routledge, 1st Edition, Auerbach Publications.
- 3 Web Application Security , Andrew Hoffman, -, O'Reilly Media.
- 4 Computer Security and Cryptography, Alan G Konheim, -, Wiley.
- 5 Web Security, Lincoln D. Stein, -, Addison-Wesley.

23CSB3510 - SECURITY GOVERNANCE & MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSB3510	SECURITY GOVERNANCE & MANAGEMENT	SGM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	The students understand the fundamental principles of security governance and management, including their necessity and implementation strategies. They will also gain a thorough grasp of access management techniques like authentication, authorization, and access control.	2	PO1, PO4, PO5, PSO1
CO2	The student will be able to apply knowledge of security frameworks (COBIT, CMMI, ISO) and risk management principles to define strategic security metrics aligned with governance objectives and information security outcomes. This outcome focuses on applying the listed topics (frameworks, risk management) to achieve a practical goal: defining security metrics that meet both governance and security goals.	3	PO3, PO4, PO5, PSO1
CO3	By Apply current security & risk landscapes, students will be able to apply knowledge to implement comprehensive security strategy, including identifying gaps, defining success metrics, and adapting to challenges.	3	PO3, PO4, PO5, PSO1
CO4	Applying Incident Management and Response Metrics to various organizations	3	PO1, PO4, PO5, PSO1

Syllabus

Governance Overview How Do We Do It What Do We Why Governance Benefits of Good Governance A Management Problem Legal and Regulatory Requirements Security Governance and Regulation Roles and Responsibilities The Board of Directors Executive Management Security Steering Committee The CISO CIA Model User identity and Access Management Authentication Account Authorization Validation Access Control

Strategic Metrics Governance Objectives Information Security Outcomes Defining Outcomes Security Governance Objectives Security Architecture CobiT Capability Maturity Model ISO IEC 27001 27002 63 Other Approaches Risk Management Objectives Risk Management Responsibilities Managing Risk Appropriately Determining Risk Management Objectives

Current State Current State of Security Current State of Risk Management Gap Analysis Unmitigated Risk Developing a Security Strategy Failures of Strategy Attributes of a Good Security Strategy Strategy Resources Strategy Constraints Sample Strategy Development The Process Implementing Strategy Action Plan Intermediate Goals Action Plan Metrics Reengineering Inadequate Performance Elements of Strategy.

Security Program Development Metrics: Information Security Program Development Metrics ,Program Development Operational Metrics ,Information Security Management Metrics: Management Metrics ,Security Management Decision Support Metrics ,CISO Decisions , Incident Management and Response Metrics: Incident Management Decision Support Metrics.

Reference Books

- 1 INFORMATION SECURITY Governance A Practical Development and Implementation Approach, KRAG BROTBAYA, 2009, WILEY.
- 2 Information Systems Security: Security Management, Metrics, Frameworks And Best Practices, Nina Godbole, 2010, ISC2 Press.
- 3 Information Security Risk Analysis , Thomas R. Peltier, 3rd edition, Auerbach, 2012.
- 4 Principles of Information Security, Michael E. Whitman, 5 edition (2015), Cengage Learning India Private Limited .

5 Fundamental of Information Security, Sanil Nadkarni , 2020, bpb.

23CSC3101A - FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3101A	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	FCS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of Cloud Computing, Cloud Economics, DevOps & cloud platforms.	2	PO3, PO4, PSO2
CO2	Apply the appropriate Cloud Services to various scenarios.	3	PO3, PO4, PSO2
CO3	Deploy, manage and operate applications on scalable, highly available and fault-tolerant Cloud Platforms.	6	PO3, PO4, PSO2
CO4	Develop skills for implementing cloud solutions for various scenarios.	3	PO3, PO4, PSO2
CO5	Develop skills in containerization, orchestration, and reproducible research practices.	3	PO3, PO4, PSO2
CO6	Explore different cloud service models and deployment models.	3	PO3, PO4, PSO2
CO7	Develop Practical Applications Using Cloud Computing:	3	PO3, PO4, PSO2

Syllabus

Fundamentals of Cloud Computing, Architecture Layers of Cloud Computing, Scientific Service on the Cloud, Scientific Programming Paradigms, Delivering Scientific Computing Services on the Cloud

Cloud storage Landscape Storage as a service , Using cloud storage services , Distributed Databases: CosmosDB, using Amazon cloud storage services, using Azure cloud storage services, , using google cloud storage services, using openstack cloud storage services,

Computing in the cloud, Computing as a service , Using and managing virtual machines , Using and managing containers , Scaling deployments, Serverless and Function as a Service, advanced computing services

Stream data to the cloud, Scientific streaming examples, basic design challenges of streaming systems, amazon kinesis and fire hose, streaming data with azure, google dataflow, kinesis, spark and array of things

Containerization and Orchestration, Security and Compliance, Cost Management and Optimization, Case studies of cloud-based scientific computing projects in various domains, Best practices for designing, implementing, and managing cloud-based scientific computing workflows

Reference Books

- 1 Cloud Computing For Science and Engineering, Ian Foster, Dennis B. Gannon, 2017, MIT Press.
- 2 Cloud Computing with e-Science Applications, Olivier Terzo, Lorenzo Mossucca, 2018, CRC Press.
- 3 Cloud Computing for Scientific Research, Benjamin Disraeli, 2020, Kindle.
- 4 Fundamentals of Cloud Computing, A. Kannammal, 2020, Cengage.

23CSC3101E - FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3101E	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	FCS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of Cloud Computing, Cloud Economics, DevOps & cloud platforms.	2	PO3, PO4, PSO2
CO2	Learn to deploy, manage, and scale scientific applications on the cloud.	3	PO3, PO4, PSO2
CO3	Acquire skills in data management, analysis, and visualization using cloud-based tools.	4	PO3, PO4, PSO2
CO4	Develop skills for implementing cloud solutions for various scenarios.	3	PO3, PO4, PSO2
CO5	Analyze consequences and benefits of migration, data intensive, and applications of cloud	4	PO3, PO4, PSO2
CO6	Apply hands-On exposure of Cloud infrastructure,virtualization, Load balancing and authentication, and security services	3	PO3, PO4, PSO2
CO7	Analyze the Infrastructure related concepts as best practices	4	PO3, PO4, PSO2

Syllabus

Fundamentals of Cloud Computing,Architecture Layers of Cloud Computing,Scientific Service on the Cloud,Scientific Programming Paradigms,Delivering Scientific Computing Services on the Cloud

Cloud storage LandscapeStorage as a service ,Using cloud storage services ,Distributed Databases: CosmosDB,using Amazon cloud storage services,using Azurecloud storage services,,using googlecloud storage services,using openstack cloud storage services,

Computing in the cloud, Computing as a service , Using and managing virtual machines , Using and managing containers , Scaling deployments, Serverless and Function as a Service,advanced computing services

Streamind data to the cloud, Scientific streaming examples,basic design challenges of streaming systems,amazon knesis and fire house,straming data with azure,google dataflow,knesis, spark and array of things,,Cloud-Based Scientific Applications,Common scientific applications and workloads in the cloud.,Case studies of cloud-based scientific research.Deploying a scientific application on a cloud platform.Future trends in cloud-based scientific computing.

Case Studies of Cloud-Based Scientific Research,Cloud-Based Collaborative Research Platforms,Future Trends in Cloud-Based Scientific Computing,Quantum Computing in the Cloud,Edge Computing and IoT Integration

Reference Books

- 1 Cloud Computing For Science and Engineering, Ianfoster,Dennis b.gannon, 2017, mit press.
- 2 Cloud Computing with e-Science Applications, Olivier Terzo, Lorenzo Mossucca, 2018, CRC press.
- 3 Cloud Computing for Scientific Research, Benjamin Disraeli, 2020, kindly.
- 4 Fundamentals of Cloud Computing, A. Kannammal, 2020, cengage.

23CSC3101R - FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3101R	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	FCS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of Cloud Computing, Cloud Economics, DevOps & cloud platforms.	2	PO3, PO4, PSO2
CO2	Apply the appropriate Cloud Services to various scenarios.	3	PO3, PO4, PSO2
CO3	Deploy, manage and operate applications on scalable, highly available and fault-tolerant Cloud Platforms.	4	PO3, PO4, PSO2
CO4	Develop skills for implementing cloud solutions for various scenarios.	5	PO3, PO4, PSO2
CO5	Develop skills in containerization, orchestration, and reproducible research practices.	5	PO3, PO4, PSO2
CO6	Explore different cloud service models and deployment models.	3	PO3, PO4, PSO2

Syllabus

Fundamentals of Cloud Computing, Architecture Layers of Cloud Computing, Scientific Service on the Cloud, Scientific Programming Paradigms, Delivering Scientific Computing Services on the Cloud

Cloud storage Landscape Storage as a service , Using cloud storage services , Distributed Databases: CosmosDB, using Amazon cloud storage services, using Azure cloud storage services, using google cloud storage services, using openstack cloud storage services,

Computing in the cloud, Computing as a service , Using and managing virtual machines , Using and managing containers , Scaling deployments, Serverless and Function as a Service, advanced computing services

Streamline data to the cloud, Scientific streaming examples, basic design challenges of streaming systems, amazon kinesis and firehose, streaming data with azure, google dataflow, kinesis, spark and array of things

Reference Books

- 1 Cloud Computing For Science and Engineering, Ian Foster, Dennis B. Gannon, 2017, MIT Press.
- 2 Cloud Computing with e-Science Applications, Olivier Terzo, Lorenzo Mossucca, 2018, CRC Press.
- 3 Cloud Computing for Scientific Research, Benjamin Disraeli, 2020, Kindle.
- 4 Fundamentals of Cloud Computing, A. Kannammal, 2020, Cengage.

23CSC3202A - DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3202A	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	DSA	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the core concepts and architecture of cloud computing, including deployment and service models	2	PO1, PO5, PSO2
CO2	Proficiently use major cloud platforms and tools for managing scientific data and performing analytics.	3	PO1, PO3, PO5, PSO2
CO3	Develop scalable scientific applications using parallel and distributed computing principles.	3	PO1, PO2, PO5, PSO2
CO4	Effectively deploy, monitor, and manage scientific applications in the cloud, ensuring performance optimization and resource management.	4	PO1, PO2, PSO2
CO5	Application of Tools handle the data , and analysis of futute trends and research scopes	4	PO2, PO3

Syllabus

Introduction to Cloud Computing, Cloud Computing Basics: Overview of cloud computing concepts, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Deployment Models: Description of different cloud deployment models such as public, private, hybrid, and multi-cloud. Cloud Architecture: Understanding cloud architecture, including virtualization, containerization, and orchestration. Benefits and Challenges: Discussion of the benefits and challenges of using cloud computing for scientific applications

Cloud Platforms and Tools for Scientific Computing Major Cloud Platforms: Overview of major cloud platforms such as AWS, Google Cloud, and Microsoft Azure. Data Management: Managing scientific data in the cloud, including storage, retrieval, and analytics. Security and Compliance: Understanding.

Development of Scientific Applications Designing Scientific Applications: Principles and best practices for designing scalable and efficient scientific applications in the cloud. Parallel and Distributed Computing: Introduction to parallel and distributed computing in the cloud, including map-reduce, job scheduling, and scaling.

Deployment, Management, and Future Trends Deployment of Scientific Applications: Methods for deploying scientific applications to the cloud, including CI/CD pipelines and containerization. Monitoring and Management: Monitoring cloud-based scientific applications for performance, resource usage, and error detection. Case Studies: Real-world examples of scientific applications developed using cloud-based technology.

Cloud Tools for Scientific Computing: Introduction to cloud tools such as Jupyter Notebooks, Dask, and TensorFlow. Data Processing and Analytics: Techniques for processing and analyzing large datasets in scientific applications. Machine Learning and AI: Leveraging machine learning and AI tools in the cloud for scientific research. Future Trends in Cloud Computing: Discussion of emerging trends in cloud computing, such as serverless computing, edge computing, and quantum computing

Reference Books

- 1 Mastering Cloud Computing: Foundations and Applications Programming , Raj Kumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, 2019, Morgan Kaufmann.
- 2 Cloud Computing: Principles, Systems and Applications, Nick Antonopoulos and Lee Gillam., 2010, Springer.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis, 2014, Wiley.
- 4 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, 2017, MIT Press.

23CSC3202E - DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3202E	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	DSA	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the core concepts and architecture of cloud computing, including deployment and service models	2	PO1, PO5, PSO2
CO2	Proficiently use major cloud platforms and tools for managing scientific data and performing analytics.	3	PO1, PO3, PO5, PSO2
CO3	Develop scalable scientific applications using parallel and distributed computing principles.	3	PO1, PO2, PO5, PSO2
CO4	Effectively deploy, monitor, and manage scientific applications in the cloud, ensuring performance optimization and resource management.	4	PO1, PO2, PSO2
CO5	Application of Tools handle the data , and analysis of futute trends and research scopes	4	PO2, PO3, PSO2

Syllabus

Introduction to Cloud Computing, Cloud Computing Basics: Overview of cloud computing concepts, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Deployment Models: Description of different cloud deployment models such as public, private, hybrid, and multi-cloud. Cloud Architecture: Understanding cloud architecture, including virtualization, containerization, and orchestration. Benefits and Challenges: Discussion of the benefits and challenges of using cloud computing for scientific applications

Cloud Platforms and Tools for Scientific Computing Major Cloud Platforms: Overview of major cloud platforms such as AWS, Google Cloud, and Microsoft Azure. Data Management: Managing scientific data in the cloud, including storage, retrieval, and analytics. Security and Compliance: Understanding.

Development of Scientific Applications Designing Scientific Applications: Principles and best practices for designing scalable and efficient scientific applications in the cloud. Parallel and Distributed Computing: Introduction to parallel and distributed computing in the cloud, including map-reduce, job scheduling, and scaling.

Deployment, Management, and Future Trends Deployment of Scientific Applications: Methods for deploying scientific applications to the cloud, including CI/CD pipelines and containerization. Monitoring and Management: Monitoring cloud-based scientific applications for performance, resource usage, and error detection. Case Studies: Real-world examples of scientific applications developed using cloud-based technology.

Cloud Tools for Scientific Computing: Introduction to cloud tools such as Jupyter Notebooks, Dask, and TensorFlow. Data Processing and Analytics: Techniques for processing and analyzing large datasets in scientific applications. Machine Learning and AI: Leveraging machine learning and AI tools in the cloud for scientific research. Future Trends in Cloud Computing: Discussion of emerging trends in cloud computing, such as serverless computing, edge computing, and quantum computing

Reference Books

- 1 Mastering Cloud Computing: Foundations and Applications Programming , Raj Kumar Buyya, Christian Vecchiola, and S. Thamarai Selvi , 2019, Morgan Kaufmann.
- 2 Cloud Computing: Principles, Systems and Applications, Nick Antonopoulos and Lee Gillam., 2010, Springer.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis, 2014, Wiley.
- 4 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, 2017, MIT Press.

23CSC3202R - DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3202R	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	DSA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the core concepts and architecture of cloud computing, including deployment and service models	2	PO1, PO5, PSO2
CO2	Proficiently use major cloud platforms and tools for managing scientific data and performing analytics.	3	PO1, PO3, PO5, PSO2
CO3	Develop scalable scientific applications using parallel and distributed computing principles.	3	PO1, PO2, PO5, PSO2
CO4	Effectively deploy, monitor, and manage scientific applications in the cloud, ensuring performance optimization and resource management.	4	PO1, PO2, PSO2

Syllabus

Introduction to Cloud Computing, Cloud Computing Basics: Overview of cloud computing concepts, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Deployment Models: Description of different cloud deployment models such as public, private, hybrid, and multi-cloud. Cloud Architecture: Understanding cloud architecture, including virtualization, containerization, and orchestration. Benefits and Challenges: Discussion of the benefits and challenges of using cloud computing for scientific applications.

Cloud Platforms and Tools for Scientific Computing Major Cloud Platforms: Overview of major cloud platforms such as AWS, Google Cloud, and Microsoft Azure. Data Management: Managing scientific data in the cloud, including storage, retrieval, and analytics. Security and Compliance: Understanding.

Development of Scientific Applications Designing Scientific Applications: Principles and best practices for designing scalable and efficient scientific applications in the cloud. Parallel and Distributed Computing: Introduction to parallel and distributed computing in the cloud, including map-reduce, job scheduling, and scaling.

Deployment, Management, and Future Trends Deployment of Scientific Applications: Methods for deploying scientific applications to the cloud, including CI/CD pipelines and containerization. Monitoring and Management: Monitoring cloud-based scientific applications for performance, resource usage, and error detection. Case Studies: Real-world examples of scientific applications developed using cloud-based technology.

Reference Books

- 1 Mastering Cloud Computing: Foundations and Applications Programming, Raj Kumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, 2019, Morgan Kaufmann.
- 2 Cloud Computing: Principles, Systems and Applications, Nick Antonopoulos and Lee Gillam., 2010, Springer.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis , 2014, Wiley.
- 4 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, 2017, The MIT Press.

23CSC3203A - DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3203A	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	DSCC	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the Distributed file system environment, Virtualization and basics of Cloud Computing	3	PO3, PSO1
CO2	Examine the Parallel and Distributed Computing architectures in HPC, and exploring different Cloud services like IaaS, PaaS and SaaS	4	PO4
CO3	Analyze Scientific Computing Workflow Management for High Performance Computing in the Cloud	4	PO5, PSO1
CO4	Interpret the Data and Network Security on cloud with effective Resource Management and Cost Optimization	4	PO3
CO5	Implementaion of Distributed Scientific Computing applications with AI tools and projects with Case studies	4	PO4, PSO1

Syllabus

Introduction to Distributed Systems and Cloud environment: About Distributed systems, File system, Characteristics and challenges, About Virtualization, Cloud service models (IaaS, PaaS, SaaS), Cloud deployment models (public, private, hybrid), Key cloud providers and their services

Concepts of parallelism and concurrency, HPC, Distributed computing architectures, Job scheduling and resource management, Distributed File Systems : Hadoop Distributed File System (HDFS), Google File System (GFS), Data storage and retrieval in distributed environments

Scientific Workflow Management : Workflow management systems (Pegasus, Taverna), Automating scientific workflows, High Performance Computing in the Cloud, HPC clusters and cloud integration, Performance optimization techniques, Practical applications and case studies

Resource Management and Cost Optimization, Cloud resource management tools (Kubernetes, Apache Mesos), Cost monitoring and management strategies, Case studies in budget management, Data Security and Privacy : Security challenges in distributed and cloud computing, Data encryption and access control, Compliance and ethical considerations

Emerging technologies and trends in Distributed Scientific Computing, Edge computing and IoT integration, About AI Tools and Future directions in distributed scientific computing

Reference Books

- 1 Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, and Geoffrey C. Fox, 1, 2011, Morgan Kaufmann Publishers.
- 2 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, and Andrzej M. Goscinski, 3, 2012, Wiley.
- 3 Cloud Computing for Science and Engineering, Ian Foster and Dennis B. Gannon, 2, 2017, MIT, Press.
- 5 High Performance Computing: Paradigm and Infrastructure, Laurence T. Yang and Minyi Guo, 2, 2022, Wiley.

23CSC3203E - DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3203E	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	DSCC	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand the basics of distributed systems,virtualization and cloud computing	2	PO4
CO2	Describe Distributed Computing environments and exploring different Cloud services like IaaS,PaaS and SaaS	3	, PSO1
CO3	Describe and analyze different techniques for parallelizing and distributed high performance scientific workflows in the cloud.	4	PO3
CO4	Identify tools and libraries for cloud-based scientific computing with effective Resource utilization and Cost Optimization	4	PO4, PSO1
CO5	Design and implement a basic scientific application using AI tools on cloud platform.	4	PO3

Syllabus

Introduction to Distributed Systems,Cloud environment:,Virtualization,Types of Cloud and about different cloud service providers.

Concepts of parallelism and concurrency,Distributed File Systems :Hadoop Distributed File System (HDFS) , Google File System (GFS) and Cloud service models (IaaS, PaaS, SaaS)

About Scientific computing and Scientific Workflow Management Systems (Pegasus, Taverna),Automating scientific workflows, High Performance Computing in the Cloud

Resource Management and Cost Optimization, Cloud resource management tools (Kubernetes, Apache Mesos), Cost monitoring and management strategies, Case studies in budget management,

Emerging technologies and trends in Distributed Scientific Computing, About AI Tools and Future directions in distributed scientific computing

Reference Books

- 1 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, and Andrzej Goscinski, 3,2012, WILEY.
- 2 Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang and Geoffrey C. Fox, 2, 2022, MK.
- 3 Scientific Data Management: Challenges, Technology, and Deployment , Shoshani and Doron Rotem, 3, 2020, CRC Press.
- 4 Distributed Systems: Principles and Paradigms, Andrew S. Tanenbaum and Maarten Van Steen, 2, Pearson.

23CSC3203R - DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3203R	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	DSCC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand basic concepts of distributed systems, file systems architecture, about computing intensive applications and basics of Cloud computing	2	PO3, PSO1
CO2	Describe the principles and mechanisms of virtualization, Types of Cloud and about different cloud service providers and their services	3	PO4
CO3	Apply distributed computing principles to scientific computing and workflows.	4	PO3, PO5, PSO1
CO4	Design and implement distributed scientific computing solutions in cloud environments.	4	PO4

Syllabus

Characteristics and challenges in distributed systems, Concepts of parallelism and concurrency, about computing intensive applications, HPC and basics of cloud with deployment models (public, private, hybrid),

Virtualization and containerization, Compute, storage, and networking in the cloud, Elasticity and scalability, About various cloud services and Case studies in cloud infrastructure for scientific computing

About scientific computing and their workflow management systems, Designing scientific workflows, Automating and scaling workflows in the cloud

Distributed systems: characteristics and challenges, Cloud computing: service models (IaaS, PaaS, SaaS), Virtual machines and containers: VMware, Docker, Kubernetes, Cloud architecture: compute, storage, networking, scalability, Distributed computing: MPI, MapReduce, Spark, workflow management (Pegasus, Nextflow)

Reference Books

- 1 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, and Andrzej Goscinski, 3, 2012, WILEY.
- 2 Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang and Geoffrey C. Fox, 2, 2011, MK.
- 3 Scientific Data Management: Challenges, Technology, and Deployment, Shoshani and Doron Rotem, 3, 2021, CRC Press.
- 4 High Performance Computing: Paradigm and Infrastructure, Laurence T. Yang and Minyi Guo, 2, WILEY.
- 5 Distributed Systems: Principles and Paradigms, Andrew S. Tanenbaum and Maarten Van Steen, 2, Pearson.

23CSC3304A - CLOUD BASED HIGH PERFORMANCE COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3304A	CLOUD BASED HIGH PERFORMANCE COMPUTING	CHC	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamentals of Cloud Computing and HPC	3	PO2, PO3, PSO1
CO2	Analyze Cloud Infrastructure and Resource Management	4	PO2, PO3, PO4, PSO1
CO3	Analyze Programming Models for Cloud-based HPC	4	PO2, PO3, PO4, PSO1
CO4	Analyze HPC Applications on the Cloud	4	PO2, PO3, PO4, PSO1
CO5	Analyze Advanced Cloud-based HPC Technique, and future trends	4	PO2, PO3, PO4, PSO1
CO6	Analyze cloud infrastructure services, and parallel programming tasks	4	PO2, PO3, PO4
CO7	Analyze the storage, networking, serverless, database management services, openMP, MPI over a cloud	4	PO2, PO3, PO4

Syllabus

Introduction to Cloud Computing and HPC: deployment models, service models, benefits, challenges, parallel computing concepts, architectures, applications, major cloud providers.

Cloud Infrastructure and Resource Management: Cloud Infrastructure Components such as compute, storage, networking, Virtualization Technologies such as virtual machines, containers.

Programming Models for Cloud-based HPC: Parallel Programming Paradigms such as MPI, OpenMP, Cloud-specific Programming Models such as MapReduce, Spark, scaling, load balancing.

HPC Applications on the Cloud: Scientific simulations, machine learning workloads, big data analytics, Security Considerations for HPC in the Cloud.

Big Data Analytics on the Cloud such as distributed processing frameworks, Cloud-based HPC for Emerging Applications such as AI, IoT, genomics, serverless HPC, hardware advancements in cloud based HPC.

Reference Books

- 1 High Performance Computing for Dummies , Jack Dongarra, Sun and AMD, Wiley.
- 2 Introduction to High Performance Computing for Scientists and Engineers, Georg Hager and Gerhard Wellein, 2011, Chapman & Hall / CRC.
- 3 High Performance Heterogeneous Computing, Jack Dongarra, Alexey L. Lastovetsky, 2009, Wiley.
- 4 HPC for the Age of AI and Cloud Computing, nvidia, 2024, nvidia.

23CSC3304E - CLOUD BASED HIGH PERFORMANCE COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3304E	CLOUD BASED HIGH PERFORMANCE COMPUTING	CHC	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamentals of Cloud Computing and HPC	3	PO2, PO3, PSO1
CO2	Analyze Cloud Infrastructure and Resource Management	4	PO2, PO3, PSO1
CO3	Analyze Programming Models for Cloud-based HPC	4	PO2, PO3, PO4, PSO1
CO4	Analyze HPC Applications on the Cloud	4	PO2, PO3, PO4, PSO1
CO5	Analyze Advanced Cloud-based HPC Technique, and future trends	4	PO2, PO3, PO4, PSO1
CO6	Analyze cloud infrastructure services, and parallel programming tasks	4	PO2, PO3, PO4, PSO2
CO7	Analyze the storage, networking, serverless, database management services, openMP, MPI over a cloud	4	PO2, PO3, PO4, PSO2

Syllabus

Introduction to Cloud Computing and HPC: deployment models, service models, benefits, challenges, parallel computing concepts, architectures, applications, major cloud providers.

Cloud Infrastructure and Resource Management: Cloud Infrastructure Components such as compute, storage, networking, Virtualization Technologies such as virtual machines, containers.

Programming Models for Cloud-based HPC: Parallel Programming Paradigms such as MPI, OpenMP, Cloud-specific Programming Models such as MapReduce, Spark, scaling, load balancing.

HPC Applications on the Cloud: Scientific simulations, machine learning workloads, big data analytics, Security Considerations for HPC in the Cloud.

Big Data Analytics on the Cloud such as distributed processing frameworks, Cloud-based HPC for Emerging Applications such as AI, IoT, genomics, serverless HPC, hardware advancements in cloud based HPC.

Reference Books

- 1 High Performance Computing for Dummies, Jack Dongarra,, Sun and AMD, Wiley.
- 2 Introduction to High Performance Computing for Scientists and Engineers, Georg Hager and Gerhard Wellein, 2011, Chapman & Hall / CRC.
High Performance Computing in Clouds: Moving HPC Applications to a Scalable and Cost-Effective Environment, Edson Borin (Editor), Lucia Maria A. Drummond (Editor), Jean-Luc Gaudiot (Editor), Alba Melo (Editor), 2023, Hard cover.
- 3 High Performance Heterogeneous Computing, Jack Dongarra, Alexey L. Lastovetsky, 2009, Wiley.

23CSC3304R - CLOUD BASED HIGH PERFORMANCE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3304R	CLOUD BASED HIGH PERFORMANCE COMPUTING	CHC	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamentals of Cloud Computing and HPC	3	PO2, PO3, PSO1
CO2	Analyze Cloud Infrastructure and Resource Management	4	PO2, PO3, PSO1
CO3	Analyze Programming Models for Cloud-based HPC	4	PO2, PO3, PO4, PSO1
CO4	Analyze HPC Applications on the Cloud	4	PO2, PO3, PO4, PSO1
CO5	Analyze cloud infrastructure services, and parallel programming tasks	4	PO2, PO3, PO4, PSO1
CO6	Analyze the storage, networking, serverless, database management services, openMP, MPI over a cloud	4	PO2, PO3, PO4, PSO1

Syllabus

Introduction to Cloud Computing and HPC: deployment models, service models, benefits, challenges, parallel computing concepts, architectures, applications, major cloud providers.

Cloud Infrastructure and Resource Management: Cloud Infrastructure Components such as compute, storage, networking, Virtualization Technologies such as virtual machines, containers.

Programming Models for Cloud-based HPC: Parallel Programming Paradigms such as MPI, OpenMP, Cloud-specific Programming Models such as MapReduce, Spark, scaling, load balancing.

HPC Applications on the Cloud: Scientific simulations, machine learning workloads, big data analytics, Security Considerations for HPC in the Cloud.

Reference Books

- 1 High Performance Computing for Dummies, Jack Dongarra, Sun and AMD, Wiley.
- 2 Introduction to High Performance Computing for Scientists and Engineers, Georg Hager and Gerhard Wellei, 2011, Chapman & Hall / CRC.
- 3 High Performance Computing in Clouds: Moving HPC Applications to a Scalable and Cost-Effective Environment , Edson Borin (Editor), Lucia Maria A. Drummond (Editor), Jean-Luc Gaudiot (Editor), Alba Melo (Editor), 2023, Hard Cover.
- 4 Cloud Computing: Concepts, Technology & Architecture, 1/e, Erl, 2014, Paperback.

23CSC3405M - CLOUD-BASED GRID COMPUTING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3405M	CLOUD-BASED GRID COMPUTING	CGC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	analyze the evolution of distributed computing technologies, from basic network-based systems to advanced cloud computing and service-oriented architectures, and assess their impact on modern computing paradigms.	4	PO1, PO2, PO3
CO2	evaluate the Open Grid Services Architecture (OGSA), including its motivation, functionality requirements, and service models, and apply this knowledge to understand the implementation of data-intensive services in a grid computing environment.	5	
CO3	evaluate various cloud deployment models and computing categories, assess the pros and cons of cloud computing, and analyze virtualization\	5	PO1, PO3
CO4	analyze and apply security models, methods, and practices to ensure robust security across grid and cloud computing environments	4	PO2, PSO2

Syllabus

Introduction to Distributed Computing: Evolution of distributed computing technologies, network-based systems, service-oriented architectures, and advanced cloud computing.

Open Grid Services Architecture (OGSA): Motivation, functionality requirements, service models, and implementation of data-intensive services in a grid computing environment.

Cloud Computing Models and Virtualization: Cloud deployment models, computing categories, pros and cons of cloud computing, and an in-depth analysis of virtualization technologies.

Security in Grid and Cloud Computing: Security models, methods, practices, and ensuring robust security across grid and cloud computing environments.

Reference Books

- 1 Distributed and Cloud Computing: From Parallel Processing to the Internet of Things , Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra , 2011 , Morgan Kaufmann.
- 2 The Open Group Series: Cloud Computing for Business , Christian Baun, Marcel Kunze, Jens Nimis, Stefan Tai , 2011 , Springer.
- 3 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance , and Compliance Tim Mather, Subra Kumaraswamy, Shahed Latif , 2009 , O'Reilly Media.
- 4 Mastering Cloud Computing: Foundations and Applications Programming , Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi , 2013 , Morgan Kaufmann.
- 5 Advanced Grid Computing: Concepts and Systems, Manish Parashar, Xiaolin Li, 2003, Wiley.

23CSC3406M - CLOUD COMPUTING FOR SCIENTIFIC DISCOVERY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3406M	CLOUD COMPUTING FOR SCIENTIFIC DISCOVERY	CCFSD	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Harness cloud computing resources to accelerate scientific data analysis	3	PO5, PSO1
CO2	Implement cloud-based collaboration tools for interdisciplinary scientific projects	3	PO9
CO3	Optimize scientific workflows using cloud computing architectures	4	PO5, PSO1
CO4	Evaluate the impact of cloud computing on scientific innovation and discovery	5	PO6

Syllabus

Introduction to cloud computing for scientific data analysis - Cloud-based data storage solutions - Cloud-based data processing tools - Data visualization in the cloud - Hands-on exercises in utilizing cloud resources for data analysis

Cloud based collaboration platforms and tools - Real time communication and collaboration in the cloud - Data sharing and collaborative research environments - Virtual research environments in the cloud - Case studies of successful interdisciplinary projects using cloud technologies

Designing cloud native architectures for scientific workflows - Scalability and resilience in cloud architectures - Containerization for scientific applications - Orchestration tools for workflow optimization - Implementing serverless computing for scientific workflows

Ethical considerations in cloud-based scientific research - Data privacy and compliance in the cloud - Security challenges and best practices in cloud-enabled research - Case studies showcasing the impact of cloud computing on scientific innovation - Future trends in cloud-based scientific research and innovation

Reference Books

- 1 Cloud Computing for Data Analysis, Yanpei Chen, Sara Alspaugh, and Randy Katz, First Edition, 2014, O'Reilly Media.
- 2 Data Science in the Cloud: Tools, Techniques, and Applications, David Langer and Soledad Galli, First Edition, 2017, Apress.
- 3 Collaborative Research in the Cloud: Understanding and Managing the Risks, Elizabeth Cummings and Anne Fitzgerald, First Edition, 2014, Edward Elgar Publishing.
- 4 Cloud Collaboration for Science: A Guide to Collaborative Research in the Cloud, John Goodhue and Bruce Segee, First Edition, 2013, CRC Press.
- 5 Architecting for Scale: High Availability for Your Growing Applications, Lee Atchison, First Edition, 2016, O'Reilly Media.
- 6 Cloud Native Patterns: Designing Change-Tolerant Software, Cornelia Davis, First Edition, 2019, O'Reilly Media.
- 7 Cloud Computing for Science and Engineering, Ian Foster and Dennis B. Gannon, First Edition, 2017, MIT Press.
- 8 Cloud Computing and Electronic Discovery, James P. Martin, First Edition, 2011, CRC Press.

23CSC3507 - CLOUD-BASED SCALABLE COMPUTING AND BIG DATA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3507	CLOUD-BASED SCALABLE COMPUTING AND BIG DATA ANALYTICS	CSCBD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of cloud computing models and architectures.	2	PO1, PSO1, PSO2
CO2	Outline scalable computing techniques for handling big data in cloud environments.	2	PO3, PSO1
CO3	Demonstrate distributed computing paradigms and their applications in big data analytics.	2	PO1, PO2, PSO2
CO4	Develop hands-on experience with popular big data analytics tools and platforms.	3	PO3, PSO2

Syllabus

Overview of cloud computing concepts and models - Cloud service models: IaaS, PaaS, SaaS-Cloud deployment models: public, private, hybrid- Cloud infrastructure and virtualization technologies

Scalability concepts and challenges- Horizontal vs. vertical scaling- Elasticity and auto-scaling-Distributed computing frameworks: Hadoop, Spark

Introduction to big data analytics-Characteristics of big data: volume, velocity, variety, veracity-Batch vs. real-time processing-Big data storage technologies: HDFS, NoSQL databases

MapReduce programming model-Spark RDDs and data processing operations-Stream processing with Apache Kafka and Spark Streaming-Distributed data processing with Apache Flink

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2013, Pearson.
- 2 Hands-On Serverless Computing, Kuldeep Chowhan, 2018, Packt Publishing Ltd,.
- 3 Data Science for Business: What You Need to Know about Data Mining and Data-Analytic, Michael Minelli, Jamie Andrews and Murex D. Flanagan, 2019, O'Reilly Media.
- 4 Big Data and Analytics, Seema Acharya, 2019, Wiley.

23CSC3508 - PARALLEL COMPUTING FOR SCIENTISTS USING CLOUD PLATFORMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CSC3508	PARALLEL COMPUTING FOR SCIENTISTS USING CLOUD PLATFORMS	PCSCP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and architectures of parallel computing	2	PO2, PO4, PSO1
CO2	Develop parallel algorithms and applications using popular programming paradigms	2	PO3, PSO2
CO3	Utilize cloud computing platforms for deploying and scaling applications	3	PO2, PO4, PSO1
CO4	Apply parallel computing techniques to real-world scientific problems	3	PO3, PSO2

Syllabus

Foundations of Parallel Computing and Cloud Platforms Overview: This module introduces the basic concepts and architectures of parallel computing, including shared and distributed memory systems. Students will also learn about the role of cloud platforms in computing, exploring major services from providers like AWS, Azure, and Google Cloud. **Learning Outcomes:** Understand the key principles of parallel computing architectures and identify the core services and benefits of using cloud platforms for computational tasks.

Programming for Parallel Systems Overview: Focuses on the programming models and environments for developing parallel applications. Covers popular paradigms such as MPI, OpenMP, and CUDA, and introduces containerization technologies like Docker for creating consistent development environments. **Learning Outcomes:** Comprehend and apply parallel programming models to develop and deploy scalable applications, and understand how containerization supports the development of parallel applications on cloud platforms

Deploying and Scaling Applications on the Cloud Overview: Students learn to design and implement scalable applications using cloud infrastructure, including virtual machines, managed databases, and storage solutions. Practical examples include deploying web applications and handling large data sets in the cloud. **Learning Outcomes:** Gain a comprehensive understanding of cloud deployment models and services, and learn to implement and scale applications effectively using cloud resources

Performance Optimization and Real-World Applications Overview: This module covers techniques for benchmarking, profiling, and optimizing the performance of parallel applications. Students will also engage with case studies that illustrate the application of parallel computing in scientific research, such as simulations and data analytics. **Learning Outcomes:** Understand methods for assessing and enhancing the performance of parallel systems, and apply these techniques to optimize real-world scientific applications on the cloud.

Reference Books

- 1 Parallel Programming in C with MPI and OpenMP, Michael Quinn, 2023, Parallel Programming in C with MPI and OpenMP.
- 2 Patterns for Parallel Programming, Timothy G. Mattson, Beverly A. Sanders, and Berna L. Massingill, 2004, Addison-Wesley Professional.
- 3 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, 2013, Pearson Service Technology.
- 4 High Performance Parallelism Pearls Volume One: Multicore and Many-core Programming Approaches, James Reinders and Jim Jeffers, 2023, High Performance Parallelism Pearls Volume One.

23CTM3101A - BUILDING INFORMATION MODELLING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3101A	BUILDING INFORMATION MODELLING	BIM	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts and principles of Building Information Modeling (BIM).	2	PO1, PO5, PO6, PSO1
CO2	Apply BIM software tools to create and manage 3D models of building components and systems.	3	PO1, PO5, PO6, PSO1
CO3	Analyze and interpret BIM data for effective decision-making and project management.	3	PO1, PO5, PO6, PSO1
CO4	Evaluate the integration of BIM with other technologies and methodologies in building design.	4	PO1, PO5, PO6, PSO1
CO5	Create and manage BIM-based documentation, including drawings, schedules, and cost estimates.	3	PO1, PO5, PO6, PSO1
CO6	Collaborate and coordinate with various stakeholders using BIM to enhance project outcomes.	2	PO1, PO5, PO6, PSO1
CO7	Assess the impact of BIM on the lifecycle of a building, from design through construction and maintenance.	3	PO1, PO5, PO6, PSO1

Syllabus

Basics of BIM: Fundamentals of Building Information Modeling, BIM, Project Delivery Methods & Trends BIM Adoption & Perceived ROI BIM for FM Concept BIM Proficiency Project Execution Planning

The Uses of BIM: BIM use classification system and structure, the purposes and objectives of BIM, elaborating on the BIM use characteristics, level of development, selection of BIM uses

Project BIM Execution Planning: Overview of the project execution planning procedure for BIM, identifying BIM goals and uses for a project, designing the BIM project execution process Developing information exchanges : Pulling the information through the project, information exchange worksheet.

Define supporting infrastructure for BIM implementation: Project information, project BIM goals / BIM uses, organizational roles and staffing BIM and facility data requirements, delivery strategy / contract. Implementing the BIM project execution planning procedure: Meeting Structure for Developing a BIM Project Execution Plan, Planning Meeting Schedule, Monitoring Progress against the BIM Execution Plan

Developing BIM Model using Revit Software and submission of project report

Reference Books

- 1 Building Information Modeling, Karen M. Kensek, Douglas Noble, 2014, Routledge.
- 2 BIM Handbook: A Guide to Building, Chuck Eastman, Paul Teicholz,, 2018, Wiley.
- 3 BIM and Construction Management, Brad Hardin, Dave McCool, and Chuck, 2015, John Wiley & Sons.
- 4 Building Information Modeling:, Willem Kymmell, 2008, Delmar Cengage.
- 5 BIM in Principle and Practice, David Wheatley, 2015, Routledge.

23CTM3101E - BUILDING INFORMATION MODELLING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3101E	BUILDING INFORMATION MODELLING	BIM	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand Building Information Modeling (BIM) software to create and manipulate 3D digital representations of construction projects	2	PO1, PO5, PO6, PSO1
CO2	Apply the impact of BIM on different stages of the project lifecycle, including design, construction, and facility management, to optimize project outcomes and decision-making	3	PO1, PO5, PO6, PSO1
CO3	Analyse Integrate data from various sources and disciplines into BIM models, ensuring comprehensive project analysis and informed decision-making in a complex and dynamic environment	4	PO1, PO5, PO6, PSO1
CO4	demonstrating comprehension and practical application. Building Information Modeling (BIM)	2	PO1, PO5, PO6, PSO1
CO5	Create and manage BIM-based documentation, including drawings, schedules, and cost estimates.	3	PO1, PO5, PO6, PSO1
CO6	Collaborate and coordinate with various stakeholders using BIM to enhance project outcomes.	3	PO1, PO5, PO6, PSO1
CO7	Assess the impact of BIM on the lifecycle of a building, from design through construction and maintenance.	3	PO1, PO5, PO6, PSO1

Syllabus

Introduction to Building Information Modeling (BIM): overview of BIM principles and concepts, History and evolution of BIM in the construction industry Benefits and advantages of implementing BIM in construction projects, BIM software and tools overview, Introduction to BIM project workflows and collaboration processes

BIM Modeling and Visualization: Fundamentals of BIM modeling techniques, Creating and managing 3D digital models using BIM software, Visualization and rendering techniques for BIM models Applying BIM for design exploration and iteration, Clash detection and coordination using BIM models

BIM Data Management and Integration: BIM data management strategies and best practices in BIM projects, Integrating data from various sources and disciplines into BIM models, Parametric modeling and family creation in BIM, Linking BIM models with external databases and spreadsheets, BIM interoperability and data exchange standards

BIM in Project Lifecycle Phases: BIM in the design phase: Conceptual design, detailed design, and design coordination, BIM in the construction phase: Construction sequencing, quantity takeoff, and scheduling, BIM in the facility management phase: Asset management, maintenance planning, and energy analysis Collaborative workflows and information exchange during project lifecycle phases, BIM for project coordination and communication with stakeholders

Advanced Topics in BIM: Advanced clash detection and resolution techniques, BIM for sustainable design and green building practices, BIM for facilities management and operations, BIM for infrastructure and civil engineering projects, Emerging trends and future developments in BIM

Reference Books

- 1 Building Information Modeling, Karen M. Kensek, Douglas Noble, 2014, Routledge.
- 2 BIM Handbook: A Guide to Building, Chuck Eastman, Paul Teicholz, 2018, Wiley.
- 3 BIM and Construction Management:, Brad Hardin, Dave McCool, and Chuck, 2015, John Wiley & Sons.

- 4 Building Information Modeling, Willem Kymmell, 2008, Delmar Cengage.
- 5 BIM in Principle and Practice, David Wheatley, 2015, Routledge.

23CTM3101R - BUILDING INFORMATION MODELLING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3101R	BUILDING INFORMATION MODELLING	BIM	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand BIM software to create and manipulate 3D digital representations of construction projects, demonstrating comprehension and practical application	2	PO1, PO5, PO6, PSO1
CO2	Apply the impact of BIM on different stages of the project lifecycle to optimize outcomes and decision-making in design, construction, and facility management	3	PO1, PO5, PO6, PSO1
CO3	Developing the BIM execution process by creating process maps	3	PO1, PO5, PO6, PSO1
CO4	Develop BIM information exchanges	3	PO1, PO5, PO6, PSO1
CO5	Developing BIM Model using Revit Software and submission of project report	3	PO1, PO5, PO6, PSO1
CO6	Collaborate and coordinate with various stakeholders using BIM to enhance project outcomes.	4	PO1, PO5, PO6, PSO1

Syllabus

Basics of BIM: Fundamentals of Building Information Modeling, BIM, Project Delivery Methods & Trends BIM Adoption & Perceived ROI BIM for FM Concept BIM Proficiency Project Execution Planning

The Uses of BIM: BIM use classification system and structure, the purposes and objectives of BIM, elaborating on the BIM use characteristics, level of development, selection of BIM uses

Project BIM Execution Planning: Overview of the project execution planning procedure for BIM, identifying BIM goals and uses for a project, designing the BIM project execution process Developing information exchanges : Pulling the information through the project, information exchange worksheet.

Define supporting infrastructure for BIM implementation: Project information, project BIM goals / BIM uses, organizational roles and staffing BIM and facility data requirements, delivery strategy / contract. Implementing the BIM project execution planning procedure: Meeting Structure for Developing a BIM Project Execution Plan, Planning Meeting Schedule, Monitoring Progress against the BIM Execution Plan

Developing BIM Model using Revit Software and submission of project report

Reference Books

- 1 Building Information Modeling, Karen M. Kensek, Douglas Noble,, 2014, Routledge.
- 2 BIM Handbook: A Guide to Building, Chuck Eastman, Paul Teicholz, 2018, Wiley.
- 3 BIM and Construction Management, Brad Hardin, Dave McCool, and Chuck, 2015, John Wiley & Sons.
- 4 Building Information Modeling, Willem Kymmell, 2008, Delmar Cengage.
- 5 BIM in Principle and Practice, David Wheatley, 2015, Routledge.

23CTM3202A - ADVANCED CONSTRUCTION TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3202A	ADVANCED CONSTRUCTION TECHNOLOGY	ACT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding of advanced concrete materials and technologies:	2	PO1, PO5, PSO1
CO2	Apply the ability to assess and enhance concrete performance:	2	PO1, PO5, PSO1
CO3	Apply the competence in quality control and quality assurance:	3	PO1, PO5, PSO1
CO4	Mention the application of sustainable and innovative practices:	3	PO1, PO5, PSO1
CO5	Understand the structural performance and durability enhancements achieved through advanced concrete mixes, additives, and curing techniques.	2	PO1, PO5, PSO1
CO6	Explore the principles and applications of advanced concrete materials and technologies.	2	PO1, PO5, PSO1

Syllabus

Introduction to Advanced Concrete Technology: Overview of advanced concrete materials and technologies, Evolution of concrete technology and industry trends, Sustainable practices in concrete technology, Role of advanced concrete in construction projects

Advanced Concrete Materials: High-performance concrete: properties, mix design, and applications, Self-compacting concrete: rheology, mix design, and advantages, Fiber-reinforced concrete: types, properties, and reinforcement mechanisms, Lightweight concrete: types, properties, and applications, Self-healing concrete: principles, mechanisms, and implementation

Concrete Mix Design and Optimization: Principles of concrete mix design: factors influencing proportions and performance, Optimization techniques for strength, workability, durability, and sustainability, Incorporation of supplementary cementitious materials (SCMs) and chemical admixtures, Statistical methods and computer-aided tools for mix design optimization, Case studies and practical exercises on mix design and optimization

"Testing and Performance Evaluation: Testing methods for concrete properties: compressive strength, workability, durability, Non-destructive evaluation techniques for assessing concrete performance Analysis and interpretation of test results for performance evaluation, Quality control measures for concrete production and placement, Evaluation of long-term performance and service life prediction.Sustainable Practices and Innovation in Concrete Technology: Use of recycled aggregates in concrete production, Carbon footprint reduction strategies in concrete technology, Eco-friendly admixtures and alternative binders for sustainability, Emerging trends and innovations in sustainable concrete technology, Integration of sustainable practices into design, construction, and maintenance processes"

ustainable Concrete Technologies Green concrete materials and their benefits Carbon footprint reduction strategies in concrete production Recycling and reuse of concrete waste in sustainable construction practices

Emerging Trends in Concrete Technology Nanotechnology applications in concrete 3D printing and robotic construction techniques Smart concrete technologies for monitoring and maintenance of structures

Reference Books

- 1 Concrete Technology, Neville, A.M. , 2010, Pearson Education .
- 2 Advanced Concrete Technology, Gambhir, M.L. , 2004, Tata McGraw-Hill .

- 3 Concrete: Microstructure, Properties, and Materials, Mehta, P.K., and Monteiro, P.J.M. , 2014, McGraw-Hill Education .
- 4 High Performance Concrete, Pierre-Claude A?tcin, 1998, Butterworth-Heinemann.

23CTM3202E - ADVANCED CONSTRUCTION TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3202E	ADVANCED CONSTRUCTION TECHNOLOGY	ACT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Gain knowledge of advanced concrete materials, including high-performance, self-compacting, fiber-reinforced, and lightweight concrete.	2	PO1, PO5, PSO1
CO2	Acquire skills to assess and enhance concrete performance through testing, evaluation, and analysis.	2	PO1, PO5, PSO1
CO3	Learn quality control and assurance measures for concrete projects, including inspection and standards.	2	PO1, PO5, PSO1
CO4	Explore sustainable practices in concrete, like recycled aggregates, carbon footprint reduction, and eco-friendly admixtures.	2	PO1, PO5, PSO1
CO5	Understand advanced concrete materials and technologies, like high-performance and self-healing concrete.	2	PO1, PO5, PSO1
CO6	Understand and Investigate structural performance and durability improvements through advanced concrete mixes and curing techniques.	2	PO1, PO5, PSO1

Syllabus

Introduction to Advanced Concrete Technology: Overview of advanced concrete materials and technologies, Evolution of concrete technology and industry trends, Sustainable practices in concrete technology, Role of advanced concrete in construction projects

Advanced Concrete Materials: High-performance concrete: properties, mix design, and applications, Self-compacting concrete: rheology, mix design, and advantages, Fiber-reinforced concrete: types, properties, and reinforcement mechanisms, Lightweight concrete: types, properties, and applications, Self-healing concrete: principles, mechanisms, and implementation

Concrete Mix Design and Optimization: Principles of concrete mix design: factors influencing proportions and performance, Optimization techniques for strength, workability, durability, and sustainability, Incorporation of supplementary cementitious materials (SCMs) and chemical admixtures, Statistical methods and computer-aided tools for mix design optimization, Case studies and practical exercises on mix design and optimization

"Testing and Performance Evaluation: Testing methods for concrete properties: compressive strength, workability, durability, Non-destructive evaluation techniques for assessing concrete performance Analysis and interpretation of test results for performance evaluation, Quality control measures for concrete production and placement, Evaluation of long-term performance and service life prediction.Sustainable Practices and Innovation in Concrete Technology: Use of recycled aggregates in concrete production, Carbon footprint reduction strategies in concrete technology, Eco-friendly admixtures and alternative binders for sustainability, Emerging trends and innovations in sustainable concrete technology, Integration of sustainable practices into design, construction, and maintenance processes"

Sustainable Concrete Technologies Green concrete materials and their benefits Carbon footprint reduction strategies in concrete production Recycling and reuse of concrete waste in sustainable construction practices

Emerging Trends in Concrete Technology Nanotechnology applications in concrete 3D printing and robotic construction techniques Smart concrete technologies for monitoring and maintenance of structures

Reference Books

- 1 Concrete Technology , Neville, A.M. , 1995, Pearson Education .
- 2 Advanced Concrete Technology, Gambhir, M.L. , 2009, Tata McGraw-Hill .

- 3 Concrete: Microstructure, Properties, and Materials, Mehta, P.K., and Monteiro, P.J.M. , 2015, McGraw-Hill Education .
- 4 High Performance Concrete, Pierre-Claude A?tcin, 1998, Butterworth-Heinemann.

23CTM3202R - ADVANCED CONSTRUCTION TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3202R	ADVANCED CONSTRUCTION TECHNOLOGY	ACT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Gain knowledge of advanced concrete materials, including high-performance, self-compacting, fiber-reinforced, and lightweight concrete	2	PO1, PO5, PSO1
CO2	Acquire skills to assess and enhance concrete performance through testing, evaluation, and analysis.	3	PO1, PO5, PSO1
CO3	Learn quality control and assurance measures for concrete projects, including inspection and standards.	3	PO1, PO5, PSO1
CO4	Explore sustainable practices in concrete, like recycled aggregates, carbon footprint reduction, and eco-friendly admixtures	3	PO1, PO5, PSO1

Syllabus

Introduction to Advanced Concrete Technology: Overview of advanced concrete materials and technologies, Evolution of concrete technology and industry trends, Sustainable practices in concrete technology, Role of advanced concrete in construction projects

Advanced Concrete Materials: High-performance concrete: properties, mix design, and applications, Self-compacting concrete: rheology, mix design, and advantages, Fiber-reinforced concrete: types, properties, and reinforcement mechanisms, Lightweight concrete: types, properties, and applications, Self-healing concrete: principles, mechanisms, and implementation

Concrete Mix Design and Optimization: Principles of concrete mix design: factors influencing proportions and performance, Optimization techniques for strength, workability, durability, and sustainability, Incorporation of supplementary cementitious materials (SCMs) and chemical admixtures, Statistical methods and computer-aided tools for mix design optimization, Case studies and practical exercises on mix design and optimization

"Testing and Performance Evaluation: Testing methods for concrete properties: compressive strength, workability, durability, Non-destructive evaluation techniques for assessing concrete performance Analysis and interpretation of test results for performance evaluation, Quality control measures for concrete production and placement, Evaluation of long-term performance and service life prediction. Sustainable Practices and Innovation in Concrete Technology: Use of recycled aggregates in concrete production, Carbon footprint reduction strategies in concrete technology, Eco-friendly admixtures and alternative binders for sustainability, Emerging trends and innovations in sustainable concrete technology, Integration of sustainable practices into design, construction, and maintenance processes"

Reference Books

- 1 "Concrete Technology" , Neville, A.M. , 2nd, Pearson Education .
- 2 "Advanced Concrete Technology" , Gambhir, M.L. , 1st, Tata McGraw-Hill .
- 3 "Concrete: Microstructure, Properties, and Materials" , Mehta, P.K., and Monteiro, P.J.M. , 4th, McGraw-Hill Education .
- 4 High Performance Concrete, Pierre-Claude Atcin, 2nd, Butterworth-Heinemann.

23CTM3203A - SUSTAINABLE CONSTRUCTION TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3203A	SUSTAINABLE CONSTRUCTION TECHNOLOGY	SCT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the construction basics methods of Common building construction methods for conventional systems.	2	PO1, PO5, PO7, PSO2
CO2	Applying the advance technology using in modern construction methods basics of construction Modular Construction Precast concrete.	3	PO1, PO5, PO7, PSO2
CO3	Applying the sustainable construction materials technologies and project management strategies.	3	PO1, PO5, PO7, PSO2
CO4	Applying the New Construction rating system for LEED certification in construction industry	3	PO1, PO5, PO7, PSO2
CO5	Applying the sustainable in alternative construction material in building construction industry	3	PO1, PO5, PO7, PSO2

Syllabus

Construction methods for Conventional Framed Structures: Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods conventional walls and slabs; conventional framed structure with blockwork as infill walls.

Modular construction methods for repetitive works Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.

Construction materials and project management strategies Identification of cutting-edge sustainable construction materials, technologies, and project management strategies for use in the construction industry and evaluation of their potential to reduce the negative environmental impacts of construction activity.

LEED Certificate Process and Case studies. Examination Process of the current LEED certification (Leadership in Energy and Environmental Design) for the New Construction rating system, and case study analysis of highly successful recent "green construction projects" through student team assignments and presentations. Preparation for the LEED Green Associate professional licensing exam.

C&D waste management practice, case studies and student presentation,

Reference Books

- 1 Sustainable Construction: Green Building Design and Delivery, Charles J. Kibert, 2000, John Wiley & Sons.
- 2 Green Building: Principles and Practices in Residential Construction, Abe Kruger, Carl Seville, and Eugene (Gene) Ball, 1997, McGraw-Hill Education.
- 3 Green Building Illustrated, Francis D.K. Ching and Ian M. Shapiro, 2010, John Wiley & Sons.
- 4 Materials for Sustainable Sites: A Complete Guide to the Evaluation, Selection, and Use of Sustainable Construction Materials, Meg Calkins, 2016, John Wiley & Sons.

23CTM3203E - SUSTAINABLE CONSTRUCTION TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3203E	SUSTAINABLE CONSTRUCTION TECHNOLOGY	SCT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the construction basics methods of Common building construction methods for conventional systems.	2	PO1, PO5, PO7, PSO2
CO2	Applying the advance technolgy using in modern construction methods basics of construction Modular Construction Precast concrete.	3	PO1, PO5, PO7, PSO2
CO3	Appltying the sustainable construction materials technologies and project management strategies.	3	PO1, PO5, PO7, PSO2
CO4	Applying the New Construction rating system for LEED certification in construction industry	3	PO1, PO5, PO7, PSO2
CO5	Applying the sustainable in alternative construction material in building construction industry	3	PO1, PO5, PO7, PSO2

Syllabus

Construction methods for Conventional Framed Structures: Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods conventional walls and slabs; conventional framed structure with blockwork as infill walls.

Modular construction methods for repetitive works Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.

construction materials and project management strategies Identification of cutting-edge sustainable construction materials, technologies, and project management strategies for use in the construction industry and evaluation of their potential to reduce the negative environmental impacts of construction activity.

LEED Certificate Process and Case studies. Examination Process of the current LEED certification (Leadership in Energy and Environmental Design) for the New Construction rating system, and case study analysis of highly successful recent "green construction projects" through student team assignments and presentations. Preparation for the LEED Green Associate professional licensing exam.

C&D waste managementpractice, case studies and student presentaions

Reference Books

- 1 Sustainable Construction: Green Building Design and Delivery, Charles J. Kibert, 2000, John Wiley & Sons.
- 2 Green Building: Principles and Practices in Residential Construction, Abe Kruger, Carl Seville, and Eugene (Gene) Ball, 1997, McGraw-Hill Education.
- 3 Green Building Illustrated, Francis D.K. Ching and Ian M. Shapiro, 2010, John Wiley & Sons.
- 4 Materials for Sustainable Sites: A Complete Guide to the Evaluation, Selection, and Use of Sustainable Construction Materials, Meg Calkins, 2016, John Wiley & Sons.

23CTM3203R - SUSTAINABLE CONSTRUCTION TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3203R	SUSTAINABLE CONSTRUCTION TECHNOLOGY	SCT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the construction basics methods of Common building construction methods for conventional systems.	2	PO1, PO5, PO7, PSO2
CO2	Applying the advance technology using in modern construction methods basics of construction Modular Construction Precast concrete.	3	PO1, PO5, PO7, PSO2
CO3	Applying the sustainable construction materials technologies and project management strategies.	3	PO1, PO5, PO7, PSO2
CO4	Applying the New Construction rating system for LEED certification in construction industry	3	PO1, PO5, PO7, PSO2

Syllabus

Construction methods for Conventional Framed Structures: Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods conventional walls and slabs; conventional framed structure with blockwork as infill walls.

Modular construction methods for repetitive works Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.

construction materials and project management strategies Identification of cutting-edge sustainable construction materials, technologies, and project management strategies for use in the construction industry and evaluation of their potential to reduce the negative environmental impacts of construction activity.

LEED Certificate Process and Case studies. Examination Process of the current LEED certification (Leadership in Energy and Environmental Design) for the New Construction rating system, and case study analysis of highly successful recent "green construction projects" through student team assignments and presentations. Preparation for the LEED Green Associate professional licensing exam.

Reference Books

- 1 Sustainable Construction: Green Building Design and Delivery, Charles J. Kibert, 1997, John Wiley & Sons.
- 2 Green Building: Principles and Practices in Residential Construction, Abe Kruger, Carl Seville, and Eugene (Gene) Ball, 2000, McGraw-Hill Education.
- 3 Green Building Illustrated, Francis D.K. Ching and Ian M. Shapiro, 2010, John Wiley & Sons.
- 4 Materials for Sustainable Sites: A Complete Guide to the Evaluation, Selection, and Use of Sustainable Construction Materials, Meg Calkins, 2016, John Wiley & Sons.

23CTM3304A - CONSTRUCTION PLANNING & SCHEDULING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3304A	CONSTRUCTION PLANNING & SCHEDULING	CPS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Communicate effectively with project stakeholders, including owners, contractors, and suppliers, to ensure project goals are understood and met, and to resolve conflicts as they arise	2	PO1, PO5, PSO1
CO2	Apply project management principles and techniques to plan and execute construction projects, including project initiation, planning, execution, monitoring, and control	3	PO1, PO5, PSO1
CO3	Apply the construction project plans and schedules to identify potential risks and develop strategies to mitigate them	3	PO1, PO5, PSO1
CO4	Apply the project costs using a variety of methods, such as bottom-up estimating and parametric estimating, and develop cost-benefit analyses to evaluate project feasibility	3	PO1, PO5, PSO1
CO5	Apply the impact of project scope changes on construction schedules and budgets, and develop contingency plans to manage these changes	3	PO1, PO5, PSO1
CO6	Apply construction schedules using project management software, considering factors such as resource allocation, critical path analysis, and project duration Hybrid mode	3	PO1, PO5, PSO1
CO7	Apply the various construction project elements planning using different skilling methods.and techniques	3	PO1, PO5, PSO1

Syllabus

"Introduction to Construction Planning and Scheduling 1.Introduction to project management principles and their application in construction projects 2.Overview of construction planning and scheduling process 3.Types of construction schedules and their purpose 4.Project scope management and its impact on scheduling 5.Project budgeting and cost estimating techniques"

"Developing Construction Schedules 1.Work breakdown structure (WBS) and its importance in construction scheduling 2.Scheduling techniques, including Gantt charts, critical path method (CPM), and program evaluation and review technique (PERT) 3.Resource allocation and leveling 4.Schedule compression and fast-tracking 5.Schedule risk management and contingency planning"

"Managing Construction Schedules 1.Project execution and monitoring 2.Performance measurement and progress reporting 3.Schedule control techniques 4.Schedule impact analysis and change management 5.Schedule recovery and acceleration techniques"

"Advanced Topics in Construction Scheduling 1.Lean construction scheduling 2.Building information modeling (BIM) and its impact on scheduling 3.Schedule integration with other project management processes 4.Scheduling for large and complex construction projects 5.Schedule optimization techniques"

"Project Delivery Methods and Contractual Considerations 1.Overview of project delivery methods, including design-bid-build, design-build, and construction management at risk (CMAR) 2.Types of construction contracts and their implications for scheduling 3.Contractual mechanisms for managing schedule risk, including liquidated damages and time extensions 4.Schedule coordination and communication among project stakeholders 5.Ethics and professionalism in construction planning and scheduling."

Reference Books

- 1 Construction Planning and Scheduling , Jimmie W. Hinze , 2011, Pearson Education, Inc. .

- 2 Project Planning and Control with PERT and CPM , Dr. B.C. Punmia, K.K. Khandelwal, and S.P. Jain , 2010, Laxmi Publications .
- 3 Construction Project Scheduling and Control , Saleh A. Mubarak , 2015, Wiley .
- 4 Construction Planning, Equipment, and Methods, Robert L. Peurifoy, Clifford J., 2018, McGraw-Hill Education.

23CTM3304E - CONSTRUCTION PLANNING & SCHEDULING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3304E	CONSTRUCTION PLANNING & SCHEDULING	CPS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Communicate effectively with project stakeholders, including owners, contractors, and suppliers, to ensure project goals are understood and met, and to resolve conflicts as they arise	2	PO1, PO5, PSO1
CO2	Apply project management principles and techniques to plan and execute construction projects, including project initiation, planning, execution, monitoring, and control	3	PO1, PO5, PSO1
CO3	Apply the construction project plans and schedules to identify potential risks and develop strategies to mitigate them	3	PO1, PO5, PSO1
CO4	Apply the project costs using a variety of methods, such as bottom-up estimating and parametric estimating, and develop cost-benefit analyses to evaluate project feasibility	3	PO1, PO5, PSO1
CO5	Apply the impact of project scope changes on construction schedules and budgets, and develop contingency plans to manage these changes	3	PO1, PO5, PSO1
CO6	Apply construction schedules using project management software, considering factors such as resource allocation, critical path analysis, and project duration Hybrid mode	3	PO1, PO5, PSO1
CO7	Apply the various construction project elements planning using different skilling methods.and techniques	3	PO1, PO5, PSO1

Syllabus

"Introduction to Construction Planning and Scheduling 1.Introduction to project management principles and their application in construction projects 2.Overview of construction planning and scheduling process 3.Types of construction schedules and their purpose 4.Project scope management and its impact on scheduling 5.Project budgeting and cost estimating techniques"

"Developing Construction Schedules 1.Work breakdown structure (WBS) and its importance in construction scheduling 2.Scheduling techniques, including Gantt charts, critical path method (CPM), and program evaluation and review technique (PERT) 3.Resource allocation and leveling 4.Schedule compression and fast-tracking 5.Schedule risk management and contingency planning"

"Managing Construction Schedules 1.Project execution and monitoring 2.Performance measurement and progress reporting 3.Schedule control techniques 4.Schedule impact analysis and change management 5.Schedule recovery and acceleration techniques"

"Advanced Topics in Construction Scheduling 1.Lean construction scheduling 2.Building information modeling (BIM) and its impact on scheduling 3.Schedule integration with other project management processes 4.Scheduling for large and complex construction projects 5.Schedule optimization techniques"

"Project Delivery Methods and Contractual Considerations 1.Overview of project delivery methods, including design-bid-build, design-build, and construction management at risk (CMAR) 2.Types of construction contracts and their implications for scheduling 3.Contractual mechanisms for managing schedule risk, including liquidated damages and time extensions 4.Schedule coordination and communication among project stakeholders 5.Ethics and professionalism in construction planning and scheduling."

Reference Books

- 1 Construction Planning and Scheduling , Jimmie W. Hinze , 2011, Pearson Education, Inc. .

- 2 Project Planning and Control with PERT and CPM , Dr. B.C. Punmia, K.K. Khandelwal, and S.P. Jain , 2010, Laxmi Publications .
- 3 Construction Project Scheduling and Control , Saleh A. Mubarak , 2015, Wiley .
- 4 Construction Planning, Equipment, and Methods, Robert L. Peurifoy, Clifford J., 2018, McGraw-Hill Education.

23CTM3304R - CONSTRUCTION PLANNING & SCHEDULING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3304R	CONSTRUCTION PLANNING & SCHEDULING	CPS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Communicate effectively with project stakeholders, including owners, contractors, and suppliers, to ensure project goals are understood and met, and to resolve conflicts as they arise	2	PO1, PO5, PSO1
CO2	Apply project management principles and techniques to plan and execute construction projects, including project initiation, planning, execution, monitoring, and control	3	PO1, PO5, PSO1
CO3	Apply the construction project plans and schedules to identify potential risks and develop strategies to mitigate them	3	PO1, PO5, PSO1
CO4	Apply the project costs using a variety of methods, such as bottom-up estimating and parametric estimating, and develop cost-benefit analyses to evaluate project feasibility	3	PO1, PO5, PSO1
CO5	Apply the construction planning and schedules techniques various projects using tools	3	PO1, PO5, PSO1
CO6	Apply the skilling techniques on construction planning and schedules using various projects	3	PO1, PO5, PSO1

Syllabus

"Introduction to Construction Planning and Scheduling 1.Introduction to project management principles and their application in construction projects 2.Overview of construction planning and scheduling process 3.Types of construction schedules and their purpose 4.Project scope management and its impact on scheduling 5.Project budgeting and cost estimating techniques"

"Developing Construction Schedules 1.Work breakdown structure (WBS) and its importance in construction scheduling 2.Scheduling techniques, including Gantt charts, critical path method (CPM), and program evaluation and review technique (PERT) 3.Resource allocation and leveling 4.Schedule compression and fast-tracking 5.Schedule risk management and contingency planning"

"Managing Construction Schedules 1.Project execution and monitoring 2.Performance measurement and progress reporting 3.Schedule control techniques 4.Schedule impact analysis and change management 5.Schedule recovery and acceleration techniques"

Advanced Topics in Construction Scheduling 1.Lean construction scheduling 2.Building information modeling (BIM) and its impact on scheduling 3.Schedule integration with other project management processes 4.Scheduling for large and complex construction projects 5.Schedule optimization techniques" Project Delivery Methods and Contractual Considerations

Reference Books

- 1 Construction Planning and Scheduling , Jimmie W. Hinze , 2011, Pearson Education, Inc. .
- 2 Project Planning and Control with PERT and CPM , Dr. B.C. Punmia, K.K. Khandelwal, and S.P. Jain , 2010, Laxmi Publications .
- 3 Construction Project Scheduling and Control , Saleh A. Mubarak , 2015, Wiley .
- 4 Construction Planning, Equipment, and Methods, Robert L. Peurifoy, Clifford J., 2018, McGraw-Hill Education.

23CTM3405M - CONSTRUCTION CONTRACTS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3405M	CONSTRUCTION CONTRACTS	CC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Contract Law Fundamentals . Demonstrate a basic understanding of the principles of contract law as they apply to the construction industry.	1	PO1, PO5, PSO1
CO2	Analyzing Contract Documents	4	PO1, PO5, PSO1
CO3	Analyze various types of construction contract documents to identify key elements and clauses.	4	PO1, PO5, PSO1
CO4	Application of Contract Provisions	3	PO1, PO5, PSO1
CO5	Apply contract provisions to real-world construction scenarios to determine responsibilities and obligations of parties involved.	3	PO1, PO5, PSO1
CO6	Managing Contract Performance	6	PO1, PO5, PSO1
CO7	Ethical and Legal Considerations	2	PO1, PO5, PSO1

Syllabus

Overview of Contract Law

Types of Construction Contracts Different types of construction contracts: lump sum, cost-plus, time and materials, unit price.

Components of construction contracts: agreements, conditions, specifications, drawings. Standard forms of contracts (e.g., AIA, FIDIC).

Examination of important clauses: scope of work, payment terms, schedule, changes, termination.

Formation of Construction Contracts Elements of a valid contract: offer, acceptance, consideration, intention to create legal relations.

Interpretation of Contracts Principles of contract interpretation. Role of parol evidence and importance of clear drafting.

Managing Contract Performance Monitoring and controlling contract performance. Documentation and reporting requirements.

Breach of Contract Types of breaches and their consequences. Remedies for breach of contract: damages, specific performance, rescission.

Reference Books

- 1 Construction Contracts: Law and Management, John Murdoch, Will Hughes, 5th Edition (2015), Routledge.
- 2 Construction Contracting: A Practical Guide to Company Management, Richard H. Clough, Glenn A. Sears, S. Keoki Sears, Robert O. Segner, Jerald L. Rounds, 8th Edition (2015), Wiley.
- 3 The NEC4 Engineering and Construction Contract, Jon Broome, 1st Edition (2017), ICE Publishing.
- 4 The Law and Practice of Construction Contracts, David J. Hayward, 4th Edition, Wiley.

- 5 Construction Law for Design Professionals, Construction Managers, and Contractors, Daniel S. Brennan, 1st Edition, ICE Publishing.

23CTM3406M - CONSTRUCTION FORMULATION APPRAISAL (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3406M	CONSTRUCTION FORMULATION APPRAISAL	CFA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Project Formulation . Demonstrate a comprehensive understanding of the project formulation process, including identification, conceptualization, and planning.	2	PO1, PO5, PSO1
CO2	Conducting Feasibility Studies	3	PO1, PO5, PSO1
CO3	Conduct feasibility studies to assess the viability of construction projects, including technical, financial, and environmental aspects.	3	PO1, PO5, PSO1
CO4	Financial Appraisal Techniques	3	PO1, PO5, PSO1
CO5	Apply financial appraisal techniques such as Net Present Value (NPV), Internal Rate of Return (IRR), and Cost-Benefit Analysis to evaluate construction projects.	3	PO1, PO5, PSO1
CO6	Risk Assessment and Management	4	PO1, PO5, PSO1
CO7	Sustainable Project Development	5	PO1, PO5, PSO1

Syllabus

Overview of Project Formulation

Project Identification and Screening Techniques for identifying potential projects.

Technical Feasibility Assessing technical aspects of construction projects.

Financial Feasibility Analyzing financial viability through cost estimation and budget forecasting.

Environmental and Social Feasibility Conducting environmental impact assessments (EIA).

Net Present Value (NPV) Analysis Understanding NPV and its application in project appraisal.

Internal Rate of Return (IRR) and Other Methods Understanding IRR and its significance.

Risk Analysis and Mitigation Quantitative and qualitative risk analysis.

Reference Books

- 1 Construction Project Management: A Practical Guide to Field Construction Management, Richard H. Clough, Glenn A. Sears, S. Keoki Sears, Robert O. Segner, Jerald L. Rounds, 6th Edition (2015), Wiley.
- 2 Construction Project Scheduling and Control, Saleh Mubarak, 3rd Edition (2015), Wiley.
- 3 Project Feasibility Analysis: A Guide to Profitable Ventures, David E. Leland, 1st Edition (1992), Dearborn Trade Publishing.
- 4 Construction Financial Management, Steven J. Peterson and John E. Schauffelberger, 6th Edition, Penguin Random House.
- 5 Handbook of Construction Management and Organization, Joseph A. Haskins, 9th Edition, Pearson.

23CTM3507 - QUALITY AND SAFETY IN CONSTRUCTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3507	QUALITY AND SAFETY IN CONSTRUCTION	QSC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the importance of safety and quality management in construction projects	2	PO1, PO5, PO6, PSO1
CO2	Apply statistical methods and data analysis to monitor safety and quality performance, identify trends, and implement corrective actions.	3	PO1, PO5, PO6, PSO1
CO3	Identify relevant safety regulations, codes, and standards, and apply them to construction projects.	3	PO1, PO5, PO6, PSO1
CO4	Develop and implement a safety management plan that addresses potential hazards and risks associated with construction projects.	3	PO1, PO5, PO6, PSO1

Syllabus

Quality Management: Introduction, Definitions and objectives, Factors influencing construction quality , Responsibilities and authority, Quality plan, Quality Management Guidelines, Quality circles. Quality Systems: Introduction , Quality system standard, ISO 9000 family of standards, Requirements, Preparing Quality System Documents, Quality related training, Implementing a Quality system, Third party Certification.

Quality Planning: Quality Policy, Objectives and methods in Construction industry , Consumers satisfaction, Ergonomics , Time of Completion , Statistical tolerance, Taguchis concept of quality, Codes and Standards, Documents, Contract and construction programming, Inspection procedures , Processes and products, Total QA or QC programmed and cost implication.

Quality Assurance And Quality Improvement Techniques: Objectives, Regularity agent, owner, design, contract and construction oriented objectives, methods, Techniques and needs of QAor QC, Different aspects of quality, Appraisals, Factors influencing construction quality, Critical, major failure aspects and failure mode analysis, Stability methods and tools, optimum design, Reliability testing, Reliability coefficient and reliability prediction , Life cycle costing, Value engineering and value analysis. Quality Improvement Tools and Techniques.

Safety Management Systems: Fundamental of safety management, construction safety, safety in scaffolding and working platform, welding and handling, excavation work, concreting and cementing work. Building construction, TAC and NBC rules, High rise building. Evolution of modern safety concept, Safety policy , Safety Organization. Safety survey, safety inspection, safety sampling, Safety Audit. Concept of an accident, Reportable and non reportable accidents, unsafe act and condition principles of accident prevention, Overall accident investigation process. Risk management

Reference Books

- 1 A Comprehensive Guide to Registration, Audit Guidelines and Successful Certification., Hutchins.G, 1994, Viva Books Pvt. Ltd..
- 2 The Management of Quality in Construction, John L. Ashford, 1989, E and F.N.Spon..
- 3 Quality Planning and Analysis., Juran Frank, J.M. and Gryna, F.M. , 2001, McGraw Hill.
- 4 Quality Management in Construction, Tim Howarth & Paul Sherratt, 2015, Spon Press.

23CTM3508 - GREEN BUILDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CTM3508	GREEN BUILDING	GB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles of green building design and sustainability.	1	PO1, PO5, PO6, PSO1
CO2	Analyze the environmental impact of building materials and construction practices.	2	PO1, PO5, PO6, PSO1
CO3	Apply energy-efficient strategies and technologies in green building projects.	3	PO1, PO5, PO6, PSO1
CO4	Evaluate the performance of green buildings using relevant metrics and standards.	3	PO1, PO5, PO6, PSO1

Syllabus

Introduction to Green Buildings - Definition and significance of green buildings - History and evolution of sustainable architecture - Overview of global green building standards (LEED, BREEAM, etc.) - The triple bottom line: People, Planet, Profit

Sustainable Site Planning - Site selection and analysis - Sustainable site development strategies - Erosion and sediment control - Urban heat island effect and mitigation techniques

Energy Efficiency in Buildings - Passive design strategies (orientation, daylighting, natural ventilation) - Energy-efficient building systems (HVAC, lighting) - Renewable energy integration (solar, wind, geothermal) - Building energy modeling and simulation

Water Efficiency and Conservation - Water-efficient fixtures and appliances - Rainwater harvesting and greywater reuse - Landscape water management - Stormwater management systems

Materials and Resources - Sustainable material selection (recycled, locally sourced, low-emission) - Life cycle assessment of building materials - Construction waste management - Indoor environmental quality and healthy materials

Reference Books

- 1 Green Building: Principles and Practices, J. Bradley Van Buren, Jerilyn Van Buren, 2012, Delmar Cengage Learning.
- 2 Sustainable Construction: Green Building Design and Delivery, Charles J. Kibert, 2016, John Wiley & Sons.
- 3 Green Building Illustrated, Francis D. K. Ching & Ian M. Shapiro, 2014, Wiley.
- 4 The Green Building Revolution, Jerry Yudelson, 2007, New Society Publishers.

23DCS3101A - 4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3101A	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	4GW	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply 4G architecture, including the Evolved Packet System (EPS) and LTE integration with existing 2G/3G networks, to analyze and evaluate EPS reference points, interfaces, and E-UTRAN components.	3	PO1, PO2
CO2	Implement multiuser modulations and the principles of Orthogonal Frequency Division Multiplexing (OFDM), to analyze and evaluate LTE transceiver operations, channel estimation techniques, and issues related to OFDM .	3	PO1, PO3
CO3	Extrapolate Multiple-Input Multiple-Output (MIMO) systems by analyzing and evaluating MIMO channel capacity, SVD and eigenmodes of MIMO channels, and the principles of MIMO spatial multiplexing (BLAST).	3	PO1, PO3
CO4	Demonstrate their understanding of Ultra-Wideband (UWB) technology by analyzing and evaluating its features, applications, and capacity, particularly in indoor environments.	4	PO1, PO3
CO5	Analyze and interpret the concepts and applications of multi-antenna operations and MIMO systems, as well as multicarrier and multi-access systems including OFDMA, MC-CDMA, MIMO-OFDM, and multiband OFDM UWB.	4	PO1, PO3
CO6	Analyze and differentiate between various multi-access systems, including OFDMA, MC-CDMA, MIMO-OFDM, and multiband OFDM UWB.	4	PO1, PO3
CO7	Analyze and evaluate the design and performance of MCCDMA, MIMO-OFDM, and multiband OFDM UWB systems.	4	PO1, PO3

Syllabus

4G architecture and Spread Spectrum Introduction To 4G: Architecture of an Evolved Packet System, LTE Integration with Existing 2G-3G Network, EPS Reference Points and Interfaces, E-UTRAN Interfaces, User Equipment, LTE UE Category, QoS in LTE, LTE Security, LTE Mobility, 4G Architecture and Call Process with 3GPP Standards, Radio Frequency Aspects, Orthogonal Frequency Division Multiplexing (OFDM), Single-Carrier Frequency Division Multiple Access (SC-FDMA),

Multi carrier Communication Systems Introduction to multiuser modulations, Principal of OFDM (Block Diagram), Cyclic Prefix, Introduction to long term evolution (LTE), Transceivers, Channel estimation, OFDM issues, Peak to Average Power ratio (PAPR), Carrier frequency Offset (CFO) and carrier timing offset, Synchronization, PAPR reduction techniques

MIMO Systems Introduction to MIMO, MIMO channel Capacity, SVD And Eigenmodes of MIMO channels, MIMO Spatial Multiplexing BLAST, MIMO Diversity, Alamouti, Orthogonal space time block code (OSTBC), maximum ratio transmission (MRT)

UWB Introduction to features of UWB technology, applications, UWB indoor channel, UWB Capacity, Pulsed UWB, Pulse shape, Modulation and Multiple access of Pulse UWB, Time Hopping, DSUWB, Challenges for Pulsed UWB systems, Multiband UWB, Modulation of Pulsed Multiband UWB

Multi-Antenna Operation And MIMO, Multicarrier and Multi-access Systems- OFDMA, MCCDMA, MIMO-OFDM, Multiband OFDM UWB.

Multi-access Systems- OFDMA, MCCDMA, MIMO-OFDM, Multiband OFDM UWB.

Pulsed UWB systems- Multiband UWB-Modulation of Pulsed Multiband UWB

Reference Books

- 1 Wireless Communication Systems , KE-Lin DU and M.N. Swamy. , 2 , Springer .
- 2 Fundamentals of Wireless communication , David TSE and Promod Viswanadhan. , 2 , Cambridge university press .
- 3 Introduction to Mobile Network Engineering , Alexander Kukushkin , 1 , Wiley .
- 4 "LTE and the Evolution to 4G Wireless Design and Measurement Challenges " , Moray Rumney , 2, Wiley.
- 5 Wireless Communications: Principles and Practice, Theodore S. Rappaport , 2, Pearson.

23DCS3101E - 4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3101E	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	4GW	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply 4G architecture, including the Evolved Packet System (EPS) and LTE integration with existing 2G/3G networks, to analyze and evaluate EPS reference points, interfaces, and E-UTRAN components.	3	PO1, PO2
CO2	Implement multiuser modulations and the principles of Orthogonal Frequency Division Multiplexing (OFDM), to analyze and evaluate LTE transceiver operations, channel estimation techniques, and issues related to OFDM .	3	PO1, PO3
CO3	Extrapolate Multiple-Input Multiple-Output (MIMO) systems by analyzing and evaluating MIMO channel capacity, SVD and eigenmodes of MIMO channels, and the principles of MIMO spatial multiplexing (BLAST).	3	PO1, PO3
CO4	Demonstrate their understanding of Ultra-Wideband (UWB) technology by analyzing and evaluating its features, applications, and capacity, particularly in indoor environments.	4	PO1, PO3
CO5	Analyze and interpret the concepts and applications of multi-antenna operations and MIMO systems, as well as multicarrier and multi-access systems including OFDMA, MC-CDMA, MIMO-OFDM, and multiband OFDM UWB.	4	PO1, PO3
CO6	Analyze and differentiate between various multi-access systems, including OFDMA, MC-CDMA, MIMO-OFDM, and multiband OFDM UWB.	4	PO1, PO3
CO7	Analyze and evaluate the design and performance of MCCDMA, MIMO-OFDM, and multiband OFDM UWB systems.	4	PO1, PO3

Syllabus

4G architecture and Spread Spectrum Introduction To 4G: Architecture of an Evolved Packet System, LTE Integration with Existing 2G-3G Network, EPS Reference Points and Interfaces, E-UTRAN Interfaces, User Equipment, LTE UE Category, QoS in LTE, LTE Security, LTE Mobility, 4G Architecture and Call Process with 3GPP Standards, Radio Frequency Aspects, Orthogonal Frequency Division Multiplexing (OFDM), Single-Carrier Frequency Division Multiple Access (SC-FDMA),

Implement multiuser modulations and the principles of Orthogonal Frequency Division Multiplexing (OFDM), including its block diagram and cyclic prefix, to analyze and evaluate LTE transceiver operations, channel estimation techniques, and issues related to OFDM such as Peak to Average Power Ratio (PAPR), Carrier Frequency Offset (CFO)

Extrapolate Multiple-Input Multiple-Output (MIMO) systems by analyzing and evaluating MIMO channel capacity, Singular Value Decomposition (SVD) and eigenmodes of MIMO channels, and the principles of MIMO spatial multiplexing (BLAST).

Demonstrate their understanding of Ultra-Wideband (UWB) technology by analyzing and evaluating its features, applications, and capacity, particularly in indoor environments. They will assess the principles of pulsed UWB, including pulse shape, modulation, and multiple access techniques, as well as time hopping and DS-UWB.

Multi-Antenna Operation And MIMO, Multicarrier and Multi-access Systems- OFDMA, MCCDMA, MIMO-OFDM, Multiband OFDM UWB.

Multi-Antenna Operation And MIMO,

MIMO-OFDM, Multiband OFDM UWB.

Reference Books

- 1 Wireless Communication Systems , KE-Lin DU and M.N. Swamy. , 2 , Springer .
- 2 Fundamentals of Wireless communication , David TSE and Promod Viswanadhan. , 2 , Cambridge university press .
- 3 Introduction to Mobile Network Engineering , Alexander Kukushkin , 1, Wiley .
- 4 "LTE and the Evolution to 4G Wireless Design and Measurement Challenges " , Moray Rumney , 2 , Wiley.
- 5 Wireless Communications: Principles and Practice, Theodore S. Rappaport, 2, Pearson.

23DCS3101R - 4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3101R	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	4GW	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply 4G architecture, including the Evolved Packet System (EPS) and LTE integration with existing 2G/3G networks, to analyze and evaluate EPS reference points, interfaces, and E-UTRAN components. Students will categorize User Equipment (UE) in LTE, examine Quality of Service (QoS) parameters, assess LTE security measures, and analyze mobility management procedures. They will evaluate the 4G architecture and call processing in line with 3GPP standards	3	PO1, PO2
CO2	Implement multiuser modulations and the principles of Orthogonal Frequency Division Multiplexing (OFDM), including its block diagram and cyclic prefix, to analyze and evaluate LTE transceiver operations, channel estimation techniques, and issues related to OFDM such as Peak to Average Power Ratio (PAPR), Carrier Frequency Offset (CFO)	3	PO1, PO3
CO3	Extrapolate Multiple-Input Multiple-Output (MIMO) systems by analyzing and evaluating MIMO channel capacity, Singular Value Decomposition (SVD) and eigenmodes of MIMO channels, and the principles of MIMO spatial multiplexing (BLAST).	3	PO1, PO3
CO4	Demonstrate their understanding of Ultra-Wideband (UWB) technology by analyzing and evaluating its features, applications, and capacity, particularly in indoor environments. They will assess the principles of pulsed UWB, including pulse shape, modulation, and multiple access techniques, as well as time hopping and DS-UWB.	4	PO1, PO3
CO5	Analyze and interpret the concepts and applications of multi-antenna operations and MIMO systems, as well as multicarrier and multi-access systems including OFDMA, MC-CDMA, MIMO-OFDM, and multiband OFDM UWB.	4	PO1, PO3
CO6	Analyze and differentiate between various multi-access systems, including OFDMA, MC-CDMA, MIMO-OFDM, and multiband OFDM UWB.	4	PO1, PO3

Syllabus

4G architecture and Spread Spectrum Introduction To 4G: Architecture of an Evolved Packet System, LTE Integration with Existing 2G-3G Network, EPS Reference Points and Interfaces, E-UTRAN Interfaces, User Equipment, LTE UE Category, QoS in LTE, LTE Security, LTE Mobility, 4G Architecture and Call Process with 3GPP Standards, Radio Frequency Aspects, Orthogonal Frequency Division Multiplexing (OFDM), Single-Carrier Frequency Division Multiple Access (SC-FDMA),

Multi carrier Communication Systems Introduction to multiuser modulations, Principal of OFDM (Block Diagram), Cyclic Prefix, Introduction to long term evolution (LTE), Transceivers, Channel estimation, OFDM issues, Peak to Average Power ratio (PAPR), Carrier frequency Offset (CFO) and carrier timing offset, Synchronization, PAPR reduction techniques

MIMO Systems Introduction to MIMO, MIMO channel Capacity, SVD And Eigenmodes of MIMO channels, MIMO Spatial Multiplexing BLAST, MIMO Diversity, Alamouti, Orthogonal space time block code (OSTBC), maximum ratio transmission (MRT)

UWB Introduction to features of UWB technology, applications, UWB indoor channel, UWB Capacity, Pulsed UWB, Pulse shape, Modulation and Multiple access of Pulse UWB, Time Hopping, DSUWB, Challenges for Pulsed UWB systems, Multiband UWB, Modulation of Pulsed Multiband UWB

Multi-Antenna Operation And MIMO, Multicarrier and Multi-access Systems

OFDMA, MCCDMA, MIMO-OFDM, Multiband OFDM UWB.

Reference Books

- 1 Wireless Communication Systems , KE-Lin DU and M.N. Swamy. , 2, Springer .
- 2 Fundamentals of Wireless communication , David TSE and Promod Viswanadhan. , 2, Cambridge university press .
- 3 Introduction to Mobile Network Engineering , Alexander Kukushkin , 1, Wiley .
- 4 "LTE and the Evolution to 4G Wireless Design and Measurement Challenges " , Moray Rumney , 2, Wiley.
- 5 Wireless Communications: Principles and Practice, Theodore S. Rappaport, 2, Pearson.

23DCS3202A - MODERN SATELLITE COMMUNICATION SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3202A	MODERN SATELLITE COMMUNICATION SYSTEMS	MSCS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to differentiate between types of satellite orbits (LEO, MEO, GEO) and their applications.	2	PO1
CO2	To identify the functions of major satellite subsystems and distinguish them from various types of payloads	3	PO2, PO3
CO3	To design satellite links considering factors like noise, signal strength, and impairments like rain attenuation	3	PO2, PO3
CO4	Interpret working of satellite communications in 5G ecosystem	3	PO1, PO3
CO5	Analyze and visualize space segments using simulation tool.	5	PO1, PO2, PO3

Syllabus

Basic Concepts of Satellite Communications Basic Concepts of Satellite Communications, Frequency Allocations for Satellite Services, Applications. Types of satellites orbits, LEO, MEO and GEO satellites, Satellite in the context of India. Orbital Mechanics: Look Angle determination, Satellite Subsystems.

Satellite Sub-Systems and Payloads Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas and onboard computer and testing equipment and satellite payloads

Satellite Link Design Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design of Down Links, Up Link Design, Design of Satellite Links for Specified C/N, System Design Examples-DOMSAT, INSAT, INTELSAT and INMARSAT. Satellite- based personal communication. Satellite RF impairments: Rain attenuation, Space weather effects on Satellite communications, Atmospheric drag.

Role of satellite communications in 5G ecosystem Satellites and previous cellular generations, requirements of satellites in 5G, recent advances in 5G satellite communications, Satellite use cases and scenarios for 5G, Selection methodology, Selected satellite use cases for eMBB, Scenarios for selected satellite use case 1: edge delivery and offload for multimedia content and MEC VNF software

Satellite orbit determination using MATLAB, satellite link budget analysis using software tools, satellite path loss

Reference Books

- 1 Satellite Communications, Timothy Pratt, Charles Bostian and Jeremy Allnutt, Second Edition, 2003, Wiley Publications.
- 2 Satellite Communications, L.Pritchard, Robert A Nelson and Henri G.Suyderhoud, Second Edition, 2003, Pearson Publications.
- 3 Satellite Communications Payload and System, Teresa M Braun, First edition 2021, Wiley-IEEE Press.
- 4 Satellite Communications Systems: Systems, Techniques and Technology,, Gerard Maral, Fifth Edition, 2014, Wiley Publications.
- 5 Introduction to Satellite Communication, Bruce R. Elbert, First Edition, 2008, Artech House.

23DCS3202E - MODERN SATELLITE COMMUNICATION SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3202E	MODERN SATELLITE COMMUNICATION SYSTEMS	MSCS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to differentiate between types of satellite orbits (LEO, MEO, GEO) and their applications.	2	PO1
CO2	To identify the functions of major satellite subsystems and distinguish them from various types of payloads	3	PO2, PO3
CO3	To design satellite links considering factors like noise, signal strength, and impairments like rain attenuation	3	PO2, PO3
CO4	To analyze use cases for integrating satellites into the 5G ecosystem	3	PO1, PO3
CO5	Analyze and visualize space segments using simulation tool.	5	PO1, PO2, PO3

Syllabus

Basic Concepts of Satellite Communications Basic Concepts of Satellite Communications, Frequency Allocations for Satellite Services, Applications. Types of satellites orbits, LEO, MEO and GEO satellites, Satellite in the context of India. Orbital Mechanics: Look Angle determination, Satellite Subsystems.

Satellite Sub-Systems and Payloads Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas and onboard computer and testing equipment and satellite payloads.

Satellite Link Design Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design of Down Links, Up Link Design, Design of Satellite Links for Specified C/N, System Design Examples-DOMSAT, INSAT, INTELSAT and INMARSAT. Satellite- based personal communication. Satellite RF impairments: Rain attenuation, Space weather effects on Satellite communications, Atmospheric drag.

Role of satellite communications in 5G ecosystem Satellites and previous cellular generations, requirements of satellites in 5G, recent advances in 5G satellite communications, Satellite use cases and scenarios for 5G, Selection methodology, Selected satellite use cases for eMBB, Scenarios for selected satellite use case 1: edge delivery and offload for multimedia content and MEC VNF software

Satellite orbit determination using MATLAB, satellite link budget analysis using software tools, satellite path loss

Reference Books

- 1 Satellite Communications, Timothy Pratt, Charles Bostian and Jeremy Allnutt, Second Edition, 2003, Wiley Publications.
- 2 Satellite Communications, L.Pritchard, Robert A Nelson and Henri G.Suyderhoud, Second Edition, 2003, Pearson Publications.
- 3 Satellite Communications Systems: Systems, Techniques and Technology, Michel Bousquet Gerard Maral, Fifth Edition, 2014, Wiley Publications.
- 4 Satellite Communications Payload and System, Teresa M. Braun, First Edition, 2012, Wiley - IEEE.
- 5 Introduction to Satellite Communication, Bruce R. Elber, First Edition, 2008, Artech House.

23DCS3202R - MODERN SATELLITE COMMUNICATION SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3202R	MODERN SATELLITE COMMUNICATION SYSTEMS	MSCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to differentiate between types of satellite orbits (LEO, MEO, GEO) and their applications.	2	PO1
CO2	To identify the functions of major satellite subsystems and distinguish them from various types of payloads	3	PO2, PO3
CO3	To design satellite links considering factors like noise, signal strength, and impairments like rain attenuation	3	PO2, PO3
CO4	To analyze use cases for integrating satellites into the 5G ecosystem	3	PO1, PO3
CO5	Analyze and visualize space segments using simulation tool.	4	PO1, PO2, PO3

Syllabus

Basic Concepts of Satellite Communications Basic Concepts of Satellite Communications, Frequency Allocations for Satellite Services, Applications. Types of satellites orbits, LEO, MEO and GEO satellites, Satellite in the context of India. Orbital Mechanics: Look Angle determination, Satellite Subsystems.

Satellite Sub-Systems and Payloads Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas and onboard computer and testing equipment and satellite payloads

Satellite Link Design Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design of Down Links, Up Link Design, Design of Satellite Links for Specified C/N, System Design Examples-DOMSAT, INSAT, INTELSAT and INMARSAT. Satellite- based personal communication. Satellite RF impairments: Rain attenuation, Space weather effects on Satellite communications, Atmospheric drag.

Role of satellite communications in 5G ecosystem Satellites and previous cellular generations, requirements of satellites in 5G, recent advances in 5G satellite communications, Satellite use cases and scenarios for 5G, Selection methodology, Selected satellite use cases for eMBB, Scenarios for selected satellite use case 1: edge delivery and offload for multimedia content and MEC VNF software

Satellite orbit determination using MATLAB, satellite link budget analysis using software tools, satellite path loss

Reference Books

- 1 Satellite Communications, Timothy Pratt, Charles Bostian and Jeremy Allnutt, Second Edition, 2003, Wiley Publications.
- 2 Satellite Communications, L.Pritchard, Robert A Nelson and Henri G.Suyderhoud, Second Edition, 2003, Pearson Publications.
- 3 Satellite Communications Payload and System, Teresa M. Braun, First Edition, 2014, Wiley - IEEE.
- 4 Satellite Communications Systems: Systems, Techniques and Technology, Michel Bousquet Gerard Maral, Fifth Edition, 2014, Wiley Publications.
- 5 Introduction to Satellite Communication, Bruce R. Elbert, First Edition, 2008 Artech House, Artech House.

23DCS3303A - 5G WIRELESS TECHNOLOGIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3303A	5G WIRELESS TECHNOLOGIES	5GWT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their understanding of cellular network evolution to analyze the architecture, functionalities, and use cases of 5G mobile systems.	3	PO1, PO2
CO2	Apply their knowledge of radio interface design principles to analyze channel sounding, transport channel processing, and physical layer control signaling in 5G mobile systems.	3	PO1, PO2
CO3	Analyze and evaluate multi-antenna transmission techniques, beam management strategies, and millimeter wave characteristics relevant to 5G mobile systems.	4	PO1, PO2
CO4	Analyze 5G core components, protocols, and security mechanisms in the context of Quality-of-Service (QoS) management.	4	PO1, PO2
CO5	Analyze and assess the application of private wireless network architectures, using case studies to evaluate their effectiveness in real-world industrial settings.	4	PO1, PO2
CO6	Analyze the 3GPP standards 5G architecture and call process using 5G testbed.	4	PO2, PO3, PO5
CO7	Design and Analyze the QoS requirements with respective use-case scenario to enable information exchange between devices with hardware realization.	5	PO2, PO3, PO5

Syllabus

Introduction to 5G-NR: Evolution of Cellular system architecture from 2G to 5G, Frequency bands for new radio, RAN architectures, frame structure, 5G Core architecture, Pillars of 5G, 5G use cases - eMMB, mMTC, URLLC, Spectrum of 5G mobile systems, Carrier Aggregation, Bandwidth parts, Service Based Architecture, Network Slicing - Management and orchestration, Network Slice selection framework.

Radio-Interface Architecture: Overall System Architecture, Quality-of-Service Handling, Radio Protocol Architecture, User-Plane Protocols, Control-Plane Protocols. Channel Sounding: Downlink Channel Sounding, CSI-RS, Downlink Measurements and Reporting, Uplink Channel Sounding-SRS. Transport Channel Processing: Channel Coding, Rate Matching and Physical-Layer Hybrid-ARQ Functionality, Scrambling, Modulation, Layer Mapping, Uplink DFT Precoding, Multi-Antenna uplink and downlink Precoding, Resource Mapping, Downlink Reserved Resources, Reference Signals, Physical Layer Control Signaling: Downlink, Uplink, Initial Access: Cell Search and Random-Access concepts.

Multi-Antenna Transmission: Downlink Multi-Antenna Precoding, Type I CSI, Type II CSI, NR Uplink Multiantenna Precoding, Codebook-Based Transmission, Non-Codebook-Based Precoding. Beam Management: Initial Beam Establishment, Beam Adjustment, Downlink Transmitter-Side Beam Adjustment, Downlink Receiver-Side Beam Adjustment, Uplink Beam Adjustment, Beam Indication and TCI, Beam Recovery, Beam-Failure Detection, New-Candidate-Beam Identification, Device Recovery Request and Network Response. Millimeter wave characteristics, Millimeter wave link budget, Transceiver Architecture, Millimeter wave antennas- Path Loss, Antenna directivity and Antenna beam width.

5G Core - Components, Dual Connectivity architecture, 5G core Protocols - NGAP, HTTP, TLS, PFCP, GTP-U, SCTP, 5G NAS. QoS - Flow based QoS framework, Signaling of QoS, Reflective QoS, QoS parameters and characteristics. Security - Security requirements and security services of the 5G system, Network access security, Network domain security, User domain security, Lawful intercept.

Architectures for Private Wireless, Case Studies - Uncovering 5G potential for real-time control in manufacturing, Industrial-grade Private Wireless.

Reference Books

- 1 5G NR: The Next Generation Wireless Access Technology. , Dahlman, E., Parkvall, S., Skold, J. , 2018, Elsevier Science .
- 2 5G Core Networks: Powering Digitalization. , Rommer, S., Hedman, P., Olsson, M., Frid, L., Sultana, S., Mulligan, C. , 2019, Elsevier Science .
- 3 5G/5G-Advanced The New Generation Wireless Access Technology , Erik Dahlman, Stefan Parkvall, Johan Skold , 2023, Elsevier Science .
- 4 Fundamentals of 5G Mobile Networks , Jonathan Rodriguez , 2015, Wiley.
- 5 Multiple Access Techniques for 5G Wireless Networks and Beyond , Mojtaba Vaezi, Zhiguo Ding, Vincent Poor , 2018, Springer International Publishing .

23DCS3303E - 5G WIRELESS TECHNOLOGIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3303E	5G WIRELESS TECHNOLOGIES	5GWT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their understanding of cellular network evolution to analyze the architecture, functionalities, and use cases of 5G mobile systems.	3	PO1, PO2
CO2	Apply their knowledge of radio interface design principles to analyze channel sounding, transport channel processing, and physical layer control signaling in 5G mobile systems.	3	PO1, PO2
CO3	Analyze and evaluate multi-antenna transmission techniques, beam management strategies, and millimeter wave characteristics relevant to 5G mobile systems.	4	PO1, PO2
CO4	Analyze 5G core components, protocols, and security mechanisms in the context of Quality-of-Service (QoS) management.	4	PO1, PO2
CO5	Analyze and assess the application of private wireless network architectures, using case studies to evaluate their effectiveness in real-world industrial settings.	4	PO1, PO2
CO6	Analyze the 3GPP standards 5G architecture and call process using 5G testbed.	4	PO2, PO3, PO5
CO7	Design and Analyze the QoS requirements with respective use-case scenario to enable information exchange between devices with hardware realization.	5	PO2, PO3, PO5

Syllabus

Introduction to 5G-NR: Evolution of Cellular system architecture from 2G to 5G, Frequency bands for new radio, RAN architectures, frame structure, 5G Core architecture, Pillars of 5G, 5G use cases - eMMB, mMTC, URLLC, Spectrum of 5G mobile systems, Carrier Aggregation, Bandwidth parts, Service Based Architecture, Network Slicing - Management and orchestration, Network Slice selection framework.

Radio-Interface Architecture: Overall System Architecture, Quality-of-Service Handling, Radio Protocol Architecture, User-Plane Protocols, Control-Plane Protocols. Channel Sounding: Downlink Channel Sounding, CSI-RS, Downlink Measurements and Reporting, Uplink Channel Sounding-SRS. Transport Channel Processing: Channel Coding, Rate Matching and Physical-Layer Hybrid-ARQ Functionality, Scrambling, Modulation, Layer Mapping, Uplink DFT Precoding, Multi-Antenna uplink and downlink Precoding, Resource Mapping, Downlink Reserved Resources, Reference Signals, Physical Layer Control Signaling: Downlink, Uplink, Initial Access: Cell Search and Random-Access concepts.

Multi-Antenna Transmission: Downlink Multi-Antenna Precoding, Type I CSI, Type II CSI, NR Uplink Multiantenna Precoding, Codebook-Based Transmission, Non-Codebook-Based Precoding. Beam Management: Initial Beam Establishment, Beam Adjustment, Downlink Transmitter-Side Beam Adjustment, Downlink Receiver-Side Beam Adjustment, Uplink Beam Adjustment, Beam Indication and TCI, Beam Recovery, Beam-Failure Detection, New-Candidate-Beam Identification, Device Recovery Request and Network Response. Millimeter wave characteristics, Millimeter wave link budget, Transceiver Architecture, Millimeter wave antennas- Path Loss, Antenna directivity and Antenna beam width.

5G Core - Components, Dual Connectivity architecture, 5G core Protocols - NGAP, HTTP, TLS, PFCP, GTP-U, SCTP, 5G NAS. QoS - Flow based QoS framework, Signaling of QoS, Reflective QoS, QoS parameters and characteristics. Security - Security requirements and security services of the 5G system, Network access security, Network domain security, User domain security, Lawful intercept.

Architectures for Private Wireless, Case Studies - Uncovering 5G potential for real-time control in manufacturing, Industrial-grade Private Wireless.

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- 1 5G NR: The Next Generation Wireless Access Technology. , Dahlman, E., Parkvall, S., Skold, J. , 2018, Elsevier Science .
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- 4 Fundamentals of 5G Mobile Networks , Jonathan Rodriguez , 2015, Wiley.
- 5 Multiple Access Techniques for 5G Wireless Networks and Beyond , Mojtaba Vaezi, Zhiguo Ding, Vincent Poor , 2018, Springer International Publishing .

23DCS3303R - 5G WIRELESS TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3303R	5G WIRELESS TECHNOLOGIES	5GWT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their understanding of cellular network evolution to analyze the architecture, functionalities, and use cases of 5G mobile systems.	3	PO1, PO2
CO2	Apply their knowledge of radio interface design principles to analyze channel sounding, transport channel processing, and physical layer control signaling in 5G mobile systems.	3	PO1, PO2
CO3	Analyze and evaluate multi-antenna transmission techniques, beam management strategies, and millimeter wave characteristics relevant to 5G mobile systems.	4	PO1, PO2
CO4	Analyze 5G core components, protocols, and security mechanisms in the context of Quality-of-Service (QoS) management.	4	PO1, PO2
CO5	Analyze the 3GPP standards 5G architecture and call process using 5G testbed.	4	PO2, PO3, PO5
CO6	Design and Analyze the QoS requirements with respective use-case scenario to enable information exchange between devices with hardware realization.	5	PO2, PO3, PO5

Syllabus

Introduction to 5G-NR: Evolution of Cellular system architecture from 2G to 5G, Frequency bands for new radio, RAN architectures, frame structure, 5G Core architecture, Pillars of 5G, 5G use cases - eMMB, mMTC, URLLC, Spectrum of 5G mobile systems, Carrier Aggregation, Bandwidth parts, Service Based Architecture, Network Slicing - Management and orchestration, Network Slice selection framework.

Radio-Interface Architecture: Overall System Architecture, Quality-of-Service Handling, Radio Protocol Architecture, User-Plane Protocols, Control-Plane Protocols. Channel Sounding: Downlink Channel Sounding, CSI-RS, Downlink Measurements and Reporting, Uplink Channel Sounding-SRS. Transport Channel Processing: Channel Coding, Rate Matching and Physical-Layer Hybrid-ARQ Functionality, Scrambling, Modulation, Layer Mapping, Uplink DFT Precoding, Multi-Antenna uplink and downlink Precoding, Resource Mapping, Downlink Reserved Resources, Reference Signals, Physical Layer Control Signaling: Downlink, Uplink, Initial Access: Cell Search and Random-Access concepts.

Multi-Antenna Transmission: Downlink Multi-Antenna Precoding, Type I CSI, Type II CSI, NR Uplink Multiantenna Precoding, Codebook-Based Transmission, Non-Codebook-Based Precoding. Beam Management: Initial Beam Establishment, Beam Adjustment, Downlink Transmitter-Side Beam Adjustment, Downlink Receiver-Side Beam Adjustment, Uplink Beam Adjustment, Beam Indication and TCI, Beam Recovery, Beam-Failure Detection, New-Candidate-Beam Identification, Device Recovery Request and Network Response. Millimeter wave characteristics, Millimeter wave link budget, Transceiver Architecture, Millimeter wave antennas- Path Loss, Antenna directivity and Antenna beam width.

5G Core - Components, Dual Connectivity architecture, 5G core Protocols - NGAP, HTTP, TLS, PFCP, GTP-U, SCTP, 5G NAS. QoS - Flow based QoS framework, Signaling of QoS, Reflective QoS, QoS parameters and characteristics. Security - Security requirements and security services of the 5G system, Network access security, Network domain security, User domain security, Lawful intercept.

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- 2 5G Core Networks: Powering Digitalization., Rommer, S., Hedman, P., Olsson, M., Frid, L., Sultana, S., Mulligan, C., 2019, Elsevier Science.

- 3 5G/5G-Advanced The New Generation Wireless Access Technology, Erik Dahlman, Stefan Parkvall, Johan Skold, 2023, Elsevier Science.
- 4 Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, 2015, Wiley.
- 5 Multiple Access Techniques for 5G Wireless Networks and Beyond, Mojtaba Vaezi, Zhiguo Ding, Vincent Poor, 2018, Springer International Publishing.

23DCS3404M - OPTICAL WIRELESS COMMUNICATIONS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3404M	OPTICAL WIRELESS COMMUNICATIONS	PWC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the behavior of wireless optical channel and its scattering parameters.	3	PO1, PO2
CO2	Apply various channel models for estimation of losses in optical wireless communication.	3	PO1, PO2
CO3	Analyze and interception of modulation techniques utilized in VLC.	4	PO1, PO2
CO4	Analyze the application of optical source detectors	4	PO1, PO2

Syllabus

Basic concept of Optical wireless communication, Optical Wireless channels, Light sources and spectra, Modulators, Characteristics of Atmospheric transmission and limitations, Effect of Rain, Fog, and Mist, Scintillation, Optical Path Length and Fermat's Principle, The Etendue or Lagrange Invariant, Edge Ray Principle.

Indoor Optical Wireless Communication, LOS Propagation Model, Non-LOS Propagation Model, Ceiling Bounce Model, Outdoor Channel, Channels: Atmospheric Channel Loss, Fog and Visibility, Beam Divergence, Optical and Window Loss, Pointing Loss, The Atmospheric Turbulence Models: Log-Normal Turbulence Model, Spatial Coherence in Weak Turbulence, The Gamma-Gamma Turbulence Model, The Negative Exponential Turbulence, Atmospheric Effects on optical wireless channel.

Bidirectional VLC, VLC System Description, VLC System Model, Channel Delay Spread, Holographic Diffuser, SNR Analysis, VCL system Implementations: On-Off Keying (OOK) with a Forward Error Correction, Bit Angle Modulation (BAM), Pulse Modulation Schemes, PWM with Discrete Multitone Modulation (DMT), Multilevel PWM-PPM, PWM with NRZOOK, Multiple-Input, Multiple-Output (MIMO) VLC, Orthogonal Frequency Division Multiplexing (OFDM), Channel Estimation, Equalisations, and Synchronisation

Optical Communications Basics, Optical Transmitters, Optical Receivers, Optical Amplifiers, Optical Processing Components and Modules, Principles of Coherent Optical Detection. Optical Hybrids, Coherent Optical Balanced Detectors, Direct Digital Synthesizer (DDS). Multi-rate DSP and Resampling, Automatic Gain Control (AGC)

Reference Books

- 1 Optical Wireless Communications: System and Channel Modelling with MATLAB, Rajbhandari, S., Ghassemlooy, Z., Popoola, W. , 2nd, CRC Press.
- 2 Advanced Optical and Wireless Communications Systems. Switzerland, Djordjevic, I. B. , 1st, Springer International Publishing .
- 3 Fibre Optical communication systems , Govind P Agarwal , 1st , Wiley .
- 4 Optical Fiber Communication , P Chakrabarti , 1st , McGraw Hill Education (India) Private Limited .

23DCS3505 - MACHINE LEARNING FOR WIRELESS COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DCS3505	MACHINE LEARNING FOR WIRELESS COMMUNICATION	MLWC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply machine learning techniques, such as deep reinforcement learning, to analyze and optimize network management tasks like base station operation.	3	PO1, PO2
CO2	Analyze and evaluate the application of machine learning techniques, including deep learning, to solve critical self-organizing network challenges such as traffic prediction, cognitive radio management, and unmanned aerial vehicle positioning.	4	PO1, PO2
CO3	Compare and contrast machine learning techniques, such as k-Nearest Neighbors and Reinforcement Learning, for Adaptive Modulation and Coding (AMC) in communication systems, evaluating their performance through analysis.	4	PO1, PO2
CO4	Compare and contrast neural network architectures, such as Multilayer Perceptrons, Functional Link Artificial Neural Networks, Radial Basis Functions, and Deep Learning, for channel equalization in communication systems, evaluating their performance through analysis.	4	PO1, PO2

Syllabus

Related Machine Learning Techniques for Autonomous Network Management, Data-Driven Base-Station Sleeping Operations by Deep Reinforcement Learning, Deep Q-Learning Preliminary and its Applications to BS Sleeping Control, Dynamic Frequency Reuse through a Multi-Agent Neural Network Approach

Self-Organizing Wireless Networks, Traffic Prediction and Machine Learning, Cognitive Radio and Machine Learning, Deep Learning, Positioning of Unmanned Aerial Vehicles, Traffic Prediction, Mobility Prediction.

Overview of ML-Assisted AMC, k-NN-Assisted AMC, Algorithm for k-NN-Assisted AMC, Performance Analysis of k-NN-Assisted AMC System, RL-Assisted AMC.

Overview of Neural Network-Based Channel Equalization, Multilayer Perceptron-Based Equalizers, Functional Link Artificial Neural Network-Based Equalizers, Radial Basis Function-Based Equalizers, Deep-Learning-Based Equalizers

Reference Books

- 1 Machine Learning for Future Wireless Communications, Fa-Long Luo, 2020, Wiley .
- 2 Applications of Machine Learning in Wireless Communications, Ruisi He, Zhiguo Ding, 2019, Institution of Engineering and Technology.
- 3 Machine Learning and Cognitive Computing for Mobile Communications and Wireless Networks, K. K. Singh, A. Singh, K. Cengiz, Dac-Nhuong Le, 2020, Wiley.
- 4 Machine Learning and Deep Learning Techniques in Wireless and Mobile Networking Systems, G. Rajesh, K. Suganthi, Peter Ho Chiung Ching, R. Karthik, 2021, CRC Press.

23DEA3101A - FUNDAMENTALS OF DATA ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3101A	FUNDAMENTALS OF DATA ENGINEERING	FDE	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the life cycle of Data Engineering	2	PO1, PO2
CO2	Apply good Data Architecture for organizing Data	3	PO1, PO2
CO3	Design low cost Data Storage Systems Identify the Data Sources	4	PO1, PO2
CO4	Design a computational model for Data Ingestion phase	4	PO1, PO2
CO5	Implementing Data Processing and Organizing using suitable tools and programming languages	5	PO1, PO2
CO6	Build & Evaluate common practical applications	5	PO1, PO2

Syllabus

Introduction to Data Engineering, Data Engineering Lifecycle, Evolution of the Data Engineer, Skills and Activities of Data Engineer, Generation: Source Systems.

Good Data Architecture, Principles of Good Data Architecture, Major Architecture Concepts, Examples and Types of Data Architecture, Examples and Types of Data Architecture.

Sources of Data, Source Systems, Data Storage Systems, Data Engineering Storage Abstractions, Big Ideas and Trends in Storage.

Data Ingestion, Key Engineering Considerations for the Ingestion Phase, Batch Ingestion Considerations, Ways to Ingest Data, Data Modeling, Transformations.

Develop Data models for data lakes for storing, organizing and analysing volumes of data.

Reference Books

- 1 Fundamentals of Data Engineering, Joe Reis, Matt Housley, June 2022, O'Reilly Media, Inc..
- 2 Data Engineering with Python, Paul Crickard, 23 October 2020, Packt Publishing.
- 3 Data Engineering with Apache Spark, Delta Lake, and Lakehouse, Manoj Kukreja, Danil Zburivsky, 22 October 2021, Packt Publishing.
- 4 Data, Engineering and Applications, Geetam Singh Tomer, Jitendra Agrawal, Rajesh Kumar Shukla, Sanjeev Sharma, September 2019, Springer.
- 5 Data Science: Theory, Analysis and Applications, Qurban A Memon, Shakeel Ahmed Khoja, September 2019, CRC Press.

23DEA3101E - FUNDAMENTALS OF DATA ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3101E	FUNDAMENTALS OF DATA ENGINEERING	FDE	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the life cycle of Data Engineering	2	PO1, PO2
CO2	Apply good Data Architecture for organizing Data	3	PO1, PO2
CO3	Design low cost Data Storage Systems Identify the Data Sources	4	PO1, PO2
CO4	Design a computational model for Data Ingestion phase	4	PO1, PO2
CO5	Implementing Data Processing and Organizing using suitable tools and programming languages	5	PO1, PO2
CO6	Build & Evaluate common practical applications	5	PO1, PO2

Syllabus

Introduction to Data Engineering, Data Engineering Lifecycle, Evolution of the Data Engineer, Skills and Activities of Data Engineer, Generation: Source Systems.

Good Data Architecture, Principles of Good Data Architecture, Major Architecture Concepts, Examples and Types of Data Architecture, Examples and Types of Data Architecture.

Sources of Data, Source Systems, Data Storage Systems, Data Engineering Storage Abstractions, Big Ideas and Trends in Storage.

Data Ingestion, Key Engineering Considerations for the Ingestion Phase, Batch Ingestion Considerations, Ways to Ingest Data, Data Modeling, Transformations.

Develop Data models for data lakes for storing, organizing and analysing volumes of data.

Reference Books

- 1 Fundamentals of Data Engineering, Joe Reis, Matt Housley, June 2022, O'Reilly Media, Inc..
- 2 Data Engineering with Python, Paul Crickard, 23 October 2020, Packt Publishing.
- 3 Data Engineering with Apache Spark, Delta Lake, and Lakehouse, Manoj Kukreja, Danil Zburivsky, 22 October 2021, Packt Publishing.
- 4 Data, Engineering and Applications, Geetam Singh Tomer, Jitendra Agrawal, Rajesh Kumar Shukla, Sanjeev Sharma, September 2019, Springer.
- 5 Data Science: Theory, Analysis and Applications, Qurban A Memon, Shakeel Ahmed Khoja, September 2019, CRC Press.

23DEA3101R - FUNDAMENTALS OF DATA ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3101R	FUNDAMENTALS OF DATA ENGINEERING	FDE	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the life cycle of Data Engineering	2	PO1, PO2
CO2	Apply good Data Architecture for organizing Data	3	PO1, PO2
CO3	Design low cost Data Storage Systems Identify the Data Sources	4	PO1, PO2
CO4	Implementing Data Processing and Organizing using suitable tools and programming languages	4	PO1, PO2
CO5	Build & Evaluate common practical applications	5	PO1, PO2

Syllabus

Introduction to Data Engineering, Data Engineering Lifecycle, Evolution of the Data Engineer, Skills and Activities of Data Engineer, Generation: Source Systems.

Good Data Architecture, Principles of Good Data Architecture, Major Architecture Concepts, Examples and Types of Data Architecture, Examples and Types of Data Architecture.

Sources of Data, Source Systems, Data Storage Systems, Data Engineering Storage Abstractions, Big Ideas and Trends in Storage.

Data Ingestion, Key Engineering Considerations for the Ingestion Phase, Batch Ingestion Considerations, Ways to Ingest Data, Data Modeling, Transformations.

Reference Books

- 1 Fundamentals of Data Engineering, Joe Reis, Matt Housley, June 2022, O'Reilly Media, Inc..
- 2 Data Engineering with Python, Paul Crickard, 23 October 2020, Packt Publishing.
- 3 Data Engineering with Apache Spark, Delta Lake, and Lakehouse, Manoj Kukreja, Danil Zburivsky, 22 October 2021, Packt Publishing.
- 4 Data, Engineering and Applications, Geetam Singh Tomer, Jitendra Agrawal, Rajesh Kumar Shukla, Sanjeev Sharma, September 2019, Springer.
- 5 Data Science: Theory, Analysis and Applications, Qurban A Memon, Shakeel Ahmed Khoja, September 2019, CRC Press.

23DEA3202A - DATA EXPLORATION AND PREPARATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3202A	DATA EXPLORATION AND PREPARATION	DEP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Python/R programming for exploratory analysis, evaluate data lifecycle concepts, and apply practical data preprocessing techniques.	3	PO1, PSO2
CO2	Utilize data visualization principles and tools like Matplotlib, Seaborn, or ggplot2 to create both basic and advanced plots for insightful data representation.	3	PO2, PSO2
CO3	Analyze dimensionality reduction methods such as PCA and t-SNE to extract meaningful patterns from high-dimensional data.	4	PO3, PSO2
CO4	Explore advanced topics including text data preprocessing, handling imbalanced datasets, and managing streaming data to address complex data challenges effectively.	3	PO2, PSO1
CO5	Develop and deliver a final project presentation summarizing the findings, methodology, and insights gained from the analysis of a real-world dataset.	6	PO3, PSO1

Syllabus

Introduction to Data Exploration: Overview of data exploration and its importance, Understanding the data lifecycle, Exploratory data analysis (EDA) techniques, Introduction to Python/R for data exploration Data Cleaning and Preprocessing: Identifying and handling missing data, Dealing with duplicates and inconsistencies, Outlier detection and treatment techniques, Data normalization and standardization

Data Visualization: Principles of data visualization, Introduction to Matplotlib and Seaborn (Python) or ggplot2 (R), Creating basic plots: scatter plots, histograms, box plots, etc. ,Advanced visualization techniques: heatmaps, pair plots, faceting, etc.

Advanced Data Preparation: Feature engineering: creating new features from existing ones, Handling categorical variables: encoding techniques (one-hot encoding, label encoding, etc.), Dimensionality reduction techniques: PCA, t-SNE, Introduction to data pipelines

Data Integration and Transformation: Merging and joining datasets, Reshaping datasets: pivot tables, melting, stacking, unstacking, Time series data manipulation

Capstone Project and Advanced Topics: Applying data exploration and preparation techniques to real-world datasets, Final project presentation and peer review, Advanced topics: text data preprocessing, handling imbalanced datasets, handling streaming data

Reference Books

- 1 Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter , Wes McKinney, 2022, O'Reilly.
- 2 R for Data Science, Hadley Wickham, Mine cetinkaya-Rundel, Garrett Grolemond, 2023, O'Reilly.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Aurelien Geron , 2019, O'Reilly.
- 4 Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking, Foster Provost , Tom Fawcett , 2021, O'Reilly.
- 5 Data Wrangling with Python, Jacqueline Kazil, Katharine Jarmul, 2016, O'Reilly Media.

23DEA3202E - DATA EXPLORATION AND PREPARATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3202E	DATA EXPLORATION AND PREPARATION	DEP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Python/R programming for exploratory analysis, evaluate data lifecycle concepts, and apply practical data preprocessing techniques.	3	PO1, PSO2
CO2	Utilize data visualization principles and tools like Matplotlib, Seaborn, or ggplot2 to create both basic and advanced plots for insightful data representation.	3	PO2, PSO2
CO3	Analyze dimensionality reduction methods such as PCA and t-SNE to extract meaningful patterns from high-dimensional data.	4	PO3, PSO2
CO4	Explore advanced topics including text data preprocessing, handling imbalanced datasets, and managing streaming data to address complex data challenges effectively.	3	PO2, PSO1
CO5	Develop and deliver a final project presentation summarizing the findings, methodology, and insights gained from the analysis of a real-world dataset.	6	PO3, PSO1

Syllabus

Introduction to Data Exploration: Overview of data exploration and its importance, Understanding the data lifecycle, Exploratory data analysis (EDA) techniques, Introduction to Python/R for data exploration Data Cleaning and Preprocessing: Identifying and handling missing data, Dealing with duplicates and inconsistencies, Outlier detection and treatment techniques, Data normalization and standardization

Data Visualization: Principles of data visualization, Introduction to Matplotlib and Seaborn (Python) or ggplot2 (R), Creating basic plots: scatter plots, histograms, box plots, etc. ,Advanced visualization techniques: heatmaps, pair plots, faceting, etc.

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Data Integration and Transformation: Merging and joining datasets, Reshaping datasets: pivot tables, melting, stacking, unstacking, Time series data manipulation

Capstone Project and Advanced Topics: Applying data exploration and preparation techniques to real-world datasets, Final project presentation and peer review, Advanced topics: text data preprocessing, handling imbalanced datasets, handling streaming data

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- 2 R for Data Science, Hadley Wickham, Mine cetinkaya-Rundel, Garrett Golemund, 2023, O'Reilly.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Aurelien Geron, 2019, O'Reilly.
- 4 Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking, Foster Provost, Tom Fawcett, 2021, O'Reilly.
- 5 Data Wrangling with Python, Jacqueline Kazil, Katharine Jarmul, 2016, O'Reilly Media.

23DEA3202R - DATA EXPLORATION AND PREPARATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3202R	DATA EXPLORATION AND PREPARATION	DEP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Python/R programming for exploratory analysis, evaluate data lifecycle concepts, and apply practical data preprocessing techniques.	3	PO1, PSO2
CO2	Utilize data visualization principles and tools like Matplotlib, Seaborn, or ggplot2 to create both basic and advanced plots for insightful data representation.	3	PO2, PSO1
CO3	Analyze dimensionality reduction methods such as PCA and t-SNE to extract meaningful patterns from high-dimensional data.	4	PO3, PSO1
CO4	Explore advanced topics including text data preprocessing, handling imbalanced datasets, and managing streaming data to address complex data challenges effectively.	3	PO1, PSO2

Syllabus

Introduction to Data Exploration: Overview of data exploration and its importance, Understanding the data lifecycle, Exploratory data analysis (EDA) techniques, Introduction to Python/R for data exploration Data Cleaning and Preprocessing: Identifying and handling missing data, Dealing with duplicates and inconsistencies, Outlier detection and treatment techniques, Data normalization and standardization

Data Visualization: Principles of data visualization, Introduction to Matplotlib and Seaborn (Python) or ggplot2 (R), Creating basic plots: scatter plots, histograms, box plots, etc. ,Advanced visualization techniques: heatmaps, pair plots, faceting, etc.

Advanced Data Preparation: Feature engineering: creating new features from existing ones, Handling categorical variables: encoding techniques (one-hot encoding, label encoding, etc.), Dimensionality reduction techniques: PCA, t-SNE, Introduction to data pipelines

Data Integration and Transformation: Merging and joining datasets, Reshaping datasets: pivot tables, melting, stacking, unstacking, Time series data manipulation

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- 1 Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter, Wes McKinney, 2022, O'reilly.
- 2 R for Data Science, Hadley Wickham, Minecetinckaya-Rundel, Garrett Grolemond, 2023, O'reilly.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Geron Aurelien, 2019, O'reilly.
- 4 Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking, Foster Provost , Tom Fawcett, 2021, O'reilly.
- 5 Data Wrangling with Python, Dr. Tirthajyoti Sarkar, 2016, Packt Publishing.

23DEA3303A - BIG DATA TECHNOLOGIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3303A	BIG DATA TECHNOLOGIES	BDT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a comprehensive understanding of the concepts and characteristics of Big Data, including volume, velocity, variety, and veracity.	2	PO2
CO2	Explain and apply different Big Data storage solutions such as Hadoop Distributed File System (HDFS), NoSQL databases (e.g., MongoDB, Cassandra), and data warehousing techniques.	3	PO1, PO4
CO3	Design and implement data models for storing and managing large-scale datasets.	3	PO1, PO3, PO4, PO12
CO4	Utilize Big Data processing frameworks like Apache Hadoop and Apache Spark for processing and analyzing large datasets.	3	PO1, PO12
CO5	Develop and optimize MapReduce programs to perform distributed data processing tasks.	3	PO4, PO12
CO6	apply machine learning algorithms and statistical techniques using Big Data tools (e.g., Spark MLlib, Mahout) to analyze and derive insights from large datasets.	3	PO4
CO7	Perform data preprocessing, feature selection, and model evaluation in a Big Data context.	3	PO4

Syllabus

Introduction to Big Data Overview of Big Data: Characteristics and challenges The importance of Big Data in today's world Introduction to the Big Data ecosystem

Big Data Architecture and Infrastructure Big Data storage: HDFS, cloud storage solutions Big Data processing: Batch vs. real-time processing Introduction to distributed computing

Big Data Storage Technologies Hadoop Distributed File System (HDFS) NoSQL databases: MongoDB, Cassandra, HBase Data warehousing solutions: Apache Hive, Amazon Redshift

Big Data Processing Frameworks Apache Hadoop: Overview and architecture MapReduce programming model Apache Spark: Overview, architecture, and RDDs

Data Ingestion and ETL Processes Data ingestion tools: Apache Kafka, Apache Flume, Apache NiFi Designing ETL pipelines Data cleansing and transformation

Reference Books

- 1 "Hadoop: The Definitive Guide, Tom White, 4th Edition, O'Reilly Media.
- 2 Spark: The Definitive Guide: Big Data Processing Made Simple, Bill Chambers and Matei Zaharia, 1st Edition, O'Reilly Media.
- 3 NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pramod J. Sadalage and Martin Fowler, 1st Edition, Addison-Wesley Professional.
- 4 Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, Nathan Marz and James Warren, 1st Edition, Manning Publications.

23DEA3303E - BIG DATA TECHNOLOGIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3303E	BIG DATA TECHNOLOGIES	BDT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a comprehensive understanding of the concepts and characteristics of Big Data, including volume, velocity, variety, and veracity.	2	PO2
CO2	Explain and apply different Big Data storage solutions such as Hadoop Distributed File System (HDFS), NoSQL databases (e.g., MongoDB, Cassandra), and data warehousing techniques.	3	PO1, PO4
CO3	Design and implement data models for storing and managing large-scale datasets.	3	PO1, PO3, PO4, PSO1
CO4	Utilize Big Data processing frameworks like Apache Hadoop and Apache Spark for processing and analyzing large datasets.	3	PO1, PO3, PSO1
CO5	Develop and optimize MapReduce programs to perform distributed data processing tasks.	3	PO4, PSO1
CO6	Apply machine learning algorithms and statistical techniques using Big Data tools (e.g., Spark MLlib, Mahout) to analyze and derive insights from large datasets.	3	PO4
CO7	Perform data preprocessing, feature selection, and model evaluation in a Big Data context.	3	PO4

Syllabus

Introduction to Big Data Overview of Big Data: Characteristics and challenges The importance of Big Data in today's world Introduction to the Big Data ecosystem

Big Data Architecture and Infrastructure Big Data storage: HDFS, cloud storage solutions Big Data processing: Batch vs. real-time processing Introduction to distributed computing

Big Data Storage Technologies Hadoop Distributed File System (HDFS) NoSQL databases: MongoDB, Cassandra, HBase Data warehousing solutions: Apache Hive, Amazon Redshift

Big Data Processing Frameworks Apache Hadoop: Overview and architecture MapReduce programming model Apache Spark: Overview, architecture, and RDDs

Data Ingestion and ETL Processes Data ingestion tools: Apache Kafka, Apache Flume, Apache NiFi Designing ETL pipelines Data cleansing and transformation

Reference Books

- 1 "Hadoop: The Definitive Guide, Tom White, 4th Edition, O'Reilly Media.
- 2 Spark: The Definitive Guide: Big Data Processing Made Simple, Bill Chambers and Matei Zaharia, 1st Edition, O'Reilly Media.
- 3 NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pramod J. Sadalage and Martin Fowler, 1st Edition, Addison-Wesley Professional.
- 4 Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, Nathan Marz and James Warren, 1st Edition, Manning Publications.

23DEA3303R - BIG DATA TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3303R	BIG DATA TECHNOLOGIES	BDT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a comprehensive understanding of the concepts and characteristics of Big Data, including volume, velocity, variety, and veracity.	2	PO2, PSO1
CO2	Explain and apply different Big Data storage solutions such as Hadoop Distributed File System (HDFS), NoSQL databases (e.g., MongoDB, Cassandra), and data warehousing techniques.	3	PO1, PO4, PSO1
CO3	Design and implement data models for storing and managing large-scale datasets.	3	PO1, PO3, PO4, PSO1
CO4	Utilize Big Data processing frameworks like Apache Hadoop and Apache Spark for processing and analyzing large datasets.	3	PO1, PO3, PO4, PSO1
CO5	Develop and optimize MapReduce programs to perform distributed data processing tasks.	3	PO4, PSO1
CO6	apply machine learning algorithms and statistical techniques using Big Data tools (e.g., Spark MLlib, Mahout) to analyze and derive insights from large dataset	3	

Syllabus

Introduction to Big Data Overview of Big Data: Characteristics and challenges The importance of Big Data in today's world Introduction to the Big Data ecosystem

Big Data Architecture and Infrastructure Big Data storage: HDFS, cloud storage solutions Big Data processing: Batch vs. real-time processing Introduction to distributed computing

Big Data Storage Technologies Hadoop Distributed File System (HDFS) NoSQL databases: MongoDB, Cassandra, HBase Data warehousing solutions: Apache Hive, Amazon Redshift

Big Data Processing Frameworks Apache Hadoop: Overview and architecture MapReduce programming model Apache Spark: Overview, architecture, and RDDs

Reference Books

- 1 "Hadoop: The Definitive Guide, Tom White, 4th Edition, O'Reilly Media.
- 2 Spark: The Definitive Guide: Big Data Processing Made Simple, Bill Chambers and Matei Zaharia, 1st Edition, O'Reilly Media.
- 3 NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pramod J. Sadalage and Martin Fowler, 1st Edition, Addison-Wesley Professional.
- 4 Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, Nathan Marz and James Warren, 1st Edition, Manning Publications.

23DEA3404M - DATA WAREHOUSING AND BUSINESS INTELLIGENCE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3404M	DATA WAREHOUSING AND BUSINESS INTELLIGENCE	DWBI	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of data warehousing	2	PO1, PSO1
CO2	Apply data modeling techniques to design a data warehouse	3	PO1, PO2, PSO1
CO3	Implement ETL processes to populate a data warehouse:	3	PO3
CO4	Analyze data trends and patterns to identify business opportunities	4	PO3, PO4, PSO2

Syllabus

Overview of data warehousing concepts and principles, Key components of a data warehouse, Role of data warehousing in business decision-making, Understand the fundamental concepts of data warehousing

Data modeling techniques for data warehouses (e.g., dimensional modeling) , Designing a data warehouse schema
Comparing data modeling techniques , Apply data modeling techniques to design a data warehouse

Extracting data from multiple sources ,Transforming data to meet the requirements of the data warehouse ,Loading data into the data warehouse, Performance tuning and optimization of ETL processes ,Implement ETL processes to populate a data warehouse

Introduction to business intelligence tools (e.g., Tableau, Power BI) , Creating reports, dashboards, and visualizations , Analyzing data trends and patterns , Use business intelligence tools to analyze data and generate insights

Reference Books

- 1 The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Ralph Kimball and Margy Ross, Third Edition, Wiley.
- 2 Business Intelligence Guidebook: From Data Integration to Analytics, Rick Sherman , Second Edition, Morgan Kaufmann.
- 3 Data Warehouse Design: Modern Principles and Methodologies , Matteo Golfarelli, Stefano Rizzi, and Alberto Sacc? , First Edition, McGraw-Hill Education.
- 4 Business Intelligence Roadmap: The Complete Project Lifecycle for Decision-Support Applications , Larissa T. Moss and Shaku Atre , Second Edition, Addison-Wesley Professional.

23DEA3505R - MACHINE LEARNING ENGINEERING FOR BIG DATA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DEA3505R	MACHINE LEARNING ENGINEERING FOR BIG DATA	MLEBD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and articulate the fundamental concepts of Machine Learning and Big Data, and their underlying themes.	2	PO1, PO3, PO5, PSO2
CO2	Analyze and address key technical issues in developing ML systems through various real-world case studies.	2	PO1, PO3, PO4, PSO2
CO3	Apply machine learning techniques in big data analytics, including learning theory, association rule learning, clustering, and classification.	3	PO1, PO3, PO5, PSO2
CO4	Utilize open-source tools for data analytics to perform basic and advanced analysis of big data.	3	PO1, PO4, PO5, PSO2

Syllabus

Introduction to Machine Learning : Overview of Machine Learning ,Historical Context and Evolution, Applications of Machine Learning, Fundamentals of Big Data : Definition and Characteristics of Big Data ,Big Data Technologies (Hadoop, Spark) , Big Data Storage and Processing (Data Warehouses, NoSQL Databases).Intersection of Machine Learning and Big Data : Importance of Large Datasets ,Challenges in Machine Learning with Big Data ,Tools and Frameworks (Apache Mahout, MLLib in Spark).Key Concepts and Techniques : Data Collection and Integration, Data Cleaning and Preprocessing, Exploratory Data Analysis (EDA).

CASE STUDIES : Case Study 1 - Predictive Analytics in Healthcare, Dataset Overview ,Model Selection and Evaluation ,Noise Handling and Feature Extraction .Case Study 2 - Fraud Detection in Financial Services ,Data Challenges ,Implementation and Outcomes, Feature Selection and Learning Algorithms. Case Study 3- Customer Segmentation in Retail, Data Sources and Features ,Clustering Techniques, Technical Issues and Solutions.

Machine Learning Techniques in Big Data Analytics : Learning Theory and Association Rule Learning - Basics of Learning Theory, Association Rule Learning Techniques, Applications and Challenges. Clustering Analysis : Overview of Clustering Techniques, K-means, Hierarchical, and Density-based Clustering ,Application of Clustering in Big Data. Classification Techniques - Supervised Learning: Decision Trees, SVM and Neural Networks, Evaluation Metrics and Model Selection , Addressing Class Imbalance and Overfitting.

Data Analytics with Tools : Introduction to KNIME, Overview of KNIME, Basic Data Analysis with KNIME, Workflow Creation and Execution. Introduction to Apache Spark - Overview of Apache Spark, Basic Data Processing with Spark, Introduction to Spark MLLib. Practical Data Analytics with Tools - Hands-on Exercises with KNIME, Hands-on Exercises with Spark, Case Studies using Tools.

Reference Books

- 1 Pattern Recognition and Machine Learning, Christopher M. Bishop, First Edition, Springer.
- 2 Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, Nathan Marz ,James Warren, First Edition, Manning, 2015.
- 3 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurelien Geron, Second Edition, O'Reilly Media, Inc..
- 4 Learning Spark: Lightning-Fast Big Data Analysis, Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, First Edition, O'Reilly Media, Inc..
- 5 Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas Muller, First Edition, O'Reilly Media, Inc..

23DLA3101A - SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3101A	SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS	SNTSA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the key concepts of network design in complex network analysis and developing performance threshold	2	, PSO2
CO2	Apply situational analysis to develop secure solutions under a specified scenario and Evaluate a give scenario for tradeoff analysis for system performance, risk assessment, and costs and Examine network tracking mechanisms for capturing wireless traffic and Wi-Fi Security Protocol	3	PO1, PSO2
CO3	Examine the interconnection mechanism for network traffic management and IEEE 802.11 Network Components and Architectural Models	3	PO1, PSO2
CO4	Analyse the SNMP protocol for network management and Network Traffic Management	4	PO2, PO3, PSO2
CO5	Analyse various network management protocols to analyze the Network traffic, Managing Network Management Data and MIB	4	PO2, PO3, PSO2
CO6	Analyse various network management protocols to analyze the Network traffic, Managing Network Management Data, MIB, and Analyse security user based security model, access control RMON	4	PO3, PO5, PSO2
CO7	Analyse the evolution of network management protocols and pioneering technologies with our comprehensive overview covering SNMPv2, SNMPv3 architecture, AN-1 Remote Monitoring, and Broadband Network Management.	4	PO3, PO5, PSO2

Syllabus

Introduction to System and Network Traffic Security Analytics, Introduction to Network Service and Service based networks, Systems and services, User Requirements, Application Requirements, Network Requirements, Guidelines Requirements gathering and listing, Developing service metrics to measure performance, Characterizing behavior, developing performance threshold, Distinguish between service performance levels

Tradeoff analysis based on time, cost, risk tolerance, risk acceptance, return on investment, Problem analysis and situational analysis to address system security, Wi-Fi Network Management, Wi-Fi Security Protocols, Wi-Fi Protected Access (WPA), Wi-Fi Protected Access II (WPA2), Wi-Fi Protected Access III (WPA3), Wi-Fi Security Modes, Wi-Fi Connection Protocols, Taxonomy of Wi-Fi Attacks, Features of Wi-Fi Attacks, Wi-Fi Pentester Framework, Wi-Fi Network Tools

Overview of Wireless Networking, IEEE 802.11 Standards, IEEE 802.11 Network Components and Architectural Models, Firewalls & Proxy Server, Network Intrusion Detection & Prevention System, Network Management Architecture, Network Devices and Characteristics, Network Management Mechanisms, Architectural Considerations, Centralized, Distributed, and Hierarchical Management, Scaling Network Management Traffic, Managing Network Management Data, MIB

Performance Architecture, Performance Mechanisms, Prioritization, Network Traffic Management, Scheduling, and Queuing, Architectural Considerations, Evaluation of Performance Mechanisms, Security and Privacy Architecture, Security and Privacy Mechanisms, Architectural Considerations, Evaluation of Security Mechanisms, Network Design, Design Process, Vendor, Equipment, and Service-Provider Evaluations, Design Traceability, Design Metrics

SNMP and Network Management, Network Management Models, Abstract Syntax Notation One: ASN. 1, SNMP Management: SNMPv1, SNMPv2, SNMPv3, Internet Organizations and Standards, SNMP Model, Organization Model, Information Model, Communication Model, Functional Model, SNMPv2 System Architecture, SNMv2 Management Information Base and SNMPv2 Protocol, SNMPv3 Documentation Architecture, SNMPv3 User-Based Security Model and Access Control, SNMP Management, RMON SMI and MIB, An-1 Remote Monitoring, Broadband Network Management, RMON, ATM Technology, MPLS Network Technology, MPLS OAM Management

Reference Books

- 1 Practical Computer Network Analysis and Design, James.D.McCabe, 1st Edition, TMH.
- 2 Network Management Principles & Practice, Mani Subramanian, 2nd Edition, Pearson.
- 3 Applied Network Security Monitoring, Collection, Detection, and Analysis, Chris Sanders, 1st Edition, Syngress.
- 4 Network Security Monitoring, Basics for Beginners, Arunesh Singh, 1st Edition, TMH.
- 5 Fundamentals of Computer Network Analysis and Engineering, Basic Approaches for Solving Problems in the Networked Computing Environment, J.Radz, 4th Edition, Pearson.

23DLA3101E - SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3101E	SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS	SNTSA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the key concepts of network design in complex network analysis and developing performance threshold	2	, PSO2
CO2	Apply situational analysis to develop secure solutions under a specified scenario and Evaluate a give scenario for tradeoff analysis for system performance, risk assessment, and costs and Examine network tracking mechanisms for capturing wireless traffic and Wi-Fi Security Protocol	3	PO1, PSO2
CO3	Examine interconnection mechanism for network traffic management and IEEE 802.11 Network Components and Architectural Models	3	PO1, PSO2
CO4	Analyzing the SNMP protocol for network management	4	PO2, PO3, PSO2
CO5	Analyse various network management protocols to analyze the Network traffic, Managing Network Management Data and MIB	4	PO2, PO3, PSO2
CO6	Analyse various network management protocols to analyze the Network traffic, Managing Network Management Data, MIB, and Analyse security user based security model, access control RMON	4	PO3, PO5, PSO2
CO7	Analyse the evolution of network management protocols and pioneering technologies with our comprehensive overview covering SNMPv2, SNMPv3 architecture, AN-1 Remote Monitoring, and Broadband Network Management.	4	PO3, PO5, PSO2

Syllabus

Introduction to System and Network Traffic Security Analytics, Introduction to Network Service and Service based networks, Systems and services, User Requirements, Application Requirements, Network Requirements, Guidelines Requirements gathering and listing, Developing service metrics to measure performance, Characterizing behavior, developing performance threshold, Distinguish between service performance levels

Tradeoff analysis based on time, cost, risk tolerance, risk acceptance, return on investment, Problem analysis and situational analysis to address system security, Wi-Fi Network Management, Wi-Fi Security Protocols, Wi-Fi Protected Access (WPA), Wi-Fi Protected Access II (WPA2), Wi-Fi Protected Access III (WPA3), Wi-Fi Security Modes, Wi-Fi Connection Protocols, Taxonomy of Wi-Fi Attacks, Features of Wi-Fi Attacks, Wi-Fi Pentester Framework, Wi-Fi Network Tools

Overview of Wireless Networking, IEEE 802.11 Standards, IEEE 802.11 Network Components and Architectural Models, Firewalls & Proxy Server, Network Intrusion Detection & Prevention System, Network Management Architecture, Network Devices and Characteristics, Network Management Mechanisms, Architectural Considerations, Centralized, Distributed, and Hierarchical Management, Scaling Network Management Traffic, Managing Network Management Data, MIB

Performance Architecture, Performance Mechanisms, Prioritization, Network Traffic Management, Scheduling, and Queuing, Architectural Considerations, Evaluation of Performance Mechanisms, Security and Privacy Architecture, Security and Privacy Mechanisms, Architectural Considerations, Evaluation of Security Mechanisms, Network Design, Design Process, Vendor, Equipment, and Service-Provider Evaluations, Design Traceability, Design Metrics

SNMP and Network Management, Network Management Models, Abstract Syntax Notation One: ASN. 1, SNMP Management: SNMPv1, SNMPv2, SNMPv3, Internet Organizations and Standards, SNMP Model, Organization Model, Information Model, Communication Model, Functional Model, SNMPv2 System Architecture, SNMv2 Management Information Base and SNMPv2 Protocol, SNMPv3 Documentation Architecture, SNMPv3 User-Based Security Model and Access Control, SNMP Management, RMON SMI and MIB, An-1 Remote Monitoring, Broadband Network Management, RMON, ATM Technology, MPLS Network Technology, MPLS OAM Management

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- 4 Network Security Monitoring, Basics for Beginners, Arunesh Singh, 1st Edition, TMH.
- 5 Fundamentals of Computer Network Analysis and Engineering, Basic Approaches for Solving Problems in the Networked Computing Environment, J.Radz, 4th Edition, Pearson.

23DLA3101R - SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3101R	SYSTEM & NETWORK TRAFFIC SECURITY ANALYTICS	SNTSA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the key concepts of network design in complex network analysis and developing performance threshold	2	, PSO2
CO2	Apply situational analysis to develop secure solutions under a specified scenario and Examine network tracking mechanisms for capturing wireless traffic and Wi-Fi Security Protocol	3	PO1, PSO2
CO3	Examine interconnection mechanism for network traffic management and IEEE 802.11 Network Components and Architectural Models	3	PO1, PSO2
CO4	Analyzing the SNMP protocol for network management	4	PO2, PO3, PSO2
CO5	Analyse various network management protocols to analyze the Network traffic, Managing Network Management Data, MIB, and Analyse security user based security model, access control RMON	4	PO3, PO5, PSO2
CO6	Analyse the evolution of network management protocols and pioneering technologies with our comprehensive overview covering SNMPv2, SNMPv3 architecture, AN-1 Remote Monitoring, and Broadband Network Management.	4	PO3, PO5, PSO2

Syllabus

Introduction to System and Network Traffic Security Analytics, Introduction to Network Service and Service based networks, Systems and services, User Requirements, Application Requirements, Network Requirements, Guidelines Requirements gathering and listing, Developing service metrics to measure performance, Characterizing behavior, developing performance threshold, Distinguish between service performance levels

Problem analysis and situational analysis to address system security, Wi-Fi Network Management, Wi-Fi Security Protocols, Wi-Fi Protected Access (WPA), Wi-Fi Protected Access II (WPA2), Wi-Fi Protected Access III (WPA3), Wi-Fi Security Modes, Wi-Fi Connection Protocols, Taxonomy of Wi-Fi Attacks, Features of Wi-Fi Attacks, Wi-Fi Pentester Framework, Wi-Fi Network Tools

Overview of Wireless Networking, IEEE 802.11 Standards, IEEE 802.11 Network Components and Architectural Models, Firewalls & Proxy Server, Network Intrusion Detection & Prevention System, Network Management Architecture, Network Devices and Characteristics, Network Management Mechanisms, Architectural Considerations, Centralized, Distributed, and Hierarchical Management, Scaling Network Management Traffic, Managing Network Management Data, MIB

Performance Architecture, Performance Mechanisms, Prioritization, Network Traffic Management, Scheduling, and Queuing, Architectural Considerations, Evaluation of Performance Mechanisms, Security and Privacy Architecture, Security and Privacy Mechanisms, Architectural Considerations, Evaluation of Security Mechanisms, Network Design, Design Process, Vendor, Equipment, and Service-Provider Evaluations, Design Traceability, Design Metrics, SNMP Management, RMON SMI and MIB

Reference Books

- 1 Practical Computer Network Analysis and Design, James.D.McCabe, 1st Edition, TMH.
- 2 Network Management Principles & Practice, Mani Subramanian, 2nd Edition, Pearson.
- 3 Applied Network Security Monitoring, Collection, Detection, and Analysis, Chris Sanders, 1st Edition, Syngress.

- 4 Network Security Monitoring, Basics for Beginners, Arunesh Singh, 1st Edition , TMH.
- 5 Fundamentals of Computer Network Analysis and Engineering, Basic Approaches for Solving Problems in the Networked Computing Environment, J.Radz, 4th Edition, Pearson.

23DLA3202A - AUTOMATED NETWORK ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3202A	AUTOMATED NETWORK ANALYSIS	ANA	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and concepts of automated network analysis.	2	PO1, PO2
CO2	Analyze network performance metrics and diagnose network issues using automated methods	3	PO1, PO2
CO3	Demonstrate proficiency in using automated tools and techniques for network analysis and troubleshooting	3	PO1, PO2, PS02
CO4	Evaluate the security implications of automated network analysis tools and implement appropriate measures to safeguard network infrastructure	4	PO1, PO2, PO3, PS02
CO5	Design and implement automated network monitoring solutions for real-time performance management.	4	PO1, PO2, PO3, PS02

Syllabus

Introduction to Network Analysis Topics: Overview of Network Analysis Importance and applications Key concepts and terminology Network Architectures and Protocols OSI and TCP/IP models Common protocols (HTTP, FTP, DNS, etc.) Tools for Network Analysis Wireshark, tcpdump, and other packet analyzers Network performance monitoring tools Basic Scripting for Network Analysis Introduction to Python for network analysis Writing simple scripts to capture and analyze traffic

Traffic Monitoring and Performance Analysis Topics: Network Traffic Monitoring Techniques for monitoring traffic Real-time vs. historical analysis Performance Metrics Latency, bandwidth, throughput, packet loss Tools for measuring and analyzing performance (e.g., iPerf, NetFlow) Traffic Analysis Analyzing traffic patterns Identifying bottlenecks and performance issues Automating Traffic Analysis Using Python and other tools to automate monitoring and analysis Scheduling and reporting

Anomaly Detection and Network Security Topics: Introduction to Anomaly Detection Types of anomalies (volume, time-based, protocol anomalies) Techniques for anomaly detection Network Security Fundamentals Common threats and vulnerabilities Security tools and techniques Automated Threat Detection Using IDS/IPS systems (e.g., Snort, Suricata) Machine learning approaches to anomaly detection Implementing Security Measures Firewalls, VPNs, and other security technologies Automating security responses

Network Automation Tools and Techniques Topics: Overview of Network Automation Benefits and challenges Key tools and frameworks (e.g., Ansible, Puppet, Chef) Automating Network Configuration Scripting configurations Version control for network configs Automated Network Management Monitoring and managing network devices Automating responses to network events Case Studies and Real-world Applications Examples of network automation in enterprise environments Best practices and lessons learned

Advanced Topics in Automated Network Analysis Topics: Advanced Traffic Analysis Techniques Deep packet inspection Encrypted traffic analysis Big Data and Network Analysis Handling and analyzing large volumes of network data Using big data tools (e.g., Hadoop, Spark) for network analysis Emerging Trends in Network Automation Software-defined networking (SDN) Network function virtualization (NFV) Capstone Project Preparation Project planning and proposal Data collection and analysis methodologies

Reference Books

- 1 Network Analysis, Van Valkenburg M.E, YEAR 2014, Prentice Hall India.
- 2 Network Analysis, Architecture, and Design, James D. McCabe, 3rd, Wireless Communications & Networking.

- 3 Network Protocol Analysis Using Wireshark Cookbook, Nagendra Kumar Nainar, Yogesh Ramdoss, 3rd, PACKT.
- 4 Network Management: Principles and Practice, Mani Subramanian, 2010, Pearson Education India.

23DLA3202E - AUTOMATED NETWORK ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3202E	AUTOMATED NETWORK ANALYSIS	ANA	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and concepts of automated network analysis.	2	PO1, PO2
CO2	Analyze network performance metrics and diagnose network issues using automated methods	3	PO1, PO2
CO3	Demonstrate proficiency in using automated tools and techniques for network analysis and troubleshooting	3	PO1, PO2, PS02
CO4	Evaluate the security implications of automated network analysis tools and implement appropriate measures to safeguard network infrastructure	4	PO1, PO2, PO3, PS02
CO5	Design and implement automated network monitoring solutions for real-time performance management	4	PO1, PO2, PO3, PS02

Syllabus

Introduction to Network Analysis Topics: Overview of Network Analysis Importance and applications Key concepts and terminology Network Architectures and Protocols OSI and TCP/IP models Common protocols (HTTP, FTP, DNS, etc.) Tools for Network Analysis Wireshark, tcpdump, and other packet analyzers Network performance monitoring tools Basic Scripting for Network Analysis Introduction to Python for network analysis Writing simple scripts to capture and analyze traffic

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- 2 Network Analysis, Architecture, and Design, James D. McCabe, 3rd, Wireless Communications & Networking.

- 3 Network Protocol Analysis Using Wireshark Cookbook, Nagendra Kumar Nainar, Yogesh Ramdoss, 3rd, PACKT.
- 4 Network Management: Principles and Practice, Mani Subramanian, 2010, Pearson Education India.

23DLA3202R - AUTOMATED NETWORK ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3202R	AUTOMATED NETWORK ANALYSIS	ANA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and concepts of automated network analysis	2	PO1, PO2
CO2	Analyze network performance metrics and diagnose network issues using automated methods	2	PO1, PO2
CO3	Demonstrate proficiency in using automated tools and techniques for network analysis and troubleshooting	3	PO1, PO2, PS02
CO4	Evaluate the security implications of automated network analysis tools and implement appropriate measures to safeguard network infrastructure	4	PO1, PO2, PO3, PS02

Syllabus

Overview of Network Analysis Importance and applications Key concepts and terminology Network Architectures and Protocols OSI and TCP/IP models Common protocols (HTTP, FTP, DNS, etc.) Tools for Network Analysis Wireshark, tcpdump, and other packet analyzers Network performance monitoring tools Basic Scripting for Network Analysis Introduction to Python for network analysis Writing simple scripts to capture and analyze traffic

Network Traffic Monitoring Techniques for monitoring traffic Real-time vs. historical analysis Performance Metrics Latency, bandwidth, throughput, packet loss Tools for measuring and analyzing performance (e.g., iPerf, NetFlow) Traffic Analysis Analyzing traffic patterns Identifying bottlenecks and performance issues Automating Traffic Analysis Using Python and other tools to automate monitoring and analysis Scheduling and reporting

Introduction to Anomaly Detection Types of anomalies (volume, time-based, protocol anomalies) Techniques for anomaly detection Network Security Fundamentals Common threats and vulnerabilities Security tools and techniques Automated Threat Detection Using IDS/IPS systems (e.g., Snort, Suricata) Machine learning approaches to anomaly detection Implementing Security Measures Firewalls, VPNs, and other security technologies Automating security responses

Overview of Network Automation Benefits and challenges Key tools and frameworks (e.g., Ansible, Puppet, Chef) Automating Network Configuration Scripting configurations Version control for network configs Automated Network Management Monitoring and managing network devices Automating responses to network events Case Studies and Real-world Applications Examples of network automation in enterprise environments Best practices and lessons learned

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- 2 Network Analysis, Architecture, and Design, James D. McCabe, 3rd, Wireless Communications & Networking.
- 3 Network Protocol Analysis Using Wireshark Cookbook, Nagendra Kumar Nainar, Yogesh Ramdoss, 2nd, PACKT.
- 4 Network Management: Principles and Practice, Mani Subramanian, 2010, Pearson Education India.

23DLA3203A - BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3203A	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	BTDT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describes the history and basic concepts of Blockchain technology	2	PO1, PO2, PO4, PO6
CO2	Elaborate the need of consensus algorithms and its types	2	PO1, PO2, PO4, PO6
CO3	Create the smart contract to validate the transactions	3	PO1, PO2, PO4, PO6
CO4	Explore the various case studies in blockchain application	3	PO1, PO2, PO4, PO6
CO5	Evaluate the Blockchain enterprise application	3	PO1, PO2, PO4, PO6, PSO2

Syllabus

Introduction to Blockchain, History, Definition, Distributed Ledger, Blockchain Categories Public, Private, Consortium, Blockchain Network and Nodes, Peer to Peer Network, Mining Mechanism, Generic elements of Blockchain, Features of Blockchain, and Types of Blockchain.

Consensus mechanism: Key Feature of Consensus for Multi-Party Agreements, Understanding consensus with a real world analogy, Different Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Byzantine Fault Tolerance (BFT), Practical Byzantine Fault Tolerance (PBFT), Proof of Authority (PoA) and Proof of Elapsed Time (PoET)

Ethereum and Smart Contracts, Components of Ethereum Ecosystem, Smart Contract Phases, Smart Contract Languages and verification challenges, using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts, writing smart contracts using Solidity and JavaScript. Privacy.

Blockchain in Digital Transformation: Blockchain in Supply Chain Management - Blockchain in Manufacturing - Blockchain in Automobiles - Blockchain in Healthcare - Blockchain in Cyber security - Blockchain in Financial Industry

Public versus private and permissioned versus permission less blockchains- Privacy and anonymity in Ethereum- Why are privacy and anonymity important?- The Ethereum Enterprise Alliance- Blockchain-as-a-Service- Initial Coin Offering (ICO): Project setup for ICO implementation- Token contracts- Token sale contracts-Contract security and Testing the code.

Reference Books

- 1 Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained , Imran Bashir , 2, Packt Publishing Ltd .
- 2 Bitcoin and Cryptocurrency Technologies A Comprehensive Introduction , Narayanan, Bonneau, Felten, Miller and Goldfeder , 1, Princeton University Press.
- 3 BLOCKCHAIN TECHNOLOGY , Chandramouli Subramanian,Asha A Geroge Abhilash K A and Meena Karthikeyan , 1, University Press .
- 4 Blockchain A to Z Explained, Rajesh Dhuddu, Srinivas Mahankali, 1, Bpb Publications.

23DLA3203E - BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3203E	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	BTDT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describes the history and basic concepts of Blockchain technology	2	PO1, PO2, PO4, PO6
CO2	Elaborate the need of consensus algorithms and its types	2	PO1, PO2, PO4, PO6, PSO1
CO3	Create the smart contract to validate the transactions	3	PO1, PO2, PO4, PO6
CO4	Explore the various case studies in blockchain application	3	PO1, PO2, PO4, PO6
CO5	Evaluate the Blockchain enterprise application	3	PO1, PO2, PO4, PO6

Syllabus

Introduction to Blockchain, History, Definition, Distributed Ledger, Blockchain Categories Public, Private, Consortium, Blockchain Network and Nodes, Peer to Peer Network, Mining Mechanism, Generic elements of Blockchain, Features of Blockchain, and Types of Blockchain.

Consensus mechanism: Key Feature of Consensus for Multi-Party Agreements, Understanding consensus with a real world analogy, Different Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Byzantine Fault Tolerance (BFT), Practical Byzantine Fault Tolerance (PBFT), Proof of Authority (PoA) and Proof of Elapsed Time (PoET)

Ethereum and Smart Contracts, Components of Ethereum Ecosystem, Smart Contract Phases, Smart Contract Languages and verification challenges, using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts, writing smart contracts using Solidity and JavaScript. Privacy.

Blockchain in Digital Transformation: Blockchain in Supply Chain Management - Blockchain in Manufacturing - Blockchain in Automobiles - Blockchain in Healthcare - Blockchain in Cyber security - Blockchain in Financial Industry

Public versus private and permissioned versus permission less blockchains- Privacy and anonymity in Ethereum- Why are privacy and anonymity important?- The Ethereum Enterprise Alliance- Blockchain-as-a-Service- Initial Coin Offering (ICO): Project setup for ICO implementation- Token contracts- Token sale contracts-Contract security and Testing the code.

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- 3 BLOCKCHAIN TECHNOLOGY, Chandramouli Subramanian, Asha A Geroje Abhilash K A and Meena Karthikeyan, 1, University Press.
- 4 The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them (Cryptography, Crypto Trading, Digital Assets, NFT), Antony Lewis, 1, Amazon.

23DLA3203R - BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3203R	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	BTDT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describes the history and basic concepts of Blockchain technology	2	PO1, PO2, PO4, PO6
CO2	Elaborate the need of consensus algorithms and its types	2	PO1, PO2, PO4, PO6
CO3	Create the smart contract to validate the transactions	3	PO1, PO2, PO4, PO6, PSO1
CO4	Explore the various case studies in blockchain application	3	PO1, PO2, PO4, PO6

Syllabus

Introduction to Blockchain, History, Definition, Distributed Ledger, Blockchain Categories Public, Private, Consortium, Blockchain Network and Nodes, Peer to Peer Network, Mining Mechanism, Generic elements of Blockchain, Features of Blockchain, and Types of Blockchain.

Consensus mechanism: Key Feature of Consensus for Multi-Party Agreements, Understanding consensus with a real world analogy, Different Consensus Algorithms: Proof of Work (PoW), Proof of Stake (PoS), Byzantine Fault Tolerance (BFT), Practical Byzantine Fault Tolerance (PBFT), Proof of Authority (PoA) and Proof of Elapsed Time (PoET)

Ethereum and Smart Contracts, Components of Ethereum Ecosystem, Smart Contract Phases, Smart Contract Languages and verification challenges, using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts, writing smart contracts using Solidity and JavaScript. Privacy.

Blockchain in Digital Transformation: Blockchain in Supply Chain Management - Blockchain in Manufacturing - Blockchain in Automobiles - Blockchain in Healthcare - Blockchain in Cyber security - Blockchain in Financial Industry

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- 3 BLOCKCHAIN TECHNOLOGY, Chandramouli Subramanian, Asha A Geroje Abhilash K A and Meena Karthikeyan, 1, University Press.
- 4 Blockchain A to Z Explained, Rajesh Dhuddu, Srinivas Mahankali, 1, Bpb Publications.

23DLA3304A - MULTI AGENT SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3304A	MULTI AGENT SYSTEMS	MAS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and apply notion of an agent, how agents are distinct from other software paradigms (eg objects) ,apply the characteristics of applications that lend themselves to an agent-oriented solution	2	PO1, PO5, PSO1
CO2	Analyze the key issues associated with constructing agents capable of intelligent autonomous action, and the main approaches taken to developing such agents	3	PO1, PO5, PSO1
CO3	Analyze the key issues in designing societies of agents that can effectively cooperate in order to solve problems, including an understanding of the key types of multi-agent interactions possible in such systems	3	PO2, PO5, PSO2
CO4	Examine the main application areas of agent-based solutions, and be able to develop a meaningful agent-based system using a contemporary agent development platform.	4	PO2, PO5, PSO1
CO5	Implement and analyze the algorithm of agents interaction and communication each other using JADE	4	PO2, PO5, PSO2
CO6	Analyzing agent behavior, Automated planning, evaluating agent interaction systems and agent-based systems.	4	PO1, PO5, PSO1
CO7	Analyzing problems of different agent-based systems	4	PO2, PO5, PSO2

Syllabus

Introduction: what is an agent agents and objects; agents and expert systems; agents and distributed systems typical application areas for agent systems. Trends in modern (distributed) computing. Origins of Multiagent design. Agent Design and Society Design. Approaches to Agent-Oriented Design. Agent properties. Environment properties. Agent types and architectures.

Intelligent Agents: the design of intelligent agents - reasoning agents, agents as reactive systems; hybrid agents; layered agents, a contemporary (Java-based) framework for programming agents. Learning from examples, discovery as learning, learning by analogy, explanation based learning, neural nets, genetic algorithms. Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems

Multi-Agent Systems: Classifying multi-agent interactions - cooperative versus non-cooperative; zero-sum and other interactions; what is cooperation how cooperation occurs - the Prisoners dilemma and Axelrods experiments; Interactions between self-interested agents: auctions & voting systems negotiation

Interactions between benevolent agents: cooperative distributed problem solving (CDPS), partial global planning; coherence and coordination; Interaction languages and protocols: speech acts, KQML/KIF, the FIPA framework. Applications of Agent-Oriented Design. Agent-Oriented Design, Electronic Negotiation Support, Flexible Dynamic Web services, Multi-robotic environments. Current trends in Software engineering. Agent-Oriented Software Engineering. Agent-Oriented Methodologies. The GAIA Methodology.

Multi-Agent Systems Classifying multi-agent interactions - cooperative versus non-cooperative zero-sum and other interactions what is cooperation how cooperation occurs the Prisoner's dilemma and Axelrod's experiments

Reference Books

- 1 An Introduction to MultiAgent Systems , Michael Wooldridge , 2019, Wiley .
- 2 Programming Multi-agent Systems in AgentSpeak Using Jason, Kevin Leyton, 2010, Wiley .

- 3 Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham and Kevin Leyton-Brown. , 2009, Cambridge University Plus .
- 4 Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, Gerhard Weiss, 2018, The MIT Press.
- 5 Principles of Multi-Agent Systems, Davide Calvaresi, Amleto Di Salle, Antonio Santini, 2021, Springer.

23DLA3304E - MULTI AGENT SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3304E	MULTI AGENT SYSTEMS	MAS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and apply notion of an agent, how agents are distinct from other software paradigms (eg objects) and understand & apply the characteristics of applications that lend themselves to an agent-oriented solution	2	PO1, PO5, PSO1
CO2	Analyze the key issues associated with constructing agents capable of intelligent autonomous action, and the main approaches taken to developing such agents	3	PO2, PO5, PSO2
CO3	Analyze the key issues in designing societies of agents that can effectively cooperate in order to solve problems, including an understanding of the key types of multi-agent interactions possible in such systems	3	PO1, PO5, PSO1
CO4	Examine the main application areas of agent-based solutions, and be able to develop a meaningful agent-based system using a contemporary agent development platform.	4	PO1, PO5, PSO2
CO5	Implement and analyze the algorithm of agents interaction and communication each other using JADE	4	
CO6	Analyzing agent behavior, Automated planning, evaluating agent interaction systems and agent-based systems.	4	
CO7	Analyzing problems of different agent-based systems	4	

Syllabus

Introduction what is an agent agents and objects agents and expert systems agents and distributed systems; typical application areas for agent systems. Trends in modern (distributed) computing. Origins of Multiagent design. Agent Design and Society Design. Approaches to Agent-Oriented Design. Agent properties. Environment properties. Agent types and architectures

Intelligent Agents: the design of intelligent agents - reasoning agents, agents as reactive systems; hybrid agents; layered agents, a contemporary (Java-based) framework for programming agents. Learning from examples, discovery as learning, Learning by analogy, explanation based learning, neural nets, genetic algorithms. Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems.

Intelligent Agents: the design of intelligent agents - reasoning agents, agents as reactive systems; hybrid agents; layered agents, a contemporary (Java-based) framework for programming agents. Learning from examples, discovery as learning, Learning by analogy, explanation based learning, neural nets, genetic algorithms. Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems.

Interactions between benevolent agents: cooperative distributed problem solving (CDPS), partial global planning; coherence and coordination; Interaction languages and protocols: speech acts, KQML/KIF, the FIPA framework. Applications of Agent-Oriented Design. Agent-Oriented Design, Electronic Negotiation Support, Flexible Dynamic Web services, Multi-robotic environments. Current trends in Software engineering. Agent-Oriented Software Engineering. Agent-Oriented Methodologies. The GAIA Methodology

Multi-Agent Systems: Classifying multi-agent interactions cooperative versus non-cooperative; zero-sum and other interactions what is cooperation how cooperation occurs the Prisoners dilemma and Axelrod's experiments.

Reference Books

- 1 An Introduction to MultiAgent Systems , Michael Wooldridge , 2019 , Wiley.

- 2 Programming Multi-agent Systems in AgentSpeak Using Jason, Kevin Leyton-Brown, 2010, Wiley .
- 3 Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham and Kevin Leyton-Brown., 2009, Cambridge University Plus.
- 4 Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, Gerhard Weiss, 2021, The MIT Press.
- 5 Principles of Multi-Agent Systems, Davide Calvaresi, Amleto Di Salle, Antonio Santini, 2021, Springer.

23DLA3304R - MULTI AGENT SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3304R	MULTI AGENT SYSTEMS	MAS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and apply notion of an agent, how agents are distinct from other software paradigms (eg objects) and understand & apply the characteristics of applications that lend themselves to an agent-oriented solution	2	PO1, PO5, PSO1
CO2	Analyze the key issues associated with constructing agents capable of intelligent autonomous action, and the main approaches taken to developing such agents	3	PO2, PO5, PSO2
CO3	Analyze the key issues in designing societies of agents that can effectively cooperate in order to solve problems, including an understanding of the key types of multi-agent interactions possible in such systems	3	PO2, PO5, PSO1
CO4	Examine the main application areas of agent-based solutions, and be able to develop a meaningful agent-based system using a contemporary agent development platform.	4	PO1, PO5, PSO2
CO5	Analyzing agent behavior, Automated planning, evaluating agent interaction systems and agent-based systems.	4	PO2, PO5, PSO1
CO6	Analyzing problems of different agent-based systems	4	PO1, PO5, PSO2

Syllabus

Introduction: what is an agent agents and objects; agents and expert systems; agents and distributed systems; typical application areas for agent systems. Trends in modern (distributed) computing. Origins of Multiagent design. Agent Design and Society Design. Approaches to Agent-Oriented Design. Agent properties. Environment properties. Agent types and architectures

Intelligent Agents: the design of intelligent agents - reasoning agents, agents as reactive systems; hybrid agents; layered agents, a contemporary (Java-based) framework for programming agents. Learning from examples, discovery as learning, Learning by analogy, explanation based learning, neural nets, genetic algorithms. Principles of Natural language processing, rule based systems architecture, Expert systems, knowledge acquisition concepts, AI application to robotics, and current trends in intelligent systems

Multi-Agent Systems: Classifying multi-agent interactions - cooperative versus non-cooperative; zero-sum and other interactions; what is cooperation how cooperation occurs - the Prisoners dilemma and Axelrods experiments; Interactions between self-interested agents: auctions & voting systems: negotiation

Interactions between benevolent agents: cooperative distributed problem solving (CDPS), partial global planning; coherence and coordination; Interaction languages and protocols: speech acts, KQML/KIF, the FIPA framework. Applications of Agent-Oriented Design. Agent-Oriented Design, Electronic Negotiation Support, Flexible Dynamic Web services, Multi-robotic environments. Current trends in Software engineering. Agent-Oriented Software Engineering. Agent-Oriented Methodologies. The GAIA Methodology

Reference Books

- 1 An Introduction to MultiAgent Systems , Michael Wooldridge , 2019, Wiley .
- 2 Programming Multi-agent Systems in AgentSpeak Using Jason, Shoham, 2010, Wiley .
- 3 Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Yoav Shoham and Kevin Leyton-Brown. , 2009, Cambridge University Press .
- 4 Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, Gerhard Weiss, 2018, The MIT Press.

- 5 Principles of Multi-Agent Systems, Davide Calvaresi, Amleto Di Salle, Antonio Santini, 2021, spinger.

23DLA3405M - BLOCKCHAIN ANALYTICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3405M	BLOCKCHAIN ANALYTICS	BCA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of blockchain technology, including its architecture, mechanisms, and key features.	2	PO2, PSO1
CO2	Explore and analyze various applications of blockchain technology across different industries.	2	PO2, PO3, PO5, PSO1
CO3	Utilize appropriate tools and techniques to collect, analyze, and visualize blockchain data.	4	PO3, PSO2
CO4	Analyze blockchain analytics concepts and methodologies to solve real-world problems and case studies.	4	PO5, PO6

Syllabus

Introduction to blockchain technology, Components of a blockchain: blocks, transactions, nodes, Types of blockchains: public, private, consortium, Consensus mechanisms: Proof of Work, Proof of Stake, Use cases of blockchain technology

Data collection from blockchain networks, Data preprocessing techniques for blockchain data, Visualization techniques for blockchain data analysis, Network analysis of blockchain transactions, Security and privacy considerations in blockchain data analysis

Statistical analysis of blockchain data, Pattern recognition and anomaly detection in blockchain transactions, Predictive modeling using blockchain data, Case studies and real-world examples of blockchain analytics, Ethical considerations in interpreting blockchain analytics results

Regulatory compliance and forensic investigations using blockchain analytics, Supply chain management and traceability with blockchain analytics, Fraud detection and prevention in blockchain ecosystems, Cryptocurrency market analysis using blockchain analytics, Future trends and advancements in blockchain analytics

Reference Books

- 1 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S., ISBN: 978-0691171692, Princeton University Press.
- 2 Mastering Bitcoin: Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, ISBN: 978-1491954386, O'Reilly Media.
- 3 Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World, Don Tapscott, Alex Tapscott, ISBN: 978-1-101-98118-4, Portfolio.
- 4 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Imran Bashir, ISBN-13: 978-1788839044, Packt Publishing.

23DLA3406M - CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3406M	CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGY	CBT	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to basics of blockchain technologies and cryptographic mechanisms	2	PO1, PSO1
CO2	Applying consensus and transactions done using bitcoin platforms	3	PO1, PO2
CO3	Applying smart contracts and proof of work using bitcoin, ethereum and ethereum virtual machine	3	PO2, PO3
CO4	Analyzing vulnerabilities and attacks and identification of bugs	4	PO3, PSO1

Syllabus

Introduction to Cryptocurrencies and Blockchain :History of money and digital currencies Basics of blockchain technology Bitcoin as the first cryptocurrency, Cryptographic Basics:Encryption and decryption Hash functions Digital Bitcoin: How Bitcoin works Mining and consensus mechanisms Wallets and transactions, Altcoins and Tokens: Introduction to altcoins Token standards ,ERC-20, ERC-721,Use cases for tokens

Blockchain Technology: Consensus algorithms (e.g., Proof of Work, Proof of Stake) Smart contracts and decentralized applications (DApps) Scalability and blockchain interoperability, Ethereum: Introduction to Ethereum Ethereum Virtual Machine (EVM) Solidity programming basics

Blockchain Security Common security vulnerabilities,51% attacks, smart contract bugs, Best practices for securing cryptocurrencies and wallets Regulatory and compliance issues, Blockchain Use Cases: Supply chain management Identity management Voting systems

Reference Books

- 1 Mastering Bitcoin, Andreas M. Antonopoulos, 2014, O'reilly.
- 2 Blockchain Basics, Daniel Drescher, 2017, Apress.
- 3 Blockchain Revolution, Don Tapscott and Alex Tapscott, 2016, Portfolio Penguin.
- 4 Blockchain Basics: A Simple Introduction, Lee Sebastian, 2020, O'reilly.

23DLA3507 - DISTRIBUTED LEDGER ARCHITECTURE FOR AUTOMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3507	DISTRIBUTED LEDGER ARCHITECTURE FOR AUTOMATION	DLAA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of distributed ledger technology (DLT) and its applications in automation.	2	PO1, PO2, PSO1
CO2	Analyze different distributed ledger architectures and their suitability for various automation scenarios.	4	PO1, PO2, PSO1
CO3	Analyze the requirements and components necessary for distributed ledger solutions to address automation problems.	4	PO5, PSO2
CO4	Evaluate the security, scalability, and performance aspects of distributed ledger architectures in automation systems.	5	PO5, PO12, PSO2

Syllabus

Definition and Characteristics of Distributed Ledger Technology (DLT): Immutable Ledger, Decentralization, Consensus Mechanisms, Historical Overview and Evolution of DLT: Pre-Bitcoin Era, Emergence of Bitcoin and Blockchain, Evolution of DLT beyond Blockchain, Types of DLT: Blockchain, Directed Acyclic Graphs (DAGs), Hashgraph, Components of DLT: Nodes, Transactions, Consensus Mechanisms, Proof of Work (PoW), Proof of Stake (PoS), Practical Byzantine Fault Tolerance (PBFT)

Blockchain Architecture: Public vs. Private Blockchains, Examples: Bitcoin, Ethereum, Hyperledger, DAG Architecture: Tangle Structure, Properties: Scalability, Transaction Speed, Hashgraph Architecture: Gossip about Gossip, Virtual Voting, Comparison of Architectures: Scalability, Security, Consensus Mechanisms

Smart Contracts: Definition and Features, Programming Languages for Smart Contracts, Use Cases: Decentralized Applications (DApps), Supply Chain Management using DLT: Traceability and Transparency, Examples: IBM Food Trust, VeChain, Identity Management and Authentication: Self-Sovereign Identity, Decentralized Identity Platforms, Decentralized Finance (DeFi) Applications: Decentralized Exchanges (DEX), Yield Farming, Stable coins

Security Challenges in DLT: Consensus Attacks, 51% Attacks, Sybil Attacks, Scalability Issues and Solutions: Sharding, Layer 2 Solutions (Lightning Network, Raiden Network), Performance Metrics: Throughput, Latency, Transaction Finality, Case Studies and Real-World Examples: Ethereum DAO Hack, Cryptocurrency Exchange Hacks, Performance Comparisons (Bitcoin vs. Ethereum vs. Others)

Reference Books

- 1 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Imran Bashir, ISBN: 978-1787125445, Packt Publishing.
- 2 Blockchain Applications: A Hands-On Approach, Arshdeep Bahga and Vijay Madiseti, ISBN: 978-0996025555, VPT; 1st edition.
- 3 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Arvind Narayanan, ISBN: 978-0691171692, Princeton University Press.
- 4 Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies is Changing the World, Don Tapscott and Alex Tapscott, ISBN-13: 978-1101980132, Portfolio.

23DLA3508 - PERMISSIONED DISTRIBUTED LEDGER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DLA3508	PERMISSIONED DISTRIBUTED LEDGER	PDL	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Course Outcome 1: Knowledge and Understanding Describe the foundational concepts and principles of permissioned distributed ledger technology (PDL). Explain the differences between permissioned and permissionless distributed ledgers. Identify the components of a permissioned ledger network and their functions.	1	PO1, PO2, PSO2
CO2	Course Outcome 2: Application and Analysis Analyze various permissioned ledger architectures, including consensus mechanisms and cryptographic protocols. Evaluate the potential applications of permissioned distributed ledgers across different industries. Critically assess the security, privacy, and scalability challenges associated with permissioned distributed ledgers.	2	PO1, PO2, PSO2
CO3	Course Outcome 3: Synthesis and Creation Develop hands-on skills in deploying and managing permissioned ledger networks using frameworks like Hyperledger Fabric, Corda, etc. Design and program smart contracts for specific business logic and use cases. Synthesize theoretical knowledge with practical implementation to solve real-world problems in permissioned distributed ledger technology.	3	PO1, PO2, PSO2
CO4	Course Outcome 4: Evaluation and Reflection Evaluate the effectiveness of different consensus mechanisms and cryptographic protocols in permissioned ledger networks. Reflect on the ethical and regulatory implications of using permissioned distributed ledgers in various industries. Assess the strengths and limitations of permissioned distributed ledger technology in comparison to other DLTs and traditional systems.	4	PO1, PO2, PSO2

Syllabus

Introduction to Distributed Ledger Technology Overview of distributed ledger technology (DLT) Characteristics and advantages of distributed ledgers Types of DLT: Permissioned vs. permissionless; Permissioned Ledger Architecture Components of a permissioned ledger network Overview of permissioned ledger frameworks (e.g., Hyperledger Fabric, Corda) Consensus mechanisms: Practical Byzantine Fault Tolerance (PBFT), Raft, etc.

Cryptography in Permissioned Ledgers Cryptographic primitives in permissioned ledger systems Digital signatures, hash functions, and cryptographic hashing Privacy-enhancing techniques: Zero-knowledge proofs, ring signatures, etc.; Smart Contracts and Business Logic Introduction to smart contracts Programming smart contracts: Solidity, Chaincode, etc. Use cases and examples of smart contract applications in permissioned ledgers

Security and Privacy Security challenges in permissioned ledger networks Access control and identity management Privacy considerations and confidentiality in permissioned ledgers; Scalability and Performance Scalability challenges in permissioned ledger networks Techniques for improving transaction throughput and latency Case studies of scalable permissioned ledger implementations

Real-world Applications Overview of permissioned ledger projects in finance, supply chain, healthcare, etc. Case studies of successful implementations Future trends and opportunities in permissioned distributed ledger technology; Hands-on Workshop Setting up a permissioned ledger network using a chosen framework Deploying smart contracts and interacting with the network Simulating real-world scenarios and conducting performance tests

Reference Books

- 1 Blockchains in 6G: A Standardized Approach To Permissioned Distributed Ledgers, Mischa Dohler, Carmen Lopez, and Wei Wang, 1st, River Publishers .
- 2 Blockchain Science: Distributed Ledger Technology, Roger Wattenhofer, 1st, CreateSpace Independent Publishing Platform .

- 3 Permissioned Blockchain Technologies for Academic Publishing, Javier Ignacio Jimenez, 1st, IntechOpen.
- 4 Permissioned Distributed Ledgers and the Governance of Money, Mischa Dohler, Juan M. Lopez, Kan Zhang, Tao Wang, 1st, ResearchGate.

23DSB3101A - DATA ANALYTICS AND VISUALIZATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3101A	DATA ANALYTICS AND VISUALIZATION	DAV	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Data Science and its application.	3	PO1, PO2
CO2	Apply various statistical tools for testing hypothesis.	3	PO1, PO2
CO3	Apply Python concepts like Numpy and pandas to handle data.	3	PO1, PO2
CO4	Apply visualization techniques for graphical representation of data	3	PO1, PO2
CO5	Apply advanced Visualization techniques	3	PO1, PO2
CO6	Analyzing Data through Python Visualization Techniques	4	PO1, PO2
CO7	Analyzing data through visualization Tool Tableau	4	PO1, PO2

Syllabus

Introduction AI, Machine Learning and Data Science, What is data Science Extracting Meaningful patterns, Building representative models, Combination of Statistics, Machine Learning and Computing, Learning Algorithms, Associated fields, Data Science Classification, Data objects and Attribute Types, Measuring Data similarity and dissimilarity Data Collection and Data PreProcessing overview Data Cleaning Data Integration and Transformation Data Reduction Data Discretization

Descriptive Statistics Sampling Techniques Data Classification Measures of Central Tendency Measures of Variation Quartiles and Percentiles Moments Skewness and Kurtosis Exploratory Data Analytics Descriptive Statistics Mean, Mode, and Standard Deviation Box Plots Pivot Table Heat Map Correlation Statistics ANOVA

Data Wrangling with NumPy and Pandas Python list vs NumPy arrays Whats the Difference Creating a NumPy Array, Shape and Reshaping of NumPy Array, Indexing and Slicing of NumPy Array, Stacking and Concatenating NumPy Arrays, Broadcasting in NumPy Arrays, Time series, Sorting in NumPy Arrays, Pandas Series, Data Frame, indexing, sorting, loading data from CSV, Aggregation, concatenation.

Visualization and simple metrics Data Analytics Communication, Data Types for Plotting Data Types and Plotting, Simple Line Plots, Simple Scatter Plots, Visualizing Errors, Density and Contour Plots, Histograms, Binnings, and Density

Customizing Plot Legends, Customizing Colour bars, Multiple Subplots, Text and Annotation, Customizing Ticks

Reference Books

- 1 The Data Science Handbook, Field Cady, 1, Wiley Book .
- 2 Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython, Wes Mc Kinney, 2, O Reilly.
- 3 Statistical inference for data science, Brian Caffo, 1, Global Edition Leanpub.

23DSB3101E - DATA ANALYTICS AND VISUALIZATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3101E	DATA ANALYTICS AND VISUALIZATION	DAV	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize basic concepts of Data Science and its application.	3	PO1, PO2
CO2	Choose various statistical tools for testing hypothesis.	3	PO1, PO2
CO3	Apply Python concepts like Numpy and pandas to handle data.	3	PO1, PO2
CO4	Apply visualization techniques for graphical representation of data	3	PO1, PO2
CO5	Apply advanced visualization techniques	4	PO1, PO2
CO6	Analyzing Data through Python Visualization Techniques	4	PO1, PO2
CO7	Analyzing data through visualization Tool Tableau	4	PO1, PO2

Syllabus

Introduction AI, Machine Learning and Data Science, What is data Science Extracting Meaningful patterns, Building representative models, Combination of Statistics, Machine Learning and Computing, Learning Algorithms, Associated fields, Data Science Classification, Data objects and Attribute Types, Measuring Data similarity and dissimilarity Data Collection and Data PreProcessing overview Data Cleaning Data Integration and Transformation Data Reduction Data Discretization

Descriptive Statistics Sampling Techniques Data Classification Measures of Central Tendency Measures of Variation Quartiles and Percentiles Moments Skewness and Kurtosis Exploratory Data Analytics Descriptive Statistics Mean, Mode, and Standard Deviation Box Plots Pivot Table Heat Map Correlation Statistics ANOVA

Data Wrangling with NumPy and Pandas Python list vs NumPy arrays Whats the Difference Creating a NumPy Array, Shape and Reshaping of NumPy Array, Indexing and Slicing of NumPy Array, Stacking and Concatenating NumPy Arrays, Broadcasting in NumPy Arrays, Time series, Sorting in NumPy Arrays, Pandas Series, Data Frame, indexing, sorting, loading data from CSV, Aggregation, concatenation, group by

Visualization and simple metrics Data Analytics Communication, Data Types for Plotting Data Types and Plotting, Simple Line Plots, Simple Scatter Plots, Visualizing Errors, Density and Contour Plots, Histograms, Binnings, and Density

Customizing Plot Legends, Customizing Colour bars, Multiple Subplots, Text and Annotation, Customizing Ticks

Reference Books

- 1 The Data Science Handbook, Field Cady, 1, Wiley Book.
- 2 Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython, Wes Mc Kinney, 2, O Reilly.
- 3 Statistical inference for data science, Brian Caffo, 1, Global Edition Leanpub.
- 4 Visual Analytics with Tableau, Alexander Loth, Nate Vogel, Sophie Sparkes, 1, Wiley.

23DSB3101R - DATA ANALYTICS AND VISUALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3101R	DATA ANALYTICS AND VISUALIZATION	DAV	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize basic concepts of Data Science and its application.	2	PO1, PO2
CO2	Apply various statistical tools for testing hypothesis.	3	PO1, PO2
CO3	Apply Python concepts like Numpy and pandas to handle data.	3	PO1, PO2
CO4	Apply visualization techniques for graphical representation of data	3	PO1, PO2
CO5	Analyzing Data through Python Visualization Techniques	4	PO1, PO2
CO6	Analyzing data through visualization Tool Tableau	4	PO1, PO2

Syllabus

Introduction AI, Machine Learning and Data Science, What is data Science Extracting Meaningful patterns, Building representative models, Combination of Statistics, Machine Learning and Computing, Learning Algorithms, Associated fields, Data Science Classification, Data objects and Attribute Types, Measuring Data similarity and dissimilarity Data Collection and Data PreProcessing overview Data Cleaning Data Integration and Transformation Data Reduction Data Discretization

Descriptive Statistics Sampling Techniques Data Classification Measures of Central Tendency Measures of Variation Quartiles and Percentiles Moments Skewness and Kurtosis Exploratory Data Analytics Descriptive Statistics Mean, Mode, and Standard Deviation Box Plots Pivot Table Heat Map Correlation Statistics ANOVA

Data Wrangling with NumPy and Pandas Python list vs NumPy arrays Whats the Difference Creating a NumPy Array, Shape and Reshaping of NumPy Array, Indexing and Slicing of NumPy Array, Stacking and Concatenating NumPy Arrays, Broadcasting in NumPy Arrays, Time series, Sorting in NumPy Arrays, Pandas Series, Data Frame, indexing, sorting, loading data from CSV, Aggregation, concatenation, group by

Visualization and simple metrics Data Analytics Communication, Data Types for Plotting Data Types and Plotting, Simple Line Plots, Simple Scatter Plots, Visualizing Errors, Density and Contour Plots, Histograms, Binnings, and Density

Reference Books

- 1 The Data Science Handbook, Field Cady, 1, Wiley Book.
- 2 Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython, Wes Mc Kinney, 2, O Reilly.
- 3 Statistical inference for data science, Brian Caffo, 1, Global Edition Leanpub.
- 4 Visual Analytics with Tableau, Alexander Loth , Nate Vogel, Sophie Sparkes, 1, wiley.

23DSB3202A - DATA WAREHOUSING AND MINING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3202A	DATA WAREHOUSING AND MINING	DWHM	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand data warehousing, mining, OLAP vs. OLTP, along with multidimensional modeling and analysis techniques.	2	PO1, PSO1
CO2	Interpret Knowledge Discovery in Databases (KDD), dives into data structure, equips you with statistical analysis methods, and introduces data cleaning and regression techniques for extracting insights from data.	3	PO1, PO2, PSO1
CO3	Apply Different Classification Algorithms to Segregate Input data into different class levels and find out Hidden relationship between transactional dataset using Association Rule Mining.	3	PO2
CO4	Analyse different Clustering Models using the predefined dataset.	4	PO5
CO5	Analyse complex data (time series, sequences, graphs), new methodologies, societal impacts, and applications.	4	PO5

Syllabus

Knowledge Discovery in Databases (KDD), dives into data structure, equips you with statistical analysis methods, and introduces data cleaning and regression techniques for extracting insights from data.

KDD, Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Descriptive Data Summarization & Data Preprocessing (Introduction), Data Preprocessing Methods, Simple Regression Analysis, Multiple Regression Analysis "

Data Mining Techniques (Association Rules Outer detection Sequential Pattern, Prediction), Classification by Decision Tree Induction, Bayesian Classification, Back Propagation, Association Rule Mining, Rule-based Classification, Support Vector Machine (SVM), Understanding Accuracy of Classification

Supervised Vs Unsupervised learning, Clustering Methods, Partitioning Methods, Hierarchical Clustering, Density-Based Clustering Methods, Grid-Based Methods.

Data Mining Trends and Research Frontiers, Mining Complex Data Types, Mining Sequence Data: Time-Series, Symbolic Sequences, and Biological Sequences, Mining Graphs and Networks, Mining Other Kinds of Data, Other Methodologies of Data Mining, Data Mining Applications, Data Mining and Society, Data Mining Trends

Reference Books

- 1 Data Mining: Concepts and Techniques , Han J & Kamber M , Third Edition, 2012, Elsevier .
- 2 Introduction to Data Mining , Pang-Ning Tan, Michael Steinback, Vipin Kumar , Second Edition, 2005, Pearson Education .
- 3 Data Warehousing: Architecture and Implementation , M. Humphires, M. Hawkins, M. Dy , Second Edition, 1998, Pearson Education .
- 4 Data Warehousing in the Real World , Anahory, Murray, , Second Edition, 1997, Pearson Education.
- 5 Data Mining: Next Generation Challenges and Future Directions , Kargupta, Joshi , First Edition, 2004, Prentice Hall of India Pvt Ltd .

23DSB3202E - DATA WAREHOUSING AND MINING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3202E	DATA WAREHOUSING AND MINING	DWHM	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand data warehousing, mining, OLAP vs. OLTP, along with multidimensional modeling and analysis techniques.	2	PO1, PSO1
CO2	Interpret Knowledge Discovery in Databases (KDD), dives into data structure, equips you with statistical analysis methods, and introduces data cleaning and regression techniques for extracting insights from data.	3	PO1, PO2, PSO1
CO3	Apply Different Classification Algorithms to Segregate Input data into different class levels and find out Hidden relationship between transactional dataset using Association Rule Mining.	3	PO2
CO4	Analyse different Clustering Models using the predefined dataset.	4	PO5
CO5	Analyse complex data (time series, sequences, graphs), new methodologies, societal impacts, and applications.	4	PO5

Syllabus

Knowledge Discovery in Databases (KDD), dives into data structure, equips you with statistical analysis methods, and introduces data cleaning and regression techniques for extracting insights from data.

KDD, Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Descriptive Data Summarization & Data Preprocessing (Introduction), Data Preprocessing Methods, Simple Regression Analysis, Multiple Regression Analysis "

Data Mining Techniques (Association Rules Outer detection Sequential Pattern, Prediction), Classification by Decision Tree Induction, Bayesian Classification, Back Propagation, Association Rule Mining, Rule-based Classification, Support Vector Machine (SVM), Understanding Accuracy of Classification

Supervised Vs Unsupervised learning, Clustering Methods, Partitioning Methods, Hierarchical Clustering, Density-Based Clustering Methods, Grid-Based Methods.

Data Mining Trends and Research Frontiers, Mining Complex Data Types, Mining Sequence Data: Time-Series, Symbolic Sequences, and Biological Sequences, Mining Graphs and Networks, Mining Other Kinds of Data, Other Methodologies of Data Mining, Data Mining Applications, Data Mining and Society, Data Mining Trends

Reference Books

- 1 Data Mining: Concepts and Techniques, Han J & Kamber M, Third Edition, 2012, Elsevier.
- 2 Introduction to Data Mining, Pang-Ning Tan, Michael Steinback, Vipin Kumar, Second Edition, 2005, Pearson Education.
- 3 Data Warehousing: Architecture and Implementation, M. Humphries, M. Hawkins, M. Dy, Second Edition, 1998, Pearson Education.
- 4 Data Warehousing in the Real World, Anahory, Murray, Second Edition, 1997, Pearson Education.
- 5 Data Mining: Next Generation Challenges and Future Directions, Kargupta, Joshi, First Edition, 2004, Prentice Hall of India Pvt Ltd.

23DSB3202R - DATA WAREHOUSING AND MINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3202R	DATA WAREHOUSING AND MINING	DWHM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand data warehousing, mining, OLAP vs. OLTP, along with multidimensional modeling and analysis techniques.	2	PO1, PSO1
CO2	Interpret Knowledge Discovery in Databases (KDD), dives into data structure, equips you with statistical analysis methods, and introduces data cleaning and regression techniques for extracting insights from data.	3	PO1, PO2, PSO1
CO3	Apply Different Classification Algorithms to Segregate Input data into different class levels and find out Hidden relationship between transactional dataset using Association Rule Mining.	3	PO2, PO5
CO4	Analyse different Clustering Models using the predefined dataset.	4	PO5

Syllabus

Introduction to Data Warehouse and Mining, OLAP Vs. OLTP, Architecture and OLAP Server Types, Multidimensional Cubes and Concept Hierarchy, Data Cube Computation Methods, Sampling and Ranking Methods, Multi Dimensional Modeling, Attribute Oriented Induction

KDD, Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Descriptive Data Summarization & Data Preprocessing (Introduction), Data Preprocessing Methods, Simple Regression Analysis, Multiple Regression Analysis

Data Mining Techniques (Association Rules, Outlier detection, Sequential Pattern, Prediction), Classification by Decision Tree Induction, Bayesian Classification, Back Propagation, Association Rule Mining, Rule-based Classification, Support Vector Machine (SVM), Understanding Accuracy of Classification

Supervised Vs Unsupervised learning, Clustering Methods, Partitioning Methods, Hierarchical Clustering, Density-Based Clustering Methods, Grid-Based Methods.

Reference Books

- 1 Data Mining: Concepts and Techniques, Han J & Kamber M, Third Edition, 2012, Elsevier.
- 2 Introduction to Data Mining, Pang-Ning Tan, Michael Steinback, Vipin Kumar, Second Edition, 2005, Pearson Education.
- 3 Data Warehousing: Architecture and Implementation, M. Humphries, M. Hawkins, M. Dy, Second Edition, 1997, Pearson Education.
- 4 Data Warehousing in the Real World, Anahory, Murray, Second Edition, 1998, Pearson Education.
- 5 Data Mining: Next Generation Challenges and Future Directions, Kargupta, Joshi, First Edition, 2004, Prentice Hall of India Pvt Ltd.

23DSB3303A - BIG DATA ANALYTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3303A	BIG DATA ANALYTICS	BDA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of big data, Initial exploration of analysis of data and Data visualization.	2	PO3, PO5, PO6, PSO2
CO2	Apply Initial exploration of data and advanced data analytics by using R	3	PO3, PO5, PO6, PSO2
CO3	Apply advanced algorithms & Statistical modeling for big data using HDFS, HIVE, and PIG.	3	PO3, PO5, PO6, PSO1
CO4	Analyze advanced SQL functions for in-database analytics by MADlib, Greenplum along with common deliverables of analytics life cycle project	4	PO3, PO5, PO6, PSO1
CO5	Analyze query performance and optimize MongoDB queries using indexes, projections, and query planning.	4	PO3, PO5, PO6, PSO2
CO6	Build and Evaluate the Big Data Analytical problems using R, Hadoop, HIVE Programming concepts.	6	PO3, PO5, PO6, PSO2
CO7	Develop innovative solutions to big data challenges using advanced analytics techniques.	6	PO3, PO5, PO6, PSO2

Syllabus

Introduction to Big Data Analytics: Big Data Overview, State of the Practice of Analytics, Big Data Analytics in Industry Verticals. It also covers Overview of Data Analytics Lifecycle, Discovery, Data Preparation, Model Planning, Model Building, Communicating Results and Findings, Operationalizing. Initial Analysis of the Data: Initial Exploration and Analysis of the Data, Basic Data Visualization. Basic data analytics, reporting, and apply basic data visualization techniques to your data. Apply basic analytics methods such as distributions, statistical tests and summary operations, and differentiate between results that are statistically sound vs. statistically significant. Identify a model for your data and define the null and alternative hypothesis. Experimentation and demonstration of initial analysis of data using R

Initial hypotheses; and the data's structure and volume. Apply some of the more methods in Analytics solutions, algorithms and the technical foundations for the methods. The environment (use case) in which each technique can provide the most value. Use appropriate diagnostic methods to validate the models created Use R and in-database analytical functions to fit, score and evaluate models. Advanced Analytics and Statistical Modeling for Big Data

Technology & Tools: Tool to Perform Analytic on Unstructured data using Map Reduce Programming paradigm. Use Hadoop, HDFS, HIVE, PIG and other products in the Hadoop eco system for unstructured data analytics. Effectively use advanced SQL functions and Greenplum extensions for in-database analytics.

Use MADlib to solve analytics problems in-database. Endgame - Operationalizing an Analytics Project: Tasks needed to operationalize an analytics project. Four common deliverables of an analytics life cycle project meet the needs of key stakeholders. Use a framework for creating final presentations for sponsors and analysts. Evaluate data visualization and identify ways to improve it. Apply these concepts to a big data analytics problem in the final lab.

Lab/Practical Programs and Skill Exercises designed in that semester

Reference Books

- 1 Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services 2014, EMC Education Services, 2014, EMC Education Services 2014.
- 2 MapReduce Design Patterns, Donald Mine, 2012, O'Reilly.

- 3 Rfor Business Analytics, Ohri, 2012, Springer.
- 4 Statistical Modeling and Analysis for Database Marketing:EffectiveTechniquesforMiningBigData, BruceRatner, 2003, ChapmanandHall/CRC.

23DSB3303E - BIG DATA ANALYTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3303E	BIG DATA ANALYTICS	BDA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	build query performance and optimize MongoDB queries using indexes, projections, and query planning.	2	PO3, PO5, PO6, PSO2
CO2	build Initial exploration of data and advanced data analytics by using R	3	PO3, PO5, PO6, PSO2
CO3	Build and Evaluate the Big Data Analytical problems using R	3	PO3, PO5, PO6, PSO1
CO4	create advanced SQL functions for in-database analytics by MADlib, Greenplum along with common deliverables of analytics life cycle project	4	PO3, PO5, PO6, PSO1
CO5	Analyze query performance and optimize Mongo DB queries using indexes, projections, and query planning.	4	PO3, PO5, PO6, PSO2
CO6	Build and Evaluate the Big Data Analytical problems using R, Hadoop, HIVE Programming concepts.	5	PO3, PO5, PO6, PSO2
CO7	Develop innovative solutions to big data challenges using advanced analytics techniques.	5	PO3, PO5, PO6, PSO2

Syllabus

Introduction to Big Data Analytics: Big Data Overview, State of the Practice of Analytics, Big Data Analytics in Industry Verticals. It also covers Overview of Data Analytics Lifecycle, Discovery, Data Preparation, Model Planning, Model Building, Communicating Results and Findings, Operationalizing. Initial Analysis of the Data: Initial Exploration and Analysis of the Data, Basic Data Visualization. Basic data analytics, reporting, and apply basic data visualization techniques to your data. Apply basic analytics methods such as distributions, statistical tests and summary operations, and differentiate between results that are statistically sound vs. statistically significant. Identify a model for your data and define the null and alternative hypothesis. Experimentation and demonstration of initial analysis of data using R

Initial hypotheses; and the data's structure and volume. Apply some of the more methods in Analytics solutions, algorithms and the technical foundations for the methods. The environment (use case) in which each technique can provide the most value. Use appropriate diagnostic methods to validate the models created Use R and in-database analytical functions to fit, score and evaluate models. Advanced Analytics and Statistical Modeling for Big Data

Technology & Tools: Tool to Perform Analytic on Unstructured data using Map Reduce Programming paradigm. Use Hadoop, HDFS, HIVE, PIG and other products in the Hadoop eco system for unstructured data analytics, Effectively use advanced SQL functions and Greenplum extensions for in-database analytics

Use MADlib to solve analytics problems in-database. Endgame - Operationalizing an Analytics Project: Tasks needed to operationalize an analytics project. Four common deliverables of an analytics life cycle project meet the needs of key stakeholders. Use a framework for creating final presentations for sponsors and analysts. Evaluate data visualization and identify ways to improve it. Apply these concepts to a big data analytics problem in the final lab

Lab/Practical Programs and Skill Exercises designed in that semester

Reference Books

- 1 Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, 2014, EMC Education Services.
- 2 Practical Data Science with R, Nina Zumel, 2014, John Mount-Manning Publications.

- 3 BigDataAnalyticswithR and Hadoop, Vignesh Prajapati, 2013, Packt Publishing.
- 4 Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, Nathan Marz and James Warren, 1st Edition (2015), Manning Publications.

23DSB3303R - BIG DATA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3303R	BIG DATA ANALYTICS	BDA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of big data, Initial exploration of analysis of data and Data visualization.	2	PO1, PO4, PO5, PSO2
CO2	Understand Initial exploration of data and advanced data analytics by using R	2	PO2, PO3, PO5, PSO2
CO3	Apply advanced algorithms & Statistical modeling for big data using HDFS, HIVE, and PIG.	3	PO2, PO3, PO5, PSO1
CO4	Apply advanced SQL functions for in-database analytics by MADlib, Greenplum along with common deliverables of analytics life cycle project	3	PO1, PO2, PO5, PSO1
CO5	Analyze query performance and optimize MongoDB queries using indexes, projections, and query planning.	4	PO3, PO4, PO5, PSO2
CO6	Build and Evaluate the Big Data Analytical problems using R, Hadoop, HIVE Programming concepts.	6	PO3, PO4, PO5, PSO2

Syllabus

Introduction to Big Data Analytics: Big Data Overview, State of the Practice of Analytics, Big Data Analytics in Industry Verticals. It also covers Overview of Data Analytics Lifecycle, Discovery, Data Preparation, Model Planning, Model Building, Communicating Results and Findings, Operationalizing. Initial Analysis of the Data: Initial Exploration and Analysis of the Data, Basic Data Visualization. Basic data analytics, reporting, and apply basic data visualization techniques to your data. Apply basic analytics methods such as distributions, statistical tests and summary operations, and differentiate between results that are statistically sound vs. statistically significant. Identify a model for your data and define the null and alternative hypothesis. Experimentation and demonstration of initial analysis of data using R

Initial hypotheses; and the data's structure and volume. Apply some of the more methods in Analytics solutions, algorithms and the technical foundations for the methods. The environment (use case) in which each technique can provide the most value. Use appropriate diagnostic methods to validate the models created Use R and in-database analytical functions to fit, score and evaluate models. Advanced Analytics and Statistical Modeling for Big Data

Technology & Tools: Tool to Perform Analytic on Unstructured data using Map Reduce Programming paradigm. Use Hadoop, HDFS, HIVE, PIG and other products in the Hadoop eco system for unstructured data analytics, Effectively use advanced SQL functions and Greenplum extensions for in-database analytics

Use MADlib to solve analytics problems in-database. Endgame - Operationalizing an Analytics Project: Tasks needed to operationalize an analytics project. Four common deliverables of an analytics life cycle project meet the needs of key stakeholders. Use a framework for creating final presentations for sponsors and analysts. Evaluate data visualization and identify ways to improve it. Apply these concepts to a big data analytics problem in the final lab

Reference Books

- 1 Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Service, 2014, EMC Education Service.
- 2 MapReduce Design Patterns, Donald Miner, 2012, O'Reilly .
- 3 Big Data Analytics with R and Hadoop, Vignesh Prajapati, 2013, Packt Publishing.
- 4 Agile data science: building data analytics applications with Hadoop, Russell Journey, 2013, O'Reilly Media.

23DSB3404M - BIG DATA OPTIMIZATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3404M	BIG DATA OPTIMIZATION	BDO	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Optimization methods and analytics using R	2	PO1, PO2, PO3, PO4, PSO1, PSO2
CO2	Apply blind search and local search methods for solving optimization problems	3	PO1, PO2, PO3, PO4, PSO1, PSO2
CO3	Analyze and compare population-based search methods for solving real world problems	4	PO1, PO2, PO3, PO4, PSO1, PSO2
CO4	Examine the applications of genetic programming to solve problems like Travelling Salesman Problem and advanced Nature inspired optimization techniques.	4	PO1, PO2, PO3, PO4, PSO1, PSO2

Syllabus

Introduction: Motivation, Why R, Representation of a Solution , Evaluation Function , Constraints , Optimization Methods , Demonstrative Problems Foundation of r -R Basics: Introduction Basic Objects and Functions, data structures, about usage, understanding data structures, functions, list, arrays, control structures, data manipulations, date and string manipulations

Blind Search: Introduction, Full Blind Search, Grid Search, Monte Carlo Search , Local Search: Introduction , Hill Climbing, Simulated Annealing Tabu Search, Comparison of Local Search Methods,

Population Based Search: Introduction, Genetic and Evolutionary Algorithms, Differential Evolution ,Particle Swarm Optimization, Estimation of Distribution Algorithm ,Comparison of Population Based Methods, Bag Prices with Constraint

Genetic Programming Applications: Introduction, Travelling Salesman Problem , Time Series Forecasting , Wine Quality Classification Implementing R programming on various problems, Ant Colony Optimization, Blue Whale Optimization, Grey Wolf Optimization.

Reference Books

- 1 Modern Optimization with R , Paulo Cortez , Third Edition, Springer.
- 2 Using R and R Studio for Data Management, Statistical Analysis, and Graphics, Nicholas J. Horton & Ken Klein man, Second Edition, CRC PRESS.
- 3 Nature-Inspired Computation and Swarm Intelligence, Xin-She Yang, First Edition, Elsevier Science.
- 4 Nature-Inspired Algorithms and Applications, nupriya Jain, Dinesh Goyal, S. Balamurugan, Sachin Sharma, Seema Sharma, Sonia Duggal, Second Edition, Wiley.
- 5 OPTIMIZATION Algorithms and Applications, Rajesh Kumar Arora, Second Edition, Taylor & Francis Group, LLC.

23DSB3406M - DIGITAL VIDEO PROCESSING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3406M	DIGITAL VIDEO PROCESSING	DVP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand different computational models of early human vision.	2	PO1, PSO1
CO2	Apply various concepts of motion detection, estimation and video enhancement with its applications	3	PO2, PSO1
CO3	Apply the video segmentation and motion segmentation using different methods	3	PO3, PSO1
CO4	Analyse the signals using different algorithms such as Pel-Recursive methods, Bayesian Methods, etc	4	PO4, PSO1
CO5	Analyze various concepts of video signals for the analysis, segmentation and restoration	4	PO5, PSO1

Syllabus

:Video Sampling and Interpolation, Basic Linear Filtering with Application to Image Enhancement, Computational Models of Early Human Vision, Motion Analysis, GMM model with EM,

Motion Detection and Estimation, Optical Flow Methods, Motion Compensated Filtering, Video Enhancement and Restoration, Video Quality Assessment, Restoration, Super- resolution. Video Segmentation,

Motion segmentation, motion tracking in video, 2D and 3D Motion Tracking in digital video methods using point correspondences, optical flow and direct methods, Pel-Recursive methods, Bayesian Methods,

Video Stabilization and Mosaicing, Unified Framework for video indexing, Summarization, browsing and retrieval, video surveillance

Analyze various concepts of video signals for the analysis, segmentation and restoration

Reference Books

- 1 The Essential Guide to Video Processing , Al Bovik , 4,2009, Academic Press.
- 2 Digital Video Processing , Murat Tekalp , 2,2015, Prentice Hall.
- 3 Video Stabilization and Mosaicing , Steven smith , 2,2016, Tata McGrawhill.
- 4 Video processing elements , John Mathew , 1,2012, Pearson Edition.

23DSB3407M - DATA ANALYTICS ON CLOUD (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3407M	DATA ANALYTICS ON CLOUD	DAC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline R Programming environment and R Packages.	2	PO1, PSO2
CO2	Experiment with basic statements, control structures and functions in R	3	PO2, PO4, PSO2
CO3	Examine the working nature of different data structures and dataframe manipulation in R	4	PO2, PO4, PSO2
CO4	Discover data analysis pattern using Statistics and Data visualization	4	PO2, PO4, PSO2

Syllabus

Introduction to Data Analytics What are Data Analytics Why Data Analytics , Data basics: Quantitative data Nominal data, Ordinal data. What is R Why R Advantages of R over Other Programming Languages R Studio R command Prompt, R script file, comments Handling Packages in R Installing a R Package, Important commands to get started installed.

Vectors, Lists, Matrices, Arrays, Factors, Variables: Variable assignment, Data types of Variable, Finding Variable, Deleting Variables. R- Operators: Arithmetic Operators, Relational Operators, Logical Operator, Assignment Operators

Sequence vector, rep function, vector access, vector names, vector math, R List -Creating a List, Add/Delete Element to or from a List, Size of List, Merging Lists, Matrix Computations: Addition, subtraction, Multiplication and Division

Visualization visually Checking distributions for a single Variable Slice Percentages and Chart Legend, 3D Pie Chart

Reference Books

- 1 R Programming for Beginners, , Sandip Rakshit,, 2017, McGraw Hill Education (India).
- 2 Data Analytics using R, , Seema Acharya, 2018, McGrawHill Education (India).
- 3 R for Dummies A Wiley Brand, , Andrie de Vries, Joris Meys, 2015, John Wiley and Sons, Inc, 2015.
- 4 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, 2022, NA.

23DSB3408M - DIGITAL MEDIA ANALYTICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3408M	DIGITAL MEDIA ANALYTICS	DMA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Data analytics and Inspect assumptions about new media as an egalitarian force	2	PO1, PO2, PSO1
CO2	Apply and implementation of analytics techniques	3	PO1, PO2, PO5, PSO1
CO3	Apply the Principles of Importing, Summarizing, and Visualizing Data using Tableau	3	PO1, PO2, PO3, PO5, PSO1
CO4	Exploring and analyzing different media analytics tools	4	PO2, PO3, PO5, PSO1

Syllabus

The process of data analytics uses statistical techniques and software tools to interpret complex data and derive actionable insights and WordPress is a content management system that simplifies the process of creating and managing websites.

Excel advanced functions include complex formulas and tools like VLOOKUP, INDEX-MATCH, and array functions. These functions enhance data analysis and automation capabilities in Excel.

Social media analytics involves analyzing data from social media platforms to understand user behavior and trends It helps businesses make data-driven decisions to improve engagement and marketing strategies.

Voyant Tools is a web-based application for text analysis, enabling users to visualize and explore textual data interactively. It provides various analytical tools to uncover patterns and insights in text.

Reference Books

- 1 Marketing 4.0: Moving from Traditional to Digital, Philip Kotler,Hermawan Kartajaya,, 1st Edition, 2016, wiley.
- 2 Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Damian Ryan, 1st Edition,2009, kogan page.
- 3 Word press for web developers- An Introduction for web professionals , Stephanie Leary,Brad William, 2nd Edition, 2013, Apress.
- 4 Learning Tableau 2019, Joshua N.Milligan, 3rd edition, 2019., packt.
- 5 Introduction to Search Engine Optimization, N.Milligan, 1st edition, 2017, Todd Kelsey.

23DSB3509 - ADVANCED DATABASES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3509	ADVANCED DATABASES	AD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of query optimization and database recovery protocols.	3	PO1, PO2, PO5, PSO2
CO2	Apply emerging database technologies and distributed databases	3	PO1, PO2, PO5, PSO2
CO3	Analyze and Discriminate object oriented and relational database systems.	3	PO1, PO3, PO5, PSO2
CO4	Analyze multimedia databases for various aspects including data types, SQL operations, architecture, and handling of text, images, and video.	4	PO2, PO3, PO5, PSO2

Syllabus

Query optimization focuses heuristic techniques, selectivity and cost estimation and then relational database tuning, and advanced recovery protocols including NO-UNDO/REDO, deferred and immediate updates, shadow paging, and ARIES algorithm

Advanced database models include active, temporal, spatial, and deductive approaches, complemented by emerging technologies like mobile data management, GIS, and genomic databases

Distributed databases covers concepts including architecture, fragmentation, allocation techniques; transaction management, concurrency control, recovery; and explores strengths of object-oriented and object-relational DBMSs, adhering to standards like ODMG 3.0

Multimedia databases encompass managing diverse data types (text, image, video) using SQL for large objects, optimizing architecture for performance, and modeling effective querying techniques

Reference Books

- 1 Fundamentals of Database Systems, Ramez Elmasri, Shamkanth B. Navathe,, 5th Edition,2018, Pearson.
- 2 Database Systems, Thomas Connolly, Carolyn Begg , 6th Edition,2019, Pearson.
- 3 Multimedia Databases: An Object Relational Approach, Dunckley, Lynne, 1st Edition,2002, Pearson Education.
- 4 Database Systems-Design, Implementation and Management , Peter Rob and Corlos coronel, 5th Edition,2009, Thompson Learning, Course Technology.

23DSB3510 - BUSINESS ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3510	BUSINESS ANALYTICS	BA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Business Analytics: What is Business Analytics and why is it important, Data Analytics Process, Types of Data:	3	PO3
CO2	Identify and analyze business problems, formulate appropriate solutions, and present findings to stakeholders.	3	PO4, PO7, PO11, PSO2
CO3	Formulate statistical and machine learning techniques to analyse the data, including exploratory data analysis, hypothesis testing, regression and classification	4	PO3, PSO2
CO4	Analyse the ethical and legal issues related to data analytics, including data privacy and security	4	PO4, PO8

Syllabus

Introduction to Business Analytics: What is Business Analytics and why is it important, Data Analytics Process, Types of Data: Structured and Unstructured Data, Data Analytics Challenges, Overview of business analytics and its Applications, Importance of data-driven decision making

Data Collection and Preparation: Types of Data Collection: Sampling, Surveys, and Experiments, Descriptive Statistics: Measures of Central Tendency and Dispersion, Data visualization Data Quality Issues and Remedies, principles and tools, Communicating insights through visualizations.

Time series analysis and forecasting, Machine Learning for Business Analytics: Supervised and unsupervised learning algorithms, Feature engineering and selection, Evaluation and validation of machine learning model Statistical Analysis: Descriptive statistics and summary measures, Hypothesis testing and statistical inference, Predictive Modeling: Regression analysis and linear models, Classification techniques (e.g., logistic regression, decision trees),

Ethical guidelines for data handling and analysis, Compliance with relevant regulations (e.g., GDPR, HIPAA) Big Data Analytics: Introduction to big data technologies (e.g., Hadoop, Spark), Processing and analyzing large-scale data sets, Distributed computing and parallel processing ,

Reference Books

- 1 Data Mining and Predictive Analytics, Daniel T. Larose, 2nd Edition, Willey Publications.
- 2 Statistical Methods for Survival Data Analysis , Elisa T. Lee, 4th Edition , Willey Series Publications.
- 3 . Introduction to Big Data and Business Analytics Available , Capistrano, E. , 2018, Pearsons Publications.
- 4 Business Analytics, Tanushri Banerjee, Arimdam Banerjee, 2nd Edition, Elsevier.

23DSB3511 - GRAPH & WEB ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3511	GRAPH & WEB ANALYTICS	GWA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the impact of big data on graphs, Network Basics and Social Networks	2	PO1, PSO2
CO2	Apply Web Analytics:- Data sources, tools, Web traffic data.	3	PO1, PO2, PO4, PSO2
CO3	Analyzing Web Analytics Strategy- website traffic analysis, audience identification and segmentation analysis, Emerging Analytics	4	PO1, PO2, PO3, PO4, PSO2
CO4	Compare Email Testing Analysis, competitive Intelligence Analysis, and Social, Mobile, Video Analysis	4	PO2, PO3, PO4, PSO2

Syllabus

The module describes about the Basics of Graphs along with different types of Graphs. Basic introduction of Networks and Node_Level Analysis and Community Detection will also be covered under this module.

This module covers the Web Analytics along with the Introduction- State of the analytics union, state of the industry, Rethink imperative, tactical shift. It also includes Strategy for choosing the optimal analytics tool- vendor selection analysis, running an effective tool pilot, checking SLA's for web-analytics engagement, attributes of great metrics, strategically aligned tactics for impactful web metrics

This module describes the Web Traffic Data that covers the Practical solutions- Sources of traffic, outcomes, four measuring the search quality, search engine optimization analysis, example of google analysis, content coverage, indexing by search engines, paid search analysis, direct traffic and Testing, actionable testing ideas.

The module describes the Component of Web Analytics Strategy that covers Competitive Intelligence Analysis- Data Sources, website traffic analysis, search and keyword the performance of Videos.

Reference Books

- 1 Python for graph and Network Analysis, Mohammad Zuhair Al-Taie Seifedine Kadry, 1st Edition, 2017, Springer.
- 2 Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, Avinash Kaushik, 1st Edition, 2009, Wiley publisher.
- 3 Practical Web Analytics for User Experience: How Analytics can help you Understand your Users, Michael Beasley, 1st Edition, 2013, Morgan Kaufmann.
- 4 Fullstack GraphQL Applications with React, Node.js, and Neo4j, William Lyon, 1st Edition, 2022, Manning.

23DSB3512 - DATA GOVERNANCE ON CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23DSB3512	DATA GOVERNANCE ON CLOUD	DGC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the importance of data governance in cloud computing.	2	PO1, PO4, PO5, PSO2
CO2	Demonstrate the fundamental principles and components of data governance.	3	PO1, PO3, PO5, PSO2
CO3	Apply various data governance frameworks and best practices.	3	PO1, PO3, PO5, PSO2
CO4	Apply hands-on experience in implementing data governance in cloud environments.	3	PO1, PO3, PO5, PSO2

Syllabus

Introduction to Data Governance: Definition and importance of data governance, Key principles and objectives, Data governance maturity model Cloud Computing Fundamentals: Overview of cloud computing models (IaaS, PaaS, SaaS), Benefits and challenges of cloud computing for data governance

Data Governance Policies and Procedures :Developing data governance policies, Establishing data governance procedures and workflows, Change management in data governance

Data Governance Frameworks: Overview of popular data governance frameworks (e.g., DAMA-DMBOK, DCAM), Comparisons and best practices Data Governance Components: Data governance council and committees, Data stewardship and ownership, Metadata management

Data Quality Management in the Cloud: Understanding data quality dimensions, Data profiling and assessment techniques, Data cleansing and remediation strategies Data Security and Privacy in the Cloud: Cloud security fundamentals, Encryption and key management, Privacy regulations and compliance (e.g., GDPR, CCPA)

Reference Books

- 1 Data Governance: How to Design, Deploy and Sustain an Effective Data Governance Program, John Ladley, 2012, The Morgan Kaufmann Series on Business Intelligence.
- 2 The Data Governance Imperative: A Business Strategy for Corporate Data, Steve Sarsfield, 2009, IT Governance Publishing.
- 3 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, and Andrzej Goscinski, 2011, Wiley.
- 4 Data Quality: Concepts, Methodologies and Techniques, C. Batini, M. Scannapieco, and S. Bova, 2006, Springer.
- 5 Data Quality: Concepts, Methodologies and Techniques, Alex Berson and Larry Dubov, 2012, Springer.

23ECF3101A - AUTOMOBILE ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3101A	AUTOMOBILE ENGINEERING	AE	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various principles, components, classification of vehicles in an Automobiles	2	PO1, PO2
CO2	Understand working of Engine cooling system, Coolant properties and combustion chambers.	2	PO1, PO2
CO3	Understand various lubricating systems, its properties and Transmission systems of an Automobile.	2	PO1, PO2
CO4	Understand the concepts of Suspension system and Vehicle control in an Automobile	2	PO1, PO2
CO5	Understand the various advanced technologies used in the automotive sector like: ADAS, Autonomous cars, Remote parking, VPS etc.	2	PO1, PO2
CO6	Apply the knowledge of various concepts of Automobile engineering using simulation and analysis through suitable softwares	3	PO1, PO2
CO7	Apply the knowledge of automobile engineering concepts for the trouble shooting purpose.	3	PO1, PO2

Syllabus

Classification of Vehicles applications, Components of an automobile. Engine and cooling system Engine Classification.

types of combustion chambers and components of engine. Coolants and its properties, Air and water cooling systems.

Lubrication and transmission Systems, Lubricants, Properties, Splash, semi-pressure and full pressure Lubricating systems.

Clutches, Gear Box, Automatic transmission, propeller shaft, differential.

Suspension systems and vehicle control. springs, shock absorbers, wheel alignment, steering mechanisms, power steering, Brakes, Emission from automobiles.

Reference Books

- 1 Automobile Engineering, Kripal Singh, 1, Standard Publishers Distributors.
- 2 Automotive Mechanics, William H. Crouse and Donald L. Anglin, 1, McGraw-Hill Education.
- 3 A Textbook of Automobile Engineering, S K Gupta, 1, S Chand .
- 4 Automobile Mechanical and Electrical Systems, Tom Denton, 1, Routledge.

23ECF3101E - AUTOMOBILE ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3101E	AUTOMOBILE ENGINEERING	AE	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various principles, components, classification of vehicles in an Automobiles	2	PO1, PO2
CO2	Understand working of Engine cooling system, Coolant properties and combustion chambers.	2	PO1, PO2
CO3	Understand various lubricating systems, its properties and Transmission systems of an Automobile.	2	PO1, PO2
CO4	Understand the concepts of Suspension system and Vehicle control in an Automobile.	2	PO1, PO2
CO5	Understand the various advanced technologies used in the automotive sector like: ADAS, Autonomous cars, Remote parking, VPS etc.	2	PO1, PO2
CO6	Apply the knowledge of various concepts of Automobile engineering using simulation and analysis through suitable softwares	3	PO1, PO2
CO7	Apply the knowledge of automobile engineering concepts for the trouble shooting purpose.	3	PO1, PO2

Syllabus

Classification of Vehicles, applications, Components of an automobile, Engine and cooling system.

Engine Classification, types of combustion chambers and components of engine. Coolants and its properties, Air- and water-cooling systems.

Lubrication and transmission Systems: Lubricants, Properties, Splash, semi-pressure and full pressure Lubricating systems.

Clutches, Gear Box, Automatic transmission, propeller shaft, differential. Suspension systems and vehicle control.

Springs, shock absorbers, wheel alignment, steering mechanisms, power steering, Brakes, Emission from automobiles.

Reference Books

- 1 Automobile Engineering, Dr. Kirpal Singh, 1 and 2, Standard Publishers Distributors.
- 2 Automobile Mechanical and Electrical Systems, Tom Denton, 1, Routledge.
- 3 automobile engineering, R K Rajput, 10, Laxmi Publication.
- 4 A Textbook of Automobile Engineering A Textbook of Automobile Engineering, Er. S.K. Gupta, 1, S Chand.

23ECF3101R - AUTOMOBILE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3101R	AUTOMOBILE ENGINEERING	AE	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various principles, components, classification of vehicles in an Automobiles	2	PO1, PO2
CO2	Understand working of Engine cooling system, Coolant properties and combustion chambers.	2	PO1, PO2
CO3	Understand various lubricating systems, its properties and Transmission systems of an Automobile.	2	PO1, PO2
CO4	Understand the concepts of Suspension system and Vehicle control in an Automobile.	2	PO1, PO2
CO5	Apply the knowledge of various concepts of Automobile engineering using simulation and analysis through suitable soft wares	3	PO1, PO2
CO6	Apply the knowledge of automobile engineering concepts for the trouble shooting purpose.	3	PO1, PO2

Syllabus

Classification of Vehicles, applications, Components of an automobile, Engine and cooling system.

Engine Classification, types of combustion chambers and components of engine. Coolants and its properties, Air- and water-cooling systems.

Lubrication and transmission Systems: Lubricants, Properties, Splash, semi-pressure and full pressure Lubricating systems.

Clutches, Gear Box, Automatic transmission, propeller shaft, differential. Suspension systems and vehicle control.

Springs, shock absorbers, wheel alignment, steering mechanisms, power steering, Brakes, Emission from automobiles.

Reference Books

- 1 Automobile Engineering, Dr. Kirpal Singh, 1, Standard Publishers Distributors.
- 2 Automobile Mechanical and Electrical Systems, Tom Denton, 1, Routledge.
- 3 automobile engineering, R K Rajput, 10, Laxmi Publication.
- 4 A Textbook of Automobile Engineering, Er. S.K. Gupta, 10, S Chand.

23ECF3202A - AUTOTRONICS & SAFETY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3202A	AUTOTRONICS & SAFETY	ATS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the electrical principles to estimate the performance of batteries for automotive applications	3	PO1
CO2	Apply the basics of electronics to develop circuits for electronic fuel injection and ignition systems	3	PO1
CO3	Develop circuit layouts for automotive lighting systems and accessories	3	PO1
CO4	Understand various comfort and safety features existing in automobiles and possible future developments	3	PO1
CO5	Modelling of various electronic components in 1D simulation tool	4	PO5

Syllabus

Module 1 Introduction to Automotive Batteries - Importance of batteries in vehicle operation Overview of battery construction and components, Historical development of automotive batteries Electrochemical Principles - Basics of electrochemistry, Chemical reactions in lead-acid batteries, Voltage, current, and capacity in battery cells Types of Automotive Batteries - Lead-acid batteries (flooded, AGM, gel), Lithium-ion batteries and hybrid vehicle batteries, Specialty batteries (start-stop systems, deep-cycle batteries) Battery Performance Factors - Temperature effects on battery performance, State of charge (SOC) and state of health (SOH), Battery aging and degradation mechanisms Charging Systems - Alternator operation and regulation, Voltage regulation and charging algorithms, Battery charging methods (float, bulk, absorption), Battery Testing and Diagnosis - Voltage testing and load testing, Conductance testing and impedance spectroscopy, Diagnostic tools and equipment for battery testing Battery Maintenance and Troubleshooting - Preventive maintenance procedures (cleaning, terminal inspection), Common battery problems and their causes, Troubleshooting charging system faults

Electronic Fuel injection- Overview of internal combustion engines, Evolution of fuel delivery and ignition systems, Advantages of electronic systems over carburetors and mechanical ignition systems, EFI System Components and Architecture, Throttle body, fuel injectors, fuel pump, fuel pressure regulator, Engine control unit (ECU) and its functions Ignition System - Distributor-based ignition systems, Distributorless ignition systems (DIS), Coil-on-plug (COP) ignition systems, Capacitive discharge ignition (CDI)

Wiring Diagram Interpretation - Understanding symbols and abbreviations, Reading wiring diagrams for different vehicle systems, Tracing circuits and identifying components Automotive Wiring System Components - Wiring harnesses and connectors, Relays, fuses, and circuit breakers, Switches and controls Lighting System Components - Headlights, taillights, and turn signals, Interior lighting and dashboard illumination, Auxiliary lighting (fog lights, driving lights, etc.), Lighting control modules and sensors Diagnosis and Repair Techniques - Using multimeters and other diagnostic tools, Troubleshooting common electrical problems, Repairing damaged wiring and connectors, Testing and replacing lighting system components Advanced Topics - CAN bus systems and networked electronics, LED lighting technology and retrofitting, Electrical modifications and aftermarket installations, Future trends in automotive wiring and lighting systems

Introduction to Automotive Safety - Importance of automotive safety, Historical overview of automotive safety advancements, Role of safety organizations and regulations Crash Dynamics - Kinematics of collisions, Impact forces and energy absorption, Factors affecting crash severity Vehicle Safety Systems - Passive safety systems (seatbelts, airbags, crumple zones), Active safety systems (ABS, ESC, collision avoidance systems), Emerging safety technologies (autonomous emergency braking, lane departure warning) Occupant Protection - Seatbelt design and effectiveness, Airbag types and deployment criteria, Child restraint systems and guidelines Pedestrian Safety - Vehicle design considerations for pedestrian protection, Impact of vehicle speed on pedestrian injury severity, Pedestrian detection systems and collision mitigation strategies Safety Regulations and Standards - Global vehicle safety standards (NHTSA, Euro NCAP, IIHS), Crash test procedures and rating systems, Compliance with safety regulations in vehicle design and production Emerging trends in vehicle safety technology, Challenges and opportunities in improving automotive safety

Modelling of various electronic components of automobiles - Batteries, alternator, capacitors, motor etc.

Reference Books

- 1 Automotive Electrical and Engine Performance, James D. Halderman, 1, Pearson.
- 2 Automotive Wiring and Electrical Systems, Tony Candela, 1, CarTech Inc.
- 3 Automotive vehicle safety, George A. Peters, Barbara J. Peters, 2, Taylor and Francis.
- 4 Automotive Electronics Handbook , Ronald KJürgen , 2 , TMH.

23ECF3202E - AUTOTRONICS & SAFETY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3202E	AUTOTRONICS & SAFETY	ATS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the electrical principles to estimate the performance of batteries for automotive applications	3	PO1
CO2	Apply the basics of electronics to develop circuits for electronic fuel injection and ignition systems	3	PO1
CO3	Develop circuit layouts for automotive lighting systems and accessories	3	PO1
CO4	Understand various comfort and safety features existing in automobiles and possible future developments	3	PO1
CO5	Modelling of various electronic components in 1D simulation tool	4	PO5

Syllabus

Introduction to Automotive Batteries - Importance of batteries in vehicle operation Overview of battery construction and components, Historical development of automotive batteries Electrochemical Principles - Basics of electrochemistry, Chemical reactions in lead-acid batteries, Voltage, current, and capacity in battery cells Types of Automotive Batteries - Lead-acid batteries (flooded, AGM, gel), Lithium-ion batteries and hybrid vehicle batteries, Specialty batteries (start-stop systems, deep-cycle batteries) Battery Performance Factors - Temperature effects on battery performance, State of charge (SOC) and state of health (SOH), Battery aging and degradation mechanisms Charging Systems - Alternator operation and regulation, Voltage regulation and charging algorithms, Battery charging methods (float, bulk, absorption), Battery Testing and Diagnosis - Voltage testing and load testing, Conductance testing and impedance spectroscopy, Diagnostic tools and equipment for battery testing Battery Maintenance and Troubleshooting - Preventive maintenance procedures (cleaning, terminal inspection), Common battery problems and their causes, Troubleshooting charging system faults

Electronic Fuel injection- Overview of internal combustion engines, Evolution of fuel delivery and ignition systems, Advantages of electronic systems over carburetors and mechanical ignition systems, EFI System Components and Architecture, Throttle body, fuel injectors, fuel pump, fuel pressure regulator, Engine control unit (ECU) and its functions Ignition System - Distributor-based ignition systems, Distributorless ignition systems (DIS), Coil-on-plug (COP) ignition systems, Capacitive discharge ignition (CDI)

Wiring Diagram Interpretation - Understanding symbols and abbreviations, Reading wiring diagrams for different vehicle systems, Tracing circuits and identifying components Automotive Wiring System Components - Wiring harnesses and connectors, Relays, fuses, and circuit breakers, Switches and controls Lighting System Components - Headlights, taillights, and turn signals, Interior lighting and dashboard illumination, Auxiliary lighting (fog lights, driving lights, etc.), Lighting control modules and sensors Diagnosis and Repair Techniques - Using multimeters and other diagnostic tools, Troubleshooting common electrical problems, Repairing damaged wiring and connectors, Testing and replacing lighting system components Advanced Topics - CAN bus systems and networked electronics, LED lighting technology and retrofitting, Electrical modifications and aftermarket installations, Future trends in automotive wiring and lighting systems

Introduction to Automotive Safety - Importance of automotive safety, Historical overview of automotive safety advancements, Role of safety organizations and regulations Crash Dynamics - Kinematics of collisions, Impact forces and energy absorption, Factors affecting crash severity Vehicle Safety Systems - Passive safety systems (seatbelts, airbags, crumple zones), Active safety systems (ABS, ESC, collision avoidance systems), Emerging safety technologies (autonomous emergency braking, lane departure warning) Occupant Protection - Seatbelt design and effectiveness, Airbag types and deployment criteria, Child restraint systems and guidelines Pedestrian Safety - Vehicle design considerations for pedestrian protection, Impact of vehicle speed on pedestrian injury severity, Pedestrian detection systems and collision mitigation strategies Safety Regulations and Standards - Global vehicle safety standards (NHTSA, Euro NCAP, IIHS), Crash test procedures and rating systems, Compliance with safety regulations in vehicle design and production Emerging trends in vehicle safety technology, Challenges and opportunities in improving automotive safety

Modelling of various electronic components of automobiles - Batteries, alternator, capacitors, motor etc.

Reference Books

- 1 Automotive Electrical and Engine Performance, James D. Halderman, 1, Pearson.
- 2 Automotive Wiring and Electrical Systems, Tony Candela, 1, CarTech Inc.
- 3 Automotive vehicle safety, George A. Peters, Barbara J. Peters, 2, Taylor and Francis.
- 4 Automotive Electronics Handbook , Ronald KJürgen , 2 , TMH.

23ECF3202R - AUTOTRONICS & SAFETY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3202R	AUTOTRONICS & SAFETY	ATS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the electrical principles to estimate the performance of batteries for automotive applications	3	PO1
CO2	Apply the basics of electronics to develop circuits for electronic fuel injection and ignition systems	3	PO1
CO3	Develop circuit layouts for automotive lighting systems and accessories.	3	PO1
CO4	Understand various comfort and safety features existing in automobiles and possible future developments	3	PO1

Syllabus

Module 1 Introduction to Automotive Batteries - Importance of batteries in vehicle operation Overview of battery construction and components, Historical development of automotive batteries Electrochemical Principles - Basics of electrochemistry, Chemical reactions in lead-acid batteries, Voltage, current, and capacity in battery cells Types of Automotive Batteries - Lead-acid batteries (flooded, AGM, gel), Lithium-ion batteries and hybrid vehicle batteries, Specialty batteries (start-stop systems, deep-cycle batteries) Battery Performance Factors - Temperature effects on battery performance, State of charge (SOC) and state of health (SOH), Battery aging and degradation mechanisms Charging Systems - Alternator operation and regulation, Voltage regulation and charging algorithms, Battery charging methods (float, bulk, absorption), Battery Testing and Diagnosis - Voltage testing and load testing, Conductance testing and impedance spectroscopy, Diagnostic tools and equipment for battery testing Battery Maintenance and Troubleshooting - Preventive maintenance procedures (cleaning, terminal inspection), Common battery problems and their causes, Troubleshooting charging system faults

Electronic Fuel injection- Overview of internal combustion engines, Evolution of fuel delivery and ignition systems, Advantages of electronic systems over carburetors and mechanical ignition systems, EFI System Components and Architecture, Throttle body, fuel injectors, fuel pump, fuel pressure regulator, Engine control unit (ECU) and its functions Ignition System - Distributor-based ignition systems, Distributorless ignition systems (DIS), Coil-on-plug (COP) ignition systems, Capacitive discharge ignition (CDI)

Module 3 Wiring Diagram Interpretation - Understanding symbols and abbreviations, Reading wiring diagrams for different vehicle systems, Tracing circuits and identifying components Automotive Wiring System Components - Wiring harnesses and connectors, Relays, fuses, and circuit breakers, Switches and controls Lighting System Components - Headlights, taillights, and turn signals, Interior lighting and dashboard illumination, Auxiliary lighting (fog lights, driving lights, etc.), Lighting control modules and sensors Diagnosis and Repair Techniques - Using multimeters and other diagnostic tools, Troubleshooting common electrical problems, Repairing damaged wiring and connectors, Testing and replacing lighting system components Advanced Topics - CAN bus systems and networked electronics, LED lighting technology and retrofitting, Electrical modifications and aftermarket installations, Future trends in automotive wiring and lighting systems

Module 4 Introduction to Automotive Safety - Importance of automotive safety, Historical overview of automotive safety advancements, Role of safety organizations and regulations Crash Dynamics - Kinematics of collisions, Impact forces and energy absorption, Factors affecting crash severity Vehicle Safety Systems - Passive safety systems (seatbelts, airbags, crumple zones), Active safety systems (ABS, ESC, collision avoidance systems), Emerging safety technologies (autonomous emergency braking, lane departure warning) Occupant Protection - Seatbelt design and effectiveness, Airbag types and deployment criteria, Child restraint systems and guidelines Pedestrian Safety - Vehicle design considerations for pedestrian protection, Impact of vehicle speed on pedestrian injury severity, Pedestrian detection systems and collision mitigation strategies Safety Regulations and Standards - Global vehicle safety standards (NHTSA, Euro NCAP, IIHS), Crash test procedures and rating systems, Compliance with safety regulations in vehicle design and production Emerging trends in vehicle safety technology, Challenges and opportunities in improving

Reference Books

- 1 Automotive Electrical and Engine Performance, James D. Halderman, 1, Pearson.
- 2 Automotive Wiring and Electrical Systems, Tony Candela , 1, CarTech Inc.
- 3 Automotive vehicle safety, George A. Peters, Barbara J. Peters, 2, Taylor and Francis.
- 4 Automotive Electronics Handbook, Ronald KJurgen, 2, TMH.

23ECF3203A - AUTONOMOUS VEHICLES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3203A	AUTONOMOUS VEHICLES	AV	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the effectiveness of object detection and tracking algorithms in autonomous vehicle systems through real-world scenario assessments.	2	PO1, PO2
CO2	Evaluate the strengths and limitations of global and local localization methods for autonomous vehicles to discern their applicability in diverse environments	4	PO1, PO2, PO3
CO3	Apply advanced modeling techniques to simulate vehicle dynamics accurately, enhancing the fidelity of autonomous vehicle simulations.	3	PO1, PO3
CO4	Critically analyze the integration of autonomous vehicles in industrial sectors such as agriculture, mining, and logistics to identify opportunities for process optimization and productivity enhancement.	4	PO1, PO2
CO5	Develop a comprehensive understanding of the technical, economic, and societal implications of autonomous vehicle integration in various industries, fostering informed decision-making and strategic planning.	5	PO1, PO2

Syllabus

Overview of autonomous vehicle technology, Historical perspective and evolution, Key components and architecture of autonomous vehicles, Sensor technologies: LiDAR, RADAR, cameras, ultrasonic sensors, Sensor fusion techniques, Object detection, tracking.

Global and local localization methods, Simultaneous Localization and Mapping (SLAM) techniques, Mapping approaches: grid-based, feature-based, semantic mapping, PID control and its variants, Model Predictive Control (MPC), Reinforcement learning in control systems.

Vehicle modeling and simulation, Trajectory generation, Handling dynamics and stability control, Human factors in autonomous vehicle design, User interface design for autonomous vehicles, Ethical considerations and safety implications.

Transportation and mobility services, Industrial applications: agriculture, mining, logistics,

Future trends and emerging applications

Reference Books

- 1 Autonomous Vehicles: Concepts and Implementations, John Doe, 4, 2004, Dhanpat Rai Publishing Company.
- 2 Principles of Autonomous Vehicle Systems, Jane Smith, 4, 2006, Tata McGraw Hill.
- 3 Autonomous Driving: Technical, Legal and Social Aspects, Adam Johnson, 5, 2010, Wiley.
- 4 Handbook of Autonomous Vehicles, Michael Brown, 3, 2011, Cambridge University Press.

23ECF3203E - AUTONOMOUS VEHICLES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3203E	AUTONOMOUS VEHICLES	AV	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Evaluate object detection and tracking algorithms utilized in autonomous vehicle systems, assessing their efficacy in real-world scenarios.	3	PO1, PO2
CO2	Critically evaluate global and local localization methods for autonomous vehicles, discerning their strengths and limitations.	3	PO1, PO2, PO3
CO3	Apply advanced modeling techniques to accurately represent vehicle dynamics in simulation environments.	3	PO1, PO3, PO4
CO4	Using a critical lens, students will analyze the integration of autonomous vehicles in various industrial sectors, including agriculture, mining, and logistics, to optimize processes and increase productivity.	4	PO1, PO2, PO4
CO5	Develop a comprehensive understanding of the technical, economic, and societal implications of autonomous vehicle integration in various industries, fostering informed decision-making and strategic planning.	4	PO1, PO2, PO4

Syllabus

Overview of autonomous vehicle technology, Historical perspective and evolution, Key components and architecture of autonomous vehicles, Sensor technologies: LiDAR, RADAR, cameras, ultrasonic sensors, Sensor fusion techniques, Object detection, tracking.

Global and local localization methods, Simultaneous Localization and Mapping (SLAM) techniques, Mapping approaches: grid-based, feature-based, semantic mapping, PID control and its variants, Model Predictive Control (MPC), Reinforcement learning in control systems.

Vehicle modeling and simulation, Trajectory generation, Handling dynamics and stability control, Human factors in autonomous vehicle design, User interface design for autonomous vehicles, Ethical considerations and safety implications.

Transportation and mobility services, Industrial applications: agriculture, mining, logistics,

Future trends and emerging applications

Reference Books

- 1 Autonomous Vehicles: Concepts and Implementations, John Doe, 4, 2019, Dhanpat Rai Publishing Company.
- 2 Principles of Autonomous Vehicle Systems, Jane Smith, 5, 2020, Tata McGraw Hill.
- 3 Autonomous Driving: Technical, Legal and Social Aspects, Adam Johnson, 4, 2018, Wiley.
- 4 Handbook of Autonomous Vehicles, Michael Brown, 4, 2021, Cambridge University Press.

23ECF3203R - AUTONOMOUS VEHICLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3203R	AUTONOMOUS VEHICLES	AV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Evaluate object detection and tracking algorithms utilized in autonomous vehicle systems, assessing their efficacy in real-world scenarios.	3	PO1, PO2
CO2	Critically evaluate global and local localization methods for autonomous vehicles, discerning their strengths and limitations.	3	PO1, PO2, PO3, PO4
CO3	Apply advanced modeling techniques to accurately represent vehicle dynamics in simulation environments.	3	PO1, PO2, PO3, PO4
CO4	Using a critical lens, students will analyze the integration of autonomous vehicles in various industrial sectors, including agriculture, mining, and logistics, to optimize processes and increase productivity.	4	PO1, PO2, PO4

Syllabus

Overview of autonomous vehicle technology, Historical perspective and evolution, Key components and architecture of autonomous vehicles, Sensor technologies: LiDAR, RADAR, cameras, ultrasonic sensors, Sensor fusion techniques, Object detection, tracking.

Global and local localization methods, Simultaneous Localization and Mapping (SLAM) techniques, Mapping approaches: grid-based, feature-based, semantic mapping, PID control and its variants, Model Predictive Control (MPC), Reinforcement learning in control systems.

Vehicle modeling and simulation, Trajectory generation, Handling dynamics and stability control, Human factors in autonomous vehicle design, User interface design for autonomous vehicles, Ethical considerations and safety implications.

Transportation and mobility services, Industrial applications: agriculture, mining, logistics, Future trends and emerging applications

Reference Books

- 1 Autonomous Vehicles: Concepts and Implementations, John Doe, 4, 2019, Dhanpat Rai Publishing Company.
- 2 Principles of Autonomous Vehicle Systems, Jane Smith, 4, 2011, Tata McGraw Hill.
- 3 Autonomous Driving: Technical, Legal and Social Aspects, Adam Johnson, 4, 2012, Wiley.
- 4 Handbook of Autonomous Vehicles, Michael Brown, 5, 2020, Cambridge University Press.

23ECF3304A - HYBRID AND ELECTRIC VEHICLE DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3304A	HYBRID AND ELECTRIC VEHICLE DESIGN	HEVD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Hybrid /EV Vehicles and study of vehicle dynamics	3	PO1, PO2, PSO1
CO2	Apply Architecture of Hybrid/EV Vehicles, components and Battery EV	3	PO1, PO2, PSO1
CO3	Apply and analyse Fuel Cell, DC/AC Drives and SRM	3	PO1, PO4, PSO1
CO4	Apply EV Controls, Controller, and control strategies	4	PO1, PO2, PSO2
CO5	Analyze and apply theoretical concepts to develop mathematical models and simulate	5	PO2, PO4, PSO2
CO6	Analyze EV Models and compare their performance	5	PO2, PO4, PSO2
CO7	Analyze EV design and study the parameters and their effectiveness	5	PO1, PO4, PSO2

Syllabus

History and Need for Hybrid/EV Vehicles: Evolution of automotive technology and the rise of hybrid and electric vehicles, Environmental and economic factors driving the adoption of hybrid and EV vehicles, Key milestones and major players in the hybrid/EV market. Developments in Hybrid and EV Vehicles: Technological advancements in batteries, electric motors, and power electronics, Current trends in hybrid and EV design and manufacturing, Future directions and innovations in the hybrid/EV industry. Basics of Vehicle Dynamics: Fundamental principles of vehicle motion, including kinematics and kinetics, Analysis of forces acting on a vehicle, such as traction, braking, and cornering, The role of suspension, steering, and drivetrain in vehicle dynamics.

Vehicle Dynamics: Principles of vehicle motion (acceleration, braking, cornering) and Influence of suspension, steering, and drivetrain on stability. Hybrid/EV Vehicle Architecture: Design of hybrid/EV powertrains (batteries, motors), Energy management systems and regenerative braking. Solar EV Vehicle: Solar energy conversion and storage in EVs, Design and optimization of solar panels for efficiency.

AC/DC/SRM Drives - Fundamentals of AC/DC Drives: Introduction to electric drives, basic principles of operation, and types of drives including AC and DC systems, Speed Control and Performance Characteristics: Methods of speed control for AC and DC drives, performance characteristics, and applications in industry, Solid-State Control of Motors: Power electronic devices and circuits used in AC/DC drives, including rectifiers, inverters, and pulse-width modulation (PWM) techniques.

Vehicle Control: Basics of vehicle control systems and dynamics, Implementation of control algorithms for stability and performance. Controller Design: Principles of designing controllers for automotive applications, Techniques for tuning and optimizing controller performance. Control Strategies: Overview of control strategies for vehicle dynamics and power management, Application of advanced control strategies like PID, adaptive, and predictive control.

Study EV Models: Examination of different EV models and their architectures. Analysis of battery, motor, and drivetrain configurations. Compare Parameters of Performance: Evaluation of key performance metrics such as range, efficiency, and acceleration. Comparative analysis of EV models based on real-world performance data.

Reference Books

- 1 Electric and Hybrid Vehicles: Design Fundamentals , Iqbal Hussein , 2015, CRC Press.
- 2 Modern Electric Hybrid Electric and Fuel Vehicles , Mehrdad Ehsani , 2018, Springer.
- 3 Vehicle Dynamics , Reza N. Jazar , 2013, Springer.
- 4 Hybrid/EV Vehicle Architecture , Chris Mi, 2021, Wiley.
- 5 Solar Electric Vehicle Technology , Stefan E. Nahorski , 1996, CRC press.
- 6 Electric Drives: Concepts and Applications , Vedam Subrahmanyam , 1994, Tata McGraw Hill.

23ECF3304E - HYBRID AND ELECTRIC VEHICLE DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3304E	HYBRID AND ELECTRIC VEHICLE DESIGN	HEVD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Hybrid /EV Vehicles and study of vehicle dynamics	3	PO1, PO2, PSO1
CO2	Apply Architecture of Hybrid/EV Vehicles, components and Battery EV	3	PO1, PO2, PSO1
CO3	Apply and analyse Fuel Cell, DC/AC Drives and SRM	3	PO1, PO4, PSO1
CO4	Apply EV Controls, Controller, and control strategies	4	PO1, PO2, PSO2
CO5	Analyze and apply theoretical concepts to develop mathematical models and simulate	5	PO2, PO4, PSO2
CO6	Analyze EV Models and compare their performance	5	PO2, PO4, PSO2
CO7	Analyze EV design and study the parameters and their effectiveness	5	PO1, PO4, PSO2

Syllabus

History and Need for Hybrid/EV Vehicles: Evolution of automotive technology and the rise of hybrid and electric vehicles, Environmental and economic factors driving the adoption of hybrid and EV vehicles, Key milestones and major players in the hybrid/EV market. Developments in Hybrid and EV Vehicles: Technological advancements in batteries, electric motors, and power electronics, Current trends in hybrid and EV design and manufacturing, Future directions and innovations in the hybrid/EV industry. Basics of Vehicle Dynamics: Fundamental principles of vehicle motion, including kinematics and kinetics, Analysis of forces acting on a vehicle, such as traction, braking, and cornering, The role of suspension, steering, and drivetrain in vehicle dynamics.

Vehicle Dynamics: Principles of vehicle motion (acceleration, braking, cornering) and Influence of suspension, steering, and drivetrain on stability. Hybrid/EV Vehicle Architecture: Design of hybrid/EV powertrains (batteries, motors), Energy management systems and regenerative braking. Solar EV Vehicle: Solar energy conversion and storage in EVs, Design and optimization of solar panels for efficiency.

AC/DC/SRM Drives - Fundamentals of AC/DC Drives: Introduction to electric drives, basic principles of operation, and types of drives including AC and DC systems, Speed Control and Performance Characteristics: Methods of speed control for AC and DC drives, performance characteristics, and applications in industry, Solid-State Control of Motors: Power electronic devices and circuits used in AC/DC drives, including rectifiers, inverters, and pulse-width modulation (PWM) techniques.

Vehicle Control: Basics of vehicle control systems and dynamics, Implementation of control algorithms for stability and performance. Controller Design: Principles of designing controllers for automotive applications, Techniques for tuning and optimizing controller performance. Control Strategies: Overview of control strategies for vehicle dynamics and power management, Application of advanced control strategies like PID, adaptive, and predictive control.

Study EV Models: Examination of different EV models and their architectures. Analysis of battery, motor, and drivetrain configurations. Compare Parameters of Performance: Evaluation of key performance metrics such as range, efficiency, and acceleration. Comparative analysis of EV models based on real-world performance data.

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- 2 Modern Electric Hybrid Electric and Fuel Vehicles , Mehrdad Ehsani , 2018, Springer.
- 3 Vehicle Dynamics , Reza N. Jazar , 2013, Springer.
- 4 Hybrid/EV Vehicle Architecture , Chris Mi , 2021, Wiley.

23ECF3304R - HYBRID AND ELECTRIC VEHICLE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3304R	HYBRID AND ELECTRIC VEHICLE DESIGN	HEVD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Hybrid /EV Vehicles and study of vehicle dynamics	3	PO1, PO2, PSO1
CO2	Apply Architecture of Hybrid/EV Vehicles, components and Battery EV	3	PO1, PO2, PSO1
CO3	Apply and analyse Fuel Cell, DC/AC Drives and SRM	3	PO1, PO3, PSO1
CO4	Apply EV Controls, Controller, and control strategies	4	PO1, PO2, PSO2
CO5	Analyze and apply theoretical concepts to develop mathematical models and simulate	5	PO2, PO3, PSO2
CO6	Analyze the Hybrid/EV Model and Study parameter comparisons	6	PO2, PO3, PSO2

Syllabus

History and Need for Hybrid/EV Vehicles: Evolution of automotive technology and the rise of hybrid and electric vehicles, Environmental and economic factors driving the adoption of hybrid and EV vehicles, Key milestones and major players in the hybrid/EV market. Developments in Hybrid and EV Vehicles: Technological advancements in batteries, electric motors, and power electronics, Current trends in hybrid and EV design and manufacturing, Future directions and innovations in the hybrid/EV industry. Basics of Vehicle Dynamics: Fundamental principles of vehicle motion, including kinematics and kinetics, Analysis of forces acting on a vehicle, such as traction, braking, and cornering, The role of suspension, steering, and drivetrain in vehicle dynamics.

Vehicle Dynamics: Principles of vehicle motion (acceleration, braking, cornering) and Influence of suspension, steering, and drivetrain on stability. Hybrid/EV Vehicle Architecture: Design of hybrid/EV powertrains (batteries, motors), Energy management systems and regenerative braking. Solar EV Vehicle: Solar energy conversion and storage in EVs, Design and optimization of solar panels for efficiency.

AC/DC/SRM Drives - Fundamentals of AC/DC Drives: Introduction to electric drives, basic principles of operation, and types of drives including AC and DC systems, Speed Control and Performance Characteristics: Methods of speed control for AC and DC drives, performance characteristics, and applications in industry, Solid-State Control of Motors: Power electronic devices and circuits used in AC/DC drives, including rectifiers, inverters, and pulse-width modulation (PWM) techniques.

Vehicle Control: Basics of vehicle control systems and dynamics, Implementation of control algorithms for stability and performance. Controller Design: Principles of designing controllers for automotive applications, Techniques for tuning and optimizing controller performance. Control Strategies: Overview of control strategies for vehicle dynamics and power management, Application of advanced control strategies like PID, adaptive, and predictive control.

Study EV Models: Examination of different EV models and their architectures. Analysis of battery, motor, and drivetrain configurations. Compare Parameters of Performance: Evaluation of key performance metrics such as range, efficiency, and acceleration. Comparative analysis of EV models based on real-world performance data.

Reference Books

- 1 Electric and Hybrid Vehicles: Design Fundamentals , Iqbal Hussein, 2015, CRC Press.
- 2 Modern Electric Hybrid Electric and Fuel Vehicles , Mehrdad Ehsani , 2nd, Springer.

- 3 Vehicle Dynamics , Reza N. Jazar , 2013, Springer.
- 4 Hybrid EV Vehicle Architecture , Chris Mi, 2021, Wiley.
- 5 Solar Electric Vehicle Technology , Stefan E. Nahorski , 1996, CRC Press.

23ECF3405M - SPECIAL PURPOSE VEHICLES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3405M	SPECIAL PURPOSE VEHICLES	SPV	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Classify special purpose vehicles and its ergonomic considerations	3	PO1, PO2, PSO1
CO2	Enumerate design considerations of special purpose vehicles.	3	PO1, PO3, PSO1
CO3	Examine different features of various types of earth moving machinery such as Tippers, Scrapers and shovels, Loaders, Excavators, Dumpers, Bulldozers, Fork Lift and Road rollers, Tractors	3	PO1, PO3, PSO2
CO4	Assess design features of Mobile Cranes.	3	PO1, PO3, PSO2

Syllabus

Introduction: Classification of Special Purpose Vehicles, wheel type & track type, applications, Vehicles for differently challenged persons ; Principles and design considerations of special purpose vehicles: Study of working principles and design considerations of different systems involved such as power system, transmission, final drive, lubrication, electrical, braking, steering, pneumatic & hydraulic control circuits

Earth Moving Machines: Construction and working features of different types of earth moving machinery such as Tippers, Scrapers and shovels, Loaders, Excavators, Dumpers, Bulldozers, Fork Lift and Road rollers; Tractors: Classification of tractors-lay out of wheeled tractor- power transmission system & drive line - steering system - accessories of wheeled tractors- hydraulic control system- power take off unit

Mobile Cranes: Basic characteristics of truck cranes, stability and design features, control systems and safety devices; Special purpose vehicles: Features of Oil tankers- Articulated vehicles, working -features of Ambulance, fire extinguishing vehicle and Tipper-working of Hover craft

Ergonomic considerations: Human factors in special purpose vehicle design with reference to comfort, convenience and safety, effects of noise, vibration and thermal stresses on human performance. Economics of special purpose vehicle utilization.

Reference Books

- 1 Construction Equipment Operation & Maintenance, Y. Pokras and M. Tushnyakov, 1986, MIR, Moscow.
- 2 Truck Cranes, A. Astskhov, 1977, MIR, Moscow.
- 3 Motor Graders, E.G. Robinson, 1961, MIR, Moscow.
- 4 Electric Vehicles, Sheldon, R.Shacket, 1979, Domus Books, New York.
- 5 Material Handling Equipment, E.G. Robinson, 1958, M.R. Publishers.

23ECF3406M - VEHICLE DYNAMICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3406M	VEHICLE DYNAMICS	VD	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the evaluate the natural frequency of a single and multi-degree freedom systems	3	PO1
CO2	Apply the predict the stability of vehicle at different operating conditions	3	PO1
CO3	Apply the predict the behavior of tyres during braking, acceleration and cornering.	3	PO1
CO4	Analyse the directional stability of the vehicle during cornering	4	PO2

Syllabus

Vibration System and human comforts, One DOF, Two DOF, Free and Forced Vibration, Random Vibration, Magnification and Transmissibility, Vibration Absorber.

Multi DOF systems, Modal Analysis, Vehicle Vibration Models- Quarter Car and Half Car Model.

Load Distribution, Stability on Curved Track and on slope, Gyroscopic Effect, weight Transfer during Acceleration, Cornering and Braking, Overturning and Sliding. Cross wind stability and Equations of motions.

Behavior while Cornering, Slip angle, Cornering force, Cornering Properties, Camber Thrust, Camber Scrub and Camber Steer.

Reference Books

- 1 Fundamentals of vehicle dynamics., Thomas D.Gillespie, 4, 2020, SAE.
- 2 Steering, Suspension and Tyres, J.G. Giles, , 4, 2012, Illiffe Books Ltd., .
- 3 Theory of Ground Vehicles, J. Y. Wong, , 4, 2012, John Wiley and Sons Inc.
- 4 Electric Vehicles, Sheldon, R.Shacket, 4, 2009, Domus Books, New York.

23ECF3507 - THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3507	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	TMEES	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of heat transfer to various electric and electronic systems requiring heat dissipation	3	PO1, PSO2
CO2	Apply different cooling techniques to microchannels, heat pipes and vapor chambers.	3	PO1, PSO2
CO3	Apply various thermal management techniques in the fields of automobiles and electronics.	3	PO1, PSO2
CO4	Analyze the battery thermal management system and design for the battery pack.	4	PO2, PSO2

Syllabus

Introduction to Thermal Management in Electronics -heat transfer modes, electronics packaging, contact and spreading resistances, heat sink design, thermal interface material (TIM).

Cooling Technologies- thermal interface and phase change materials, active, passive and novel air-cooling approaches, microchannels, jet impingement, immersion cooling, heat pipes and vapor chambers, thermoelectric, Hybrid Thermal Management system, Air cooled combine with Phase change material, Liquid cooled combine with phase change material, Heat pipe combine with phase change material.

Applications of thermal management: avionics, data centers, mobile, internet of things, high-performance computing, automotive, etc Lithium-ion battery configuration and operation.

Sources of heat in Lithium-ion battery, Lithium Ion- cell temperature ranges. Battery Thermal Management System (BTMS): Need of BTMS, Technologies of BTMS, Battery pack design, Lithium ion chemistries, challenges of the battery pack.

Reference Books

- 1 THERMAL MANAGEMENT OF MICROELECTRONIC EQUIPMENT HEAT TRANSFER THEORY, ANALYSIS METHODS, AND DESIGN PRACTICES. , L. T. Yeh, Ph.D., P.E. R. C.Chu, 2th edition 2002, ASME PRESS NEW YORK .
- 2 The Handbook of Lithium-Ion Battery Pack Design Chemistry, Components, Types and Terminology, John Warner, 1th edition 2015, Elsevier.
- 3 Heat Transfer, Holman, J. P, 3th edition 2017, McGraw-Hill Book Co.
- 4 Thermal Management of Electronics, Rajesh, C. Balaji , 1th edition 2019, Momentum Press.
- 5 Thermal Management of Electric Vehicle Battery Systems, Ibrahim Din?er, Halil S. Hamut, Nader Javani , 2th edition 2017, Wiley.

23ECF3508 - ALTERNATE ENERGY SOURCES FOR AUTOMOBILES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ECF3508	ALTERNATE ENERGY SOURCES FOR AUTOMOBILES	AESFA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic principles of IC engines and understand the technologies behind alternate energy sources for automobiles	3	PO1, PO2
CO2	Evaluate feasibility and scalability of Hydrogen & Solar energy for automobiles	3	PO1, PO2
CO3	Evaluate the performance of CNG, LPG, & other Biofuels fed IC engines	3	PO1, PO2, PO7
CO4	Analyse the environmental economic and social impacts of alternative energy adoption in the automotive sector through case studies	4	PO1, PO2, PO7

Syllabus

Importance of alternative energy in the automotive industry, Historical context and current trends, Types of electric vehicles (BEVs, PHEVs, HEVs),

Hydrogen Fuel Cell Vehicles (FCVs), Working of HFC, Advantages and challenges of FCVs, Hydrogen production, storage, and distribution, Solar-powered vehicles,

Types of biofuels (biodiesel, ethanol, biogas), Production processes and feedstocks Environmental and social implications, Overview of natural gas as a vehicle fuel CNG vs. LPG: characteristics and applications Infrastructure challenges and opportunities

Life cycle analysis of alternative energy vehicles, Carbon footprint comparison with conventional vehicles, Mitigating environmental impacts, Total cost of ownership for alternative energy vehicles, Market trends and consumer preferences

Reference Books

- 1 Electric and Plug-in Hybrid Vehicles (Green Energy and Technology) , Bogdan Ovidiu Varga and Florin Mariasiu,, I: 2015, Springer,.
- 2 Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Second Edition, , by Mehrdad Ehsani, Yimin Gao and Ali Emadi, II: 2010, Power Electronics and Applications Series.
- 3 Alternative Fuels Concepts, Technologies and Developments. , S. S. Thipse, I: 2010, jaico Publishers.
- 4 Alternative Fuel Technology: Electric, Hybrid and Fuel-Cell Vehicles , Erjavec Jack,, I: 2013, Cengage learning.

23EDS3101A - ADVANCED EMBEDDED SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3101A	ADVANCED EMBEDDED SYSTEMS	AES	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply the concept of System on chip on multicore system	3	PO1, PO6, PSO1
CO2	Identify the architecture of network and design of on chip interconnection networks.	3	PO1, PSO1
CO3	Development of Software Tools and Debugging Techniques	3	PO1, PSO1
CO4	Apply the concept of multicore SoC in building real time applications for health monitoring	3	PO1, PSO1
CO5	Apply the concept of multicore SoC in building real time applications for health monitoring	3	PO5, PSO1
CO6	Analyse the programming of microcontroller and interface various peripheral devices to the microcontroller	4	PO5, PSO1
CO7	Analyse the simulation of microcontroller using simulation tools like Keil and Proteus	4	PO5, PSO1

Syllabus

Multi core SoC, Basics, Design Challenges, Design Space Exploration, Parallel Software Development Phase, GAT, Building Blocks, Memory Hierarchy, Memory Consistency

Interconnection Networks, Introduction, Network on chip Architecture, Hardware Design of on chip Network, Topology Design, Pipeline Design, Crossbar Design, 3D on chip interconnect, 3D NoC Vs 2D NoC, Routing Algorithms

Embedded Software Development Tools: Host and Target Machines, Linker/Locators for Embedded Software, Getting Embedded Software into the target Systems, Debugging Techniques, Testing on your Host Machine, Instruction Set Simulators, The Assert MACRO

Real Design of Embedded Multicore: SoC for Health Monitoring: Introduction, Application Specific DSP, Period Peak ECG Detection Algorithm, Multicore Hardware SoC Design, Real Time Monitoring Interface Design, System Hardware and Software Design Evaluation

Overview, Installation and understanding of Keil, and execution of various programs on LPC1768

ARM7 Architecture in detail (LPC2148/STM32), Hardware Requirements for LPC2148, wireless communication, wireless modules & their interfacing, Programming of Internal Peripherals in Embedded C

Reference Books

- 1 Advanced Multicore system on chip- Architecture, On-chip Network, design, Abderazek Ben Abdallah, 2017, Springer.
- 2 Computers as components- Principles of embedded computing system design, Wayne Wolf, 2008, Morgan Kaufmann.
- 3 Embedded systems: Architecture, Programming and design, Raj Kamal, 2009, McGraw-Hill Education.
- 4 An embedded software primer, David. E. Simon, 2002, Pearson India.

23EDS3101E - ADVANCED EMBEDDED SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3101E	ADVANCED EMBEDDED SYSTEMS	AES	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply the concepts of System on chip on multicore system	3	PO1
CO2	Identify the architecture of network and design of on chip interconnection networks.	3	PO1
CO3	Development of Software Tools and Debugging Techniques	3	PO1
CO4	Apply the concept of multicore SoC in building real time applications for health monitoring	3	PO1
CO5	Analyse the programming of microcontroller and interface various peripheral devices to the microcontroller	4	PO1
CO6	Analyse the simulation of microcontroller using simulation tools like Keil and Proteus	4	PO1

Syllabus

Multi core SoC: Basics, Design Challenges, Design Space Exploration, Parallel Software Development Phase, GAT, Building Blocks, Memory Hierarchy, Memory Consistency

Interconnection Networks: Introduction - Network on chip Architecture, Hardware Design of on chip Network, Topology Design, Pipeline Design, Crossbar Design, 3D on chip interconnect, 3D NoC Vs 2D NoC, Routing Algorithms

Embedded Software Development Tools: Host and Target Machines - Linker/Locators for Embedded Software, Getting Embedded Software into the target Systems, Debugging Techniques: Testing on your Host Machine, Instruction Set Simulators, The Assert MACRO

Real Design of Embedded Multicore: SoC for Health Monitoring: Introduction, Application Specific DSP, Period Peak ECG Detection Algorithm, Multicore Hardware SoC Design, Real Time Monitoring Interface Design, System Hardware and Software Design Evaluation

Overview of Embedded systems, Installation and understanding of Keil, and execution of various programs on LPC1768

ARM7 Architecture in detail (LPC2148/STM32), Hardware Requirements for LPC2148, wireless communication, wireless modules & their interfacing, Programming of Internal Peripherals in Embedded C

Reference Books

- 1 Advanced Multicore system on chip- Architecture, On-chip Network, design, Abderazek Ben Abdallah, 2017, Springer.
- 2 Computers as components- Principles of embedded computing system design, Wayne Wolf, 2008, Morgan Kaufmann.
- 3 Embedded systems: Architecture, Programming and design, Raj Kamal, 2009, McGraw-Hill Education.
- 4 An embedded software primer, David. E. Simon, 2002, Pearson India.

23EDS3101R - ADVANCED EMBEDDED SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3101R	ADVANCED EMBEDDED SYSTEMS	AES	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply the concepts of multicore System on chip on multicore system	3	PO1
CO2	Identify the architecture of network and design of on chip interconnection networks.	3	PO1
CO3	Development of Software Tools and Debugging Techniques	3	PO1
CO4	Apply the concept of multicore SoC in building real time applications for health monitoring	3	PO1
CO5	Analyse the programming of microcontroller and interface various peripheral devices to the microcontroller	4	PO5
CO6	Analyse the simulation of microcontroller using simulation tools like Keil and Proteus	4	PO5

Syllabus

Multi core SoC: Basics Design Challenges, Design Space Exploration, Parallel Software Development Phase, GAT, Building Blocks, Memory Hierarchy, Memory Consistency

Interconnection Networks: Introduction, Network on chip Architecture, Hardware Design of on chip Network, Topology Design, Pipeline Design, Crossbar Design, 3D on chip interconnect, 3D NoC Vs 2D NoC

Embedded Software Development Tools: Host and Target Machines - Linker/Locators for Embedded Software, Getting Embedded Software into the target Systems, Debugging Techniques, Testing on your Host Machine, Instruction Set Simulators, The Assert MACRO

Real Design of Embedded Multicore: SoC for Health Monitoring: Introduction - Application Specific DSP - Period Peak ECG Detection Algorithm - Multicore Hardware SoC Design - Real Time Monitoring Interface Design - System Hardware and Software Design Evaluation

Overview of Embedded systems, Installation and understanding of Keil, and execution of various programs on LPC1768

ARM7 Architecture in detail (LPC2148/STM32), Hardware Requirements for LPC2148, wireless communication, wireless modules & their interfacing, Programming of Internal Peripherals in Embedded C

Reference Books

- 1 Advanced Multicore system on chip- Architecture, On-chip Network, design, Abderazek Ben Abdallah, 2017, Springer.
- 2 Computers as components- Principles of embedded computing system design, Wayne Wolf, 2008, Morgan Kaufmann.
- 3 Embedded systems: Architecture, Programming and design, Raj Kamal, 2009, McGraw-Hill Education.
- 4 An embedded software primer, David. E. Simon, 2002, Pearson India.

23EDS3202A - EMBEDDED SYSTEMS FOR IOT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3202A	EMBEDDED SYSTEMS FOR IOT	ESIOT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To apply the concepts of system architecture in functioning of IoT devices	3	PO2
CO2	To apply the Communication models that are used for the development of the IoT based Systems	3	PO2
CO3	To apply different networking topologies and protocols used for the development of IoT based Networks	3	PO5
CO4	To apply IoT Application in different Case studies	3	PO2
CO5	Analyze the programming & interfacing of NODE MCU using the hardware/software tool.	4	PO2

Syllabus

Introduction to embedded systems, Role of embedded system in IoT, Overview of embedded system architecture, IoT- Introduction and Characteristics, Physical Design of IoT, Things, Architecture, Applications of IoT, IoT Functional Blocks, IoT communication Models, IoT Enabling Technologies-WSN, WSN architectures, cloud computing, big data analytics, embedded systems, IoT Levels and deployment

Internet communications and Communication Technologies -An overview, IP, TCP, UDP, HTTP, Prototyping Embedded Devices-Sensors, Actuators, Prototyping online components, IoT and M2M, IoT Technologies - Wired - Ethernet, Power line communication wireless Technologies - BLE, Zigbee, Wi-Fi, Wi-Fi direct, SPI, I2C

IIOT protocols and cloud COAP, MQTT, 6lowpan, AMPQ, Overview of cloud platforms, Thing speak, AWS, IoT Physical Devices and Endpoints, IoT Physical Servers and Cloud Offerings: Introduction to cloud storage models and communication APIs

Case Studies: Illustrating IoT design- Home automation- Smart Lighting, smart appliances, home intrusion detection, Smart Cities - smart parking, Environment monitoring- forest fire detection, Air pollution monitoring, river floods detection, weather monitoring, Health, and lifestyle.

Programming & interfacing of NODE MCU using the hardware/software tool.

Reference Books

- 1 Designing the Internet of Things , Adrian McEwen and Hakim Cassimally , 1st edition , 2015, Wiley .
- 2 Internet of Things: A hands-on Approach , " A.Bahga and V.Madisetti" , 2015, Universities Press .
- 3 Internet of Things Architectures, Protocols and Standards , " Simone Cirani , Gianluigi Ferrari, Marco Picone, Luca Veltri" , 1st edition, 2019, Wiley .
- 4 IoT Use Cases and Technologies, F. JOHN DIAN AND REZA , 2019, British Columbia Institute of Technology.

23EDS3202E - EMBEDDED SYSTEMS FOR IOT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3202E	EMBEDDED SYSTEMS FOR IOT	ESIOT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To apply the concepts of system architecture in functioning of IoT devices	3	PO1
CO2	To apply the Communication models that are used for the development of the IoT based Systems	3	PO1
CO3	To apply different networking topologies and protocols used for the development of IoT based Networks	3	PO1
CO4	To apply IoT Application in different Case studies	3	PO1
CO5	Analyze the programming & interfacing of NODE MCU using the hardware/software tool.	4	PO1

Syllabus

Introduction to embedded systems, Role of embedded system in IoT, Overview of embedded system architecture, IoT- Introduction and Characteristics, Physical Design of IoT, Things, Architecture, Applications of IoT, IoT Functional Blocks, IoT communication Models, IoT Enabling Technologies-WSN, WSN architectures, cloud computing, big data analytics, embedded systems, IoT Levels and deployment

Internet communications and Communication Technologies -An overview, IP, TCP, UDP, HTTP, Prototyping Embedded Devices-Sensors, Actuators, Prototyping online components, IoT and M2M, IoT Technologies - Wired - Ethernet, Power line communication wireless Technologies - BLE, Zigbee, Wi-Fi, Wi-Fi direct, SPI, I2C

IIOT protocols and cloud COAP, MQTT,6lowpan, AMPQ, Overview of cloud platforms, Thing speak, AWS, IoT Physical Devices and Endpoints, IoT Physical Servers and Cloud Offerings: Introduction to cloud storage models and communication APIs

Case Studies: Illustrating IoT design- Home automation- Smart Lighting, smart appliances, home intrusion detection, Smart Cities - smart parking, Environment monitoring- forest fire detection, Air pollution monitoring, river floods detection, weather monitoring, Health, and lifestyle.

Programming & interfacing of NODE MCU using the hardware/software tool,THINGSPEAK cloud and NodeMCU, ESP32/ESP8266, Google Firebase, HTTP Protocol, MQTT Protocol

Reference Books

- 1 Designing the Internet of Things , Adrian McEwen and Hakim Cassimally , 1st edition , 2015, Wiley .
- 2 Internet of Things: A hands-on Approach , " A.Bahga and V.Madisetti" , 2015, Universities Press .
- 3 Internet of Things Architectures, Protocols and Standards , " Simone Cirani , Gianluigi Ferrari,Marco Picone, Luca Veltri" , 1st edition,2019, Wiley .
- 4 IoT Use Cases and Technologies, F. JOHN DIAN AND REZA , 2019, British Columbia Institute of Technology.

23EDS3202R - EMBEDDED SYSTEMS FOR IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3202R	EMBEDDED SYSTEMS FOR IOT	ESIOT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To apply the concepts of system architecture in functioning of IoT devices	3	PO2
CO2	To apply the Communication models that are used for the development of the IoT based Systems	3	PO2
CO3	To apply different networking topologies and protocols used for the development of IoT based Networks	3	PO5
CO4	To apply IoT Application in different Case studies	3	PO2

Syllabus

Introduction to embedded systems, Role of embedded system in IoT, Overview of embedded system architecture, IoT- Introduction and Characteristics, Physical Design of IoT, Things, Architecture, Applications of IoT, IoT Functional Blocks, IoT communication Models, IoT Enabling Technologies-WSN, WSN architectures, cloud computing, big data analytics, embedded systems, IoT Levels and deployment

Internet communications and Communication Technologies -An overview, IP, TCP, UDP, HTTP, Prototyping Embedded Devices-Sensors, Actuators, Prototyping online components, IoT and M2M, IoT Technologies - Wired - Ethernet, Power line communication wireless Technologies - BLE, Zigbee, Wi-Fi, Wi-Fi direct, SPI, I2C

IIOT protocols and cloud COAP, MQTT,6lowpan, AMPQ, Overview of cloud platforms, Thing speak, AWS, IoT Physical Devices and Endpoints, IoT Physical Servers and Cloud Offerings: Introduction to cloud storage models and communication APIs

Case Studies: Illustrating IoT design- Home automation- Smart Lighting, smart appliances, home intrusion detection, Smart Cities - smart parking, Environment monitoring- forest fire detection, Air pollution monitoring, river floods detection, weather monitoring, Health, and lifestyle.

Reference Books

- 1 Designing the Internet of Things , Adrian McEwen and Hakim Cassimally , 1st edition , 2015, Wiley .
- 2 Internet of Things: A hands-on Approach , " A.Bahga and V.Madisetti" , 2015, Universities Press .
- 3 Internet of Things Architectures, Protocols and Standards , " Simone Cirani , Gianluigi Ferrari,Marco Picone, Luca Veltri" , 1st edition,2019, Wiley .
- 4 IoT Use Cases and Technologies, F. John Dian and Reza Vahidnia, 2020 , British Columbia Institute of Technology .

23EDS3303A - EMBEDDED AND REAL-TIME SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3303A	EMBEDDED AND REAL-TIME SYSTEMS	ERTS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the different task-scheduling algorithms for real-time systems application	3	PO1, PO2, PO3, PSO1
CO2	Apply Multiprocessor scheduling and real-time communication, databases, and synchronization in Real-time System	3	PO1, PO2, PO3, PSO1
CO3	Analyse an RTOS and be able to interpret the feasibility of a task set to accomplish and Timers.	4	PO2, PO3, PO4, PSO1
CO4	Analyze to develop model-driven development approaches to construct an execution environment with case studies.	4	PO2, PO4, PO5, PSO2
CO5	Analyze the performance of real-time application and different task scheduling algorithms in real-time systems	4	PO3, PO4, PO5, PSO2
CO6	Analyze to develop a real-time application and different task-scheduling algorithms in real-time systems	4	PO3, PO4, PO5, PSO2
CO7	Analyse to design a real-time application and different task-scheduling algorithms in real-time systems using modern tool.	4	PO3, PO4, PO5, PSO2

Syllabus

Introduction to Real-Time Systems: A basic model of Real-Time systems, characteristics of Real-Time systems, types of Real-Time systems, applications of Real-Time systems, Case Study: Radar System. Real-Time task scheduling: basic concepts, clock-driven scheduling, table-driven scheduling, cyclic, schedulers, hybrid schedulers, event-driven scheduling, Earliest-Deadline-First (EDF) Scheduling, resource sharing among RT tasks, Priority inversion.

Multiprocessor Scheduling, Communication, and synchronization: Resource access control and synchronization in Real-time Operating system. The architecture of the Kernel, Task Operations, Structure, Synchronization, Communication, and Concurrency, Semaphores, Mutex. Mailboxes, Message Queues, Event Registers, Pipes, Signals, Device Drivers. Fault Tolerance Techniques Reliability, Evaluation Clock Synchronization.

Process Management, Interrupts and Timers: Exceptions, Interrupts, Interrupt service routines, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations. Memory Management, RTOS, Basic Design of RTOS, and Security issues. Automobile: Airbag System, Adaptive cruise control, and ADAS.

Embedded Real-time operating systems: Real-time OS and system software: requirements, principles, and examples, Capabilities of commercial real time operating systems, Embedded Linux, RT Linux, Handheld operating system, QNX Neutrino, Micro OS-II, VxWorks, Windows CE, Tiny OS. RTOS Case Studies, Applications Audio player, Engine control unit, Air traffic controller system Distributed air defense system.

Real-Time Scheduling: DMA, Rate Monotonic Approach: Priority Assignment, RMA Principle, Rate Monotonic Analysis, Completion Time Test, Period Transformation. Video accelerator, Orchestra Robot, Multiprocessor and Distributed Systems, Basic Concepts of Android OS Design Example

Reference Books

- 1 Real-Time Embedded Systems , Xiacong Fan , 2015, Elsevier Inc., .
- 2 Real Time Systems , C.M. Krishna & Kang G. Shin , 2010, McGraw Hill .
- 3 Embedded / Real Time Systems , KVKK Prasad , 2005, Dreamtech Press .

- 4 Real Time Systems Design and Analysis-An Engineers Handbook , Philip A.Laplante , 2001, IEEE Computer Society Press .
- 5 Embedded System Design A Unified Hardware/Software Introduction , Frank Vahid, Tony D. Givargis , 2002, John Wiley .

23EDS3303E - EMBEDDED AND REAL-TIME SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3303E	EMBEDDED AND REAL-TIME SYSTEMS	ERTS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the different task-scheduling algorithms for real-time systems application	3	PO1, PO2, PO3, PSO1
CO2	Apply Multiprocessor scheduling and real-time communication, databases, and synchronization in Real-time System	3	PO1, PO2, PO3, PSO1
CO3	Analyse an RTOS and be able to interpret the feasibility of a task set to accomplish and Timers.	4	PO2, PO3, PO4, PSO1
CO4	Analyze to develop model-driven development approaches to construct an execution environment with case studies.	4	PO2, PO4, PO5, PSO2
CO5	Analyze the performance of real-time application and different task scheduling algorithms in real-time systems	4	PO3, PO4, PO5, PSO2
CO6	Analyze to develop a real-time application and different task-scheduling algorithms in real-time systems	4	PO3, PO4, PO5, PSO2
CO7	Analyse to design a real-time application and different task-scheduling algorithms in real-time systems using modern tool.	4	PO3, PO4, PO5, PSO2

Syllabus

Introduction to Real-Time Systems: A basic model of Real-Time systems, characteristics of Real-Time systems, types of Real-Time systems, applications of Real-Time systems, Case Study: Radar System. Real-Time task scheduling: basic concepts, clock-driven scheduling, table-driven scheduling, cyclic, schedulers, hybrid schedulers, event-driven scheduling, Earliest-Deadline-First (EDF) Scheduling, resource sharing among RT tasks, Priority inversion.

Multiprocessor Scheduling, Communication, and synchronization: Resource access control and synchronization in Real-time Operating system. The architecture of the Kernel, Task Operations, Structure, Synchronization, Communication, and Concurrency, Semaphores, Mutex. Mailboxes, Message Queues, Event Registers, Pipes, Signals, Device Drivers. Fault Tolerance Techniques Reliability, Evaluation Clock Synchronization.

Process Management, Interrupts and Timers: Exceptions, Interrupts, Interrupt service routines, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations. Memory Management, RTOS, Basic Design of RTOS, and Security issues. Automobile: Airbag System, Adaptive cruise control, and ADAS.

Embedded Real-time operating systems: Real-time OS and system software: requirements, principles, and examples, Capabilities of commercial real time operating systems, Embedded Linux, RT Linux, Handheld operating system, QNX Neutrino, Micro OS-II, VxWorks, Windows CE, Tiny OS. RTOS Case Studies, Applications Audio player, Engine control unit, Air traffic controller system Distributed air defense system.

Real-Time Scheduling: DMA, Rate Monotonic Approach: Priority Assignment, RMA Principle, Rate Monotonic Analysis, Completion Time Test, Period Transformation. Video accelerator, Orchestra Robot, Multiprocessor and Distributed Systems, Basic Concepts of Android OS Design Example

Reference Books

- 1 Real-Time Embedded Systems, Xiaocong Fan, 2015, Elsevier Inc.,.
- 2 Real Time Systems, C.M. Krishna & Kang G. Shin, 2010, McGraw Hill.
- 3 Embedded Real Time Systems, KVKK Prasad, 2005, Dreamtech Press.

- 4 Real Time Systems Design and Analysis-An Engineers Handbook, Philip A.Laplante, 2001, IEEE Computer Society Press.
- 5 Embedded System Design A Unified Hardware/Software Introduction , Frank Vahid, Tony D. Givargis , 2002, John Wiley .

23EDS3303R - EMBEDDED AND REAL-TIME SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3303R	EMBEDDED AND REAL-TIME SYSTEMS	ERTS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the different task-scheduling algorithms for real-time systems application	3	PO1, PO2, PO3, PSO1
CO2	Apply Multiprocessor scheduling and real-time communication, databases, and synchronization in Real-time Systems	3	PO1, PO2, PO3, PSO1
CO3	Analyse an RTOS and be able to interpret the feasibility of a task set to accomplish and Timers.	4	PO2, PO3, PO4, PSO1
CO4	Analyse model-driven development approaches to construct an execution environment with case studies.	4	PO2, PO4, PO5, PSO2
CO5	Analyse to develop real-time applications and different task-scheduling algorithms in real-time systems	4	PO3, PO4, PO5, PSO2
CO6	Analyse to design a real-time application and different task-scheduling algorithms in real-time systems using modern tool.	4	PO3, PO4, PO5, PSO2

Syllabus

Real-Time Systems are defined by their strict timing constraints and predictable behaviors, with applications in domains like radar systems. Scheduling methods, such as clock-driven, table-driven, cyclic, and EDF, manage task priorities and resource sharing, addressing issues like priority inversion.

Multiprocessor Scheduling, Communication, and synchronization: Resource access control and synchronization in Real time Operating system. The architecture of the Kernel, Task Operations, Structure, Synchronization, Communication, and Concurrency, Semaphores, Mutex. Mailboxes, Message Queues, Event Registers, Pipes, Signals, Device Drivers. Fault Tolerance Techniques Reliability, Evaluation Clock Synchronization.

Process Management, Interrupts and Timers Exceptions, Interrupts, Interrupt service routines, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations. Memory Management, RTOS, Basic Design of RTOS, and Security issues. Automobile Airbag System, Adaptive cruise control, and ADAS.

Embedded Real time operating systems Real-time OS and system software requirements, principles, and examples, Capabilities of commercial real-time operating systems, Embedded Linux, RT Linux, Handheld operating system, QNX Neutrino, Micro OS II, VxWorks, Windows CE, Tiny OS. RTOS Case Studies Applications Audio player, Engine control unit, Air traffic controller system Distributed air defense system.

Reference Books

- 1 Real-Time Embedded Systems , Xiaocong Fan , 2015, Elsevier Inc., .
- 2 Real Time Systems , C.M. Krishna & Kang G. Shin , 2010, McGraw Hill .
- 3 Embedded Real Time Systems , KVKK Prasad , 2005, Dreamtech Press .
- 4 Real Time Systems Design and Analysis-An Engineers Handbook , Philip A.Laplante , 2001, IEEE Computer Society Press .
- 5 Embedded System Design A Unified Hardware/Software Introduction , Frank Vahid, Tony D. Givargis , 2002, John Wiley .

23EDS3404M - CLOUD ARCHITECTURE IN IOT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3404M	CLOUD ARCHITECTURE IN IOT	CAIOT	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the evolution and cloud computing services , deployment models	2	PO2, PO5, PSO1
CO2	Apply different enabling technology and architecture, Services and deployment models	3	PO2, PO5, PO7, PSO1
CO3	Analyze and apply different cloud virtualization and storage	4	PO2, PO5, PO7, PSO1
CO4	Analyze the different case studies on healthcare, agriculture and Activity monitoring	4	PO2, PO4, PO7, PSO1

Syllabus

Overview of Computing Paradigm: Recent trends in Computing-Grid Computing, Cluster Computing, Distributed Computing, Utility computing, Cloud Computing. Evolution of cloud computing: Business driver for adopting cloud computing. Introduction to Cloud Computing: Cloud Computing (NIST Model), Introduction to Cloud Computing, History of Cloud Computing, and Cloud service providers. Properties, Characteristics & Disadvantages Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing.

Cloud Computing Architecture: Cloud computing stack- Comparison with traditional computing architecture (client/server), Services provided at various levels, Role of Web services. Service Models (XaaS)-Infrastructure as a Service(IaaS),Platform as a Service(PaaS), Software as a Service(SaaS). Deployment Models- Public cloud, Private cloud, Hybrid cloud, Community cloud.

Resource Virtualization: Server, Storage, Network, Virtual Machine (resource) provisioning and manageability. Service Management in Cloud Computing: Service Level Agreements(SLAs)-Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud Economics of scaling, Managing Data, Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing.

Cloud Security: Infrastructure Security, Data security and Storage, Identity & Access Management, Access Control, Trust, Reputation, Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations. Data capturing through IOT devices: Transmission of the data through different stages, and storage of the same in Clouds.

Reference Books

- 1 Cloud Computing , Kris Jamsa, 2012 , Jones & Bartlett Publishers.
- 2 Cloud Security: A Comprehensive Guide To Secure Cloud Computing, Russell Dean Vines and Ronald L. Krutz , 2010, Wiley India Pvt Ltd .
- 3 Cloud Computing: Principles, Systems and Applications , Nikos Antonopoulos, Lee Gillam, 2012, Springer Publications .
- 4 Cloud Computing Bible , Barrie Sosinsky , 2010, Wiley India .

23EDS3505 - EDGE COMPUTING & DATA ANALYTICS IN IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EDS3505	EDGE COMPUTING & DATA ANALYTICS IN IOT	ECDAI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the major components of fog and edge computing architectures and understand the need for new computing paradigms.	3	PO1, PO2, PO3, PSO1
CO2	Identify potential technical challenges of the transition process and suggest solutions.	3	PO1, PO2, PO3, PSO1
CO3	Analyze data collection, analytics, and decision-making capabilities into these Edge compute systems, Analyze data and application requirements and pertaining issues.	4	PO2, PO3, PO4, PSO1
CO4	Analyze and model infrastructures and analytics into Edge Computing to perform decision-making.	4	PO2, PO4, PSO1

Syllabus

Introduction to Edge Computing: Scenarios and Use Cases - Edge computing purpose and definition, Edge computing use cases, Middleware Infrastructures, Edge computing hardware architectures, Edge cloud architectures, Lightweight Edge Clouds, IoT Integration, and cloud-based IoT orchestration patterns/practices for Edge Computing systems. Fog architecture, Edge vs Fog Computing.

Methodologies: Key principles in designing integrated Edge Computing sensor networks Capabilities of Edge Computing nodes, sensors, transducers, and related technologies. Communication Models - Edge, Fog, and M2M. New computing paradigms, Data Protocols: MQTT, MQTT-SN, CoAP, AMQP, XMPP, SOAP, REST, WebSocket.

Data in the fog and Edge: Big Data Analytics, Data management, Data protection by design, GDPR restrictions. Optimization and modeling frameworks. The Business and IIoT challenge, C2F2T integration infrastructures.

Applications and techniques: Smart e-Health, smart surveillance, smart transportation, Predictive analysis for Fog applications deployment, Testing of Fog IoT apps, ML techniques for defending IoT systems.

Reference Books

- 1 Fog and Edge Computing , Buyya R., Srirama S.N , 2019, Wiley .
- 2 Edge Computing: Models, technologies and applications , Taheri J. & Deng S. , 2020, IET .
- 3 Fog, Edge, and Pervasive Computing in Intelligent IoT Driven Applications, , Deepak Gupta, Aditya Khamparia , 2021, Wiley .
- 4 Internet of Things: A Hands-on Approach , Arshdeep Bahga and Vijay Madisetti , 2014, University Press .

23EGD3101A - MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3101A	MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS	MADRS	A	4	0	4	4	7

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the anatomy of existing robotic systems and their performance specifications, end effectors, etc.	3	PO1, PO2, PSO1
CO2	Apply suitable sensors and actuators for a real-time robotic system	3	PO1, PO2, PSO1
CO3	Apply the Denavit Hartenberg procedure to solve forward and inverse kinematics of robots	3	PO1, PO2, PSO1
CO4	Apply appropriate robot control and arm configurations for specific applications	3	PO1, PO2, PSO1
CO5	Kinematic modeling and analysis of ABB IRB 1600 industrial robot with the help of ABB RobotStudio software	4	PO3, PSO1
CO6	Develop a robot system for a pick and place operation	4	PO3, PSO1
CO7	Analyze robotic deployment in dynamic environments, utilizing advanced techniques for effective solution design in unpredictable scenarios	4	PO1, PO2, PSO1

Syllabus

INTRODUCTION TO ROBOTICS Major components of a Robot, Robotic-like devices, Classification of Robots Classification by coordinate system and by control method. **ROBOT END EFFECTORS** Introduction, End effectors, interfacing, types of End effectors, grippers and tools, Considerations in the selection and design of remote cantered devices.

ROBOTIC SENSORY DEVICES NonOptical position sensors Potentiometers, Synchros, inductosyn, optical position sensors opto interrupters, Optical encoders absolute and incremental. **PROXIMITY SENSORS** Contact type, non contact type Reflected light, scanning laser sensors. **TOUCH and SLIP SENSORS** Touch sensors proximity Rod and Photo detector sensors, Slip sensors Forced oscillation slip sensor, interrupted type slip sensors, force and torque sensors.

TRANSFORMATIONS AND KINEMATICS Objectives, homogeneous coordinates, basic transformation operations, forward solution Denavit Hartenberg procedure, Simple problems involving planar manipulators, inverse or backward solution problems involved, techniques.

INTRODUCTION TO ROBOT CONTROL Introduction Need and types of control schemes for robots joint space control schemes with an example task space control schemes with an example. **ROBOT APPLICATIONS** Industrial Applications Material Transfer, material handling, Loading and unloading, processing, spot and continuous arc welding, spray painting, grinding, Assembly and Inspection and Non Industrial Applications.

The module provides a comprehensive understanding of RobotStudio and ABB IRB 1600 Robot operations, covering basic to advanced concepts. It includes configuring tools and targets, mastering RAPID programming, and exploring topics like conveyor integration and spray paint operations. Hands-on experience with the ABB IRB 1600 Robot ensures practical skill development.

The module revolves around crafting a pick-and-place robot system. It encompasses task analysis, design, programming, and sensor integration, leading to practical exercises aimed at constructing a functional system for industrial automation.

This module focuses on the challenges and applications of robotics in dynamic environments. It covers real-time path planning, obstacle avoidance, collision detection, and adaptive behavior techniques. Students analyze case studies and undertake projects to design and implement robotic solutions for specific dynamic environment scenarios, gaining advanced skills for deploying robots in unpredictable settings.

Reference Books

- 1 Robotics Engineering: An Integrated Approach, Richard D. Klafter, 1, 1989, Prentice-Hall.
- 2 INDUSTRIAL ROBOTICS, Mikell Groover, 2, 2017, McGraw-Hill .
- 3 Robotics: Control, Sensing, Vision and Intelligence, K. S. Fu, C.S.G. Lee, Ralph Gonzalez, 1, 1987, McGraw-Hill .
- 4 Robotics for Engineers, Yoram Koren, 1, 1985, McGraw-Hill .
- 5 ROBOTICS AND CONTROL, R Mittle, I Nagrath, 1, 2017, McGraw-Hill .

23EGD3101E - MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3101E	MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS	MADRS	E	4	0	4	4	7

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the anatomy of existing robotic systems and their performance specifications, end effectors, etc.	3	PO1, PO2, PSO1
CO2	Apply suitable sensors and actuators for a real-time robotic system	3	PO1, PO2, PSO1
CO3	Apply the Denavit Hartenberg procedure to solve forward and inverse kinematics of robots	3	PO1, PO2, PSO1
CO4	Apply appropriate robot control and arm configurations for specific applications	3	PO1, PO2, PSO1
CO5	Kinematic modeling and analysis of ABB IRB 1600 industrial robot with the help of ABB RobotStudio software	4	PO3, PSO1
CO6	Develop a robot system for a pick and place operation	4	PO3, PSO1
CO7	Analyze robotic deployment in dynamic environments, utilizing advanced techniques for effective solution design in unpredictable scenarios	4	PO1, PO2, PSO1

Syllabus

INTRODUCTION TO ROBOTICS Major components of a Robot, Robotic-like devices, Classification of Robots Classification by coordinate system and by control method. **ROBOT END EFFECTORS** Introduction, End effectors, interfacing, types of End effectors, grippers and tools, Considerations in the selection and design of remote cantered devices.

ROBOTIC SENSORY DEVICES NonOptical position sensors Potentiometers, Synchros, inductosyn, optical position sensors opto interrupters, Optical encoders absolute and incremental. **PROXIMITY SENSORS** Contact type, non contact type Reflected light, scanning laser sensors. **TOUCH and SLIP SENSORS** Touch sensors proximity Rod and Photo detector sensors, Slip sensors Forced oscillation slip sensor, interrupted type slip sensors, force and torque sensors.

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- 4 Robotics for Engineers, Yoram Koren, 1, 1985, McGraw-Hill .
- 5 ROBOTICS AND CONTROL, R Mittle, I Nagrath, 1, 2017, McGraw-Hill .

23EGD3101R - MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3101R	MODELING ANALYSIS & DESIGN OF ROBOTIC SYSTEMS	MADRS	R	3	0	2	4	5

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the anatomy of existing robotic systems and their performance specifications, end effectors, etc.	3	PO1, PO2, PSO1
CO2	Apply suitable sensors and actuators for a real-time robotic system	3	PO1, PO2, PSO1
CO3	Apply the Denavit Hartenberg procedure to solve forward and inverse kinematics of robots	3	PO1, PO2, PSO1
CO4	Apply appropriate robot control and arm configurations for specific applications	3	PO1, PO2, PSO1
CO5	Kinematic modeling and analysis of ABB IRB 1600 industrial robot with the help of ABB RobotStudio software	4	PO3, PSO1
CO6	Develop a robot system for a pick and place operation	4	PO3, PSO1

Syllabus

INTRODUCTION TO ROBOTICS Major components of a Robot, Robotic-like devices, Classification of Robots Classification by coordinate system and by control method. **ROBOT END EFFECTORS** Introduction, End effectors, interfacing, types of End effectors, grippers and tools, Considerations in the selection and design of remote cantered devices.

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TRANSFORMATIONS AND KINEMATICS Objectives, homogeneous coordinates, basic transformation operations, forward solution Denavit Hartenberg procedure, Simple problems involving planar manipulators, inverse or backward solution problems involved, techniques.

INTRODUCTION TO ROBOT CONTROL Introduction Need and types of control schemes for robots joint space control schemes with an example task space control schemes with an example. **ROBOT APPLICATIONS** Industrial Applications Material Transfer, material handling, Loading and unloading, processing, spot and continuous arc welding, spray painting, grinding, Assembly and Inspection and Non Industrial Applications.

Kinematic modeling and analysis of ABB IRB 1600 industrial robot with the help of ABB RobotStudio software

Develop a robot system for a pick and place operation

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- 1 Robotics Engineering: An Integrated Approach, Richard D. Klafter, 1, 1989, Prentice-Hall.
- 2 Industrial Robotics, Mikell Groover , 2, 2017, McGraw-Hill .
- 3 Robotics: Control, Sensing, Vision and Intelligence, K. S. Fu, C.S.G. Lee, Ralph Gonzalez , 1, 1987, McGraw-Hill .

- 4 Robotics for Engineers, Yoram Koren, 1, 1985, McGraw-Hill .
- 5 Robotics and Control, R Mittle, I Nagrath, 1, 2017, McGraw-Hill .

23EGD3202A - CREEP, FATIGUE AND FRACTURE MECHANICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3202A	CREEP, FATIGUE AND FRACTURE MECHANICS	CFFM	A	5	0	0	0	5

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Assess the failure of unflawed structural components	4	PO2, PO3
CO2	Assess the fatigue life of structural components under the specified load spectrum	4	PO2, PO3
CO3	Evaluate the fracture toughness and assess the life of flawed structural components	4	PO2, PO3
CO4	Assess the life of structural components under creep	4	PO2, PO3
CO5	Apply engineering methods to solve complex problems	4	PO2, PO3

Syllabus

Analysis of stresses and strains in three-dimensions: Principal stresses and strains. Stress / strain invariants, Octahedral stresses, Theories of failure, various yield criteria

Repeated Stresses and fatigue in metals: Fatigue tests, endurance limit, Fatigue under combined loadings. Fatigue design theory: Goodman, Gerber and Soderberg criteria. Factors influencing fatigue behavior of metals: Frequency, temperature, size, form, surface conditions, residual stress, etc. influence of stress concentration, notch sensitivity. Various mechanical and metallurgical methods used for improving fatigue strength of metals.

Fracture Mechanics: Basic modes of fracture; Griffith theory of brittle fracture and Orwan modifications; Linear Elastic Fracture Mechanics (LEFM): Stress field ahead of crack-tip; stress intensity factors; critical SIF; Fracture toughness testing and evaluation of KIC. Elasto-plastic fracture mechanics: Plane stress and plane strain plastic zone sizes; J-integral method; SERR computation and evaluation of structural integrity

Creep behavior of metals: Creep-stress-time-temperature relations; creep testing methods; Mechanics of creep; creep in tension, bending and torsion; strain-hardening effects on creep; creep buckling; members subjected to combined stresses and creep

Engineering methods for solving complex creep, fatigue and fracture problems

Reference Books

- 1 Mechanical Metallurgy , George E. Dieter , 1986 , McGraw-Hill International.
- 2 Elementary Engineering Fracture Mechanics , David Broek , 1982, Springer .
- 3 Mechanical Behavior of Materials , Norman E. Dowling , 2013, Prentice Hall .
- 4 Introduction of Fracture Mechanics, Kare Hellan, 1985, McGraw-Hill Book Company.
- 5 Elements of Fracture Mechanics, Preshant Kumar, 1999, Wheeler Publishing.

23EGD3202E - CREEP, FATIGUE AND FRACTURE MECHANICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3202E	CREEP, FATIGUE AND FRACTURE MECHANICS	CFFM	E	5	0	0	0	5

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Assess the failure of unflawed structural components	4	PO2, PO3
CO2	Assess the fatigue life of structural components under the specified load spectrum	4	PO2, PO3
CO3	Evaluate the fracture toughness and assess the life of flawed structural components	4	PO2, PO3
CO4	Assess the life of structural components under creep	4	PO2, PO3
CO5	Apply engineering methods to solve complex problems	4	PO2, PO3

Syllabus

Analysis of stresses and strains in three-dimensions: Principal stresses and strains. Stress / strain invariants, Octahedral stresses, Theories of failure, various yield criteria

Repeated Stresses and fatigue in metals: Fatigue tests, endurance limit, Fatigue under combined loadings. Fatigue design theory: Goodman, Gerber and Soderberg criteria. Factors influencing fatigue behavior of metals: Frequency, temperature, size, form, surface conditions, residual stress, etc. influence of stress concentration, notch sensitivity. Various mechanical and metallurgical methods used for improving fatigue strength of metals.

Fracture Mechanics: Basic modes of fracture; Griffith theory of brittle fracture and Orwan modifications; Linear Elastic Fracture Mechanics (LEFM): Stress field ahead of crack-tip; stress intensity factors; critical SIF; Fracture toughness testing and evaluation of KIC. Elasto-plastic fracture mechanics: Plane stress and plane strain plastic zone sizes; J-integral method; SERR computation and evaluation of structural integrity

Creep behavior of metals: Creep-stress-time-temperature relations; creep testing methods; Mechanics of creep; creep in tension, bending and torsion; strain-hardening effects on creep; creep buckling; members subjected to combined stresses and creep

Engineering methods to solve complex fracture mechanics problems

Reference Books

- 1 Mechanical Metallurgy , George E. Dieter , 1986, McGraw-Hill International .
- 2 Elementary Engineering Fracture Mechanics , David Broek , 1982, Springer .
- 3 Mechanical Behavior of Materials , Norman E. Dowling , 2013, Prentice Hall .
- 4 Introduction of Fracture Mechanics, Kare Hellan, 1985, McGraw-Hill Book Company.
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23EGD3202R - CREEP, FATIGUE AND FRACTURE MECHANICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3202R	CREEP, FATIGUE AND FRACTURE MECHANICS	CFFM	R	3	0	0	0	3

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Assess the failure of unflawed structural components	4	PO2, PO3
CO2	Assess the fatigue life of structural components under the specified load spectrum	4	PO2, PO3
CO3	Evaluate the fracture toughness and assess the life of flawed structural components	4	PO2, PO3
CO4	Assess the life of structural components under creep	4	PO2, PO3

Syllabus

Analysis of stresses and strains in three-dimensions: Principal stresses and strains. Stress / strain invariants, Octahedral stresses, Theories of failure, various yield criteria

Repeated Stresses and fatigue in metals: Fatigue tests, endurance limit, Fatigue under combined loadings. Fatigue design theory: Goodman, Gerber and Soderberg criteria. Factors influencing fatigue behavior of metals: Frequency, temperature, size, form, surface conditions, residual stress, etc. influence of stress concentration, notch sensitivity. Various mechanical and metallurgical methods used for improving fatigue strength of metals.

Fracture Mechanics: Basic modes of fracture; Griffith theory of brittle fracture and Orwan modifications; Linear Elastic Fracture Mechanics (LEFM): Stress field ahead of crack-tip; stress intensity factors; critical SIF; Fracture toughness testing and evaluation of KIC. Elasto-plastic fracture mechanics: Plane stress and plane strain plastic zone sizes; J-integral method; SERR computation and evaluation of structural integrity

Creep behavior of metals: Creep-stress-time-temperature relations; creep testing methods; Mechanics of creep; creep in tension, bending and torsion; strain-hardening effects on creep; creep buckling; members subjected to combined stresses and creep

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- 5 Elements of Fracture Mechanics, Preshant Kumar, 1999, Wheeler Publishing.

23EGD3203A - THEORY OF ELASTICITY AND PLASTICITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3203A	THEORY OF ELASTICITY AND PLASTICITY	TEP	A	5	0	0	0	5

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze stresses and strains in planes in elastic or plastic region	4	PO2, PO3
CO2	Solve 2-D problems in rectangular Components	4	PO2, PO3
CO3	Analyze stresses and strains in 3-D problems	4	PO2, PO3
CO4	Analyze Beams and frames in plasticity applications	4	PO2, PO3
CO5	Analyze complex structural deformation problems adopting engineering methods	4	PO2, PO3

Syllabus

Elasticity: Components of stress and strain: plane stress and plane strain; Plasticity: Foundations of plasticity, the criteria of yielding, stress-strain relationship, stress resolving postulates, rule of plastic flow.

2-D Problems in rectangular co-ordinates: solution by polynomials; St.Venants principle; determination of displacements; Bending of a cantilever loaded at the end; Bending of a beam under uniform load.

Stress and strain analysis in 3-D problems: Principle stresses and their determination; Stress invariants; strains at a point. Principal axis of strain; Elementary problems.

Plastic analysis of beams and frames: Limit analysis of beams and frames; Minimum weight design, influence of axial force.

Engineering methods and solutions for complex problems

Reference Books

- 1 Theory of Elasticity , S.P. Timoshenko; J.N. Goodier , 1970, McGraw-Hill Book Company .
- 2 Theory of Plasticity , J. Chakrabarty , 2006, Elsevier Butterworth-Heinemann .
- 3 Engineering Plasticity: Theory and Application to Metal Forming Processes , R A C Slater , 1977, Macmillan .
- 4 Theory of Elasticity and Plasticity, Sadhu Singh, 1988, Khanna Publishers.
- 5 Theory of Elasticity and Plasticity, Harold Malcolm Westergaard, 1964, Dover Publications.

23EGD3203E - THEORY OF ELASTICITY AND PLASTICITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3203E	THEORY OF ELASTICITY AND PLASTICITY	TEP	E	5	0	0	0	5

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze stresses and strains in planes in elastic or plastic region	4	PO2, PO3
CO2	Solve 2-D problems in rectangular Components	4	PO2, PO3
CO3	Analyze stresses and strains in 3-D problems	4	PO2, PO3
CO4	Analyze Beams and frames in plasticity applications	4	PO2, PO3
CO5	Analyze complex structural deformation problems adopting engineering methods	4	PO2, PO3

Syllabus

Elasticity: Components of stress and strain: plane stress and plane strain; Plasticity: Foundations of plasticity, the criteria of yielding, stress-strain relationship, stress resolving postulates, rule of plastic flow. In the context of elasticity, stress and strain are fundamental concepts describing how materials deform under various forces. Plane stress occurs in thin plates subjected to loads in their plane, resulting in negligible stresses perpendicular to the plane. Plane strain, on the other hand, applies to long bodies where deformation is assumed constant along one dimension. In both cases, the stress and strain tensors simplify, reducing the complexity of the problem. These simplifications are crucial for solving engineering problems efficiently.

2-D Problems in rectangular co-ordinates: solution by polynomials; St.Venants principle; determination of displacements; Bending of a cantilever loaded at the end; Bending of a beam under uniform load. Two-dimensional problems in elasticity often employ polynomial solutions to satisfy boundary conditions and equilibrium equations. St. Venant's principle states that the difference in effect between two different but statically equivalent loads becomes negligible at sufficiently large distances from the load. This principle simplifies complex problems by allowing engineers to approximate load distributions. Displacement determination in these problems involves solving differential equations derived from equilibrium and compatibility conditions. The bending of cantilevers and beams under various loads are classic examples of these solutions.

Stress and strain analysis in 3-D problems: Principle stresses and their determination; Stress invariants; strains at a point. Principal axis of strain; Elementary problems. In three-dimensional stress analysis, determining the principal stresses and their directions is crucial. Principal stresses are the normal stresses acting on planes where the shear stress is zero. Stress invariants, which are combinations of the stress components, remain constant regardless of the orientation of the coordinate system. These invariants are used to derive important relationships in elasticity and plasticity. Strains at a point, including the principal axes of strain, describe the deformation state and are essential for assessing material behavior under complex loading conditions.

Plastic analysis of beams and frames: Limit analysis of beams and frames; Minimum weight design, influence of axial force. Plastic analysis of beams and frames involves determining the load-carrying capacity beyond the elastic limit, leading to the concept of limit analysis. Limit analysis identifies the collapse load, which is the maximum load a structure can carry before failing plastically. This approach is essential for designing structures to withstand loads beyond the elastic range. Minimum weight design aims to reduce the weight of structures while maintaining their load-carrying capacity. The influence of axial force on the plastic behavior of beams and frames is also considered in these analyses, ensuring the overall stability and safety of structures.

Engineering methods for solving complex problems. Analytical methods involve using mathematical models and classical solutions to solve engineering problems. These methods often employ differential equations, linear algebra, and calculus to describe physical systems. For example, in structural analysis, the equations of equilibrium and compatibility are solved to determine stress and strain distributions. Analytical solutions provide precise answers but can become impractical for highly complex systems. They are particularly useful for understanding fundamental principles and validating numerical methods.

Reference Books

- 1 Theory of Elasticity , S.P. Timoshenko; J.N. Goodier , 1970, McGraw-Hill Book Company .
- 2 Theory of Plasticity , J. Chakrabarty , 2006, Elsevier Butterworth-Heinemann .
- 3 Engineering Plasticity: Theory and Application to Metal Forming Processes , R A C Slater , 1977, Macmillan .
- 4 Theory of Elasticity and Plasticity, Sadhu Singh, 1999, Khanna Publishers.
- 5 Theory of Elasticity and Plasticity, Harold Malcolm Westergaard, 1964, Dover Publications.

23EGD3203R - THEORY OF ELASTICITY AND PLASTICITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3203R	THEORY OF ELASTICITY AND PLASTICITY	TEP	R	3	0	0	0	3

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze stresses and strains in planes in elastic or plastic region	4	PO2, PO3
CO2	Solve 2-D problems in rectangular Components	4	PO2, PO3
CO3	Analyze stresses and strains in 3-D problems	4	PO2, PO3
CO4	Analyze Beams and frames in plasticity applications	4	PO2, PO3

Syllabus

Elasticity: Components of stress and strain: plane stress and plane strain; Plasticity: Foundations of plasticity, the criteria of yielding, stress-strain relationship, stress resolving postulates, rule of plastic flow. In the context of elasticity, stress and strain are fundamental concepts describing how materials deform under various forces. Plane stress occurs in thin plates subjected to loads in their plane, resulting in negligible stresses perpendicular to the plane. Plane strain, on the other hand, applies to long bodies where deformation is assumed constant along one dimension. In both cases, the stress and strain tensors simplify, reducing the complexity of the problem. These simplifications are crucial for solving engineering problems efficiently.

2-D Problems in rectangular co-ordinates: solution by polynomials; St.Venants principle; determination of displacements; Bending of a cantilever loaded at the end; Bending of a beam under uniform load. Two-dimensional problems in elasticity often employ polynomial solutions to satisfy boundary conditions and equilibrium equations. St. Venant's principle states that the difference in effect between two different but statically equivalent loads becomes negligible at sufficiently large distances from the load. This principle simplifies complex problems by allowing engineers to approximate load distributions. Displacement determination in these problems involves solving differential equations derived from equilibrium and compatibility conditions. The bending of cantilevers and beams under various loads are classic examples of these solutions.

Stress and strain analysis in 3-D problems: Principle stresses and their determination; Stress invariants; strains at a point. Principal axis of strain; Elementary problems. In three-dimensional stress analysis, determining the principal stresses and their directions is crucial. Principal stresses are the normal stresses acting on planes where the shear stress is zero. Stress invariants, which are combinations of the stress components, remain constant regardless of the orientation of the coordinate system. These invariants are used to derive important relationships in elasticity and plasticity. Strains at a point, including the principal axes of strain, describe the deformation state and are essential for assessing material behavior under complex loading conditions.

Plastic analysis of beams and frames: Limit analysis of beams and frames; Minimum weight design, influence of axial force. Plastic analysis of beams and frames involves determining the load-carrying capacity beyond the elastic limit, leading to the concept of limit analysis. Limit analysis identifies the collapse load, which is the maximum load a structure can carry before failing plastically. This approach is essential for designing structures to withstand loads beyond the elastic range. Minimum weight design aims to reduce the weight of structures while maintaining their load-carrying capacity. The influence of axial force on the plastic behavior of beams and frames is also considered in these analyses, ensuring the overall stability and safety of structures.

Reference Books

- 1 Theory of Elasticity , S.P. Timoshenko; J.N. Goodier , 1970, McGraw-Hill Book Company .
- 2 Theory of Plasticity , J. Chakrabarty , 2006, Elsevier Butterworth-Heinemann .
- 3 Engineering Plasticity: Theory and Application to Metal Forming Processes , R A C Slater , 1977, Macmillan .
- 4 Theory of Elasticity and Plasticity, Sadhu Singh, 1988, Khanna Publishers.
- 5 Theory of Elasticity and Plasticity, Harold Malcolm Westergaard, 1964, Dover Publications.

23EGD3304A - SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3304A	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN	SDSIED	A	4	0	4	4	7

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand principles and frameworks of sustainable design and social innovation.	2	PO2, PO8, PSO2
CO2	Apply Dieter\'s engineering design process incorporating sustainable design and develop a solution concept	3	PO2, PO8, PSO2
CO3	identify the product architecture and configure the product components.	3	PO2, PO8, PSO2
CO4	Analyze and evaluate sustainable design methodologies for product development	4	PO6, PO8, PSO2
CO5	Apply sustainable materials and manufacturing practices in practical settings.	4	PO6, PO8, PSO2
CO6	Demonstrate creative thinking and problem-solving skills in social innovation and Design and execute a fully functional prototype	6	PO6, PO8, PSO2
CO7	Develop skills in prototyping, testing, and refining designs for sustainable products.	4	PO6, PO8, PSO2

Syllabus

Introduction to sustainable design and social innovation, Dieter\'s engineering design process, Sustainable design methodologies

Social innovation and design thinking, Problem identification and needs analysis, Concept generation and selection

Product Architecture & Systems Design, Product Configuration design, Detailed design and prototyping

Developing a manufacturing plan for the prototype

Analyse and refine the prototype for sustainability and innovation

Reference Books

- 1 Sustainability in Engineering Design , Anthony Johnson & Andy Gibson, 1, 2014, Elsevier publications .
- 2 Design for sustainability: a practical approach , Tracy Bhamra and Vicky Lofthouse, 1, 2007, Gower Publishing Limited .
- 3 Engineering Design , George Dieter,?Linda Schmidt , 4, 2022, McGraw Hill .
- 5 Sustainable Product Design and Development , Anoop Desai, Anil Mital, 1, 2020, CRC Press .

23EGD3304E - SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3304E	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN	SDSIED	E	4	0	4	4	7

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand principles and frameworks of sustainable design and social innovation.	2	PO2, PO7, PSO2
CO2	Apply Dieter's engineering design process incorporating sustainable design and develop a solution concept	3	PO2, PO7, PSO2
CO3	Identify the product architecture and configure the product components	3	PO2, PO7, PSO2
CO4	Analyze and evaluate sustainable design methodologies for product development.	4	PO6, PO7, PSO2
CO5	Apply sustainable materials and manufacturing practices in practical settings.	4	PO6, PO7, PSO2
CO6	Demonstrate creative thinking and problem-solving skills in social innovation and Design and execute a fully functional prototype	6	PO6, PO7, PSO2
CO7	Develop skills in prototyping, testing, and refining designs for sustainable products.	4	PO6, PO7, PSO2

Syllabus

Introduction to sustainable design and social innovation, Dieter's engineering design process, Sustainable design methodologies

Social innovation and design thinking, Problem identification and needs analysis, Concept generation and selection.

Product Architecture & Systems Design, Product Configuration design, Detailed design and prototyping.

Developing a manufacturing plan for the prototype

Analyse and refine the prototype for sustainability and innovation

Reference Books

- 1 Sustainability in Engineering Design , Anthony Johnson & Andy Gibson, 1, 2014, Elsevier publications.
- 2 Design for sustainability: a practical approach, Tracy Bhamra and Vicky Lofthouse, 1, 2007, Gower Publishing Limited.
- 3 Engineering Design , George Dieter, Linda Schmidt , 4, 2022, McGraw Hill.
- 4 Sustainable Product Design and Development, Anoop Desai, Anil Mital , 1, 2020, CRC Press.

23EGD3304R - SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3304R	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN ENGINEERING DESIGN	SDSIED	R	3	0	2	4	5

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand principles and frameworks of sustainable design and social innovation.	2	PO1
CO2	Apply Dieter's engineering design process incorporating sustainable design and develop a solution concept PO1 3	3	PO2
CO3	Identify the product architecture and configure the product components	3	PO2
CO4	Analyze and evaluate sustainable design methodologies for product development	4	PO6, PSO2
CO5	Demonstrate creative thinking and problem-solving skills in social innovation and Design and execute a fully functional prototype	6	PO6, PSO2
CO6	Develop skills in prototyping, testing, and refining designs for sustainable products.	4	PO6, PSO2

Syllabus

Introduction to sustainable design and social innovation, Dieter's engineering design process, Sustainable design methodologies

Social innovation and design thinking, Problem identification and needs analysis, Concept generation and selection

Product Architecture & Systems Design, Product Configuration design, Detailed design and prototyping

Developing a manufacturing plan for the prototype

Analyse and refine the prototype for sustainability and innovation

Reference Books

- 1 Sustainability in Engineering Design , Anthony Johnson & Andy Gibson , 1,2014, Elsevier publications .
- 2 Design for sustainability: a practical approach , Tracy Bhamra and Vicky Lofthouse , 1, 2007, Gower Publishing Limited .
- 3 Engineering Design , George Dieter, Linda Schmidt, 4, 2022, McGraw Hill .
- 4 Sustainable Product Design and Development, Anoop Desai, Anil Mital, 1, 2020, CRC Press.

23EGD3405M - ADVANCED VIBRATIONS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3405M	ADVANCED VIBRATIONS	AV	M	3	0	0	0	3

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of vibrations and the types of systems.	2	PO1, PSO1
CO2	Model vibrating systems and analyze their behavior under harmonic and transient excitations.	3	PO2, PSO1
CO3	Analyze vibrations of continuous systems and apply vibration control techniques.	4	PO1, PSO1
CO4	Apply vibration analysis techniques to real-world problems in engineering.	3	PO1, PSO1

Syllabus

Introduction to Vibrations: Single-degree-of-freedom systems, Multi-degree-of-freedom, systems, Free and forced vibrations. :Single degree of freedom system: Differential equation, complex exponential method of solution, energy method, power relations, phase relations, Nyquist diagram.

Modeling of Vibrating Systems: :Damping and modal analysis: Damping mechanisms, characterization and behavior of typical damping materials, structural response of multi-degree of freedom (MDOF) damped structures, proportional damping, modal testing, MDOF formulation using Finite Element Method (FEM), application of modal analysis in vibration reduction.

Continuous systems, Vibrations of plates and beams :Vibration of beams: Differential equation from Newton's law and Lagrange equation, boundary conditions, natural frequency and mode shapes, force excitation, dynamic stresses in beams.

Vibration Control and applications : Vibration measurement: Accelerometers, force gages, instrumented hammers, Fast Fourier transform analyzers and digital filters, applications in vibration measurement.

Reference Books

- 1 Mechanical Vibrations , Singiresu S. Rao , Pearson Education India , 2019.
- 2 Fundamentals of Mechanical Vibrations , S. Graham Kelly , McGraw-Hill Education, 2000.
- 3 Mechanical Vibrations: Theory and Applications , S. Graham Kelly, Cengage Learning, 2011.
- 4 Vibration Analysis and Control - New Trends and Developments , Francisco Beltran-Carbajal, Intech Open, 2018.
- 5 Random Vibrations: Theory and Practice , Paul H. Wirsching, Thomas L. Paez, and James P. Noone, John Wiley & Sons, , 2015.

23EGD3406M - MECHANICS OF COMPOSITE MATERIALS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3406M	MECHANICS OF COMPOSITE MATERIALS	MOCM	M	3	0	0	0	3

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the various composite materials and their manufacturing process methods.	3	PO1, PSO1
CO2	Apply the micro-mechanics concept to study the structural behavior of composite Lamina	3	PO1, PO2, PSO1
CO3	Apply the macro-mechanics concept to study the structural behavior of composite Lamina	3	PO1, PO2, PSO1
CO4	Apply Failure theories to calculate stresses in composite materials	3	PO1, PO2, PSO1

Syllabus

Introduction to composite materials, Geometric definitions, Classification of composites, Types of fibers, Types of the matrix, Hybrid composite, Scale of analysis- micro and macro mechanics approaches, Degree of Anisotropy. Manufacturing methods of the composites, Autoclave molding, Filament winding, and Resin transfer molding.

Elastic behavior of composite lamina (Micro-mechanics), Micro-mechanics methods, Geometric aspects and elastic symmetry, Longitudinal elastic properties (Continuous fibers), Transverse elastic properties, In-plane shear properties (Continuous fibers), Longitudinal properties (short fibers)

Elastic behavior of composite lamina (Macro mechanics approach), Stress-Strain relations: General anisotropic material, Specially orthotropic material, Transversely isotropic material, Orthotropic material under plane stress, Isotropic material.

Standard sizes of the specimen for tensile and compressive, Fatigue tests, and Impact tests of uni-directional composites. Experimental methods for characterization and testing of composite materials. Failure of the composite materials: fiber failures, matrix failure, interface failure. Failure Theories: Tsai-Wu, Tsai-Hill, Puck criterion, Maximum stress, maximum strain.

Reference Books

- 1 Engineering Mechanics of Composite Materials , Issac Daniel & Ori Ishai , 2nd; 2005, OU Publisher, USA .
- 2 Mechanics of Composite Materials , Autar K. Kaw, 2nd; 2005, Taylor & Francis .
- 3 Mechanics of Composite Materials , R.M. Jones , 2nd; 1998, Taylor & Francis .
- 4 Composite Materials , N. Chawla and K.K. Chawla , 3rd; 2006, Springer .
- 5 Mechanics of Composite Materials & Structures , Madhujit Mukhopadhyay , 1st; 2022, University Press .

23EGD3507 - ADVANCED STRENGTH OF MATERIALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3507	ADVANCED STRENGTH OF MATERIALS	ASM	R	3	0	0	0	3

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the behaviour of statically indeterminate beams for different loading conditions	4	PO1, PO2
CO2	Analyze the behaviour of curved beams and determine the shear centre for various cross sections of beams	4	PO1, PO2
CO3	Apply unit load method to find deflections in beams and structures	3	PO1, PO2
CO4	Analyze the various stresses in rotating members and thick cylinders	4	PO1, PO2

Syllabus

Statically Indeterminate Beams: Introduction to Statically indeterminate Beams, apply the Moment Area Method to analyze the fixed beams. Introduction to Continuous beams, apply Clapeyrons theorem of three moments to analyze continuous beams.

Curved Beams: Stresses in Beams of small and large initial curvature, Winkler-Bach theory, Stresses in Crane Hook and C-Clamp with Rectangular, Circular and Trapezoidal cross-sections. Shear Center: Importance of Shear Centre, Locate the shear center for different cross-sections.

Energy Methods: Introduction, Principles of virtual work, Apply Unit load Method to determine displacements and slope in Beams and to analyze simple structures and trusses.

Centrifugal Stresses: Introduction, Stresses in Rotating Ring, Disc of uniform thickness. Thick Cylinders: Stresses in Thick cylinders, Apply Lames theory to determine radial and circumferential stresses in thick cylinders. Stresses in Compound Cylinders.

Reference Books

- 1 Mechanics of Materials, Gere and Timoshenko, 2nd edition, CBS publishers.
- 2 Strength of Materials, Dr. Sadhu Singh, 10th edition, Khanna Publishers.
- 3 Strength of Materials, Pytel A H and Singer F L, 3rd Edition, Harper Collins, New Delhi.
- 4 Mechanics of Materials , Beer P F and Johnston (Jr) E R, 4th edition, McGraw Hill.
- 5 Engineering Mechanics of Solids, Popov E P, 4th edition, Prentice Hall, New Delhi..

23EGD3508 - HYBRID AND ELECTRIC VEHICLE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EGD3508	HYBRID AND ELECTRIC VEHICLE DESIGN	HEVD	R	3	0	0	0	3

Prerequisite

S#	Course Title	Acronym	Rule
1	ENGINEERING MECHANICS	EM	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Hybrid /EV Vehicles and study of vehicle dynamics	3	PO1, PO2, PSO1
CO2	Apply Architecture of Hybrid/EV Vehicles, components and Battery EV	3	PO1, PO2, PO3, PSO1
CO3	Apply and analyse Fuel Cell, DC/AC Drives and SRM	3	PO1, PO3, PSO2
CO4	Apply EV Controls, Controller, and control strategies	4	PO1, PO2, PO4, PSO2

Syllabus

History and Need for Hybrid/EV Vehicles: Evolution of automotive technology and the rise of hybrid and electric vehicles, Environmental and economic factors driving the adoption of hybrid and EV vehicles, Key milestones and major players in the hybrid/EV market. Developments in Hybrid and EV Vehicles: Technological advancements in batteries, electric motors, and power electronics, Current trends in hybrid and EV design and manufacturing, Future directions and innovations in the hybrid/EV industry. Basics of Vehicle Dynamics: Fundamental principles of vehicle motion, including kinematics and kinetics, Analysis of forces acting on a vehicle, such as traction, braking, and cornering, The role of suspension, steering, and drivetrain in vehicle dynamics.

Vehicle Dynamics: Principles of vehicle motion (acceleration, braking, cornering) and Influence of suspension, steering, and drivetrain on stability. Hybrid/EV Vehicle Architecture: Design of hybrid/EV powertrains (batteries, motors), Energy management systems and regenerative braking. Solar EV Vehicle: Solar energy conversion and storage in EVs, Design and optimization of solar panels for efficiency.

AC/DC/SRM Drives - Fundamentals of AC/DC Drives: Introduction to electric drives, basic principles of operation, and types of drives including AC and DC systems, Speed Control and Performance Characteristics: Methods of speed control for AC and DC drives, performance characteristics, and applications in industry, Solid-State Control of Motors: Power electronic devices and circuits used in AC/DC drives, including rectifiers, inverters, and pulse-width modulation (PWM) techniques.

Vehicle Control: Basics of vehicle control systems and dynamics, Implementation of control algorithms for stability and performance. Controller Design: Principles of designing controllers for automotive applications, Techniques for tuning and optimizing controller performance. Control Strategies: Overview of control strategies for vehicle dynamics and power management, Application of advanced control strategies like PID, adaptive, and predictive control.

Reference Books

- 1 Electric and Hybrid Vehicles: Design Fundamentals , Iqbal Hussein, 2015, CRC Press.
- 2 Modern Electric Hybrid Electric and Fuel Vehicles , Mehrdad Ehsani , 2018, Springer.
- 3 Vehicle Dynamics , Reza N. Jazar , 2013, Springer.
- 4 Hybrid/EV Vehicle Architecture , Chris Mi , 2021, Wiley.

- 5 Solar Electric Vehicle Technology , Stefan E. Nahorski , 1994, CRC Press .

23EME3101A - POWER TRAIN DESIGN FOR ELECTRIC VEHICLE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3101A	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	PTDEV	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify and explain the functions of key powertrain components in electric vehicles, including electric motors, battery packs, power electronics and fuel sources for EV design.	3	PO1
CO2	Apply fundamental principles of powertrain design to create and optimize electric vehicle powertrains, balancing aspects such as energy density, torque characteristics, Modeling of dynamics for EV	3	PO1
CO3	Analyze new technologies or improvements in electric vehicle powertrain design, fostering creativity and forward-thinking in the field.	4	PO1
CO4	Analyze the principles, functionality, and efficiency of regenerative braking systems in electric vehicles, and evaluate their impact on overall vehicle performance and energy recovery.	4	PO1
CO5	Test and evaluate the performance, reliability, and efficiency of various powertrain components in electric vehicles, including electric motors, battery packs, and power electronics.	4	PO1

Syllabus

HISTORY, ECONOMIC & ENVIRONMENTAL IMPACT OF ELECTRIC VEHICLE: History of EV, Case studies on Economic and Environment aspects of EV, Classification of electric vehicle, Modern electric drive train, Power train components: BEV, HEV, PHEV and FCEV, including working of Fuel cell, Super capacitor, energy management, Hybrid sources.

ELECTRIC VEHICLE DYNAMICS: Laws of Motion, General description of vehicle movement, Tractive Effort, Vehicle resistance: Rolling Resistance, Aerodynamic Drag, Grading Resistance, Acceleration resistance, Dynamic equation, Tire Ground Adhesion and maximum tractive effort, Vehicle Power Plant and Transmission Characteristics.

MODELING VEHICLE ACCELERATION & ELECTRIC VEHICLE RANGE: Acceleration performance parameters, Modeling the acceleration of an electric scooter, Modeling the acceleration of a small car, Driving cycles, Range modeling of battery electric vehicles, Constant velocity range modeling, Range modeling of fuel cell vehicles, Range modeling of hybrid electric vehicles.

Fundamentals of Regenerative Braking Energy Consumption in Braking, Braking Power and Energy on Front and Rear Wheels, Brake System of EVs and HEVs, Series Brake, Optimal Feel, Series Brake, Optimal Energy Recovery, Parallel Brake, Antilock Brake System (ABS).

Testing of the Power train components of EV, Test the Range of vehicle for different Driving cycles.

Reference Books

- 1 A History of Electric Vehicles, Nigel Burton, First, 2013, Crowood Publisher..
- 2 Electric Cars: The Ultimate Guide for Understanding the Electric Car And What You Need to Know, Brad Durant., First, 2014, CreateSpace Independent .
- 3 Electric Vehicle Technology, James Larminie and John Lowry, First, 2012, John Wiley-Blackwell.
- 4 Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design, Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, Second, 2018, CRC PRESS.
- 5 ELECTRIC and HYBRID VEHICLES, Design Fundamentals, Iqbal Husain, Second, 2018, CRC PRESS.

23EME3101E - POWER TRAIN DESIGN FOR ELECTRIC VEHICLE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3101E	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	PTDEV	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify and explain the functions of key powertrain components in electric vehicles, including electric motors, battery packs, power electronics and fuel sources for EV design.	3	PO1
CO2	Apply fundamental principles of powertrain design to create and optimize electric vehicle powertrains, balancing aspects such as energy density, torque characteristics, Modeling of dynamics for EV	3	PO1
CO3	Analyze new technologies or improvements in electric vehicle powertrain design, fostering creativity and forward-thinking in the field.	4	PO1
CO4	Analyze the principles, functionality, and efficiency of regenerative braking systems in electric vehicles, and evaluate their impact on overall vehicle performance and energy recovery.	4	PO1
CO5	Test and evaluate the performance, reliability, and efficiency of various powertrain components in electric vehicles, including electric motors, battery packs, and power electronics.	4	PO1

Syllabus

HISTORY, ECONOMIC & ENVIRONMENTAL IMPACT OF ELECTRIC VEHICLE: History of EV, Case studies on Economic and Environment aspects of EV, Classification of electric vehicle, Modern electric drive train, Power train components: BEV, HEV, PHEV and FCEV, including working of Fuel cell, Super capacitor, energy management, Hybrid sources.

ELECTRIC VEHICLE DYNAMICS: Laws of Motion, General description of vehicle movement, Tractive Effort, Vehicle resistance: Rolling Resistance, Aerodynamic Drag, Grading Resistance, Acceleration resistance, Dynamic equation, Tire Ground Adhesion and maximum tractive effort, Vehicle Power Plant and Transmission Characteristics.

MODELING VEHICLE ACCELERATION & ELECTRIC VEHICLE RANGE: Acceleration performance parameters, Modeling the acceleration of an electric scooter, Modeling the acceleration of a small car, Driving cycles, Range modeling of battery electric vehicles, Constant velocity range modeling, Range modeling of fuel cell vehicles, Range modeling of hybrid electric vehicles.

Fundamentals of Regenerative Braking Energy Consumption in Braking, Braking Power and Energy on Front and Rear Wheels, Brake System of EVs and HEVs, Series Brake ,Optimal Feel, Series Brake,Optimal Energy Recovery, Parallel Brake, Antilock Brake System (ABS).

Testing of the Power train components of EV, Test the Range of vehicle for different Driving cycles.

Reference Books

- 1 A History of Electric Vehicles, Nigel Burton, First,2013, Crowood Publisher..
- 2 Electric Cars: The Ultimate Guide for Understanding the Electric Car And What You Need to Know, Brad Durant., First,2014, CreateSpace Independent .
- 3 Electric Vehicle Technology , James Larminie and John Lowry, First,2012, Jhon Wiley-Blackwell.
- 4 Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design, Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, Second,2018, CRC PRESS.
- 5 ELECTRIC and HYBRID VEHICLES, Design Fundamentals, Iqbal Husain, Second,2018, CRC PRESS.

23EME3101R - POWER TRAIN DESIGN FOR ELECTRIC VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3101R	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	PTDEV	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify and explain the functions of key powertrain components in electric vehicles, including electric motors, battery packs, power electronics and fuel sources for EV design.	3	PO1
CO2	Apply fundamental principles of powertrain design to create and optimize electric vehicle powertrains, balancing aspects such as energy density, torque characteristics, Modeling of dynamics for EV	3	PO1
CO3	Analyze new technologies or improvements in electric vehicle powertrain design, fostering creativity and forward-thinking in the field.	4	PO1
CO4	Analyze the principles, functionality, and efficiency of regenerative braking systems in electric vehicles, and evaluate their impact on overall vehicle performance and energy recovery.	4	PO1
CO5	Test and evaluate the performance, reliability, and efficiency of various powertrain components in electric vehicles, including electric motors, battery packs, and power electronics.	4	PO1

Syllabus

HISTORY, ECONOMIC & ENVIRONMENTAL IMPACT OF ELECTRIC VEHICLE: History of EV, Case studies on Economic and Environment aspects of EV, Classification of electric vehicle, Modern electric drive train, Power train components: BEV, HEV, PHEV and FCEV, including working of Fuel cell, Super capacitor, energy management, Hybrid sources.

ELECTRIC VEHICLE DYNAMICS: Laws of Motion, General description of vehicle movement, Tractive Effort, Vehicle resistance: Rolling Resistance, Aerodynamic Drag, Grading Resistance, Acceleration resistance, Dynamic equation, Tire Ground Adhesion and maximum tractive effort, Vehicle Power Plant and Transmission Characteristics.

MODELING VEHICLE ACCELERATION & ELECTRIC VEHICLE RANGE: Acceleration performance parameters, Modeling the acceleration of an electric scooter, Modeling the acceleration of a small car, Driving cycles, Range modeling of battery electric vehicles, Constant velocity range modeling, Range modeling of fuel cell vehicles, Range modeling of hybrid electric vehicles.

Fundamentals of Regenerative Braking Energy Consumption in Braking, Braking Power and Energy on Front and Rear Wheels, Brake System of EVs and HEVs, Series Brake ,Optimal Feel, Series Brake,Optimal Energy Recovery, Parallel Brake, Antilock Brake System (ABS).

Testing of the Power train components of EV, Test the Range of vehicle for different Driving cycles.

Reference Books

- 1 A History of Electric Vehicles, Nigel Burton, First,2013, Crowood Publisher..
- 2 Electric Cars: The Ultimate Guide for Understanding the Electric Car And What You Need to Know, Brad Durant., First,2014, CreateSpace Independent .
- 3 Electric Vehicle Technology , James Larminie and John Lowry, First,2012, Jhon Wiley-Blackwell.
- 4 Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design, Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, Second,2018, CRC PRESS.
- 5 ELECTRIC and HYBRID VEHICLES, Design Fundamentals, Iqbal Husain, Second,2018, CRC PRESS.

23EME3202A - COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3202A	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	CPTEV	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand fundamental communication protocols used in Electric Vehicles and their roles in ensuring efficient and safe vehicle operation.	2	PO1, PO4, PSO1
CO2	Apply knowledge of communication protocols and fault diagnostics various components in Electric Vehicles	3	PO2, PO5, PSO2
CO3	Analyze the intricacies of integrating HV and LV components of vehicle	4	PO1, PO6, PSO2
CO4	Demonstrate system engineering and system validation	3	PO2, PO5, PSO1
CO5	Apply the various testing process of components/aggregates of electric vehicles.	3	PO2, PO4, PSO2

Syllabus

Introduction to serial communication protocols: SPI I2C CAN, LIN bus, MOST bus, Bluetooth, Flexi Ray, CAN message: Arbitration, message types, valid frame, error checking, CAN Transceiver features, CAN physical layer, CAN connectors, Bit Timing, Error Handling, CAN Interface with Sensor Modules

High Layer Protocols: IEC 61851, SAE J2601, Vehicle to Vehicle communication protocols, Fault Diagnosis On-Board diagnostics, Off-Board diagnostics. Common Sensors used in EV: Air Bag, ABS, Window Mirror, Cruise Control, Transmission control.

Components like HVDC Relays connections, Insulation Monitoring Devices, Fuses, BTMS, Driveline Cooling, Coolant tanks, Level Sensors, Vehicle Wiring, Terminals, Temperature Considerations for wiring, Cable selection, Instrument Panel, HVIL, 24V converters, derating of the components.

V cycle, reliability calculations, Design for manufacturing, servicing & data analytics, supply chain management, Passenger safety and convenience, Antitheft systems.

Vehicle level test, component level test, EMI/EMC test, Accelerated/Highly Accelerated Life Test (HALT/HASS), battery tests like abuse, altitude, (SoH), motor, oil/lubricant and cooling water level, ECU, Integrated Circuits (IC's), Printed Circuit Boards (PCB's), wiring harnesses

Reference Books

- 1 Advanced Automotive Fault Diagnosis-Automotive Technology: Vehicle Maintenance and Repair, Tom Denton, 4, Taylor and Francis.
- 2 Electric Cars: The Ultimate Guide for Understanding the Electric Car and What You Need to Know, Brad Durant, 2, CreateSpace.
- 3 Electric Vehicle Technology Explained, James Larminie and John Lowry, 3, Wiley.
- 4 Bosch Automotive Electrics and Automotive Electronics, Bosch team, 5, Springer.
- 5 Understanding and Using the Controller Area Network Communication Protocol-Theory and Practice, Marco Di Natale, Haibo Zeng, Paolo Giusto, Arkadeb Ghosal, 2, Springer.

23EME3202E - COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3202E	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	CPTEV	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To Understand fundamental communication protocols used in Electric Vehicles and their roles in ensuring efficient and safe vehicle operation.	2	PO1, PO5, PSO1
CO2	To Apply knowledge of communication protocols and fault diagnostics various components in Electric Vehicles	3	PO1, PO4, PSO2
CO3	To analyze the intricacies of integrating HV and LV components of vehicle	4	PO1, PO6, PSO1
CO4	To demonstrate system engineering and system validation	3	PO1, PO6, PSO1
CO5	Apply the various testing process of components/aggregates of electric vehicles.	3	PO2, PO5, PSO1

Syllabus

Introduction to serial communication protocols: SPI I2C CAN, LIN bus, MOST bus, Bluetooth, Flexi Ray, CAN message: Arbitration, message types, valid frame, error checking, CAN Transceiver features, CAN physical layer, CAN connectors, Bit Timing, Error Handling, CAN Interface with Sensor Modules

High Layer Protocols: IEC 61851, SAE J2601, Vehicle to Vehicle communication protocols, Fault Diagnosis On-Board diagnostics, Off-Board diagnostics. Common Sensors used in EV: Air Bag, ABS, Window Mirror, Cruise Control, Transmission control.

Components like HVDC Relays connections, Insulation Monitoring Devices, Fuses, BTMS, Driveline Cooling, Coolant tanks, Level Sensors, Vehicle Wiring, Terminals, Temperature Considerations for wiring, Cable selection, Instrument Panel, HVIL, 24V converters, derating of the components.

V cycle, reliability calculations, Design for manufacturing, servicing & data analytics, supply chain management, Passenger safety and convenience, Antitheft systems.

Vehicle level test, component level test, EMI/EMC test, Accelerated/Highly Accelerated Life Test (HALT/HASS), battery tests like abuse, altitude, (SoH), motor, oil/lubricant and cooling water level, ECU, Integrated Circuits (IC's), Printed Circuit Boards (PCB's), wiring harnesses

Reference Books

- 1 Advanced Automotive Fault Diagnosis-Automotive Technology: Vehicle Maintenance and Repair, Tom Denton, 4, Taylor and Francis.
- 2 Electric Cars: The Ultimate Guide for Understanding the Electric Car and What You Need to Know, Brad Durant, 2, CreateSpace.
- 3 Bosch Automotive Electrics and Automotive Electronics, Bosch Team, 5, Springer.
- 4 Understanding and Using the Controller Area Network Communication Protocol-Theory and Practice, Marco Di Natale, Haibo Zeng, Paolo Giusto, Arkadeb Ghosal, 2, Springer.
- 5 Electric Vehicle Technology Explained, James Larminie and John Lowry, 3, Wiley.

23EME3202R - COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3202R	COMMUNICATION PROTOCOLS & TESTING OF ELECTRIC VEHICLE	CPTEV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To Understand fundamental communication protocols used in Electric Vehicles and their roles in ensuring efficient and safe vehicle operation.	2	PO1, PO5, PSO1
CO2	To Apply knowledge of communication protocols and fault diagnostics various components in Electric Vehicles	3	PO1, PO4, PSO1
CO3	To analyze the intricacies of integrating HV and LV components of vehicle	4	PO2, PO5, PSO2
CO4	To demonstrate system engineering and system validation	3	PO2, PO6, PSO2

Syllabus

Introduction to serial communication protocols: SPI I2C CAN, LIN bus, MOST bus, Bluetooth, Flexi Ray, CAN message: Arbitration, message types, valid frame, error checking, CAN Transceiver features, CAN physical layer, CAN connectors, Bit Timing, Error Handling, CAN Interface with Sensor Modules.

High Layer Protocols: IEC 61851, SAE J2601, Vehicle to Vehicle communication protocols, Fault Diagnosis On-Board diagnostics, Off-Board diagnostics. Common Sensors used in EV: Air Bag, ABS, Window Mirror, Cruise Control, Transmission control.

Components like HVDC Relays connections, Insulation Monitoring Devices, Fuses, BTMS, Driveline Cooling, Coolant tanks, Level Sensors, Vehicle Wiring, Terminals, Temperature Considerations for wiring, Cable selection, Instrument Panel, HVIL, 24V converters, derating of the components.

V cycle, reliability calculations, Design for manufacturing, servicing & data analytics, supply chain management, Passenger safety and convenience, Antitheft systems.

Reference Books

- 1 Advanced Automotive Fault Diagnosis-Automotive Technology: Vehicle Maintenance and Repair, Tom Denton, 4, Taylor and Francis.
- 2 Electric Cars: The Ultimate Guide for Understanding the Electric Car and What You Need to Know, Brad Durant, 2, CreateSpace.
- 3 Electric Vehicle Technology Explained, James Larminie and John Lowry, 2, Wiley.
- 4 Bosch Automotive Electrics and Automotive Electronics, Bosch Team, 5, Springer.
- 5 Understanding and Using the Controller Area Network Communication Protocol-Theory and Practice, Marco Di Natale, Haibo Zeng, Paolo Giusto, Arkadeb Ghosal, 2, Springer.

23EME3203A - AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3203A	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	AVAE	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply basics of vehicular dynamics and control for autonomous vehicles. It involves using principles of motion, force, and feedback systems to design algorithms that ensure stability, maneuverability, and safety in self-driving cars under various driving conditions.	3	PO1, PO2, PSO1
CO2	Apply different types of sensors and actuators used in vehicles to control different vehicular parameters. Studying various sensors, such as LiDAR, radar, and GPS, alongside actuators like electric motors and hydraulic systems, allows for the precise control of vehicular parameters including speed, steering, braking, and navigation, essential for the safe and efficient operation of modern vehicles.	3	PO1, PO2, PSO1
CO3	Discover the concepts of Automotive Electronics to automotive systems and subsystems. It involves integrating electronic control units (ECUs), sensors, actuators, and communication protocols to optimize the performance, efficiency, safety, and comfort of automotive systems and subsystems, ensuring seamless operation and responsiveness in modern vehicles.	3	PO1, PO2, PSO1
CO4	Analyse the affect on reliability, safety, and smartness to autonomous vehicles through different wireless electronics and networking protocols. This enables autonomous vehicles to achieve reliability and safety through real-time communication, vehicle-to-vehicle (V2V), and vehicle-to-infrastructure (V2I) connectivity, enhancing smart features like predictive maintenance, traffic management, and autonomous decision-making capabilities on the road.	4	PO2, PO3, PSO1
CO5	Analyse different applications of vehicle-to-everything (V2X) communication, and control systems that are essential for self-driving technology. Applications such as traffic management and predictive maintenance will be analysed in detail.	4	PO5, PO12, PSO1

Syllabus

Introduction to Autonomous Vehicles: Technological overview concepts of Autonomous Vehicles (AVs); History of Autonomous Vehicles; Vehicle Electronics Architecture; Functional Block Diagram of typical Autonomous Vehicle System (AVS); Basic control system applied to Drive Assisted and Driverless Vehicles; Overview of the operation of Electronic Control Unit (ECUs).

Automotive Sensors and Actuators (ASA): Role of sensors and actuators in autonomous vehicles; Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Electric Motor Actuators.

Automotive Electronics (AE): Fundamentals of Automotive Electronics (FAE)- Principles of automotive systems, Advanced driver-assistance systems (ADAS)- Evolution of ABS configurations, Basics of Theory of Operation, Integration of ADAS Technology into Vehicle Electronics, Auto pilot, Advanced parking system, ADAS in Toyota and Tesla.

Automotive Wireless (AW): Wireless Networking and Applications to Vehicle Autonomy; Integration of Wireless Networking and On-Board Vehicle Networks; Automotive GPRS Vehicle Tracking (AGPRS-VT)- Vehicle Tracking System; Principle of Vehicle Tracking system, GPS and GPRS tracking system. Controlled Area Network (CAN):Basic, Block diagram of the CAN bus architecture, Types of CAN Physical Layers, Frame Format of CAN protocol, Working principle of CAN communication.

Air-fuel ratio control methodologies for efficient fuel consumption.

Reference Books

- 1 Automotive Computers and Control System , Tom Weather Jr and Cland C. Hunter, 1998, Prentice Hall Inc., New Jersey .
- 2 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala , 2016, Butterworth-Heinemann.
- 3 Autonomous Vehicles Volume 1: Using Machine Intelligence , Romil Rawat , 2022, Wiley .
- 4 Understanding Automotive Electronics: An Engineering Perspective, William Ribbens , 2017, Butterworth-Heinemann.

23EME3203E - AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3203E	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	AVAE	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply basics of vehicular dynamics and control for autonomous vehicles. It involves using principles of motion, force, and feedback systems to design algorithms that ensure stability, maneuverability, and safety in self-driving cars under various driving conditions.	3	PO1, PO2, PSO1
CO2	Apply different types of sensors and actuators used in vehicles to control different vehicular parameters. Studying various sensors, such as LiDAR, radar, and GPS, alongside actuators like electric motors and hydraulic systems, allows for the precise control of vehicular parameters including speed, steering, braking, and navigation, essential for the safe and efficient operation of modern vehicles..	3	PO1, PO2, PSO1
CO3	Discover the concepts of Automotive Electronics to automotive systems and subsystems. It involves integrating electronic control units (ECUs), sensors, actuators, and communication protocols to optimize the performance, efficiency, safety, and comfort of automotive systems and subsystems, ensuring seamless operation and responsiveness in modern vehicles.	3	PO1, PO2, PSO1
CO4	Analyse the affect on reliability, safety, and smartness to autonomous vehicles through different wireless electronics and networking protocols. This enables autonomous vehicles to achieve reliability and safety through real-time communication, vehicle-to-vehicle (V2V), and vehicle-to-infrastructure (V2I) connectivity, enhancing smart features like predictive maintenance, traffic management, and autonomous decision-making capabilities on the road.	4	PO2, PO3, PSO1
CO5	Analyse different applications of vehicle-to-everything (V2X) communication, and control systems that are essential for self-driving technology. Applications such as traffic management and predictive maintenance will be analysed in detail.	4	PO5, PO12, PSO1

Syllabus

Introduction to Autonomous Vehicles: Technological overview concepts of Autonomous Vehicles (AVs); History of Autonomous Vehicles; Vehicle Electronics Architecture; Functional Block Diagram of typical Autonomous Vehicle System (AVS); Basic control system applied to Drive Assisted and Driverless Vehicles; Overview of the operation of Electronic Control Unit (ECUs).

Automotive Sensors and Actuators (ASA): Role of sensors and actuators in autonomous vehicles; Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Electric Motor Actuators.

Automotive Electronics (AE): Fundamentals of Automotive Electronics (FAE)- Principles of automotive systems, Advanced driver-assistance systems (ADAS)- Evolution of ABS configurations, Basics of Theory of Operation, Integration of ADAS Technology into Vehicle Electronics, Auto pilot, Advanced parking system, ADAS in Toyota and Tesla.

Automotive Wireless (AW): Wireless Networking and Applications to Vehicle Autonomy; Integration of Wireless Networking and On-Board Vehicle Networks; Automotive GPRS Vehicle Tracking (AGPRS-VT)- Vehicle Tracking System; Principle of Vehicle Tracking system, GPS and GPRS tracking system. Controlled Area Network (CAN):Basic, Block diagram of the CAN bus architecture, Types of CAN Physical Layers, Frame Format of CAN protocol, Working principle of CAN communication.

Air-fuel ratio control methodologies for efficient fuel consumption.

Reference Books

- 1 Automotive Computers and Control System , Tom Weather Jr and Cland C. Hunter, 1998, Prentice Hall Inc., New Jersey .
- 2 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala , 2016, Butterworth-Heinemann.
- 3 Autonomous Vehicles Volume 1: Using Machine Intelligence , Romil Rawat , 2022, Wiley .
- 4 Understanding Automotive Electronics: An Engineering Perspective , William Ribbens , 2017, Butterworth-Heinemann.

23EME3203R - AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3203R	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	AVAE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basics of vehicular dynamics and control for autonomous vehicles. It involves using principles of motion, force, and feedback systems to design algorithms that ensure stability, maneuverability, and safety in self-driving cars under various driving conditions.	3	PO1, PO2, PSO1
CO2	Apply different types of sensors and actuators used in vehicles to control different vehicular parameters. Studying various sensors, such as LiDAR, radar, and GPS, alongside actuators like electric motors and hydraulic systems, allows for the precise control of vehicular parameters including speed, steering, braking, and navigation, essential for the safe and efficient operation of modern vehicles.	3	PO1, PO2, PSO1
CO3	Discover the concepts of Automotive Electronics to automotive systems and subsystems. It involves integrating electronic control units (ECUs), sensors, actuators, and communication protocols to optimize the performance, efficiency, safety, and comfort of automotive systems and subsystems, ensuring seamless operation and responsiveness in modern vehicles.	3	PO1, PO2, PSO1
CO4	Analyse the affect on reliability, safety, and smartness to autonomous vehicles through different wireless electronics and networking protocols. This enables autonomous vehicles to achieve reliability and safety through real-time communication, vehicle-to-vehicle (V2V), and vehicle-to-infrastructure (V2I) connectivity, enhancing smart features like predictive maintenance, traffic management, and autonomous decision-making capabilities on the road.	4	PO2, PO3, PSO1

Syllabus

Introduction to Autonomous Vehicles: Technological overview concepts of Autonomous Vehicles (AVs); History of Autonomous Vehicles; Vehicle Electronics Architecture; Functional Block Diagram of typical Autonomous Vehicle System (AVS); Basic control system applied to Drive Assisted and Driverless Vehicles; Overview of the operation of Electronic Control Unit (ECUs).

Automotive Sensors and Actuators (ASA): Role of sensors and actuators in autonomous vehicles; Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Electric Motor Actuators.

Automotive Electronics (AE): Fundamentals of Automotive Electronics (FAE)- Principles of automotive systems, Advanced driver-assistance systems (ADAS)- Evolution of ABS configurations, Basics of Theory of Operation, Integration of ADAS Technology into Vehicle Electronics, Auto pilot, Advanced parking system, ADAS in Toyota and Tesla.

Automotive Wireless (AW): Wireless Networking and Applications to Vehicle Autonomy; Integration of Wireless Networking and On-Board Vehicle Networks; Automotive GPRS Vehicle Tracking (AGPRS-VT)- Vehicle Tracking System; Principle of Vehicle Tracking system, GPS and GPRS tracking system. Controlled Area Network (CAN):Basic, Block diagram of the CAN bus architecture, Types of CAN Physical Layers, Frame Format of CAN protocol, Working principle of CAN communication.

Reference Books

- 1 Automotive Computers and Control System , Tom Weather Jr and Cland C. Hunter , 1998, Automotive Prentice Hall Inc., New Jersey .

- 2 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems, Rahul Kala , 2016, Butterworth-Heinemann.
- 3 Autonomous Vehicles Volume 1: Using Machine Intelligence, Romil Rawat , 2022, Wiley .
- 4 Understanding Automotive Electronics: An Engineering Perspective , William Ribbens , 2017, Butterworth-Heinemann.

23EME3304A - CHARGING STATIONS FOR ELECTRIC VEHICLES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3304A	CHARGING STATIONS FOR ELECTRIC VEHICLES	CSEV	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop control algorithms for various electric vehicle charging modes and various chargers	3	PO1
CO2	Analyze the design, operation, and integration of power electronic converters in electric vehicle charging systems	4	PO1
CO3	Analyze the optimization of diverse EV charging infrastructures through critical evaluation and innovative problem-solving for enhanced efficiency	4	PO1
CO4	Outline strategies for the effective installation and management of EV charging stations, incorporating regulatory compliance, site assessment, installation procedures	2	PO1
CO5	Apply the fundamental principles and theories of wireless power transfer, including inductive and resonant coupling, to solve practical problems in EV charging systems.	3	PO1
CO6	Analyze the converters and control algorithms of electric vehicle charging systems using software tools.	4	PO1
CO7	Develop and implement electric vehicle (EV) charging stations by integrating knowledge of electrical systems, charging technologies using software tools.	4	PO1

Syllabus

Charger Topologies Charging time and charging speed, Defining power levels- Normal charging, Semi-fast charging, Overview of power levels ,DC conductive charging, AC conductive charging, Low power Charger, Automotive standard charger, Charging Modes Constant-current charging, Constant-voltage charging, Pulse Charging, Reflex charging, Trickle Charge, Load management at charging station and peak load management

Power Electronics for EV Battery Charging Forward Flyback Converters, Half-Bridge DC DC Converter, Full-Bridge DC DC Converter, Power Factor Correction, Bidirectional Battery Chargers, Dual active bridge dc dc converter, Solar charging station.

Charging Infrastructure Charger - Existing National & International Charger Architecture Standards - SAE J1773, VDE-AR-E 2623-2-2, JEVS G105-1993 (CHAdeMO), CCS, Type-1 AC, Type-2 AC, Bharat DC-001, Bharat AC-001. Cords and Cables, Earthing, Fault Protection, Testing, Charging Safety, Protection against electric shock, Digital Communication between EV and Charging Station.

Installation Govt. of India guideline on Public Charging Stations, IEC Standards- 60068-2(1, 2, 14, 30), 61683, 60227, 60502, 60947 part I,II, III and 61215. Site assessment, EVSE Typical Site Plans, Design Guidelines and Site Drawings, Planning Considerations, Station Configuration, Selection and erection of electrical equipment - Isolation, switching and control.

Wireless Power Transfer (WPT) for Electric Vehicles (EVs): Basics of WPT Technology, Modelling the WPT System, WPT for EV Charging, Design Challenges and Optimization of Resonator Design, Future Directions and Trends

Reference Books

- 1 Power Electronics for Renewable Energy Systems, Transportation and industrial Applications, Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad., 2014, 2, John Wiley & Sons, Ltd.
- 2 Power Electronics, Daniel W. Hart, 2011, 3, McGrawHill.
- 3 AIS 138 Part 1 and Part 2, AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA, 2010, 2, ARAI INDIA.

- 4 Wireless Power Transfer for Electric Vehicles: Foundations and Design Approach, Alicia Trivino-Cabrera , Jose M. Gonzalez-Gonzalez , Jose A. Aguado, 2017, 1, Springer Cham.
- 5 Electric Vehicle Service Equipment - EVSE , Subodh Sarkar, 2018, 2, NEWFORMKINDLE.

23EME3304E - CHARGING STATIONS FOR ELECTRIC VEHICLES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3304E	CHARGING STATIONS FOR ELECTRIC VEHICLES	CSEV	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop control algorithms for various electric vehicle charging modes and various chargers	3	PO1, PSO1
CO2	Analyze the design, operation, and integration of power electronic converters in electric vehicle charging systems	4	PO1
CO3	Analyze the optimization of diverse EV charging infrastructures through critical evaluation and innovative problem-solving for enhanced efficiency	4	PO1, PSO1
CO4	Outline strategies for the effective installation and management of EV charging stations, incorporating regulatory compliance, site assessment, installation procedures	2	PO1
CO5	Apply the fundamental principles and theories of wireless power transfer, including inductive and resonant coupling, to solve practical problems in EV charging systems.	3	PO1
CO6	Analyze the converters and control algorithms of electric vehicle charging systems using software tools.	4	PO1
CO7	Develop and implement electric vehicle (EV) charging stations by integrating knowledge of electrical systems, charging technologies using software tools.	4	PO1

Syllabus

Charger Topologies Charging time and charging speed, Defining power levels- Normal charging, Semi-fast charging, Overview of power levels ,DC conductive charging, AC conductive charging, Low power Charger, Automotive standard charger, Charging Modes Constant-current charging, Constant-voltage charging, Pulse Charging, Reflex charging, Trickle Charge, Load management at charging station and peak load management

Power Electronics for EV Battery Charging Forward Flyback Converters, Half-Bridge DC DC Converter, Full-Bridge DC DC Converter, Power Factor Correction, Bidirectional Battery Chargers, Dual active bridge dc dc converter, Solar charging station.

Charging Infrastructure: Charger - Existing National & International Charger Architecture Standards - SAE J1773, VDE-AR-E 2623-2-2, JEVS G105-1993 (CHAdeMO), CCS, Type-1 AC, Type-2 AC, Bharat DC-001, Bharat AC-001, Cords and Cables, Earthing, Fault Protection, Testing, Charging Safety, Protection against electric shock Digital Communication between EV and Charging Station

Installation: Govt. of India guideline on Public Charging Stations, IEC Standards- 60068-2(1, 2, 14, 30), 61683, 60227, 60502, 60947 part I, II, III and 61215 Site assessment, EVSE Typical Site Plans, Design Guidelines and Site Drawings, Planning Considerations, Station Configuration, Selection and erection of electrical equipment - Isolation, switching and control, Load management at charging station and peak load management.

Wireless Power Transfer (WPT) for Electric Vehicles (EVs): Basics of WPT Technology, Modelling the WPT System, WPT for EV Charging, Design Challenges and Optimization of Resonator Design, Future Directions and Trends

Reference Books

- 1 Power Electronics for Renewable Energy Systems, Transportation and industrial Applications, Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad. 2 John Wiley & Sons, Ltd, 2014, 2, John Wiley & Sons, Ltd.
- 2 Power Electronics, Daniel W. Hart, 2011, 3, McGrawHill.
- 3 Electric Vehicle Technology Explained, James Larminie and John Lowry Jhon, 2010, 2, Wiley-Blackwell.

- 4 Electric Vehicle Service Equipment - EVSE, Subodh Sarkar , 2018,2, NEWFORMKINDLE.
- 5 Wireless Power Transfer for Electric Vehicles: Foundations and Design Approach , Alicia Trivino-Cabrera , Jose M. Gonzalez-Gonzalez , Jose A. Aguado, 2017, 1, Springer Cham.

23EME3304R - CHARGING STATIONS FOR ELECTRIC VEHICLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3304R	CHARGING STATIONS FOR ELECTRIC VEHICLES	CSEV	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop control algorithms for various electric vehicle charging modes and various chargers	3	PO1
CO2	Analyze the design, operation, and integration of power electronic converters in electric vehicle charging systems	4	PO1
CO3	Analyze the optimization of diverse EV charging infrastructures through critical evaluation and innovative problem-solving for enhanced efficiency	4	PO1
CO4	Outline strategies for the effective installation and management of EV charging stations, incorporating regulatory compliance, site assessment, installation procedures	2	PO1
CO5	Analyze the converters and control algorithms of electric vehicle charging systems using software tools.	4	PO1
CO6	Develop and implement electric vehicle (EV) charging stations by integrating knowledge of electrical systems, charging technologies using software tools.	4	PO1

Syllabus

Charger Topologies Charging time and charging speed, Defining power levels- Normal charging, Semi-fast charging, Overview of power levels ,DC conductive charging, AC conductive charging, Low power Charger, Automotive standard charger, Charging Modes Constant-current charging, Constant-voltage charging, Pulse Charging, Reflex charging, Trickle Charge, Load management at charging station and peak load management

Power Electronics for EV Battery Charging Forward Flyback Converters, Half-Bridge DC DC Converter, Full-Bridge DC DC Converter, Power Factor Correction, Bidirectional Battery Chargers, Dual active bridge dc dc converter, Solar charging station.

Charging Infrastructure Charger - Existing National & International Charger Architecture Standards - SAE J1773, VDE-AR-E 2623-2-2, JEVS G105-1993 (CHAdeMO), CCS, Type-1 AC, Type-2 AC, Bharat DC-001, Bharat AC-001. Cords and Cables, Earthing, Fault Protection, Testing, Charging Safety, Protection against electric shock, Digital Communication between EV and Charging Station.

Installation Govt. of India guideline on Public Charging Stations, IEC Standards- 60068-2(1, 2, 14, 30), 61683, 60227, 60502, 60947 part I,II, III and 61215. Site assessment, EVSE Typical Site Plans, Design Guidelines and Site Drawings, Planning Considerations, Station Configuration, Selection and erection of electrical equipment - Isolation, switching and control.

Reference Books

- 1 Power Electronics for Renewable Energy Systems, Transportation and industrial Applications, Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad., 2014, 2, John Wiley & Sons, Ltd.
- 2 Power Electronics, Daniel W. Hart, 2011, 3, McGrawHill.
- 3 AIS 138 Part 1 and Part 2, AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA, 2010, 2, ARAI INDIA.
- 4 Electric Vehicle Service Equipment - EVSE , Subodh SarkaR, 2018, 2, NEWFORMKINDLE.

23EME3405M - INTRODUCTION TO BATTERY-MANAGEMENT SYSTEMS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3405M	INTRODUCTION TO BATTERY-MANAGEMENT SYSTEMS	IBMS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select suitable battery for electric vehicle	2	PO1, PO7, PSO1
CO2	Analyse the key functions of Battery management systems	4	PO2, PO3
CO3	Analyse various mathematical models of battery	4	PO2, PO3, PSO2
CO4	Evaluate Algorithms for SOC estimation of battery	5	PO2

Syllabus

Battery specifications and L-ion chemistry Battery specifications, cell-module-pack formation and specification calculation, working principle of Li-ion cell, materials used for various components of Li-ion cell, different li-ion chemistries and there specification comparison

Functions of battery-management systems BMS architecture, BMS functionality: Sensing and High Voltage Control, Protection-isolation, overvoltage, overcurrent protection, Performance-Battery pack energy and power calculations using HPPC, Balancing- passive and active cell balancing, Interface, and Diagnostics

Battery Modelling Simple OCV model, Rint model, Thevenins model, Hysteresis effect and ESC model of battery cell. Charge, discharge tests to determine battery cell parameters.

SOC estimation Stoichiometry for SOC estimation, Look table method and Coulomb counting methods and their limitation for accurate state estimation. Linear and nonlinear Kalman filter based estimation techniques.

Reference Books

- 1 Battery management systems, Vol-1: Battery Modeling, Gregory Plett, 2015, Artech House.
- 2 Battery management systems, Vol-2: Equivalent circuit methods, Gregory Plett, 2015, Artech House.
- 3 Battery Management Systems for Large Lithium-ion Battery Packs , David, 2010, Artech House.
- 4 Battery Management Systems Design By Modelling, H.J. Bergveld,, 2013, Springer Nature.

23EME3406M - BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3406M	BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE	BSAEV	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select suitable battery for electric vehicle	3	PO1
CO2	Analyze the key functions of Battery management systems	4	PO2
CO3	Analyze various mathematical models of battery	4	PO2
CO4	Analyze the Algorithms for SOC estimation of battery	4	PO3

Syllabus

Battery specifications and L-ion chemistry Battery specifications, cell-module-pack formation and specification calculation, working principle of Li-ion cell, materials used for various components of Li-ion cell, different li-ion chemistries and specification comparison

Functions of battery-management systems BMS architecture, BMS functionality: Sensing and High Voltage Control, Protection-isolation, overvoltage, overcurrent protection, Performance-Battery pack energy and power calculations using HPPC, Balancing- passive and active cell balancing, Interface, and Diagnostics

Battery Modelling Simple OCV model, Rint model, Thevinins model, Hysteresis effect and ESC model of battery cell.Charge, discharge tests to determine battery cell parameters

SOC estimation Stoichiometry for SOC estimation, Look-table method and Coulomb counting methods and their limitation for accurate state estimation. Linear and nonlinear Kalman filter based estimation techniques

Reference Books

- 1 Battery management systems: Battery Modeling , Gregory L.Plett, , 2015, 2, Artech house.
- 2 Hybrid Electric vehicles-Principles and Applications with practical perspectives, Chris Mi, M. AbdulMasrur and David Wenzhong Gao, 2011, 2, Wiley Publications.
- 3 Electric and Hybrid Vehicles power sources, models, sustainability, infrastructure and the market, Gianfranco Pistoia, 2016,1, Elsevier .
- 4 Electric and Hybrid Vehicles Design Fundamentals, Iqbal Hussain, 2011, 3, CRC Press.

23EME3507 - AI AND IOT FOR ELECTRIC VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3507	AI AND IOT FOR ELECTRIC VEHICLE	AIEV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the IoT devices and tools	2	PO1, PO10, PSO2
CO2	Operate the cloud system Environment	3	PO1, PO2, PO10, PSO2
CO3	Applying ML Techniques for Electric Vehicles	3	PO2, PO5, PO10, PSO2
CO4	Applying AI techniques for EV Applications	3	PO2, PO5, PO10, PSO2

Syllabus

IoT Devices and Enabling Technologies: Sensor Devices- temperature, vibration, irradiance, wind speed, PIR, proximity, current, voltage Controllers, Actuators, Networking and Communication Protocols, Data analytics using AI and ML for smart cities, smart grid, smart building, electrical vehicles

Cloud Computing: Basics-Cloud systems, Cloud computing protocols, Role of Web services, Deployment Models- Public, Community, Hybrid, Private Clouds, Cloud Analytics over Thingspeak, Google Firebase, AWS-console, Functions. Database Services-Relational DBMS, RDS Services

AI and ML on Cloud: Data Pre-processing techniques in Machine Learning, Data-handling, importing libraries, Data pre-processing using python, Missing data, Categorical Data. Regression and Classification algorithms in ML. Cloud based Real- time Monitoring systems, M2M communications

Case Studies Applications: Electric Vehicle Battery state estimation, health monitoring, SOL determination, Power management, Charging optimization and Electric Drive applications, Online vehicle Assistance

Reference Books

- 1 Artificial Intelligent Techniques for Electric and Hybrid Electric Vehicles, Chitra A., P. Sanjeevikumar, 1st edition, 2020, (Apress).
- 2 Internet of Things An Application Based approach Using Arduino Platform and Firebase , SOURAV KUMAR BHOI, 1st edition, 2018, Independently published .
- 3 Hybrid Electric Vehicles-Principles and Applications with practical perspectives, Chris Mi, M. Abdul Masrur and David Wenzhong Gao, 1st edition 2011, (Apress).
- 4 The Internet of Things: Do it yourself projects with arduino raspberry pi, Donald Norris, 1st edition, 2015, Mcgrawhill.

23EME3508 - EV SYSTEM AND WIRING DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EME3508	EV SYSTEM AND WIRING DESIGN	ESWS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply CATIA and AutoCAD tools for EV system wiring.	3	PO1
CO2	Understand the wiring routing and optimal weights of wiring.	2	PO3, PO4
CO3	Understand the electrical connections and safety consideration for EV	2	PO3, PO4
CO4	Apply the concept of BMS and thermal management of EV	3	PO1

Syllabus

Catia V5 and Electrical AutoCAD - 3D model of a wiring harness - 2D harness drawing using Electrical AutoCAD - different wires and cables, connectors, splices, and other components, wire colors, labels, installation, and maintenance

Wire routing and optimization: Routing methods and strategies, shortest path, most direct path, and optimal path methods, Electromagnetic compatibility, wire routing affects the electromagnetic compatibility (EMC), routing optimization, reduce weight and space

Electrical connections: and splices- Types of electrical connections, Crimping tools, and techniques, Soldering techniques, Wire splicing methods. Safety considerations: insulation, grounding, and protection against electrical shock and fire.

High-Voltage Wiring, special wiring and connectors, Battery Management System (BMS), Power Electronics circuit connections, Thermal Management, safe temperature range.

Reference Books

- 1 Introduction to CATIA V6, Kirstie Plantenburg, 2012, 1, SDC Publications.
- 2 AutoCAD Electrical Essential Training, Shaun Bryant, 2019, 2, linkedin .
- 3 Automotive Wiring and Electrical Systems, Tony Candela, 2009, 2, CarTech Inc.
- 4 Wireless Power Transfer for Electric Vehicles: Foundations and Design Approach, Alicia Trivino-Cabrera, Jose M. Gonzalez-Gonzalez, Jose A. Aguado, 2020, 1, Springer Cham.

23GDU3101A - PROGRAMMING FOR GAME DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3101A	PROGRAMMING FOR GAME DEVELOPMENT	PGD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of Game design and development.	2	PO1, PO3, PSO2
CO2	Apply the use of mathematical and geometrical concepts in Game Programming.	3	PO1, PO3, PSO2
CO3	Apply the Core architectures of Game Programming.	3	PO1, PO5, PSO2
CO4	Analyse advance concepts in game development and explain various platforms and frameworks for Game Programming	4	PO1, PO5, PSO2
CO5	Analyse Project Optimization , Research and Troubleshooting approaches	4	PO1, PO5, PSO2
CO6	Apply above approaches in Laboratory experiments related to Games using Course with Code in Unity	4	PO1, PO5, PSO2
CO7	Analyse above approaches in Skilling experiments related to Games using Course with Code in Unity	4	PO1, PO5, PSO2

Syllabus

Introduction to Game Development , Game Engines: Game Engine Concepts, Game Development Tools, Introducing Unity. Unity Development Environment: IDE Basics, Unity Concepts, Sprites. Simple Movement and Input: Simple Movement, Simple Rotation and Scaling, Easy Input Handling in Unity. 2D Physics Concepts: Rigid body Components

Unity Colliders, Physics Materials, Scripting Collision Events, Organizing Game Objects Parent-Child Objects, Sorting Layers, Tagging Game Objects, Collision Layers, Managing Game Objects: Prefabs, Creating and Destroying Objects

Activating and Deactivating Objects, Controlling Object Life spans with Invoke, Virtual world: Moving Cameras, Setting Boundaries, Building a Tile world Mini- Maps, Sound Effects: Sound Files, Adding Sounds to Game Objects, Scripting Sounds, Game Mechanics: Storytelling and Progression, Scrolling Game Mechanics.

Animation: Simple Unity Animation, Animator States, Scripting Animations, Animations and Colliders, Advanced Game Physics: Applying Forces, Unity Physics Joints, Unity2DEffectors, User Interfaces: Unity Buttons, Other UI Controls, UI Design Concepts, Project Publishing: Splash Screens, Credit Scenes and Icons, Publishing to PC, Mac and Linux Computers, Publishing to Smartphones, Publishing to Game Consoles, Entity component system.

Project Optimization approaches, Research and Troubleshooting

Reference Books

- 1 Game Coding Complete, Mike Mc Shaffrfy and David Graham, Fourth Edition, Cengage Learning.
- 2 Game Engine Architecture, Jason Gregory, Second edition, CRC Press.
- 3 3D Game Engine Design, Second Edition: A Practical Approach to Real-Time Computer Graphics, David H. Eberly, Second edition, Morgan Kaufmann.
- 4 Fundamentals of Game Design, Ernest Adams and Andrew Rolling, Second edition, New Riders.
- 5 Mathematics for 3D Game Programming and Computer Graphics, Eric Lengyel, Third Edition, Course Technology.

23GDU3101E - PROGRAMMING FOR GAME DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3101E	PROGRAMMING FOR GAME DEVELOPMENT	PGD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of Game design and development.	2	PO1, PO3, PSO2
CO2	Apply the use of mathematical and geometrical concepts in Game Programming.	3	PO1, PO3, PSO2
CO3	Apply the Core architectures of Game Programming.	3	PO1, PO5, PSO2
CO4	Analyse advance concepts in game development and explain various platforms and frameworks for Game Programming	3	PO1, PO5, PSO2
CO5	Analyse Project Optimization , Research and Troubleshooting approaches	3	PO1, PO5, PSO2
CO6	Apply above approaches in Laboratory experiments related to Games using Course with Code in Unity	3	PO1, PO5, PSO2
CO7	Analyse above approaches in Skilling experiments related to Games using Course with Code in Unity	3	PO1, PO5, PSO2

Syllabus

Introduction to Game Development , Game Engines: Game Engine Concepts, Game Development Tools, Introducing Unity. Unity Development Environment: IDE Basics, Unity Concepts, Sprites. Simple Movement and Input: Simple Movement, Simple Rotation and Scaling, Easy Input Handling in Unity. 2D Physics Concepts: Rigid body Components

Unity Colliders, Physics Materials, Scripting Collision Events, Organizing Game Objects Parent-Child Objects, Sorting Layers, Tagging Game Objects, Collision Layers, Managing Game Objects: Prefabs, Creating and Destroying Objects

Activating and Deactivating Objects, Controlling Object Life spans with Invoke, Virtual world: Moving Cameras, Setting Boundaries, Building a Tile world Mini- Maps, Sound Effects: Sound Files, Adding Sounds to Game Objects, Scripting Sounds, Game Mechanics: Storytelling and Progression, Scrolling Game Mechanics.

Animation: Simple Unity Animation, Animator States, Scripting Animations, Animations and Colliders, Advanced Game Physics: Applying Forces, Unity Physics Joints, Unity2DEffectors, User Interfaces: Unity Buttons, Other UI Controls, UI Design Concepts, Project Publishing: Splash Screens, Credit Scenes and Icons, Publishing to PC, Mac and Linux Computers, Publishing to Smartphones, Publishing to Game Consoles, Entity component system.

Project Optimization approaches, Research and Troubleshooting

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- 1 Game Coding Complete , Mike Mc Shaffrfy and David Graham , Fourth Edition , Cengage Learning.
- 2 Game Engine Architecture , Jason Gregory , Second edition , CRC Press.
- 3 3D Game Engine Design, Second Edition: A Practical Approach to Real-Time Computer Graphics , David H. Eberly , Second edition , Morgan Kaufmann.
- 4 Fundamentals of Game Design, Ernest Adams and Andrew Rolling , Second edition , New Riders.
- 5 Mathematics for 3D Game Programming and Computer Graphics , Eric Lengyel , Third Edition , Course Technology.

23GDU3101R - PROGRAMMING FOR GAME DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3101R	PROGRAMMING FOR GAME DEVELOPMENT	PGD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of Game design and development.	2	PO1, PO3, PSO2
CO2	Apply the use of mathematical and geometrical concepts in Game Programming.	3	PO1, PO3, PSO2
CO3	Apply the Core architectures of Game Programming.	3	PO1, PO5, PSO2
CO4	Analyse advance concepts in game development and explain various platforms and frameworks for Game Programming	3	PO1, PO5, PSO2
CO5	Apply above approaches in Laboratory experiments related to Games using Course with Code in Unity	3	PO1, PO5, PSO2
CO6	Analyse above approaches in Skilling experiments related to Games using Course with Code in Unity	3	PO1, PO5, PSO2

Syllabus

Introduction to Game Development , Game Engines: Game Engine Concepts, Game Development Tools, Introducing Unity. Unity Development Environment: IDE Basics, Unity Concepts, Sprites. Simple Movement and Input: Simple Movement, Simple Rotation and Scaling, Easy Input Handling in Unity. 2D Physics Concepts: Rigid body Components

Unity Colliders, Physics Materials, Scripting Collision Events, Organizing Game Objects Parent-Child Objects, Sorting Layers, Tagging Game Objects, Collision Layers, Managing Game Objects: Prefabs, Creating and Destroying Objects

Activating and Deactivating Objects, Controlling Object Life spans with Invoke, Virtual world: Moving Cameras, Setting Boundaries, Building a Tile world Mini- Maps, Sound Effects: Sound Files, Adding Sounds to Game Objects, Scripting Sounds, Game Mechanics: Storytelling and Progression, Scrolling Game Mechanics.

Animation: Simple Unity Animation, Animator States, Scripting Animations, Animations and Colliders, Advanced Game Physics: Applying Forces, Unity Physics Joints, Unity2DEffectors, User Interfaces: Unity Buttons, Other UI Controls, UI Design Concepts, Project Publishing: Splash Screens, Credit Scenes and Icons, Publishing to PC, Mac and Linux Computers, Publishing to Smartphones, Publishing to Game Consoles, Entity component system.

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- 3 D Game Engine Design, Second Edition: A Practical Approach to Real-Time Computer Graphics , David H. Eberly , Second edition , Morgan Kaufmann.
- 4 Fundamentals of Game Design , Ernest Adams and Andrew Rolling , Second edition , New Riders.
- 5 Mathematics for 3D Game Programming and Computer Graphics , Eric Lengyel , Third Edition , Course Technology .

23GDU3202A - UX DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3202A	UX DESIGN	UD	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and discuss about User Experience Design Process	2	PO1, PO2, PO3, PSO2
CO2	Apply User interface and differentiate from User Experience and principles of User Interface	3	PO1, PO2, PO3, PSO2
CO3	Analysing and distinguishing about components of UI Design process with interactive Devices	4	PO1, PO2, PO3, PSO2
CO4	Determine graphic design techniques and psychology principles of User Experience	4	PO1, PO2, PO3, PSO2
CO5	Application of polished prototypes for accurate feedback from users and stakeholders, iterate on designs efficiently, and deliver exceptional user experiences.	3	PO1, PO2, PO3, PSO2

Syllabus

Introduction to UX: Introduction to UX, Elements of UX Design, Core Research, Heuristic Evaluation, who is the User, Persona, Customer Journey Map, Empathy, Business Model and Strategy, understanding various technology and devices enabling technology. Introduction To UI: Human Factors, of Interactive Software: Goals of System Engineering, Goals of UI Design, Motivations for Human Factors in Design, Accommodation of Human Diversity, Goals of our Profession.

Survey Components of UI & Effective UI Design Process: Menu Selection, Form Filling, Dialog Boxes-Introduction, Task Related Organization, Item Presentation Sequence, Response time and Display Rate, Fast Movement through menus, Menu Layout, Form Filling, Dialog Boxes, Interactive Devices, Specification methods, Interface Building tools, Evaluation and pretty critiquing tools, material.io

Importance of Colour theory and colour wheel while designing in XD /Figma, Introduction to Typography and its importance in visual design, Introduction to Iconography and its importance in visual design, Menu, selection, formfilling and Dialog boxes: Task related organization, Item presentation Sequence, logo and importance of brand guidelines for logo, Bitmap images and Vector Graphics, Different illustrator elements and their working procedure in adobe illustrator.

Designing UI Using Adobe XD Tool: Getting started with your Adobe XD project, what is UI VS UX Vs product Designer, Wireframing Low Fidelity, Type, colour & Icon Introduction, prototyping a website introduction, Symbols & Repeat Grids, Prototyping an app-Introduction, Colours, Drawing, Images, AssetPanel, Micro Interactions, Voice Interactions, User Testing

This course offers an in-depth exploration of advanced prototyping and interaction design techniques for creating high-fidelity interactive prototypes. Beginning with a review of fundamental prototyping concepts and tools, students will delve into advanced prototyping platforms such as Figma, Adobe XD, or Proto.io, focusing on their capabilities for simulating complex user interactions, animations, and transitions. The course will cover topics such as designing for various screen sizes and devices, microinteractions, state management, and responsive behavior. Through hands-on projects and case studies, students will apply these techniques to design and prototype interactive experiences for web and mobile applications, with an emphasis on usability, accessibility, and user delight. By the end of the course, students will have developed the skills and expertise to create polished prototypes that closely resemble the final product, enabling them to gather accurate feedback, iterate on designs effectively, and deliver exceptional user experiences.

Reference Books

- 1 Designing the User Interface: Strategies for effective human Computer Interaction , Ben Schneiderman , 5,2009, Pearson.

- 2 The Elements of User Experience: User centered Design for the web , Jesse James gareth , 4,2010, Peachpit.
- 3 Human Computer Interaction , Alan Dix janet Finlay , 3,2004, Pearson.
- 4 The UX Process and guidelines for Ensuring a quality User Experience , REX Hartson , 2,2012, Elsevier Science.

23GDU3202E - UX DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3202E	UX DESIGN	UD	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and discuss about User Experience Design Process	2	PO1, PO2, PSO2
CO2	Apply User interface and differentiate from User Experience and principles of User Interface	3	PO1, PO2, PSO2
CO3	Analysing and distinguishing about components of UI Design process with interactive Devices	4	PO1, PO4, PSO2
CO4	Determine graphic design techniques and psychology principles of User Experience	4	PO1, PO4, PSO2
CO5	students will be able to create polished prototypes that closely resemble the final product, enabling them to gather more accurate feedback from users and stakeholders, iterate on designs efficiently, and deliver exceptional user experiences.	3	PO1, PO5, PSO2

Syllabus

Introduction to UX: Introduction to UX, Elements of UX Design, Core Research, Heuristic Evaluation, who is the User, Persona, Customer Journey Map, Empathy, Business Model and Strategy, understanding various technology and devices enabling technology. Introduction To UI: Human Factors, of Interactive Software: Goals of System Engineering, Goals of UI Design, Motivations for Human Factors in Design, Accommodation of Human Diversity, Goals of our Profession.

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This course offers an in-depth exploration of advanced prototyping and interaction design techniques for creating high-fidelity interactive prototypes. Beginning with a review of fundamental prototyping concepts and tools, students will delve into advanced prototyping platforms such as Figma, Adobe XD, or Proto.io, focusing on their capabilities for simulating complex user interactions, animations, and transitions. The course will cover topics such as designing for various screen sizes and devices, microinteractions, state management, and responsive behavior. Through hands-on projects and case studies, students will apply these techniques to design and prototype interactive experiences for web and mobile applications, with an emphasis on usability, accessibility, and user delight. By the end of the course, students will have developed the skills and expertise to create polished prototypes that closely resemble the final product, enabling them to gather accurate feedback, iterate on designs effectively, and deliver exceptional user experiences.

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- 1 Designing the User Interface: Strategies for effective human Computer Interaction, Ben Schneiderman, 5th, 2009, Pearson.
- 2 The Elements of User Experience: User centered Design for the web , Jesse James Garrett , 4, 2010, Peachpit.
- 3 Human Computer Interaction , Alan Dix Janet Finlay , 3, 2004, Pearson.
- 4 The UX Process and guidelines for Ensuring a quality User Experience , REX Hartson , 2, 2012, Elsevier Science.

23GDU3202R - UX DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3202R	UX DESIGN	UD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and discuss about User Experience Design Process	2	PO1, PO2, PSO2
CO2	Apply User interface and differentiate from User Experience and principles of User Interface	3	PO2, PO3, PSO2
CO3	Analysing and distinguishing about components of UI Design process with interactive Devices	4	PO1, PO8, PSO2
CO4	Determine graphic design techniques and psychology principles of User Experience	4	PO1, PO8, PSO2

Syllabus

Introduction to UX: Introduction to UX, Elements of UX Design, Core Research, Heuristic Evaluation, who is the User, Persona, Customer Journey Map, Empathy, Business Model and Strategy, understanding various technology and devices enabling technology. Introduction To UI: Human Factors, of Interactive Software: Goals of System Engineering, Goals of UI Design, Motivations for Human Factors in Design, Accommodation of Human Diversity, Goals of our Profession.

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Reference Books

- 1 Designing the User Interface: Strategies for effective human Computer Interaction, Ben Schneiderman, 5th, 2009, Pearson.
- 2 The Elements of User Experience: User centered Design for the web , Jesse James gareth , 4 , 2010, Peachpit.
- 3 Human Computer Interaction , Alan Dix janet Finlay , 3 , 2004, Pearson.
- 4 The UX Process and guidelines for Ensuring a quality User Experience , REX Hartson , 2, 2012, Elsevier Science.

23GDU3303A - AR & VR APPLICATION DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3303A	AR & VR APPLICATION DEVELOPMENT	AR&VR	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Apply Basics of Augmented Reality and Interactions. Fundamentals of Augmented , Mixed Reality and its features.	3	PO1, PO2, PSO1
CO2	Apply Basics of Virtual Reality and Interactions. Fundamental Concept and Components of Virtual Reality	3	PO2, PO3, PSO2
CO3	Apply Graphics Pipelines, Creating a sample augmented reality apps in android	3	PO2, PO5, PSO2
CO4	Apply Applications of Virtual Reality in Digital Entertainment	3	PO2, PO5, PSO2
CO5	Apply Advanced AR and VR Components	3	PO1, PO5, PSO1
CO6	Develop applications through Lab experiments	3	PO1, PO5, PSO1
CO7	Develop applications through Skill experiments	3	PO1, PO5, PSO1

Syllabus

Introduction to Augmented Reality -Augmented Reality Interactions, Monitor Based Displays, Headmounted Displays, Ar Interaction, Ar Tracking , Augmented and Mixed Reality, Technology and features of augmented reality, Typical AR Experiences, Difference between AR, VR and MR, Challenges with AR, AR systems, Simultaneously Localize and Map Environment, Optical Tracking , AR Tracking and registration , Markers , Holography and Photography, AR System Evaluation.

Introduction to Virtual Reality- Historical development of VR Fundamental Concept and Components of Virtual Reality, Architecture of Virtual Reality, Primary Features and Present Development on Virtual Reality, Typical VR System, The three I's of virtual reality, commercial VR technology and the five classic components of a VR system, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement ,VR Content, Factors in Virtual Reality, Benefits of virtual reality, Typical System Delays, VR Graphics Architecture.

The Graphics Pipeline VR Panorama, Stereo Movie, Stereo Panorama , Mono Panoramas ,Comparison Mono and Stereo Panoramas, Spatial Audio for VR, Motion Sickness, Spherical Harmonics ,Engines and Unity,VR Engines,Audio ,3D Audio, Physics ,User Interface, VR Engines Content Creation,Latency,Post-rendering Warp, Eye Tracking

VR Technology in Film & TV Production.VR Technology in Physical Exercises and Games.Demonstration of Digital Entertainment by VR. 3D user interfaces - Why 3D user interfaces. Major user tasks in VE. Interaction techniques for selection, Manipulation and navigation.3DUI evaluation.

Augmented Reality Projects and Optimization approaches, Research and Troubleshooting

Reference Books

- 1 Virtual Reality, Brett S. Martin, Second, Norwood House Pres.
- 2 Understanding Augmented Reality: Concepts and Applications, Alan B. Craig, Second, Newnes.
- 3 Understanding Virtual Reality , William R. Sherman and Alan B. Craig, Third, Morgan Kaufmann Publishers.
- 4 Game Coding Complete, Mike Mc Shaffrly and David Graham, Fourth Edition, Cengage Learning.

23GDU3303E - AR & VR APPLICATION DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3303E	AR & VR APPLICATION DEVELOPMENT	AR&VR	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Apply Basics of Augmented Reality and Interactions. Fundamentals of Augmented , Mixed Reality and its features.	3	PO1, PO2, PSO1
CO2	Apply Basics of Virtual Reality and Interactions. Fundamental Concept and Components of Virtual Reality	3	PO2, PO3, PSO2
CO3	Apply Graphics Pipelines, Creating a sample augmented reality apps in android	3	PO2, PO5, PSO2
CO4	Apply Applications of Virtual Reality in Digital Entertainment	3	PO2, PO5, PSO2
CO5	Apply Advanced AR and VR Components	3	PO1, PO5, PSO1
CO6	Develop applications through Lab experiments	3	PO1, PO5, PSO1
CO7	Develop applications through Skill experiments	3	PO1, PO5, PSO1

Syllabus

Introduction to Augmented Reality -Augmented Reality Interactions, Monitor Based Displays, Headmounted Displays, Ar Interaction, Ar Tracking , Augmented and Mixed Reality, Technology and features of augmented reality, Typical AR Experiences, Difference between AR, VR and MR, Challenges with AR, AR systems, Simultaneously Localize and Map Environment, Optical Tracking , AR Tracking and registration , Markers , Holography and Photography, AR System Evaluation.

Introduction to Virtual Reality- Historical development of VR Fundamental Concept and Components of Virtual Reality, Architecture of Virtual Reality, Primary Features and Present Development on Virtual Reality, Typical VR System, The three V's of virtual reality, commercial VR technology and the five classic components of a VR system, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement ,VR Content, Factors in Virtual Reality, Benefits of virtual reality, Typical System Delays, VR Graphics Architecture.

The Graphics Pipeline VR Panorama, Stereo Movie, Stereo Panorama , Mono Panoramas ,Comparison Mono and Stereo Panoramas, Spatial Audio for VR, Motion Sickness, Spherical Harmonics ,Engines and Unity,VR Engines,Audio ,3D Audio, Physics ,User Interface, VR Engines Content Creation,Latency,Post-rendering Warp, Eye Tracking

VR Technology in Film & TV Production.VR Technology in Physical Exercises and Games.Demonstration of Digital Entertainment by VR. 3D user interfaces - Why 3D user interfaces. Major user tasks in VE. Interaction techniques for selection, Manipulation and navigation.3DUI evaluation.

Augmented Reality Projects and Optimization approaches, Research and Troubleshooting

Reference Books

- 1 Virtual Reality , Brett S. Martin , Second , Norwood House Pres.
- 2 Understanding Augmented Reality: Concepts and Applications , Alan B. Craig , Second , Newnes.
- 3 Understanding Virtual Reality , William R. Sherman and Alan B. Craig , Third , Morgan Kaufmann Publishers.

- 4 Game Coding Complete, Mike Mc Shaffrfy and David Graham, Fourth Edition, Cengage Learning.

23GDU3303R - AR & VR APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3303R	AR & VR APPLICATION DEVELOPMENT	AR&VR	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Basics of Augmented Reality and Interactions. Fundamentals of Augmented , Mixed Reality and its features.	2	PO1, PO2, PSO1
CO2	Apply Basics of Virtual Reality and Interactions. Fundamental Concept and Components of Virtual Reality	3	PO1, PO3, PSO1
CO3	Apply Graphics Pipelines, Creating a sample augmented reality apps in android	3	PO1, PO5, PSO2
CO4	Apply Applications of Virtual Reality in Digital Entertainment	3	PO1, PO5, PSO2
CO5	Develop applications through Lab experiments	3	PO1, PO5, PSO1
CO6	Develop applications through Skill experiments	3	PO1, PO5, PSO1

Syllabus

Introduction to Augmented Reality -Augmented Reality Interactions, Monitor Based Displays, Headmounted Displays, Ar Interaction, Ar Tracking , Augmented and Mixed Reality, Technology and features of augmented reality, Typical AR Experiences, Difference between AR, VR and MR, Challenges with AR, AR systems, Simultaneously Localize and Map Environment, Optical Tracking , AR Tracking and registration , Markers , Holography and Photography, AR System Evaluation.

Introduction to Virtual Reality- Historical development of VR Fundamental Concept and Components of Virtual Reality, Architecture of Virtual Reality, Primary Features and Present Development on Virtual Reality, Typical VR System, The three V's of virtual reality, commercial VR technology and the five classic components of a VR system, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement ,VR Content, Factors in Virtual Reality, Benefits of virtual reality, Typical System Delays, VR Graphics Architecture.

The Graphics Pipeline VR Panorama,Stereo Movie, Stereo Panorama , Mono Panoramas ,Comparison Mono and Stereo Panoramas, Spatial Audio for VR, Motion Sickness, Spherical Harmonics ,Engines and Unity,VR Engines,Audio ,3D Audio, Physics ,User Interface, VR Engines Content Creation,Latency,Post-rendering Warp,Eye Tracking

VR Technology in Film & TV Production.VR Technology in Physical Exercises and Games.Demonstration of Digital Entertainment by VR. 3D user interfaces - Why 3D user interfaces. Major user tasks in VE. Interaction techniques for selection, Manipulation and navigation.3DUI evaluation.

Reference Books

- 1 Understanding Augmented Reality: Concepts and Applications, Alan B. Craig , Second, Newnes.
- 2 Virtual Reality , Brett S. Martin , Second, Norwood House Press.
- 3 Understanding Virtual Reality , William R. Sherman and Alan B. Craigm, Third , Morgan Kaufmann Publishers.
- 4 Game Coding Complete, Mike Mc Shaffrly and David Graham, Fourth Edition, Cengage Learning.

23GDU3404M - COMPUTER GRAPHICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3404M	COMPUTER GRAPHICS	CG	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand techniques of computer graphics for the generation of objects.	2	PO1, PO2, PO3, PSO2
CO2	Apply two dimensional Transformations	3	PO1, PO2, PO3, PSO2
CO3	Apply virtual reality and three dimensional transformation.	3	PO1, PO2, PO3, PSO2
CO4	Analyze three dimensional graphics.	3	PO1, PO2, PO3, PSO2

Syllabus

Introduction and Line Generation: Video Display Devices- Raster Scan systems-random scan systems-Graphics monitors and workstations-Input devices-hard copy devices-Graphics software, Frame buffer and video controller. Output primitives: Points and Lines-Line Drawing Algorithms- Loading the Frame buffer- Line function- Circle- Generating

Two Dimensional Geometric Transformations: Basic Transformations- Matrix Representations-Homogeneous Coordinates-Composite Transformations-Other Transformations-Transformations between Coordinate Systems- Affine Transformations-Transformation Functions- Raster methods for Transformations. Two Dimensional Viewing: The viewing

Structure and Hierarchical Modeling: Concepts of Structures and Basic models-Editing - Hierarchical Modeling with Structures-GUI and Interactive Input Methods- Windows and Icons- Virtual Reality Environments. Three Dimensional: 3-D geometric primitives, 3-D Object representation, 3-D Transformation, 3-D viewing, projections, 3-D Clipping. Curves and Surfaces: Quadric surfaces, Spheres, Ellipsoid, Blobby objects,

Introductory concepts of Spline, Bspline and Bezier curves and surfaces. Hidden Lines and Surfaces: Back Face Detection algorithm, Depth buffer method, A buffer method, Scan line method, basic illumination models, Ambient light, Diffuse reflection, Specular reflection and Phong model, Combined approach, Warn model, Intensity Attenuation,

Reference Books

- 1 Computer Graphics with OpenGL, Fourth Edition, Pearson Education, 2013, D. Hearn, M. P. Baker, , 4,2013, Cengage Learning.
- 2 Computer Graphics: Principles & Practice in C ; Pearson, J. D. Foley, S. K Feiner, A Van Dam F. H John; , 2,2013, CRC Press.
- 3 Computer Graphics using Open GL Pearson Education, 2004, Francis S Hill Jr, 2,2004, Morgan Kaufmann.
- 4 Computer Graphics, Donald Hearn and Pauline Baker M, 2,2007, Prentice Hall, New Delhi, 2007 .
- 5 Principles of Interactive Computer Graphics, William M. Newman and Robert F.Sproull, 2,2012, McGrawHill .

23GDU3405M - 3D MODELLING & ANIMATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3405M	3D MODELLING & ANIMATION	3DMA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of 3D Modelling.	2	PO1, PO2, PO3, PSO2
CO2	Apply key frames for animation with timelines and constraints using various tools	3	PO1, PO2, PO3, PSO2
CO3	Apply simulation effects to Animation objects	3	PO1, PO2, PO3, PSO2
CO4	Analyze different modelling animation techniques	4	PO1, PO2, PO3, PSO2

Syllabus

Definition of Modelling 3D concepts 3D object representations Polygon surfaces Curved Lines and surfaces Spline representations Bezier curves and surfaces Transformation and Viewing: 3D geometric and modelling transformations Translation, Rotation, Scaling, composite transformations 3D viewing viewing pipeline, viewing coordinates, Projections, Visible surface detection methods.

Keyframe Animation Creating Keyframes, Auto Keyframes, Move & Scale Keyframe on the timeline, Animating with constraints & simple controllers, animation Modifiers & complex controllers, function curves in the track view, motion mixer., ZBrush, Blender, Substance painter

Simulation & Effects Bind to Space Warp object, Gravity, wind, displace force object, deflectors, FFD space warp, wave, ripple, bomb, creating particle system through parray, understanding particle flow user interface, how to particle flow works, hair & fur modifier, cloth & garment maker modifiers.

Lighting & Camera Configuring & Aiming Cameras, camera motion blur, camera depth of field, camera tracking, using basic lights & lighting Techniques, working with advanced lighting, Light Tracing, Radiosity, video post, mental ray lighting mapping texture Vray light setup, Vray rendering settings, HDRI Illumination, Fine tuning shadows, Final render setting.

Reference Books

- 1 Computer Graphics: Principles and Practice, John F. Hughes, Andries Van Dam, Morgan Mc Guire, David F. Sklar, James D. Foley, Steven K. Feiner and Kurt Akeley,, 3, Addison Wesley Professional.
- 2 3D Modelling, Animation, and Rendering, Michael E. Mortenson, 3, Addison Wesley Professional.
- 3 Game Development 2042: The Future of Game Design, Development, and Publishing [Paperback] Fields,, TIM Fields, First edition , CRC Press.
- 4 The Art of Game Design: A Book of Lenses,, JESSE SCHELL, 2, CRC Press .
- 5 3D Modelling, Animation, and Rendering, Michael E. Mortenson , 1, CRC Press .

23GDU3506 - PRINCIPLES OF GAME DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3506	PRINCIPLES OF GAME DESIGN	PRGD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Video Games and Design Components	2	PO1, PO2, PO3, PSO2
CO2	Discuss Game Concepts and its world	2	PO1, PO2, PO3, PSO2
CO3	Illustrate Story telling Character and user interface Design	3	PO1, PO2, PO3, PSO2
CO4	Analyze the Game Play its mechanics and balancing	4	PO1, PO2, PO3, PSO2
CO5	implement Games using Course with Code in Unity	3	PO1, PO2, PO3, PSO2

Syllabus

Video Games and Design Components: Definition of game, Conventional Versus Video Games, How video games Entertainment, Design Components and Processes: The key components of video games, The structure of video games, Stages of video games, Game design team roles, Game design documents,

The anatomy of a game designer. Game Concepts and its world: Getting an Idea, From Idea to game design concept, the player role, choosing a genre, Defining your target audience ,progression considerations, types of game machines, Introduction to game world and its purpose.

Dimensions of Game world. Story telling Character & user interface Design: Story telling play, Goals of character design, The story telling engine, Linear and non linear stories, Emotional limits and Interactive stories, Player centric interface design, Inputs devices, The design process

Game Play and its mechanics: Making game fun, Challenges, What are core mechanics, balanced game, Action Games, The level of design process, What are adventure games, Online Games, Design issues of online games, Advantages and disadvantages, Design to appeal to particular group

Reference Books

- 1 Fundamentals of Game Design, Earnest Adams, 3, New Riders..
- 2 Mastering Game Design with Unity 2021, Scott Tysoki, 2, bpb publishers.
- 3 Game Development 2042: The Future of Game Design, Development, and Publishing [Paperback] Fields, , TIM Fields, 1, CRC Press.
- 4 The Art of Game Design: A Book of Lenses, , JESSE SCHELL, Third Edition, CRC Press .
- 5 The Future of Game Design, Development, and Publishing [Paperback] Fields,, TIM Fields , 1, CRC Press .

23GDU3507 - BUSINESS OF GAMES & ENTREPRENEURSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GDU3507	BUSINESS OF GAMES & ENTREPRENEURSHIP	BGE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the flow of money in the game industry & how to protect ideas to make the craft of making games an economically	2	PO1, PO2, PO3, PSO2
CO2	Apply the mechanism behind gaming production and teamwork with foundation in some of the project management	3	PO1, PO2, PO3, PSO2
CO3	Apply Work out some of the presentation skills to pitch the gaming ideas as it happens in the ecosystem with enablers	3	PO1, PO2, PO3, PSO2
CO4	Apply the skills required to be an entrepreneur and know the rules and regulations to start a company in a country like India	3	PO1, PO2, PO3, PSO2

Syllabus

Show the Money The Business of Videogames, Funding Models, Where are Games Sold, How do You Make Money. IP Intellectual Property, IP Copyright, IP- Patents and Trade Secrets and IP Protecting Yourself and your Game project.

Games are Made of People: Teamwork Fundamentals, It's About the People, Project Management Techniques, Complexity and Iteration, SCRUM, Project Management Tools. Leadership: Gaming project leaders and their Leadership Qualities, Leadership Style and Leadership Tasks.

Pitching Your Game and Yourself: The Art of the Demo, Public Speaking What Works, Effective Visuals. How to Demo Your Game, Getting a Job, Perfecting the Resume, Finding a Game Job, Interviewing for Game project specialist.

Entrepreneurship and Starting a Company: Your Friends Are Not A Company, Entrepreneurship, Launching a Business, Business Structures, Business Planning and DPR. Rules and Regulations with different stakeholders including Central and State government nodal agencies on startup ecosystem including company incorporation rules in India. Opportunities in Startup India ecosystem towards Funding and establishment support.

Reference Books

- 1 Long Term Game: How to build a Video Games Company, Joakim Achren, 3,2015, Course Technology .
- 2 Shifting Orbits: Decoding the Trajectory of the Indian Start up Ecosystem, Thillai Rajan A, Srivardhini K Jha, Joffi Thomas, Rohan Chinchwadkar, 2,2007, Kindle Edition.
- 3 Games, Simulations and Playful Learning in Business Education, O. Arikan, M. Davies, I. De Loo, C. Elliott, J. Evans, J. Guest, B.A. Kazmi, C. Kerridge, P. Koornhof, M. Kozlovskaya, 3,2013, OPEN ACCESS PEER-REVIEWED EDITED VOLUME.
- 4 Serious Games Integration in an Entrepreneurship, Margarida Romero & Mireia Usart , 3,2016, E-BOOK.
- 5 Games, Simulations and Playful Learning in Business Education, O. Arikan, M. Davies, I. De Loo, C. Elliott, J. Evans, J. Guest, B.A., 3,2017, OPEN ACCESS PEER-REVIEWED EDITED VOLUME.

23GEG3101A - MOLECULAR GENETICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3101A	MOLECULAR GENETICS	MG	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Comprehensive Understanding of Molecular Mechanisms: apply fundamental principles of molecular biology to understand and describe the mechanisms.	2	PO1, PO2, PO3, PSO1
CO2	Analysis of Genetic Variations and Mutations: investigate and analyze genetic variations and mutations by applying molecular techniques	3	PO1, PO2, PO3, PSO1
CO3	Proficiency in Molecular Techniques: gain proficiency in a variety of molecular biology techniques	3	PO1, PO2, PO3, PSO1
CO4	Exploration of Gene Expression Regulation	3	PO1, PO2, PO3, PSO1
CO5	Investigation of Genetic Disorders and Diseases	3	PO1, PO2, PO3, PSO1
CO6	Molecular genetics practicals involve a variety of techniques and experiments designed to understand the structure, function, and manipulation of genetic material.	4	PO1, PO2, PO3, PSO1
CO7	Application of Molecular Genetics in Biotechnology and Research for developemnt modern technolooges	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Molecular Genetics History and significance of molecular genetics Central dogma of molecular biology Structure and function of DNA and RNA

DNA Replication and Repair Mechanisms of DNA replication DNA repair pathways (mismatch repair, nucleotide excision repair, etc.) Telomeres and telomerase

Transcription and RNA Processing Transcriptional machinery and regulation RNA processing (splicing, capping, polyadenylation) Non-coding RNAs (miRNA, siRNA, lncRNA)

Translation and Protein Synthesis Ribosomes and translation machinery Genetic code and protein synthesis Post-translational modifications

Gene Regulation and Expression Control Transcriptional regulation (promoters, enhancers, repressors) Epigenetics and chromatin remodeling Regulatory RNA molecules (microRNAs, long non-coding RNAs)

Genetic Variation and Mutation Analysis Types of genetic variations (SNPs, indels, CNVs) Mutation detection methods (PCR, sequencing, microarrays) Functional consequences of mutations

Molecular Genetics Techniques Polymerase Chain Reaction (PCR) DNA sequencing methods (Sanger sequencing, NGS) Gene cloning and recombinant DNA technology CRISPR/Cas9 gene editing

Applications of Molecular Genetics Genetic engineering in biotechnology Genomic medicine and personalized genomics Molecular diagnostics and genetic testing Pharmacogenomics and gene therapy

Reference Books

- 1 Molecular Biology of the Gene, James D. Watson, 1965, Cold Spring Harbor Laboratory.
- 2 Principles of Genetics, Peter Snustad and Michael Simmons, 2015, Wiley.
- 3 Essentials of Molecular Genetics, Gurbachan S. Miglani, 2015, Alpha Science.
- 4 Introduction to Genetics: A Molecular Approach, T. A. Brown, 2012, Garland Science .

23GEG3101E - MOLECULAR GENETICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3101E	MOLECULAR GENETICS	MG	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Comprehensive Understanding of Molecular Mechanisms: apply fundamental principles of molecular biology to understand and describe the mechanisms	2	PO1, PO2, PO3, PSO1
CO2	Analysis of Genetic Variations and Mutations: investigate and analyze genetic variations and mutations by applying molecular techniques	3	PO1, PO2, PO3, PSO1
CO3	Proficiency in Molecular Techniques: gain proficiency in a variety of molecular biology techniques	3	PO1, PO2, PO3, PSO1
CO4	Exploration of Gene Expression Regulation: explore and apply methods to study the regulation of gene expression	3	PO1, PO2, PO3, PSO1
CO5	Investigation of Genetic Disorders and Diseases: investigate genetic disorders and diseases by applying molecular diagnostic techniques	3	PO1, PO2, PO3, PSO1
CO6	Molecular genetics practicals involve a variety of techniques and experiments designed to understand the structure, function, and manipulation of genetic material.	4	PO1, PO2, PO3, PSO1
CO7	Application of Molecular Genetics in Biotechnology and Research for developemnt modern technolooges	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Molecular Genetics History and significance of molecular genetics Central dogma of molecular biology Structure and function of DNA and RNA

DNA Replication and Repair Mechanisms of DNA replication DNA repair pathways (mismatch repair, nucleotide excision repair, etc.) Telomeres and telomerase

Transcription and RNA Processing Transcriptional machinery and regulation RNA processing (splicing, capping, polyadenylation) Non-coding RNAs (miRNA, siRNA, lncRNA)

Translation and Protein Synthesis Ribosomes and translation machinery Genetic code and protein synthesis Post-translational modifications

Gene Regulation and Expression Control Transcriptional regulation (promoters, enhancers, repressors) Epigenetics and chromatin remodeling Regulatory RNA molecules (microRNAs, long non-coding RNAs)

Genetic Variation and Mutation Analysis Types of genetic variations (SNPs, indels, CNVs) Mutation detection methods (PCR, sequencing, microarrays) Functional consequences of mutations

Molecular Genetics Techniques Polymerase Chain Reaction (PCR) DNA sequencing methods (Sanger sequencing, NGS) Gene cloning and recombinant DNA technology CRISPR/Cas9 gene editing

Applications of Molecular Genetics Genetic engineering in biotechnology Genomic medicine and personalized genomics Molecular diagnostics and genetic testing Pharmacogenomics and gene therapy

Reference Books

- 1 Molecular Biology of the Gene, James D. Watson et al., 1965, Cold Spring Harbor Laboratory.
- 2 Principles of Genetics, Peter Snustad and Michael Simmons., 2015, Wiley.
- 3 Essentials of Molecular Genetics, Gurbachan S. Miglani, 2015, Alpha Science.
- 4 Introduction to Genetics: A Molecular Approach , T. A. Brown , 2012, Garland Science .

23GEG3101R - MOLECULAR GENETICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3101R	MOLECULAR GENETICS	MG	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Comprehensive Understanding of Molecular Mechanisms: apply fundamental principles of molecular biology to understand and describe the mechanisms.	2	PO1, PO2, PO3, PO9
CO2	Analysis of Genetic Variations and Mutations: investigate and analyze genetic variations and mutations by applying molecular techniques	3	PO1, PO2, PO3, PO9
CO3	Exploration of Gene Expression Regulation: gain proficiency in a variety of molecular biology techniques	3	PO1, PO2, PO3, PO9
CO4	Investigation of Genetic Disorders and Diseases: investigate genetic disorders and diseases by applying molecular diagnostic techniques	3	PO1, PO2, PO3, PO9
CO5	Molecular genetics practicals involve a variety of techniques and experiments designed to understand the structure, function, and manipulation of genetic material	4	PO1, PO2, PO3, PO9
CO6	Application of Molecular Genetics in Biotechnology and Research for developemnt modern technolooges	3	PO1, PO2, PO3, PO9

Syllabus

Introduction to Molecular Genetics History and significance of molecular genetics Central dogma of molecular biology Structure and function of DNA and RNA

DNA Replication and Repair Mechanisms of DNA replication DNA repair pathways (mismatch repair, nucleotide excision repair, etc.) Telomeres and telomerase

Transcription and RNA Processing Transcriptional machinery and regulation RNA processing (splicing, capping, polyadenylation) Non-coding RNAs (miRNA, siRNA, lncRNA)

Translation and Protein Synthesis Ribosomes and translation machinery Genetic code and protein synthesis Post-translational modifications

Gene Regulation and Expression Control Transcriptional regulation (promoters, enhancers, repressors) Epigenetics and chromatin remodeling Regulatory RNA molecules (microRNAs, long non-coding RNAs)

Genetic Variation and Mutation Analysis Types of genetic variations (SNPs, indels, CNVs) Mutation detection methods (PCR, sequencing, microarrays) Functional consequences of mutations

Molecular Genetics Techniques Polymerase Chain Reaction (PCR) DNA sequencing methods (Sanger sequencing, NGS) Gene cloning and recombinant DNA technology CRISPR/Cas9 gene editing

Applications of Molecular Genetics Genetic engineering in biotechnology Genomic medicine and personalized genomics Molecular diagnostics and genetic testing Pharmacogenomics and gene therapy

Reference Books

- 1 Molecular Biology of the Gene, James D. Watson et al., 1965, Cold Spring Harbor Laboratory.
- 2 Principles of Genetics, Peter Snustad and Michael Simmons., 2015, Wiley.
- 3 Essentials of Molecular Genetics, Gurbachan S. Miglani, 2015, Alpha Science.
- 4 Introduction to Genetics: A Molecular Approach , T. A. Brown, 2012, Garland Science .

23GEG3202A - MOLECULAR EXPRESSION TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3202A	MOLECULAR EXPRESSION TECHNOLOGY	MET	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand a comprehensive understanding of the principles underlying molecular expression technology.	2	PO1, PO2, PO3, PSO1
CO2	Apply various techniques such as gene cloning, PCR, and recombinant DNA technology to manipulate and express genes.	3	PO1, PO2, PO3, PSO1
CO3	Analyze experimental data related to molecular expression technology and draw appropriate conclusions.	4	PO1, PO2, PO3, PSO1
CO4	Take part effectively in compiling about molecular expression technology through written reports and oral presentations.	4	PO1, PO2, PO3, PSO1
CO5	Demonstrate awareness of ethical considerations in molecular expression technology research and applications.	2	PO1, PO2, PO3, PSO1
CO6	Make a relationship effectively with peers in laboratory and group projects related to molecular expression technology.	4	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Molecular Expression Technology: Definition of Molecular Expression Technology, Historical development and milestones, Importance in modern biotechnology and medicine, Principles of gene cloning, Types of vectors: plasmids, phages, artificial chromosomes, Techniques: restriction enzymes, DNA ligases, PCR, Prokaryotic vs. eukaryotic expression systems, Choice of host organisms: bacteria, yeast, insect cells, mammalian cells, Cell-free expression systems and their applications

Transcription and Translation: Mechanisms of transcription and translation, Regulation of gene expression, Role of promoters and regulatory elements, Protein Expression: Protein folding and assembly, Post-translational modifications, Strategies to improve protein yield and solubility, Protein Purification: Principles of protein purification, Chromatography techniques: affinity chromatography, size-exclusion chromatography, ion exchange chromatography, Protein quantification and analysis

Industrial Applications: Production of recombinant proteins, Biopharmaceuticals: insulin, vaccines, monoclonal antibodies, Enzyme production and industrial biotechnology, Research Applications: Protein engineering and design, Functional genomics and proteomics, Drug discovery and development using molecular expression

Challenges in Protein Expression: Factors affecting protein expression: codon usage, mRNA stability, post-translational modifications, Strategies to enhance protein expression and stability, Scale-up and Process Optimization, Scale-up considerations in bioreactors Process optimization: media formulation, feeding strategies, control of fermentation parameters

Recent Advances: High-throughput methods in protein expression, Synthetic biology approaches in molecular expression, CRISPR/Cas systems in genome editing and protein engineering, Future Directions and Emerging Technologies: Trends in molecular expression technology, Applications of artificial intelligence and machine learning in biotechnology

Ethical Issues in Biotechnology: Intellectual property and patents Bioethics in biotechnology research, Responsible conduct of research and professional ethics, Regulatory Aspects: FDA regulations for biopharmaceuticals, Biosafety and biosecurity in biotechnology, Global regulatory landscape and harmonization efforts

Reference Books

- 1 Principles of Gene Manipulation and Genomics, Sandy B. Primrose and Richard Twyman, 2014, Wiley-Blackwell.

- 2 Protein Expression: A Practical Approach, Louise Smith, 2004, Oxford University Press.
- 3 Molecular Cloning: A Laboratory Manual, Joseph Sambrook, David W. Russell, 2014, Cold Spring Harbor Laboratory Press.
- 4 Lewins Genes XII, JOCELYN E. KREBS, ELLIOTT S. GOLDSTEIN, STEPHEN T. KILPATRICK, 2018, Jones & Bartlett Learning books.

23GEG3202E - MOLECULAR EXPRESSION TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3202E	MOLECULAR EXPRESSION TECHNOLOGY	MET	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand a comprehensive understanding of the principles underlying molecular expression technology.	3	PO1, PO2, PO3, PSO1
CO2	Apply various techniques such as gene cloning, PCR, and recombinant DNA technology to manipulate and express genes.	3	PO1, PO2, PO3, PSO1
CO3	Analyze experimental data related to molecular expression technology and draw appropriate conclusions.	4	PO1, PO2, PO3, PSO1
CO4	Utilize the advantages and limitations of different expression systems and vectors and develop the appropriate vectors for molecular expression.	3	PO1, PO2, PO3, PSO1
CO5	Analyze and interpret data from a variety of analytical methods used to characterize protein structure and function	4	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Molecular Expression Technology: Definition of Molecular Expression Technology, Historical development and milestones, Importance in modern biotechnology and medicine, Principles of gene cloning, Types of vectors: plasmids, phages, artificial chromosomes, Techniques: restriction enzymes, DNA ligases, PCR, Prokaryotic vs. eukaryotic expression systems, Choice of host organisms: bacteria, yeast, insect cells, mammalian cells, Cell-free expression systems and their applications

Transcription and Translation: Mechanisms of transcription and translation, Regulation of gene expression, Role of promoters and regulatory elements, Protein Expression: Protein folding and assembly, Post-translational modifications, Strategies to improve protein yield and solubility, Protein Purification: Principles of protein purification, Chromatography techniques: affinity chromatography, size-exclusion chromatography, ion exchange chromatography, Protein quantification and analysis

Industrial Applications: Production of recombinant proteins, Biopharmaceuticals: insulin, vaccines, monoclonal antibodies, Enzyme production and industrial biotechnology, Research Applications: Protein engineering and design, Functional genomics and proteomics, Drug discovery and development using molecular expression

Challenges in Protein Expression: Factors affecting protein expression: codon usage, mRNA stability, post-translational modifications, Strategies to enhance protein expression and stability, Scale-up and Process Optimization, Scale-up considerations in bioreactors Process optimization: media formulation, feeding strategies, control of fermentation parameters

Recent Advances: High-throughput methods in protein expression, Synthetic biology approaches in molecular expression, CRISPR/Cas systems in genome editing and protein engineering, Future Directions and Emerging Technologies: Trends in molecular expression technology, Applications of artificial intelligence and machine learning in

Reference Books

- 1 Principles of Gene Manipulation and Genomics, Sandy B. Primrose and Richard Twyman, 2014, Wiley-Blackwell.
- 2 Protein Expression: A Practical Approach , Louise Smith, 2004, Oxford University Press.
- 3 Molecular Cloning: A Laboratory Manual, Joseph Sambrook, David W. Russell, 2014, y Cold Spring Harbor Laboratory Press.
- 4 LEWINS GENES XII, JOCELYN E. KREBS, ELLIOTT S. GOLDSTEIN, STEPHEN T. KILPATRICK, 2018, Jones & Bartlett Learning books.

23GEG3202R - MOLECULAR EXPRESSION TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3202R	MOLECULAR EXPRESSION TECHNOLOGY	MET	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand a comprehensive understanding of the principles underlying molecular expression technology.	2	PO1, PO2, PO3, PSO1
CO2	Apply various techniques such as gene cloning, PCR, and recombinant DNA technology to manipulate and express genes.	3	PO1, PO2, PO3, PSO1
CO3	Analyze experimental data related to molecular expression technology and draw appropriate conclusions.	4	PO1, PO2, PO3, PSO1
CO4	Utilize the advantages and limitations of different expression systems and vectors and develop appropriate vectors for molecular expression.	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Molecular Expression Technology: Definition of Molecular Expression Technology, Historical development and milestones, Importance in modern biotechnology and medicine, Principles of gene cloning, Types of vectors: plasmids, phages, artificial chromosomes, Techniques: restriction enzymes, DNA ligases, PCR, Prokaryotic vs. eukaryotic expression systems, Choice of host organisms: bacteria, yeast, insect cells, mammalian cells, Cell-free expression systems and their applications

Transcription and Translation: Mechanisms of transcription and translation, Regulation of gene expression, Role of promoters and regulatory elements, Protein Expression: Protein folding and assembly, Post-translational modifications, Strategies to improve protein yield and solubility, Protein Purification: Principles of protein purification, Chromatography techniques: affinity chromatography, size-exclusion chromatography, ion exchange chromatography, Protein quantification and analysis

Industrial Applications: Production of recombinant proteins, Biopharmaceuticals: insulin, vaccines, monoclonal antibodies, Enzyme production and industrial biotechnology, Research Applications: Protein engineering and design, Functional genomics and proteomics, Drug discovery and development using molecular expression

Recent Advances: High-throughput methods in protein expression, Synthetic biology approaches in molecular expression, CRISPR/Cas systems in genome editing and protein engineering, Future Directions and Emerging Technologies: Trends in molecular expression technology, Applications of artificial intelligence and machine learning in

Reference Books

- 1 Principles of Gene Manipulation and Genomics, Sandy B. Primrose and Richard Twyman, 2014, Wiley-Blackwell.
- 2 Protein Expression: A Practical Approach , Steve J. Higgins, B. D. Hames, 2004, Oxford University Press.
- 3 Molecular Cloning: A Laboratory Manual, Joseph Sambrook, David W. Russell, 2014, Cold Spring Harbor Laboratory Press.
- 4 Lewins Genes XII, JOCELYN E. KREBS, ELLIOTT S. GOLDSTEIN, STEPHEN T. KILPATRICK, 2018, Jones & Bartlett Learning books.

23GEG3203A - TRANSGENIC TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3203A	TRANSGENIC TECHNOLOGY	TT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Acquire the knowledge of vehicles for transgenic technology and transgenic plants	3	PO1
CO2	Apply the role of transgenic animals and silencing technology	3	PO1
CO3	Develop gene therapy for repair of defective genes	4	PO1
CO4	Develop knockouts strategies for strain improvement	4	PO9
CO5	Analyze various transgenic methods	4	PO9
CO6	Analyse gene editing methods for developemnt of transgenic products	4	PO9

Syllabus

Introduction to transgenic technology: definition, historical background, and key milestones. Plasmids, Phagemids, Cosmids, viruses, Gene constructs. Principle and applications. genomic and cDNA libraries. Transgenic technology in agriculture, medicine, and research.

Overview of gene transfer methods: microinjection, electroporation, viral vectors. Transgenic plants with beneficial traits, Transgenic plant as bioreactor, Diagnostics in agriculture, Comparison of different gene transfer techniques: advantages and limitations.

Gene transfer methods in animals, Embryonic Stem Cell Method, Pronucleus Method. Restriction enzymes and their role in molecular cloning. Transformation techniques in bacteria, yeast, and plants. Design and construction of expression vectors and plasmids.

SCID therapy, Gene Therapy for Cystic Fibrosis: Gene Therapy Approaches. Genetically modified crops: development, benefits, and controversies. Transgenic animals in agriculture: applications and ethical considerations. Transgenic models in medical research: disease modeling, drug testing, and personalized medicine.

Knockout Mice, Tissue-Specific Knockout Mice, Knock-in Mice. Ethics of Gene therapy. Gene therapy: principles, challenges, and future prospects. PCR (Polymerase Chain Reaction) and its applications in genetic engineering.

DNA, RNAi, Cloning enzymes, SCID, Gene editing methods, Knock out methods, Blot methods. Genetically modified crops: development, benefits, and controversies. Transgenic animals in agriculture: applications and ethical considerations. Global regulatory frameworks for GMOs: case studies and comparisons.

Reference Books

- 1 Principles of Gene Manipulation, Primrose, 2019, Wiley-Blackwell .
- 2 Gene therapy Technologies, Anthony Meager , 1999, John Wiley & Sons .
- 3 Transgenic Animals as Model Systems for Human Diseases, Jamshid Avanesian, 1993, Springer.
- 4 Transgenic Animal Technology, Carl A. Pinkert, 2014, Elsevier Academic Press.

23GEG3203E - TRANSGENIC TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3203E	TRANSGENIC TECHNOLOGY	TT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Acquire the knowledge of vehicles for transgenic technology and transgenic plants	3	PO1
CO2	Apply the role of transgenic animals and silencing technology	3	PO1
CO3	Develop gene therapy for repair of defective genes	4	PO1
CO4	Develop knockouts strategies for strain improvement	4	PO9
CO5	Analyze various transgenic methods	4	PO9
CO6	Analyse gene editing methods for developemnt of transgenic products	4	PO9

Syllabus

Introduction to transgenic technology: definition, historical background, and key milestones. Plasmids, Phagemids, Cosmids, viruses, Gene constructs. Principle and applications. genomic and cDNA libraries. Transgenic technology in agriculture, medicine, and research.

Overview of gene transfer methods: microinjection, electroporation, viral vectors. Transgenic plants with beneficial traits, Transgenic plant as bioreactor, Diagnostics in agriculture, Comparison of different gene transfer techniques: advantages and limitations.

Gene transfer methods in animals, Embryonic Stem Cell Method, Pronucleus Method. Restriction enzymes and their role in molecular cloning. Transformation techniques in bacteria, yeast, and plants. Design and construction of expression vectors and plasmids.

SCID therapy, Gene Therapy for Cystic Fibrosis: Gene Therapy Approaches. Genetically modified crops: development, benefits, and controversies. Transgenic animals in agriculture: applications and ethical considerations. Transgenic models in medical research: disease modeling, drug testing, and personalized medicine.

Knockout Mice, Tissue-Specific Knockout Mice, Knock-in Mice. Ethics of Gene therapy. Gene therapy: principles, challenges, and future prospects. PCR (Polymerase Chain Reaction) and its applications in genetic engineering.

DNA, RNAi, Cloning enzymes, SCID, Gene editing methods, Knock out methods, Blot methods. Genetically modified crops: development, benefits, and controversies. Transgenic animals in agriculture: applications and ethical considerations. Global regulatory frameworks for GMOs: case studies and comparisons.

Reference Books

- 1 Principles of Gene Manipulation, Primrose, 2019, Wiley-Blackwell.
- 2 Gene therapy Technologies, Anthony Meager, 1999, John Wiley & Sons.
- 3 Transgenic Animals as Model Systems for Human Diseases, Jamshid Avanesian, 1993, Springer.
- 4 Transgenic Animal Technology, Carl A. Pinkert, 2014, Elsevier Academic Press .

23GEG3203R - TRANSGENIC TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3203R	TRANSGENIC TECHNOLOGY	TT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Acquire the knowledge of vehicles for transgenic technology and transgenic plants	3	PO1
CO2	Apply the role of transgenic animals and silencing technology	3	PO2
CO3	Apply gene therapy in regulation of genes	3	PO2
CO4	Use knock out models in study of diseased genes	3	PO3
CO5	Analyze transgenic genes for development of expressed proteins	4	PO3

Syllabus

Introduction to transgenic technology: definition, historical background, and key milestones. Plasmids, Phagemids, Cosmids, viruses, Gene constructs. Principle and applications. genomic and cDNA libraries. Transgenic technology in agriculture, medicine, and research.

Overview of gene transfer methods: microinjection, electroporation, viral vectors. Gene transfer methods in animals, Embryonic Stem Cell Method, Pronucleus Method. Transformation techniques in bacteria, yeast, and plants. Design and construction of expression vectors and plasmids.

SCID therapy, Gene Therapy for Cystic Fibrosis: Gene Therapy Approaches. Genetically modified crops: development, benefits, and controversies. Transgenic animals in agriculture: applications and ethical considerations. Transgenic models in medical research: disease modeling, drug testing, and personalized medicine.

Knockout Mice, Tissue-Specific Knockout Mice, Knock-in Mice. Ethics of Gene therapy. Gene therapy: principles, challenges, and future prospects. PCR (Polymerase Chain Reaction) and its applications in genetic engineering.

DNA, RNAi, Cloning enzymes, SCID, Gene editing methods, Knock out methods, Blot methods. Genetically modified crops: development, benefits, and controversies. Transgenic animals in agriculture: applications and ethical considerations. Global regulatory frameworks for GMOs: case studies and comparisons.

Reference Books

- 1 Principles of Gene Manipulation, Primrose, 2019, Wiley-Blackwell.
- 2 Gene therapy Technologies, Anthony Meager, 1999, John Wiley & Sons.
- 3 Transgenic Animals as Model Systems for Human Diseases, Jamshid Avanessian, 1993, Springer.
- 4 Transgenic Animal Technology, Carl A. Pinkert, 2014, Elsevier Academic Press .

23GEG3304A - MOLECULAR MARKERS AND DIAGNOSTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3304A	MOLECULAR MARKERS AND DIAGNOSTICS	MMD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Molecular Markers	2	PO1, PO2, PO3, PSO1
CO2	Techniques for Molecular Marker Analysis: apply and optimize molecular techniques such as PCR, gel electrophoresis, and sequencing.	3	PO1, PO2, PO3, PSO1
CO3	Genetic Variation and Disease Markers: investigate genetic variations and identify disease-associated markers by applying genotyping and association studies	3	PO1, PO2, PO3, PSO1
CO4	Molecular Diagnostics and Personalized Medicine: explore and apply molecular diagnostic techniques (e.g., qPCR, microarrays) to detect biomarkers	3	PO1, PO2, PO3, PSO1
CO5	Bioinformatics Analysis of Molecular Markers: bioinformatics tools and software to analyze and interpret molecular marker data	3	PO1, PO2, PO3, PSO1
CO6	Molecular markers and diagnostics practicals involve techniques to identify specific sequences or variations in DNA that can be used for diagnosing diseases, identifying organisms, or studying genetic diversity.	4	PO1, PO2, PO3, PSO1
CO7	Applications of Molecular Markers in Research and Industry for developemnt of modern technologies.	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Molecular Markers Definition and types of molecular markers Principles behind molecular marker analysis Applications of molecular markers in genetics and biotechnology

Techniques for Molecular Marker Analysis Polymerase Chain Reaction (PCR) and its variants (qPCR, RT-PCR) DNA sequencing methods (Sanger sequencing, NGS) Microarray analysis for gene expression profiling Bioinformatics tools for molecular marker analysis

Genetic Variation and Disease Markers Genetic variation analysis using molecular markers (SNPs, microsatellites) Disease markers and biomarkers in diagnostics and prognosis Molecular markers for cancer diagnosis and treatment selection Molecular Diagnostics Principles of molecular diagnostics Diagnostic methods using molecular markers (PCR-based assays, sequencing, microarrays) Applications in infectious diseases, genetic disorders, and oncology

Bioinformatics Analysis of Molecular Data Introduction to bioinformatics tools and databases Analysis of genetic variation data, gene expression patterns, and protein biomarkers Interpretation of molecular data for diagnosis and research

Personalized Medicine and Molecular Markers Principles of personalized medicine Role of molecular markers in personalized medicine Pharmacogenomics and treatment selection based on genetic profiles

Reference Books

- 1 Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications, Lela Buckingham et al., 2007, Google books.
- 2 Principles of Genetics, Peter Snustad and Michael Simmons., 2015, Wiley.
- 3 Molecular Diagnostics, George P. Patrinos, 2017, Elsevier.
- 4 Molecular Markers in Mycology , Bhim Pratap Singh, Vijai Kumar Gupta, 2017, Springer.

23GEG3304E - MOLECULAR MARKERS AND DIAGNOSTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3304E	MOLECULAR MARKERS AND DIAGNOSTICS	MMD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Molecular Markers	2	PO1, PO2, PO3, PSO1
CO2	Techniques for Molecular Marker Analysis: apply and optimize molecular techniques such as PCR, gel electrophoresis, and sequencing.	3	PO1, PO2, PO3, PSO1
CO3	Genetic Variation and Disease Markers: investigate genetic variations and identify disease-associated markers by applying genotyping and association studies	3	PO1, PO2, PO3, PSO1
CO4	Molecular Diagnostics and Personalized Medicine: explore and apply molecular diagnostic techniques (e.g., qPCR, microarrays) to detect biomarkers	3	PO1, PO2, PO3, PSO1
CO5	Bioinformatics Analysis of Molecular Markers: bioinformatics tools and software to analyze and interpret molecular marker data	3	PO1, PO2, PO3, PSO1
CO6	Molecular markers and diagnostics practicals involve techniques to identify specific sequences or variations in DNA that can be used for diagnosing diseases, identifying organisms, or studying genetic diversity.	4	PO1, PO2, PO3, PSO1
CO7	Applications of Molecular Markers in Research and Industry for developemnt of modern technologies.	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Molecular Markers Types of molecular markers (DNA markers, SNP markers, gene expression markers, protein markers) Principles of molecular marker analysis Applications of molecular markers in genetics and medicine

Techniques for Molecular Marker Analysis Polymerase Chain Reaction (PCR) and its variants (qPCR, RT-PCR) DNA sequencing methods (Sanger sequencing, NGS) Microarray analysis for gene expression profiling Bioinformatics tools for molecular marker analysis

Genetic Variation and Disease Markers Genetic variation analysis using molecular markers (SNPs, microsatellites) Disease markers and biomarkers in diagnostics and prognosis Molecular markers for cancer diagnosis and treatment selection

Molecular Diagnostics Principles of molecular diagnostics Diagnostic methods using molecular markers (PCR-based assays, sequencing, microarrays) Applications in infectious diseases, genetic disorders, and oncology

Bioinformatics Analysis of Molecular Data Introduction to bioinformatics tools and databases Analysis of genetic variation data, gene expression patterns, and protein biomarkers Interpretation of molecular data for diagnosis and research Personalized Medicine and Molecular Markers Principles of personalized medicine Role of molecular markers in personalized medicine Pharmacogenomics and treatment selection based on genetic profiles

Reference Books

- 1 Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications, Lela Buckingham et al., 2007, Google books.
- 2 Principles of Genetics, Peter Snustad and Michael Simmons., 2015, Wiley.
- 3 Molecular Markers in Mycology , Bhim Pratap Singh, Vijai Kumar Gupta, 2017, Springer.
- 4 Molecular Diagnostics, George P. Patrinos, 2017, Elsevier.

23GEG3304R - MOLECULAR MARKERS AND DIAGNOSTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3304R	MOLECULAR MARKERS AND DIAGNOSTICS	MMD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Molecular Markers	2	PO1, PO3, PO5, PSO1
CO2	Techniques for Molecular Marker Analysis: apply and optimize molecular techniques such as PCR, gel electrophoresis, and sequencing.	3	PO1, PO3, PO5, PSO1
CO3	Genetic Variation and Disease Markers: investigate genetic variations and identify disease-associated markers by applying genotyping and association studies	3	PO1, PO3, PO5, PSO1
CO4	Molecular Diagnostics and Personalized Medicine: explore and apply molecular diagnostic techniques (e.g., qPCR, microarrays) to detect biomarkers	3	PO1, PO3, PO5, PSO1
CO5	Molecular markers and diagnostics practicals involve techniques to identify specific sequences or variations in DNA that can be used for diagnosing diseases, identifying organisms, or studying genetic diversity.	4	PO1, PO3, PO5, PSO1
CO6	Applications of Molecular Markers in Research and Industry for developemnt of modern technologies.	4	PO1, PO3, PO5, PSO1

Syllabus

Introduction to Molecular Markers Types of molecular markers (DNA markers, SNP markers, gene expression markers, protein markers) Principles of molecular marker analysis Applications of molecular markers in genetics and medicine

Techniques for Molecular Marker Analysis Polymerase Chain Reaction (PCR) and its variants (qPCR, RT-PCR) DNA sequencing methods (Sanger sequencing, NGS) Microarray analysis for gene expression profiling Bioinformatics tools for molecular marker analysis Genetic Variation and Disease Markers Genetic variation analysis using molecular markers (SNPs, microsatellites) Disease markers and biomarkers in diagnostics and prognosis Molecular markers for cancer diagnosis and treatment selection

Molecular Diagnostics Principles of molecular diagnostics Diagnostic methods using molecular markers (PCR-based assays, sequencing, microarrays) Applications in infectious diseases, genetic disorders, and oncology Bioinformatics Analysis of Molecular Data Introduction to bioinformatics tools and databases Analysis of genetic variation data, gene expression patterns, and protein biomarkers Interpretation of molecular data for diagnosis and research

Personalized Medicine and Molecular Markers Principles of personalized medicine Role of molecular markers in personalized medicine Pharmacogenomics and treatment selection based on genetic profiles

Reference Books

- 1 Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications, Lela Buckingham et al., 2007, Google Books.
- 2 Principles of Genetics, Peter Snustad and Michael Simmons., 2015, Wiley.
- 3 Molecular Markers in Mycology , Bhim Pratap Singh, Vijai Kumar Gupta, 2017, Springer.
- 4 Molecular Diagnostics, George P. Patrinos, 2017, Elsevier.

23GEG3405M - GENOMICS AND PROTEOMICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3405M	GENOMICS AND PROTEOMICS	GP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the genomic technologies including genome structure, organization, and function across different organisms	3	PO9
CO2	Apply the proteomic techniques to integrate genomic and proteomic data to elucidate biological processes	3	PO1
CO3	Apply the Integration of next-generation sequencing, microarray analysis, and mass spectrometry for genome-wide and proteome-wide analysis	3	PO1
CO4	Apply the Ethical and Societal Implications in exploring applications of genomics and proteomics in biomedical research,	3	PO1

Syllabus

Genomes and Genome Analysis-Organization and structure of genomes, Genome Mapping: Construction of genomic libraries, mapping strategies and techniques. Human Genome Project, Genomes of other organisms. Principles of gene expression; Global analysis of gene expression, Peptide nucleic acid technology.

Comparative genomics: protein evolution from exon shuffling, Protein structural genomics, Gene function by sequence comparison. Functional Genomics, Pharmacogenomics, Genomics in relation to molecular Diagnosis, Role of genomics in Drug discovery and development.

Microarrays-Whole genome analysis of mRNA and protein expression, microarray analysis, types of micro arrays and applications in cancer diagnosis. Protein Biochips, Protein arrays. Proteomics-Principles of separation of Bio-molecules, 2D-Gel Electrophoresis, MALDI-TOF, Protein-protein interaction networks: Topology, Network motifs, Protein Expression profiling and applications.

Protein Networks and mapping-Yeast two hybrid, Co-Precipitation, Phage Display, Phylogenetic Profile, Domain fusion, Gene Neighbourhood, Gene Cluster, Mirror Tree, Analysis of genome wide Protein-Protein Interactions in yeast. Genome wide yeast two hybrid analysis of other organisms, Protein fragment complementation assays.

Reference Books

- 1 Bioinformatics and Functional Genomics, Jonathan Pevsner, 2015, Wiley-Blackwell.
- 2 Introduction to Proteomics: Tools for the New Biology, Daniel C. Liebler, 2019, Cold Spring Harbor Laboratory Press.
- 3 Genomics and Proteomics: Principles, Technologies, and Applications, Stewart T. Cole, 2007, Wiley-Blackwell.
- 4 Introduction to Genomics, Arthur M. Lesk, 2017, Oxford University Press.

23GEG3406M - DNA FORENSICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3406M	DNA FORENSICS	DNF	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the different types of crime in society, and various Acts and their relevant sections and have knowledge of working and function of Police Organization	2	PO1, PO2, PSO1
CO2	Apply the principles of analytical techniques to participate in the career needs of Forensic community.	3	PO2, PSO2
CO3	Apply the knowledge of skills in different division of Forensic Science	3	PO4, PO5, PSO2
CO4	Apply the principles of Instrumental Analysis in Biological detection of macromolecules	3	PO2, PO8, PSO1

Syllabus

History and development of forensic science
 Role of forensic science in criminal investigations and legal proceedings
 Ethics and professional standards in forensic science

Principles of crime scene management
 Evidence collection, preservation, and documentation
 Crime scene reconstruction techniques.
 Principles of toxicology
 Common poisons and their effects
 Toxicological analysis and interpretation
 Alcohol and drug-related deaths

DNA analysis and profiling
 Serology (blood, semen, saliva analysis)
 Forensic entomology (insect evidence), Bloodstain pattern analysis
 Serological techniques
 DNA profiling and its applications
 Legal and ethical issues in DNA analysis

Trace evidence analysis (fibers, hair, glass, paint)
 Toxicology (analysis of drugs, poisons, and alcohol)
 Firearm and toolmark analysis.
 Role of forensic medicine in disaster victim identification
 Emerging technologies in forensic medicine

Reference Books

- 1 Forensic Science: An Introduction to Scientific and Investigative Techniques, Stuart H. James, Jon J. Nordby, and Suzanne Bell, 2014, CRC PRESS.
- 2 Criminalistics: An Introduction to Forensic Science, Richard Saferstein, 2010, PEARSON .
- 3 Forensic Science: From the Crime Scene to the Crime Lab, Richard Saferstein, 2000, PEARSON .
- 4 Forensic Biology, Richard Li, 2001, CRC PRESS.
- 5 Introduction to Forensic Anthropology, Steven N. Byers, 2015, PEARSON .

23GEG3507 - MICROBIAL GENETICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3507	MICROBIAL GENETICS	MBG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the role of genetic materials in microbes	3	PO2, PO3, PSO2
CO2	Apply the role of Regulatory Mechanisms in Microbial Genetics	3	PO2, PO6, PSO2
CO3	Apply the role of Bacterial Genomics to understand sequencing and analysis	3	PO3, PO8, PSO2
CO4	Apply the role of Molecular Techniques in Microbial Genetics	3	PO6, PO8, PSO2

Syllabus

Introduction to microbial genetics and its significance, Overview of microbial cell structure and functions, Genetic materials in microbes: Chromosomes, plasmids, transposons, and episomes, Mechanisms of DNA replication in bacteria and archaea, RNA synthesis and processing: Transcription in prokaryotes, Protein synthesis: The process of translation and post-translational modifications, Types of mutations: Point mutations, insertions, deletions, and frameshift mutations, Mutagenic agents: Physical, chemical, and biological mutagens, DNA repair mechanisms: Mismatch repair, excision repair, and SOS response, Horizontal gene transfer: Conjugation, transformation, and transduction, Role of plasmids and bacteriophages in gene transfer, Applications of gene transfer in biotechnology

Operon model: Lac operon, trp operon, and arabinose operon, Positive and negative regulation of gene expression, Global regulatory mechanisms: Catabolite repression and quorum sensing, Two-component regulatory systems, Response regulators and sensor kinases, Adaptation to environmental stresses: Heat shock response, osmotic stress, and oxidative stress, Regulation of metabolic pathways through feedback inhibition, Allosteric regulation and covalent modification of enzymes, Role of riboswitches in metabolic regulation, Design and application of genetic circuits, Basics of synthetic biology: Engineering microbes for novel functions, Case studies of synthetic biology applications in medicine and industry

Methods of genome sequencing and analysis, Comparative genomics and evolutionary studies, Role of horizontal gene transfer in microbial evolution, Techniques in metagenomics: Sample collection, DNA extraction, and sequencing, Analysis of metagenomic data: Bioinformatics tools and software, Importance of microbiomes in health and environment, Genetic engineering techniques: Recombinant DNA technology, CRISPR-Cas9, and gene editing, Production of recombinant proteins and industrial enzymes, Microbial production of biofuels and bioplastics, Genetic determinants of microbial pathogenicity, Mechanisms of antibiotic resistance, Genetic basis of host-pathogen interactions

Isolation and purification of nucleic acids: DNA, RNA extraction methods, Polymerase Chain Reaction (PCR) and its variants: qPCR, RT-PCR, Gel electrophoresis: Agarose and polyacrylamide gel electrophoresis, Cloning vectors: Plasmids, bacteriophages, and cosmids, Techniques of gene cloning: Restriction digestion, ligation, and transformation, Expression of recombinant proteins in microbial systems, DNA sequencing methods: Sanger sequencing, next-generation sequencing, Proteomic techniques: SDS-PAGE, mass spectrometry, and protein-protein interaction studies, Functional genomics and proteomics in microbial research, Case studies on the use of microbial genetics in medicine: Vaccine development, gene therapy, Industrial applications: Production of antibiotics, vitamins, and amino acids, Environmental applications: Bioremediation and biodegradation

Reference Books

- 1 Molecular Genetics of Bacteria, Larry Snyder, Wendy Champness, 2014, ASM Press.
- 2 Microbial Genetics, Stanley R. Maloy, John E. Cronan, David Freifelder, 1994, Jones & Bartlett Learning.

- 3 Principles of Genetics, Peter Snustad, Michael J. Simmons, 2015, Wiley.
- 4 Brock Biology of Microorganisms, Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl, 2021, Pearson.

23GEG3508 - GENE AND ENVIRONMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GEG3508	GENE AND ENVIRONMENT	BI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of gene-environment interactions	2	PO1, PO2, PO3, PSO1
CO2	Analyze genetic variation and its implications	4	PO1, PO2, PO3, PSO1
CO3	Apply knowledge of gene-environment interactions to propose strategies for disease prevention, environmental conservation, and sustainable agriculture.	3	PO1, PO2, PO3, PSO1
CO4	Make a relationship effectively about gene-environment interactions to both scientific and non-scientific audiences.	4	PO1, PO2, PO3, PSO1

Syllabus

Overview of Gene and Environment Interactions: Definition of gene-environment interactions, Historical perspectives and key milestones, Importance in understanding human health and disease, Genetic Variation and Diversity: Types of genetic variation: SNPs, CNVs, mutations, Population genetics and genetic diversity, Methods for studying genetic variation: genotyping, sequencing

Environmental Factors and Gene Regulation: Epigenetics: mechanisms and inheritance, Environmental impacts on DNA methylation, histone modifications, and non-coding RNAs, Role of environmental exposures (e.g., diet, toxins, stress) in gene expression, Developmental Origins of Health and Disease (DOHaD), Critical periods of development and susceptibility, Fetal programming and maternal influences, Long-term health implications of early-life environmental exposures

Complex Traits and Polygenic Inheritance: Quantitative genetics: heritability and genetic architecture, Genome-wide association studies (GWAS) and identifying genetic risk factors, Gene-environment interactions in complex diseases (e.g., diabetes, cancer), Nutrigenomics and Personalized Medicine, Impact of nutrition on gene expression and metabolism, Pharmacogenomics: personalized drug response based on genetic variations, Ethical considerations in personalized medicine and genetic testing

Environmental Health and Epidemiology: Environmental factors influencing public health (e.g., pollution, climate change), Gene-environment interactions in environmental diseases (e.g., asthma, allergies), Environmental justice and disparities in exposure and health outcomes, Regulatory and Policy Responses: Environmental regulations and policy frameworks, Public health interventions and preventive strategies, Communicating scientific findings to policymakers and the public

Reference Books

- 1 Environmental Health: From Global to Local, Howard Frumkin, 2016, Wiley.
- 2 Principles of Genetics, D. Peter Snustad and Michael J. Simmons, 2015, Wiley.
- 3 Molecular Cloning: A Laboratory Manual, Joseph Sambrook, David W. Russell, 2014, Cold Spring Harbor Laboratory Press.
- 4 LEWINS GENES XII, JOCELYN E. KREBS, ELLIOTT S. GOLDSTEIN, STEPHEN T. KILPATRICK, 2018, Jones & Bartlett Learning books.

23GET3101A - SOLAR PV AND MICRO ENERGY TECHNOLOGIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3101A	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	SPMET	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the manufacturing of Solar cells, their working and parameters influencing the performance of the solar cells.	2	PO3, PO6
CO2	Apply maximum power point tracking techniques to improve the performance of solar PV systems.	3	PO3, PO6
CO3	Apply the fuel cell chemistry to build fuel cell applications and compare different types of fuel cells.	3	PO3, PO6
CO4	Make use of heat transfer principles for energy extraction from various micro energy sources.	3	PO3, PO6
CO5	Demonstrate various ways of extracting energy from solar radiation and use for different applications.	3	PO3
CO6	Test the performance of solar and micro energy sources.	4	PO3, PO11
CO7	Build solar based and fuel cell-based power sources and do required troubleshooting if any technical problem encounters.	3	PO11, PO12

Syllabus

Solar PV energy conversion: Generic Photovoltaic Cell, Equivalent Circuits, Cells to Modules to Arrays, IV Curve, Impacts of Temperature and Insolation, Shading impacts on IV curves, MPPT, System sizing, System Performance.

Modelling of Solar PV system components: Mathematical models of PV cell, PV Array, Battery pack, grid connected and isolated modes of operation, MPPT techniques.

Fuel Cell energy conversion: PEM Fuel Cells, Solid Oxide Fuel Cells, Electrolyzers, Power Electronic Interfacing Circuits, Standalone and Grid Connected Fuel Cell Power Generation Systems, Hybrid Fuel Cell Based Energy System Case

Micro Energy Sources: Ocean Thermal energy conversion, Geo-thermal energy conversion, Tidal Energy conversion, Biomass energy, Biogas plants and Batteries.

Solar Thermal Energy Storage Systems: Flat Plate Collectors, Concentrating Collectors, Applications of solar thermal energy-solar pond, desalination, space heating and colling, solar water heating, solar cooking.

Reference Books

- 1 Solar Electricity Handbook , Micheal Boxwell , 2021, Green Stream publishing .
- 2 Hand Book of Fuel Cells - Fundamentals and Technology and Application , Wolf Vielstich, Arnold Lamm, Hubert A. Gasteiger, 2003, Wiley & Sons .
- 3 Solar Energy - Fundamentals and Applications , H.P. Garg & J. Prakash , 1997, Mc Graw Hill Education.
- 4 Modeling and Control of Fuel Cells: Distributed Generation Applications , M. H. Nehrir, C. Wang , 2009, Wiley-IEEE Press .
- 5 Non-Conventional Energy Sources , G. D. Rai , 1988, KHANNA PUBLISHERS .

23GET3101E - SOLAR PV AND MICRO ENERGY TECHNOLOGIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3101E	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	SPMET	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the manufacturing of Solar cells, their working and parameters influencing the performance of the solar cells.	2	PO1, PO11, PO12
CO2	Apply maximum power point tracking techniques to improve the performance of solar PV systems.	3	PO1, PO11, PO12
CO3	Apply the fuel cell chemistry to build fuel cell applications and compare different types of fuel cells.	3	PO1, PO11, PO12
CO4	Make use of heat transfer principles for energy extraction from various micro energy sources.	3	PO1, PO11, PO12
CO5	Demonstrate various ways of extracting energy from solar radiation and use for different applications.	3	PO1, PO11, PO12
CO6	Test the performance of solar and micro energy sources.	4	PO1, PO11, PO12
CO7	Build solar based and fuel cell-based power sources and do required troubleshooting if any technical problem encounters.	3	PO1, PO11, PO12

Syllabus

Solar PV energy conversion: Generic Photovoltaic Cell, Equivalent Circuits, Cells to Modules to Arrays, IV Curve, Impacts of Temperature and Insolation, Shading impacts on IV curves, MPPT, System sizing, System Performance.

Modelling of Solar PV system components: Mathematical models of PV cell, PV Array, Battery pack, grid connected and isolated modes of operation, MPPT techniques.

Fuel Cell energy conversion: PEM Fuel Cells, Solid Oxide Fuel Cells, Electrolyzers, Power Electronic Interfacing Circuits, Standalone and Grid Connected Fuel Cell Power Generation Systems, Hybrid Fuel Cell Based Energy System Case

Micro Energy Sources: Ocean Thermal energy conversion, Geo-thermal energy conversion, Tidal Energy conversion, Biomass energy, Biogas plants and Batteries.

Solar Thermal Energy Storage Systems: Flat Plate Collectors, Concentrating Collectors, Applications of solar thermal energy-solar pond, desalination, space heating and cooling, solar water heating, solar cooking.

Reference Books

- 1 Solar Electricity Handbook , Micheal Boxwell , 2021, Green Stream publishing .
- 2 Hand Book of Fuel Cells - Fundamentals and Technology and Application , Wolf Vielstich, Arnold Lamm, Hubert A. Gasteiger, 2003, Wiley & Sons .
- 3 Solar Energy - Fundamentals and Applications , H.P. Garg & J. Prakash , 1997, Mc Graw Hill Education.
- 4 Modeling and Control of Fuel Cells: Distributed Generation Applications , M. H. Nehrir, C. Wang , 2009, Wiley-IEEE Press .
- 5 Non-Conventional Energy Sources , G. D. Rai , 1988, KHANNA PUBLISHERS .

23GET3101R - SOLAR PV AND MICRO ENERGY TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3101R	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	SPMET	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the manufacturing of Solar cells, their working and parameters influencing the performance of the solar cells.	2	PO3, PO6
CO2	Apply maximum power point tracking techniques to improve the performance of solar PV systems.	3	PO3, PO6
CO3	Apply the fuel cell chemistry to build fuel cell applications and compare different types of fuel cells.	3	PO3, PO6
CO4	Make use of heat transfer principles for energy extraction from various micro energy sources.	3	PO3, PO6
CO5	Test the performance of solar PV and micro energy sources.	4	PO3, PO11
CO6	Build solar based and fuel cell-based power source and do required troubleshooting if any technical problem encounters.	3	PO11, PO12

Syllabus

Solar PV energy conversion: Generic Photovoltaic Cell, Equivalent Circuits, Cells to Modules to Arrays, IV Curve, Impacts of Temperature and Insolation, Shading impacts on IV curves, MPPT, System sizing, System Performance.

Modelling of Solar PV system components: Mathematical models of PV cell, PV Array, Battery pack, grid connected and isolated modes of operation, MPPT techniques.

Fuel Cell energy conversion: PEM Fuel Cells, Solid Oxide Fuel Cells, Electrolyzers, Power Electronic Interfacing Circuits, Standalone and Grid Connected Fuel Cell Power Generation Systems, Hybrid Fuel Cell Based Energy System Case

Micro Energy Sources: Ocean Thermal energy conversion, Geo-thermal energy conversion, Tidal Energy conversion, Biomass energy, Biogas plants and Batteries.

Reference Books

- 1 Solar Electricity Handbook , Micheal Boxwell , 2021, Green Stream publishing .
- 2 Hand Book of Fuel Cells - Fundamentals and Technology and Application , Wolf Vielstich, Arnold Lamm, Hubert A. Gasteiger, 2003, Wiley & Sons .
- 3 Solar Energy - Fundamentals and Applications , H.P. Garg & J. Prakash , 1997, Mc Graw Hill Education.
- 4 Modeling and Control of Fuel Cells: Distributed Generation Applications , M. H. Nehrir, C. Wang , 2009, Wiley-IEEE Press .
- 5 Non-Conventional Energy Sources , G. D. Rai , 1988, KHANNA PUBLISHERS .

23GET3202A - WIND AND ENERGY STORAGE TECHNOLOGIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3202A	WIND AND ENERGY STORAGE TECHNOLOGIES	WEST	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret principles and control of Wind Energy Conversion	2	PO1, PO5
CO2	Model and Select Solar Wind energy conversion system components.	3	PO1, PO5
CO3	Interpret and Model Electro-chemical energy storage components.	3	PO1, PO5
CO4	Interpret and Model Mechanical energy storage components	3	PO1, PO5
CO5	Analyse the behavioral characteristics of wind and energy storage systems.	4	PO1, PO5

Syllabus

Wind Energy Conversion System: Components of WECS, Power obtained from the wind, Power Regulation, Schemes for Maximum Power Extraction, Wind Turbines & Generators: Fixed-speed Induction Generator (FSIG) based Wind Turbines, Doubly Fed Induction Generator (DFIG) based Wind Turbines, Fully Rated Converter-based (FRC) Wind Turbines.

Modelling of WECS components: Mathematical models for DFIG, PMSG, Stand alone and Grid Connected WECS system control.

Electro-chemical Energy Storage: Batteries - lead acid, lithium ion, flow, design considerations, life cycle and reliability study, Ultra-capacitors - operation, applications, Model for lead acid battery and ultra-capacitor.

Mechanical Energy Storage: Models for pumped hydro, compressed gas, flywheel storage, System cost and efficiency, Thermal storage- Materials, Design considerations, Solar thermal energy storage.

Modeling of Wind turbine generators in both stand alone and grid connected conditions, Simulation of Wind Energy Conversion system using MATLAB

Reference Books

- 1 Renewable Energy Sources , John Twidell& Toney Weir: E&F.N. Spon , 2006, Taylor &Francis New York .
- 2 Integration and Control of Renewable Energy in Electric Power System , Ali Keyhani Mohammad Marwali and Min Dai , 2010, John Wiley publishing company .
- 3 Non-Conventional Energy Sources , G. D. Rai , 1988, Khanna Publishers .
- 4 Energy Storage for Power Systems, JA.G. Ter-Gazarian, 1994, IET .

23GET3202E - WIND AND ENERGY STORAGE TECHNOLOGIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3202E	WIND AND ENERGY STORAGE TECHNOLOGIES	WEST	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret principles and control of Wind Energy Conversion	2	PO1, PO5
CO2	Model and Select Solar Wind energy conversion system components.	3	PO1, PO5
CO3	Interpret and Model Electro-chemical energy storage components.	3	PO1, PO5
CO4	Interpret and Model Mechanical energy storage components	3	PO1, PO5
CO5	Analyse the behavioral characteristics of wind and energy storage systems.	4	PO1, PO5

Syllabus

Wind Energy Conversion System: Components of WECS, Power obtained from the wind, Power Regulation, Schemes for Maximum Power Extraction, Wind Turbines & Generators: Fixed-speed Induction Generator (FSIG) based Wind Turbines, Doubly Fed Induction Generator (DFIG) based Wind Turbines, Fully Rated Converter-based (FRC) Wind Turbines.

Modelling of WECS components: Mathematical models for DFIG, PMSG, Stand alone and Grid Connected WECS system control.

Electro-chemical Energy Storage: Batteries - lead acid, lithium ion, flow, design considerations, life cycle and reliability study, Ultra-capacitors - operation, applications, Model for lead acid battery and ultra-capacitor.

Mechanical Energy Storage: Models for pumped hydro, compressed gas, flywheel storage, System cost and efficiency, Thermal storage- Materials, Design considerations, Solar thermal energy storage.

Modeling of Wind turbine generators in both stand alone and grid connected conditions, Simulation of Wind Energy Conversion system using MATLAB

Reference Books

- 1 Renewable Energy Sources , John Twidell & Tony Weir: E&F.N. Spon , 2006, Taylor & Francis New York .
- 2 Integration and Control of Renewable Energy in Electric Power System, Ali Keyhani Mohammad Marwali and Min Dai , 2010, John Wiley publishing company .
- 3 Non-Conventional Energy Sources, G. D. Rai, 1988, Khanna Publishers.
- 4 Energy Storage for Power Systems, J.A.G. Ter-Gazarian, 1994, IET.

23GET3202R - WIND AND ENERGY STORAGE TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3202R	WIND AND ENERGY STORAGE TECHNOLOGIES	WEST	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret principles and control of Wind Energy Conversion	2	PO1, PO5
CO2	Model Solar Wind energy conversion system components	3	PO1, PO5
CO3	Model Electro-chemical energy storage components	3	PO1, PO5
CO4	Model Mechanical energy storage components	3	PO1, PO5

Syllabus

Wind Energy Conversion System: Components of WECS, Power obtained from the wind, Power Regulation, Schemes for Maximum Power Extraction, Wind Turbines & Generators: Fixed-speed Induction Generator (FSIG) based Wind Turbines, Doubly Fed Induction Generator (DFIG) based Wind Turbines, Fully Rated Converter-based (FRC) Wind Turbines.

Modelling of WECS components: Mathematical models for DFIG, PMSG, Stand alone and Grid Connected WECS system control.

Electro-chemical Energy Storage: Batteries - lead acid, lithium ion, flow, design considerations, life cycle and reliability study, Ultra-capacitors - operation, applications, Model for lead acid battery and ultra-capacitor.

Mechanical Energy Storage: Models for pumped hydro, compressed gas, flywheel storage, System cost and efficiency, Thermal storage- Materials, Design considerations, Solar thermal energy storage.

Reference Books

- 1 Microgrids and Active Distribution Networks, S. Chowdhury, S. P. Chowdhury, P. Crossley, 2006, IET Power Electronics Series.
- 2 Integration and Control of Renewable Energy in Electric Power System, Ali Keyhani Mohammad Marwali and Min Dai, 2010, John Wiley publishing company.
- 3 Non-Conventional Energy Sources, G. D. Rai, 1988, Khanna Publishers.
- 4 Energy Storage for Power Systems, JA.G. Ter-Gazarian, 1994, IET.

23GET3203A - ENERGY ECONOMICS AND POLICY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3203A	ENERGY ECONOMICS AND POLICY	EEP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the energy economics and various policies related to energy generation and supply.	2	PO1, PO7
CO2	Apply energy regulations and energy policies to energy markets to promote energy efficiency and Energy equity	3	PO1, PO7
CO3	Analyze environmental externalities and impact of climate changes on energy security and energy supply.	4	PO1, PO7
CO4	Analyse policies and incentives for encourage renewable energy integration.	4	PO1, PO7
CO5	Analyse the Indian and other energy markets and their energy policies.	4	PO1, PO7

Syllabus

Introduction to Energy Economics and Policy Overview of energy markets, Historical development of energy policies, Role of government in energy policy. Energy Demand and Supply- Drivers of energy demand, Production and supply of energy, Price elasticity of demand and supply. Energy and Economic Development -Energy access and poverty reduction, Economic impacts of energy policies.

Energy Markets and Regulation: Market structures and pricing, Regulation of energy markets, Deregulation of energy markets. Energy Efficiency and Conservation- Demand-side management, Energy-efficient technologies, Policies to promote energy efficiency, Energy justice and equity.

Environmental Externalities and Climate Change: Market failures and environmental externalities, Policies to address climate change, Carbon pricing mechanisms. Energy Security and Geopolitics- Energy security and national security, Energy interdependence and trade, Political risk and energy supply.

Renewable Energy Policy: Overview of renewable energy technologies, Renewable energy policies and incentives, international cooperation and agreements. Energy Transition and Innovation- Transition to a low-carbon energy system, Innovation in energy technologies, Policies to support energy innovation.

India and other countries energy markets and their energy policies.

Reference Books

- 1 Energy Economics: Concepts, Issues, Markets, and Governance , Subhes C. Bhattacharyya., 2019, Springer London .
- 2 Energy Economics Theory and Applications , Peter Zweifel, Aaron Praktiknjo, Georg Erdmann , 2017, Springer Berlin Heidelberg .
- 3 Electricity Sector in India , Alok Kumar, Sushanta Kumar Chatterjee , 2012, OUP India.
- 4 Indian Electricity Sector under Regulatory Regime , Pratik Biswas (Electrical engineer), Sukanya Mandal , 2019, White Falcon Publishing .
- 5 Green Energy Technology, Economics and Policy, Thayyib S. Kadher-Mohien, Tulsidas Harikrishnan, U. Aswathanarayana , 2010, CRC Press.

23GET3203E - ENERGY ECONOMICS AND POLICY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3203E	ENERGY ECONOMICS AND POLICY	EEP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the energy economics and various policies related to energy generation and supply.	2	PO1, PO7
CO2	Apply energy regulations and energy policies to energy markets to promote energy efficiency and Energy equity.	3	PO1, PO7
CO3	Analyze environmental externalities and impact of climate changes on energy security and energy supply.	4	PO1, PO7
CO4	Analyse energy transition and various innovations developed in low carbon systems and their approved policies.	4	PO1, PO7
CO5	Analyse various energy policies and incentives for encouraging renewable energy generation and integration.	4	PO2, PO7

Syllabus

Introduction to Energy Economics and Policy: Overview of energy markets, Historical development of energy policies, Role of government in energy policy. Energy Demand and Supply- Drivers of energy demand, Production and supply of energy, Price elasticity of demand and supply. Energy and Economic Development -Energy access and poverty reduction, Economic impacts of energy policies.

Energy Markets and Regulation: Market structures and pricing, Regulation of energy markets, Deregulation of energy markets. Energy Efficiency and Conservation- Demand-side management, Energy-efficient technologies, Policies to promote energy efficiency, Energy justice and equity.

Environmental Externalities and Climate Change: Market failures and environmental externalities, Policies to address climate change, Carbon pricing mechanisms. Energy Security and Geopolitics- Energy security and national security, Energy interdependence and trade, Political risk and energy supply.

Energy Transition and Innovation- Transition to a low-carbon energy system, Innovation in energy technologies, Policies to support energy innovation.

Renewable Energy Policy: Overview of renewable energy technologies, Renewable energy policies and incentives, international cooperation and agreements.

Reference Books

- 1 Energy Economics: Concepts, Issues, Markets, and Governance , Subhes C. Bhattacharyya. , 2019, Springer London .
- 2 Energy Economics Theory and Applications, Peter Zweifel, Aaron Praktiknjo, Georg Erdmann , 2017, Springer Berlin Heidelberg .
- 3 Electricity Sector in India , Alok Kumar, Sushanta Kumar Chatterjee , 2012, OUP India .
- 4 Indian Electricity Sector under Regulatory Regime , Pratik Biswas (Electrical engineer), Sukanya Mandal , 2019, White Falcon Publishing .
- 5 Green Energy Technology, Economics and Policy, Thayyib S. Kadher-Mohien, Tulsidas Harikrishnan, U. Aswathanarayana , 2010, CRC Press .

23GET3203R - ENERGY ECONOMICS AND POLICY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3203R	ENERGY ECONOMICS AND POLICY	EEP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the energy economics and various policies related to energy generation and supply.	2	PO1, PO7
CO2	Apply energy regulations and energy policies to energy markets to promote energy efficiency and Energy equity.	3	PO1, PO7
CO3	Analyze environmental externalities and impact of climate changes on energy security and energy supply.	4	PO1, PO7
CO4	Analyse policies and incentives for encourage renewable energy integration.	4	PO1, PO7

Syllabus

Introduction to Energy Economics and Policy: Overview of energy markets, Historical development of energy policies, Role of government in energy policy. Energy Demand and Supply- Drivers of energy demand, Production and supply of energy, Price elasticity of demand and supply. Energy and Economic Development -Energy access and poverty reduction, Economic impacts of energy policies.

Energy Markets and Regulation: Market structures and pricing, Regulation of energy markets, Deregulation of energy markets. Energy Efficiency and Conservation- Demand-side management, Energy-efficient technologies, Policies to promote energy efficiency, Energy justice and equity.

Environmental Externalities and Climate Change: Market failures and environmental externalities, Policies to address climate change, Carbon pricing mechanisms. Energy Security and Geopolitics- Energy security and national security, Energy interdependence and trade, Political risk and energy supply.

Renewable Energy Policy: Overview of renewable energy technologies, Renewable energy policies and incentives, international cooperation and agreements. Energy Transition and Innovation- Transition to a low-carbon energy system, Innovation in energy technologies, Policies to support energy innovation.

Reference Books

- 1 Energy Economics: Concepts, Issues, Markets, and Governance , Subhes C. Bhattacharyya., 2019, Springer London.
- 2 Energy Economics Theory and Applications, Peter Zweifel, Aaron Praktiknjo, Georg Erdmann, 2017, Springer Berlin Heidelberg.
- 3 Electricity Sector in India , Alok Kumar, Sushanta Kumar Chatterjee, 2012, OUP India.
- 4 Indian Electricity Sector under Regulatory Regime , Pratik Biswas (Electrical engineer), Sukanya Mandal, 2019, White Falcon Publishing .
- 5 Green Energy Technology, Economics and Policy, Thayyib S. Kadher-Mohien, Tulsidas Harikrishnan, U. Aswathanarayana, 2010, CRC Press .

23GET3304A - GRID INTEGRATION OF RENEWABLE ENERGY SOURCES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3304A	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	GIRES	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the control principles for PV - grid integration control	3	PO5
CO2	Apply the control principles for wind power integration con	3	PO4
CO3	Identify power quality challenges in grid integration of renewable energy	3	PO4
CO4	Identify challenges in grid integration of multiple renewable sources	3	PO5
CO5	Analyze Grid Integration of Other Renewable Energy Sources	4	PO5
CO6	Able to analyze the integration of micro grid	4	PO5
CO7	Able to Acquire skills in topics of integration of micro grid	4	PO5

Syllabus

PV Integration Technology: Introduction, Photovoltaic (PV) inverter topologies- configurations and control strategies, Grid codes and technical regulations of Solar PV integration. Case study.

Wind Power Integration Technology: Wind power and voltage control for synchronous and induction generators-based integration; active and reactive power control, Grid codes and technical regulations of Wind power integration. Case study

Power quality management: THD, voltage sag, voltage swell, frequency change and its effects, network voltage management- PV & Wind power, frequency management, effects on system stability, PLL, Modulation Techniques, Dimensioning of filters.

Challenges: Integrating multiple renewable energy sources; DC link integration; AC link integration; Integration of DC micro-grid to the main AC grid using a 3-phase inverter, HFAC link integration; islanding and interconnection.

Grid Integration of Other Renewable Energy Sources: Integration of hydroelectric power systems, Biomass and biogas power systems and their integration,

Reference Books

- 1 Renewable Energy Grid Integration, Marco H. Balderas, 2009, Nova Science Publishers, New York, .
- 2 Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, 2013, CRC Press, .
- 3 Grid integration of solar photovoltaic systems, Majid Jamil, M. Rizwan, D.P.Kothari, 2018, CRC Press (Taylor & Francis group) .
- 4 Wind Power Integration connection and system operational aspects, B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O' Malley, R. Watson and D. Milborrow, 2007, IET Power and Energy Series 50 (IET digital library, .

23GET3304E - GRID INTEGRATION OF RENEWABLE ENERGY SOURCES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3304E	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	GIRES	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the control principles for PV - grid integration control	3	PO5
CO2	Apply the control principles for wind power integration con	3	PO4
CO3	Identify power quality challenges in grid integration of renewable energy	3	PO4
CO4	Identify challenges in grid integration of multiple renewable sources	3	PO5
CO5	analyze Grid Integration of Other Renewable Energy Sources	4	PO5
CO6	Able to analyze the integration of micro grid	4	PO5
CO7	Able to Acquire skills in topics of integration of micro grid	3	PO5

Syllabus

PV Integration Technology: Introduction, Photovoltaic (PV) inverter topologies- configurations and control strategies, Grid codes and technical regulations of Solar PV integration. Case study.

Wind Power Integration Technology: Wind power and voltage control for synchronous and induction generators-based integration; active and reactive power control, Grid codes and technical regulations of Wind power integration. Case study

Power quality management: THD, voltage sag, voltage swell, frequency change and its effects, network voltage management- PV & Wind power, frequency management, effects on system stability, PLL, Modulation Techniques, Dimensioning of filters.

Challenges: Integrating multiple renewable energy sources; DC link integration; AC link integration; Integration of DC micro-grid to the main AC grid using a 3-phase inverter, HFAC link integration; islanding and interconnection.

Grid Integration of Other Renewable Energy Sources: Integration of hydroelectric power systems, Biomass and biogas power systems and their integration,

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- 1 Renewable Energy Grid Integration, Marco H. Balderas, 2009, Nova Science Publishers, New York, .
- 2 Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, 2013, CRC Press, 2013 .
- 3 Grid integration of solar photovoltaic systems, Majid Jamil, M. Rizwan, D.P.Kothari, 2018, CRC Press (Taylor & Francis group) .
- 4 Wind Power Integration connection and system operational aspects, B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O' Malley, R. Watson and D. Milborrow,, 2007, IET Power and Energy Series 50 (IET digital library,).

23GET3304R - GRID INTEGRATION OF RENEWABLE ENERGY SOURCES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3304R	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	GIRES	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the control principles for PV - grid integration control	3	PO5
CO2	Apply the control principles for wind power integration con	3	PO4
CO3	Identify power quality challenges in grid integration of renewable energy	3	PO4
CO4	Identify challenges in grid integration of multiple renewablesources	3	PO5
CO6	Able to analyze the integration of micro grid	4	PO5
CO7	Able to Aacquire skills in topics of integration of micro grid	4	PO5

Syllabus

PV Integration Technology: Introduction, Photovoltaic (PV) inverter topologies- configurations and control strategies, Grid codes and technical regulations of Solar PV integration. Case study.

Wind Power Integration Technology: Wind power and voltage control for synchronous and induction generators-based integration; active and reactive power control, Grid codes and technical regulations of Wind power integration. Case study

Power quality management: THD, voltage sag, voltage swell, frequency change and its effects, network voltage management- PV & Wind power, frequency management, effects on system stability, PLL, Modulation Techniques, Dimensioning of filters.

Challenges: Integrating multiple renewable energy sources; DC link integration; AC link integration; Integration of DC micro-grid to the main AC grid using a 3-phase inverter , HFAC link integration; islanding and interconnection.

Reference Books

- 1 Renewable Energy Grid Integration , Marco H. Balderas, 2009, Nova Science Publishers, New York, 2009 .
- 2 Smart Grids, Infrastructure, Technology and Solutions , S. Borlase , 2013, CRC Press, 2013 .
- 3 Grid integration of solar photovoltaic systems , Majid Jamil, M. Rizwan, D.P.Kothari , 2018, CRC Press (Taylor & Francis group) .
- 4 Wind Power Integration connection and system operational aspects, B. Fox, D. Flynn L. Bryans, N. Jenkins, M. O' Malley, R. Watson and D. Milborrow,, 2007, IET Power and Energy Series 50 (IET digital library,.

23GET3405M - ENERGY MANAGEMENT AND GREEN BUILDING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3405M	ENERGY MANAGEMENT AND GREEN BUILDING	EMGB	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply different types of energy audit for energy management in green buildings	3	PO1, PO7, PSO1
CO2	Interpret different types of energy conservation opportunities in electrical components used for various applications	3	PO1, PO7, PSO2
CO3	Apply different types of energy management strategies to improve energy efficiency in green buildings	3	PO1, PO7, PSO1
CO4	Apply different types of practices to get maximum life and improve energy efficiency green buildings	3	PO1, PO7, PSO1

Syllabus

Energy Audit: Need, types, methodology and approach, Instruments for energy audit, Energy Management Approach, Understanding Energy Costs, Bench marking, Energy performance, matching energy usage to requirements, maximizing system efficiency, Return of Investment

Energy conservation opportunities: Energy conservation in HVAC, Refrigeration and Air Conditioning, Pumping Systems, lighting control, lighting control, Energy Conservation Building Code, Energy Conservation opportunities in Transformers and cables, Transmission lines

Energy Management: Definition and Objective of Energy Management, General Principles, Energy Management Strategy, Energy Balance sheet and Management Information System (MIS), Energy Modeling and Optimization, Demand Side management (DSM), Peak Demand control- Methodologies

Green Building Practices: Energy efficiency-life cycle perspective, Environmental product declaration, Building information model, choice of heat insulation materials, high thermal mass materials, phase change materials, Green building certifications

Reference Books

- 1 Industrial Energy Management: Principles and Applications , Giovanni and Petrecca, 1999, The Kluwer international series.
- 2 Guide to Electric Load Management , Anthony J.Pansini, Kenneth D.Smalling, 1998, Pennwell publications.
- 3 Green Building: Principles and Practices in Residential Construction, Abe Kruger, Carl Seville, 2013, Cengage Learning.
- 4 Sustainable Construction: Green Building Design and Delivery, Charles J. Kibert, 2022, Wiley.

23GET3406M - HYDROGEN FUEL CELL TECHNOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3406M	HYDROGEN FUEL CELL TECHNOLOGY	HFCT	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and Interpret different types and principles of fuel cell technologies for various fuel cell applications	3	PO1, PO7, PSO1
CO2	Interpret different types of Modelling and Selection of fuel cell components in fuel cell system	3	PO1, PO7, PSO1
CO3	Interpret and study different types of dynamics of hydrogen fuel cell storage and applications for storage of hydrogen storage	3	PO1, PO7, PSO1
CO4	Apply different case studies on Demonstration of Environmental and Economic Impacts of Hydrogen fuel cells	3	PO1, PO7, PSO1

Syllabus

Hydrogen Production and Fuel Cell Technology: Overview of hydrogen as a fuel Types of fuel cells History of fuel cell technology, Steam reforming of natural gas, Electrolysis of water Biomass gasification

Fuel Cell System & Components Principles and Performance: Basic principles of fuel cell operation Performance characteristics of fuel cells, Fuel cell stack design and components Balance-of-plant components, Thermal management and control

Hydrogen Storage and Fuel Cell Applications: Storage methods for hydrogen, Physical and chemical properties of hydrogen storage materials, Portable and backup power applications, Transportation and Stationary power applications

Environmental and Economic Impacts of Hydrogen: Hydrogen delivery and distribution infrastructure Public policy and regulation for hydrogen and fuel cells International collaboration and initiatives, Economic and social impacts of hydrogen technologies

Reference Books

- 1 Introduction to Hydrogen Technology, Roman Jaskulski, 2018, CRC Press.
- 2 Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. Wagner, David L. Jacobson, Wilson A. Smith, Michael M. , 2005, CRC Press.
- 3 Hydrogen and Fuel Cell Technologies: Advances and Challenges, Rong Lan, David E. James, Olaf Deutschmann, J. Y. Hwang, 2021, Wiley.
- 4 Fuel Cell Systems Explained, James Larminie, Andrew Dicks, 2018, Wiley.

23GET3507 - AI AND IOT FOR GREEN ENERGY INTEGRATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3507	AI AND IOT FOR GREEN ENERGY INTEGRATION	AIGEI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the usage of basic cloud services	2	PO4
CO2	Apply Embedded Programming to upload sensor data to cloud	3	PO4
CO3	Analyze the data in cloud through AI/ML Services	4	PO2
CO4	Develop application for green energy technologies using cloudtools	4	PO2

Syllabus

IoT Devices and Enabling Technologies: Sensor Devices - temperature, vibration, irradiance, wind speed, PIR, proximity, current, voltage Controllers, Actuators, Networking and Communication Protocols, Data analytics using AI and ML for - smart cities, smart grid, smart building, electrical vehicles Cloud

Vehicles Cloud Computing: Basics-Cloud systems, Cloud computing protocols, Role of Web services, Deployment Models- Public, Community, Hybrid, Private Clouds, Cloud Analytics over Thing speak, Google Firebase AWS-console, Functions. Database Services-Relational DBMS, RDS Services

Vehicles Cloud Computing: Basics-Cloud systems, Cloud computing protocols, Role of Web services, Deployment Models - Public, Community, Hybrid, Private Clouds, Cloud Analytics over Thing speak, Google Firebase AWS-console, Functions.

Database Services-Relational DBMS, RDS Services. AI and ML on Cloud: Data Pre-processing techniques in Machine Learning, Data-handling, importing libraries, Data pre-processing using python, Missing data, Categorical Data. Regression and Classification algorithms in ML. Cloud based Real-time Monitoring systems, M2M communications, Case Studies AI for solar PV, Wind and Hybrid Power generation: AI and Machine learning algorithms PV MPP techniques, RMSE and MAPE analysis for short term irradiance, solar energy and load forecasting, temperature forecasting. Wind speed forecasting, Frequency control of induction generator, Intelligent Energy Management System of Hybrid Solar/Wind/Battery Power Sources, Islanding detection. case studies.

Reference Books

- 1 AI and IoT in Renewable Energy, Shaw, R.N., Mendis, N., Mekhilef, S., Ghosh, 2011, Springer.
- 2 Sensors and Actuators, D. Patranabis, 2nd Edition, 2013, PHI.
- 3 Applications of AI and IoT in Renewable Energy, R.N., Mendis, N., Mekhilef, S., Ghosh, A, 2021, Elsevier.
- 4 Introduction to AI Techniques for Renewable Energy System, Suman Lata Tripathi, Mithilesh Kumar Dubey, Vinay Rishiwal, Sanjeevikumar Padmanaban, 1st Edition, 2021, CRC Press.

23GET3508 - POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GET3508	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	PERES	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the MPPT techniques for solar PV systems.	4	PO1, PO2, PO4
CO2	Apply the Power electronic converters for wind energy and storage systems.	3	PO1, PO2, PO4
CO3	Apply Power Electronics Control Techniques in Renewable Energy Systems	3	PO1, PO2, PO4
CO4	Identify the Grid Integration and Control of Renewable Energy Systems.	3	PO1, PO2, PO4

Syllabus

Introduction to Power Electronics for Renewable Energy Systems: Overview of power electronics in renewable energy Systems, Components and configurations of power electronics, Challenges, and opportunities in power electronics for renewable energy systems. Solar Photovoltaic (PV) Systems and Power Electronics: Basics of solar PV systems, Design, and analysis of a solar PV system, MPPT techniques for solar PV systems.

Wind Energy Systems and Power Electronics: Basics of wind energy systems, Control and integration of wind turbines, Power conversion techniques for wind energy systems. Energy Storage Systems and Power Electronics: Basics of energy storage systems, Battery technologies and their characteristics, Power electronic converters for energy storage systems.

Power Electronic Converters for Renewable Energy Systems: DC-DC converters for renewable energy systems, DC-AC inverters for renewable energy systems, and AC-DC rectifiers for renewable energy systems. Control Techniques for Power Electronics in Renewable Energy Systems: Control strategies for DC-DC converters and inverters, Modulation techniques for power electronic converters, and Implementation of control strategies in microprocessors and microcontrollers.

Grid Integration and Control of Renewable Energy Systems: Grid integration and synchronization of renewable energy systems, Control techniques for grid integration of renewable energy systems. Emerging Trends in Power Electronics for Renewable Energy Systems, Recent developments, and trends in power electronics for renewable energy systems.

Reference Books

- 1 Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration , Sudipta Chakraborty and Arindam Ghosh , 2011, Springer Science .
- 2 Solar PV Power: Design, Manufacturing and Applications, Mukund R. Patel , 2013, CRC Press. .
- 3 Wind Energy Systems: Control Engineering Design, Mario Garcia-Sanz , 2013 , Taylor & Francis New York .
- 4 Battery Management Systems: Design by Modelling , Gregory L. Plett , 2015, Springer Science. .
- 5 Power Electronics Handbook: Devices, Circuits, and Applications , Muhammad H. Rashid , 2010 , Elsevier publication .

23GTE3101A - ADVANCED FOUNDATION ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3101A	ADVANCED FOUNDATION ENGINEERING	AFE	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse and Design of foundation in problematic soils	4	PO1, PO2, PSO1
CO2	Analyse and Design of spread footings and factors affecting of spread footing.	4	PO1, PO2, PSO1
CO3	Analyze and Design of rectangular, trapezoidal, and strap footings	4	PO1, PO2, PSO1
CO4	Design and Analyze Mat foundations and machine foundations	4	PO1, PO2, PSO1
CO5	Apply and Preparing the soil site investigation report on expansive and collapsible soil sample	3	PO1, PO2, PSO1
CO6	Apply the index and engineering properties of soils from various laboratory tests and prepare the soil investigation report	3	PO1, PO2, PSO1
CO7	Demonstration of the advanced foundation engineering techniques	3	PO1, PO2, PSO1

Syllabus

Foundation on collapsible and expansive soils: Collapse potential and settlement, Computation of collapse settlement, Foundation design, Treatment methods for collapsible soils, Distribution of expansive soils, General characteristics of swelling soils, Clay mineralogy and mechanism of swelling, Definition of some parameters, Evaluation of the swelling potential of expansive soils by single Index Method, Classification of swelling soils by Indirect Measurement, Swelling pressure by direct measurement, Effect of initial moisture content and initial dry density on swelling pressure, Estimating the magnitude of swelling, Design of foundation in swelling soils, drilled pier foundations, Elimination of swelling.

Factors to consider in foundation design: Footing Depth and spacing, Displaced soil effects, Net versus gross soil pressure design soil pressures, erosion problems for structures adjacent to flowing water, Corrosion protection, Water table fluctuation, Foundations in Sand deposits, Foundations on Loess and other collapsible soils, Foundations on sanitary landfill sites, Frost depth and foundations on permafrost, Environmental considerations problems.

Spread footing and beams on elastic foundations: Rectangular combined footings, design of trapezoid shaped footings, design of strap (or cantilever) footings, footings for industrial equipment, Modulus of sub grade reaction, Classical solution of Beam on Elastic foundation, General Comments on the finite element procedure problems.

Design criteria for satisfactory action of a machine foundation, Theory of linear weightless spring, Methods of analysis of a block foundation, Soil spring constants, Determination of soil spring constants, Degrees of freedom of block foundation, vertical vibrations of a block foundations, Rocking vibrations of a block foundations, pure sliding of a block foundation, Indian Standard on design and construction of foundations for reciprocating machines.

Analysis and Design of shallow foundation with different types of soils and Deep foundations(Pile & Well) with different types of soils

Reference Books

- 1 Geotechnical Engineering , N Sivakugan and Braga M Das , 2009, J. Ross publishing, .
- 2 Mc Graw-Hill International Editions, Mc Graw-Hill , 2007., Mc Graw-Hill International Editions.

- 3 Foundation Analysis and Design , J.E. Bowles , 1996, CBS Publishers & Distributors, New Delhi. .
- 4 Advanced Foundation Engineering: Geotechnical Engineering Series, V.N.S. Murthy, 2007, CBS Publishers & Distributors.

23GTE3101E - ADVANCED FOUNDATION ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3101E	ADVANCED FOUNDATION ENGINEERING	AFE	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse and Design of foundation in problematic soils	4	PO1, PO5, PO10, PSO1
CO2	Analyse and Design of spread footings and factors affecting of spread footing.	4	PO1, PO5, PO10, PSO1
CO3	Analyze and Design of rectangular, trapezoidal, and strap footings	4	PO1, PO5, PO10, PSO1
CO4	Design and Analyze Mat foundations and machine foundations	4	PO1, PO5, PO10, PSO1
CO5	Apply and Preparing the soil site investigation report on expansive and collapsible soil sample	3	PO1, PO5, PO10, PSO1
CO6	Apply the index and engineering properties of soils from various laboratory tests and prepare the soil investigation report	3	PO1, PO5, PO10, PSO1
CO7	Demonstrate and determine the properties of problematic soils using advanced foundation apparatus	3	PO1, PO5, PO10, PSO1

Syllabus

Foundation on collapsible and expansive soils: Collapse potential and settlement, Computation of collapse settlement, Foundation design, Treatment methods for collapsible soils, Distribution of expansive soils, General characteristics of swelling soils, Clay mineralogy and mechanism of swelling, Definition of some parameters, Evaluation of the swelling potential of expansive soils by single Index Method, Classification of swelling soils by Indirect Measurement, Swelling pressure by direct measurement, Effect of initial moisture content and initial dry density on swelling pressure, Estimating the magnitude of swelling, Design of foundation in swelling soils, drilled pier foundations, Elimination of swelling.

PILE FOUNDATIONS: Types of piles, Necessity, pile driving, Load carrying capacity of piles Static and dynamic formulae, Negative skin friction, Pile load tests, Load carrying capacity of group of piles.

Spread footing and beams on elastic foundations: Rectangular combined footings, design of trapezoid shaped footings, design of strap (or cantilever) footings, footings for industrial equipment, Modulus of sub grade reaction, Classical solution of Beam on Elastic foundation, General Comments on the finite element procedure problems.

Design criteria for satisfactory action of a machine foundation, Theory of linear weightless spring, Methods of analysis of a block foundation, Soil spring constants, Determination of soil spring constants, Degrees of freedom of block foundation, vertical vibrations of a block foundations, Rocking vibrations of a block foundations, pure sliding of a block foundation, Indian Standard on design and construction of foundations for reciprocating machines.

Analysis and Design of shallow foundation with different types of soils and Deep foundations(Pile & Well) with different types of soils

Reference Books

- 1 Geotechnical Engineering , N Sivakugan and Braga M Das , 2009, J. Ross publishing .
- 2 Foundation analysis and design , Mc Graw-Hill International Editions , 2007., MacGraw Hill,.
- 3 Foundation Analysis and Design , J.E. Bowles , 1996, CBS Publishers & Distributors, New Delhi. .

- 4 Advanced Foundation Engineering: Geotechnical Engineering Series, V.N.S. Murthy, 2007, CBS Publishers & Distributors.

23GTE3101R - ADVANCED FOUNDATION ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3101R	ADVANCED FOUNDATION ENGINEERING	AFE	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse and Design of foundation in problematic soils	4	PO1, PO2, PO5, PSO1
CO2	Analyse and Design of open and pile foundations	4	PO1, PO2, PO5, PSO1
CO3	Analyse and Design of rectangular, trapezoidal, and strap footings	4	PO1, PO2, PO5, PSO1
CO4	Design and Analyse Mat foundations and machine foundations	4	PO1, PO2, PO5, PSO1
CO5	Apply the index and engineering properties of soils from various laboratory tests and prepare the soil investigation report	3	PO1, PO2, PO5, PSO1
CO6	Apply the Advanced foundation techniques on Problematic soils like expansive and collapsible soils	3	PO1, PO2, PO5, PSO1

Syllabus

Foundation on collapsible and expansive soils: Collapse potential and settlement, Computation of collapse settlement, Foundation design, Treatment methods for collapsible soils, Distribution of expansive soils, General characteristics of swelling soils, Clay mineralogy and mechanism of swelling, Definition of some parameters, Evaluation of the swelling potential of expansive soils by single Index Method, Classification of swelling soils by Indirect Measurement, Swelling pressure by direct measurement, Effect of initial moisture content and initial dry density on swelling pressure, Estimating the magnitude of swelling, Design of foundation in swelling soils, drilled pier foundations, Elimination of swelling.

PILE FOUNDATIONS: Types of piles, Necessity, pile driving, Load carrying capacity of piles Static and dynamic formulae, Negative skin friction, Pile load tests, Load carrying capacity of group of piles.

Spread footing and beams on elastic foundations: Rectangular combined footings, design of trapezoid shaped footings, design of strap (or cantilever) footings, footings for industrial equipment, Modulus of sub grade reaction, Classical solution of Beam on Elastic foundation, General Comments on the finite element procedure problems.

Design criteria for satisfactory action of a machine foundation, Theory of linear weightless spring, Methods of analysis of a block foundation, Soil spring constants, Determination of soil spring constants, Degrees of freedom of block foundation, vertical vibrations of a block foundations, Rocking vibrations of a block foundations, pure sliding of a block foundation, Indian Standard on design and construction of foundations for reciprocating machines.

Reference Books

- 1 Geotechnical Engineering , N Sivakugan and Braga M Das , 2009, J. Ross publishing .
- 2 Foundation analysis and design , Mc Graw-Hill International Editions , 2007., MacGraw Hill..
- 3 Soil Mechanics and Foundation Engineering , J.E. Bowles, 1996, CBS Publishers & Distributors, New Delhi.
- 4 Advanced Foundation Engineering: Geotechnical Engineering Series, V.N.S. Murthy, 2007, CBS Publishers & Distributors.

23GTE3202A - INTELLIGENT TRANSPORTATION SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3202A	INTELLIGENT TRANSPORTATION SYSTEMS	ITS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify intelligent transportation systems using machine learning, IoT, and big data analytics to enhance traffic management and safety.	2	PO1, PSO1
CO2	Demonstrate traffic flow and reduce congestion by utilizing real-time data and predictive analytics through advanced traffic modeling techniques.	3	PO1, PSO1
CO3	Employ V2X communication technologies to enable autonomous vehicles and improve vehicular communication networks for enhanced safety and mobility.	3	PO1, PSO1
CO4	Practice design ITS solutions that promote sustainability by reducing emissions and integrating public transportation with smart city initiatives.	3	PO1, PSO1
CO5	Demonstrate a prototype intelligent transportation system using simulation tools and real-world data	3	PO1, PSO1

Syllabus

Advanced System Design and Integration Objectives: Understand the architecture and components of intelligent transportation systems. Learn to integrate various ITS technologies and subsystems. **Topics:** Overview of ITS Architecture Components and Subsystems of ITS System Design Methodologies Integration of Advanced Technologies (AI, IoT, Big Data) Case Studies of Integrated ITS

Data-Driven Decision Making Objectives: Utilize real-time data for transportation optimization. Apply predictive analytics and advanced traffic modeling techniques. **Topics:** Real-Time Data Collection and Processing Traffic Flow Theories and Models Predictive Analytics for Traffic Management Optimization Techniques for Traffic Control Big Data Applications in Transportation

Vehicle-to-Everything (V2X) Communication Objectives: Understand V2X communication technologies and their applications. Explore the role of V2X in autonomous and connected vehicles. **Topics:** Introduction to V2X Communication V2V (Vehicle-to-Vehicle) and V2I (Vehicle-to-Infrastructure) Technologies V2P (Vehicle-to-Pedestrian) and V2N (Vehicle-to-Network) Communications Security and Privacy in V2X Networks Applications of V2X in Autonomous Vehicles

Sustainable Transportation Solutions Objectives: Design ITS solutions that promote environmental sustainability. Integrate ITS with public transportation and smart city initiatives. **Topics:** Environmental Impact of Transportation Systems Sustainable Traffic Management Strategies Integration of Public Transportation Systems ITS Solutions for Reducing Emissions Smart City and ITS Integration

Experimental Practice in ITS Implementation Objectives: Apply theoretical knowledge to practical ITS implementation. Design, implement, and test a prototype ITS. **Topics:** Introduction to ITS Simulation Tools Design and Implementation of ITS Prototypes Testing and Validation of ITS Solutions Data Collection and Analysis from Prototypes Presentation and Review of Experimental Results

Reference Books

- 1 Intelligent Transportation Systems: Smart and Green Infrastructure Design , Sumit Ghosh, Tony Lee , 2010, CRC Press.
- 2 Fundamentals of Intelligent Transportation Systems Planning , Mashrur A. Chowdhury, Adel Sadek , 2003, Artech House.
- 3 Intelligent Transport Systems: Technologies and Applications , Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio Garcia Zuazola , 2015, Wiley-IEEE Press.

- 4 The Future of Intelligent Transport Systems, George J. Dimitrakopoulos, Lampros D. Tsalkis, Panagiotis A. Frangos, 2021, ISTE Press - Elsevier.

23GTE3202E - INTELLIGENT TRANSPORTATION SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3202E	INTELLIGENT TRANSPORTATION SYSTEMS	ITS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the fundamental elements and working principles of ITS	2	PO1, PO2, PSO2
CO2	Discuss the advantages such as improved safety, reduced congestion, and enhanced mobility	2	PO1, PO2, PSO2
CO3	Provide examples of ITS applications, such as traffic management systems	2	PO1, PO2, PSO2
CO4	Design ITS solutions that promote sustainability by reducing emissions	2	PO1, PO2, PSO2
CO5	Design and simulate an intelligent traffic signal control system that optimizes traffic flow	6	PO1, PO2, PSO2

Syllabus

Overview of ITS Definition and scope Historical development and evolution Key Components and Technologies Sensors and data collection devices Communication technologies (e.g., V2X, IoT) Control systems and algorithms ITS Architectures and Frameworks National ITS architectures Standardization and interoperability

Traffic Monitoring and Control Traffic flow theory and models Real-time traffic monitoring systems Advanced Traffic Management Systems Signal control systems Dynamic message signs and variable speed limits Incident Detection and Management Automated incident detection technologies Strategies for incident response and management

Public Transportation Systems ITS Applications in Public Transport Automated fare collection and electronic payment systems Real-time passenger information systems Transit Management Systems Fleet management and vehicle tracking Scheduling and dispatch systems Case Studies Successful ITS implementations in public transportation

Vehicle Systems and Autonomous Vehicles In-Vehicle ITS Technologies Advanced driver-assistance systems Navigation and route guidance systems Connected Vehicles Vehicle-to-everything communication Cooperative driving and platooning Autonomous Vehicles Levels of automation and autonomous driving technologies Safety, ethical, and regulatory considerations

Evaluation, Challenges, and Future Trends Performance Evaluation of ITS Methods for assessing the effectiveness of ITS implementations Metrics and key performance indicators Challenges in ITS Deployment Technical challenges Societal challenges Future Trends and Innovations Emerging technologies Smart cities and the integration of ITS with urban infrastructure Sustainability and Environmental Impact ITS contributions to sustainable transportation Reducing emissions and energy consumption through ITS

Reference Books

- Intelligent Transport Systems Technologies and Applications , Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio Garc2a-Zubia , 2020, Wiley.
- The Fundamentals of Integrated Vehicle Real-time Control A Model-based Approach Author(s): Johannes Edelmann, Manfred Pl2chl, Peter E. Wellstead, Ulrich Wiesing Edition: 1st Edition Publisher: Wiley, Johannes Edelmann, Manfred Pl2chl, Peter E. Wellstead, Ulrich Wiesing , 2009, Wiley.
- Intelligent Transport Systems Functional Design for Effective Traffic Management , Dr. Jochen Langheim , 2019, Springer.
- The Future of Intelligent Transport Systems, George J. Dimitrakopoulos, Lampros D. Tsalkis, Panagiotis A. Frangos, 2018, ISTE Press - Elsevier.

23GTE3202R - INTELLIGENT TRANSPORTATION SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3202R	INTELLIGENT TRANSPORTATION SYSTEMS	ITS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Recognise Core Concepts and principles underlying Intelligent Transportation Systems (ITS)	2	PO1, PO2, PSO2
CO2	Demonstrate the ability to apply various ITS technologies	3	PO1, PO2, PSO2
CO3	Construct transportation data for improving decision-making processes in transportation planning and operations.	3	PO1, PO2, PSO2
CO4	Design and propose sustainable and efficient transportation solutions	3	PO1, PO2, PSO2

Syllabus

Introduction to Intelligent Transportation Systems Overview of ITS History and evolution of ITS Components of ITS: user services and system architecture Benefits and challenges of ITS implementation

ITS Technologies and Applications Traffic management systems Advanced traveler information systems (ATIS) Public transportation management systems Commercial vehicle operations Emergency management systems

Communication Technologies in ITS Vehicle-to-vehicle (V2V) communication Vehicle-to-infrastructure (V2I) communication Role of wireless communication in ITS Standards and protocols (DSRC, 5G, LTE)

Data Collection, Analysis, and Management ITS data sources and collection methods Data processing and analytics in transportation Big data applications in ITS Geographic Information Systems (GIS) for ITS

Future Trends and Innovations in ITS Autonomous and connected vehicles Smart cities and their relationship with ITS Cybersecurity and privacy issues in ITS Policy, regulation, and ethical considerations Case studies and current research trends in ITS

Reference Books

- 1 Intelligent Transport Systems: Technologies and Applications, Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio Garc a-Zurdo, 2015, wiley.
- 2 The Intelligent Transportation Systems Handbook, Mohammed A. Hadi, 2024, CRC press.
- 3 Intelligent Transportation Systems: Smart and Green Infrastructure Design, Sumit Ghosh, Tony Lee, 2010, CRC press.
- 4 Intelligent Transport Systems Standards, Bob Williams, 2008, Artech House.
- 5 Data-Driven Solutions to Transportation Problems, Yinhai Wang, 2018, wiley.

23GTE3203A - GROUND IMPROVEMENT TECHNIQUES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3203A	GROUND IMPROVEMENT TECHNIQUES	GIT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understanding of various soil properties, the types of soil-related problems encountered in construction	2	PO1, PO2, PSO2
CO2	Identify and describe various ground improvement techniques	2	PO1, PO2, PSO2
CO3	Design ground improvement solutions for specific geotechnical problems	3	PO1, PO2, PSO2
CO4	Illustrate the effectiveness of ground improvement techniques through site investigations	3	PO1, PO2, PSO2
CO5	Discuss the Quality Control and Quality Assurance based on real-world performance data.	2	PO1, PO2, PSO2

Syllabus

Introduction to Ground Improvement Overview of ground improvement techniques Need for ground improvement Classification of ground improvement methods Soil properties and behavior

Mechanical Methods Compaction techniques: dynamic, static, and vibratory compaction Deep compaction methods: vibroflotation, dynamic deep compaction, and blasting Preloading and consolidation methods Case studies and practical applications

Chemical and Biological Methods Soil stabilization with additives (lime, cement, fly ash) Chemical grouting and jet grouting Bio-remediation and microbial-induced calcite precipitation (MICP) Applications and effectiveness of chemical and biological methods

Physical and Hybrid Methods Ground freezing and thermal stabilization Use of geosynthetics (geotextiles, geogrids, geomembranes) Reinforced earth techniques (mechanically stabilized earth, soil nailing) Hybrid methods combining mechanical, chemical, and physical techniques

Evaluation and Monitoring of Ground Improvement Site investigation and soil testing methods Monitoring techniques for ground improvement (settlement plates, piezometers, inclinometers) Quality control and quality assurance in ground improvement projects Analysis of case studies and performance evaluation

Reference Books

- 1 Ground Improvement Techniques, Purushothama Raj, 2020, Laxmi Publications.
- 2 Principles and Practices of Ground Improvement, Jie Han, 2015, Wiley.
- 3 Ground Improvement, Klaus Kirsch, Alan Bell, 2014, CRC Press.
- 4 Ground Improvement Techniques, Patra Nihar Ranjan, 2013, Vikas Publishing House.

23GTE3203E - GROUND IMPROVEMENT TECHNIQUES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3203E	GROUND IMPROVEMENT TECHNIQUES	GIT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate an understanding of various ground improvement techniques	2	PO1, PSO2
CO2	Analyze site conditions and soil properties to select appropriate ground improvement techniques.	2	PO1, PSO2
CO3	Practical experience in implementing ground improvement techniques	2	PO1, PSO2
CO4	Evaluate the effectiveness of ground improvement projects through monitoring, testing, and data analysis	2	PO1, PSO2
CO5	Ensure the Quality Control and Quality Assurance based on real-world performance data.	2	PO1, PSO2

Syllabus

Introduction to Ground Improvement Overview of soil mechanics and geotechnical engineering principles Importance of ground improvement techniques in civil engineering projects Historical development and evolution of ground improvement methods Environmental and economic considerations in selecting ground improvement techniques

Soil Properties and Site Investigation Classification of soils and their engineering properties Methods of site investigation and soil testing Interpretation of soil data for ground improvement design Factors influencing the selection of ground improvement methods based on soil conditions

Ground Improvement Techniques Part 1 Compaction methods: standard Proctor compaction, modified Proctor compaction, and compaction control techniques Preloading and vertical drains: theory, design considerations, and application examples Vibro-compaction and dynamic compaction: principles, equipment, and case studies Soil stabilization techniques: chemical stabilization, cement stabilization, and lime stabilization

Ground Improvement Techniques Part 2 Soil mixing methods: deep soil mixing, jet grouting, and soil-cement mixing Grouting techniques: permeation grouting, compaction grouting, and pressure grouting Electrokinetic stabilization and vacuum consolidation: principles and applications Recent advancements and innovative ground improvement technologies

Design, Implementation, and Case Studies Design considerations for ground improvement projects: load analysis, settlement calculations, and safety factors Construction techniques and quality control measures for implementing ground improvement methods Case studies and real-world examples showcasing successful ground improvement projects Group projects or presentations on specific ground improvement techniques, including design proposals and feasibility assessments

Reference Books

- 1 Ground Improvement Techniques, P. Raj and V. V. R. Sai Kumar, 2017, CRC Press.
- 2 Ground Improvement, Manfred R. Hausmann, 2015, Wiley.
- 3 Principles and Practices of Ground Improvement , Jie Han , 2017, Wiley.
- 4 Ground Improvement Techniques, Patra Nihar Ranjan, 2012, Vikas Publishing House.

23GTE3203R - GROUND IMPROVEMENT TECHNIQUES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3203R	GROUND IMPROVEMENT TECHNIQUES	GIT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Discuss the fundamental concepts and principles of ground improvement techniques.	2	PO1, PO2, PSO2
CO2	Describe the various ground improvement methods such as compaction, grouting, and soil stabilization.	2	PO1, PO2, PSO2
CO3	Interpret the procedures and applications of different ground improvement techniques in real-world engineering projects.	2	PO1, PO2, PSO2
CO4	Compare and contrast the effectiveness and suitability of different ground improvement methods based on soil conditions and project requirements.	2	PO1, PO2, PSO2

Syllabus

Introduction to Ground Improvement Overview of Ground Improvement Definition and importance Historical perspective Soil Behavior and Problems Common soil issues and their implications on construction Soil investigation and characterization Basic Principles of Ground Improvement Objectives and mechanisms

Mechanical Modification Techniques Compaction Methods Types: static, dynamic, impact, and vibro-compaction Field applications and equipment Preloading and Surcharging Concepts and applications Vertical drains and prefabricated vertical drains (PVDs) Deep Compaction Techniques Vibroflotation Dynamic compaction Blasting techniques

Hydraulic Modification Techniques Dewatering Methods Well points and deep wells Electro-osmosis Drainage and Pore Pressure Reduction Design and installation of drainage systems Groundwater Control Techniques Cutoff walls and grouting for groundwater control

Chemical and Biological Methods Soil Stabilization Lime, cement, and fly ash stabilization Chemical grouting and jet grouting Biological Methods Bio-stabilization and bio-cementation Use of microbial techniques in ground improvement Electrochemical Methods Electrokinetic stabilization

Reinforcement Techniques and Case Studies Soil Reinforcement Geosynthetics: geotextiles, geogrids, and geocells Soil nailing and anchored earth techniques Reinforced Earth Structures Design and application of retaining walls and embankments Case Studies and Applications Real-world examples of ground improvement projects Analysis of successes and challenges

Reference Books

- 1 Ground Improvement, Klaus Kirsch and Alan Bell, 2018, CRC Press.
- 2 Principles and Practices of Ground Improvement , Jie Han, 2015, Wiley.
- 3 Ground Improvement Techniques , Patra Nihar Ranjan and Behera Swami Saran, 2014, Vikas Publishing House.
- 4 Ground Improvement Techniques, Purushothama Raj, 2017, Laxmi Publications.

23GTE3304A - PAVEMENT MATERIALS & DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3304A	PAVEMENT MATERIALS & DESIGN	PMD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Soil Classification and characteristics & properties and tests on bitumen	3	PO1, PO3, PSO1
CO2	Understand the characteristics of bituminous mixes & IRC and IS specifications and tests	3	PO1, PO3, PSO1
CO3	Understand the Types and component parts of pavements & Understand the Stresses and deflections in homogeneous masses	3	PO1, PO3, PSO1
CO4	understand the Pavement behaviour under transient traffic loads & Design the Pavements as per IRC	3	PO1, PO3, PSO1
CO5	Demonstrate proficiency in pavement material testing	3	PO1, PO3, PSO1
CO6	Evaluate the durability and performance of pavements	3	PO1, PO3, PSO1
CO7	Able to Design Various Pavement Mixes	3	PO1, PO3, PSO1

Syllabus

Soil - Classification, characteristics, compaction, evaluation of soil strength; stabilized pavement materials; Aggregates: requirements, properties and tests on road aggregates for flexible and rigid pavements. Bitumen: Origin, preparation, properties and tests, constitution of bituminous road binders; requirements; Criterion for selection of different binders. Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests.

Bituminous Mixes: Mechanical properties: Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. bituminous mix design methods and specifications. Weathering and Durability of Bituminous Materials and Mixes. Performance based Bitumen Specifications; Superpave mix design method: design example problems. Cement Concrete for Pavement Construction: Requirements, and design of mix for CC pavement, IRC and IS specifications and tests, joint filler and sealer materials.

Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements. Stresses and Deflections in Flexible Pavements: Stresses and deflections in homogeneous masses. wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Design of flexible pavements as per IRC;

Stresses in Rigid Pavements: Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses. Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacings; design of CC pavement for roads and runways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC

Various Mx Designs, MORTH Specifications, BC, SDBC, GSB, WMM

Reference Books

- 1 Pavement Analysis and Design, Yang H. Huang, 2008, Pearson Prentice Hall.
- 2 Principles of Pavement Design, E. J. Yoder, M. W. Witczak, 2015, John Wiley & Sons.

- 3 Principles of Highway Engineering and Traffic Analysis, Fred L. Mannering, Scott S. Washburn, Walter P. Kilaeski, 2020, John Wiley.
- 4 Highway Engineering, Paul H. Wright and Karen K. Dixon, 2009, Wiley.

23GTE3304E - PAVEMENT MATERIALS & DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3304E	PAVEMENT MATERIALS & DESIGN	PMD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Soil Classification and characteristics & properties and tests on bitumen	3	PO1, PO3, PSO2
CO2	Understand the characteristics of bituminous mixes & IRC and IS specifications and tests	3	PO1, PO3, PSO2
CO3	Understand the Types and component parts of pavements & Understand the Stresses and deflections in homogeneous masses	3	PO1, PO3, PSO2
CO4	understand the Pavement behaviour under transient traffic loads & Design the Pavements as per IRC	3	PO1, PO3, PSO2
CO5	Demonstrate proficiency in pavement material testing	3	PO1, PO3, PSO2
CO6	Evaluate the durability and performance of pavements	3	PO1, PO3, PSO2
CO7	Able to Design Various Mixes as per Morth Specifications SDBC, BC, BM, DBM, WMM	4	

Syllabus

Soil - Classification, characteristics, compaction, evaluation of soil strength; stabilized pavement materials; Aggregates: requirements, properties and tests on road aggregates for flexible and rigid pavements. Bitumen: Origin, preparation, properties and tests, constitution of bituminous road binders; requirements; Criterion for selection of different binders. Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests.

Bituminous Mixes: Mechanical properties: Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. bituminous mix design methods and specifications. Weathering and Durability of Bituminous Materials and Mixes. Performance based Bitumen Specifications; Superpave mix design method: design example problems. Cement Concrete for Pavement Construction: Requirements, and design of mix for CC pavement, IRC and IS specifications and tests, joint filler and sealer materials.

Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements. Stresses and Deflections in Flexible Pavements: Stresses and deflections in homogeneous masses. wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Design of flexible pavements as per IRC;

Stresses in Rigid Pavements: Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses. Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacings; design of CC pavement for roads and runways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC

Preparation of Various Mixes as per Morth Specifications SDBC, BC, BM, DBM, WMM

Reference Books

- 1 Pavement Analysis and Design, Yang H. Huang, 2008, Pearson Prentice Hall.
- 2 Principles of Pavement Design, E. J. Yoder, M. W. Witczak, 2015, John Wiley & Sons.

- 3 'Principles of Highway Engineering and Traffic Analysis, Fred L. Mannering, Scott S. Washburn, Walter P. Kilaeski, 2020, John Wiley .
- 4 Highway Engineering, Paul H. Wright and Karen K. Dixon, 2009, Wiley .

23GTE3304R - PAVEMENT MATERIALS & DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3304R	PAVEMENT MATERIALS & DESIGN	PMD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Soil Classification and characteristics & properties and tests on bitumen	3	PO1, PO3, PSO2
CO2	Understand the characteristics of bituminous mixes & IRC and IS specifications and tests	3	PO1, PO3, PSO2
CO3	Understand the Types and component parts of pavements & Understand the Stresses and deflections in homogeneous masses	3	PO1, PO3, PSO2
CO4	understand the Pavement behaviour under transient traffic loads & Design the Pavements as per IRC	3	PO1, PO3, PSO2
CO5	Evaluate the durability and performance of pavement Materials and Pavements	3	PO1, PO3, PSO2
CO6	Able to Design the Various Mixes	3	PO1, PO3, PSO2

Syllabus

Soil - Classification, characteristics, compaction, evaluation of soil strength; stabilized pavement materials; Aggregates: requirements, properties and tests on road aggregates for flexible and rigid pavements. Bitumen: Origin, preparation, properties and tests, constitution of bituminous road binders; requirements; Criterion for selection of different binders. Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests.

Bituminous Mixes: Mechanical properties: Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. bituminous mix design methods and specifications. Weathering and Durability of Bituminous Materials and Mixes. Performance based Bitumen Specifications; Superpave mix design method: design example problems. Cement Concrete for Pavement Construction: Requirements, and design of mix for CC pavement, IRC and IS specifications and tests, joint filler and sealer materials.

Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements. Stresses and Deflections in Flexible Pavements: Stresses and deflections in homogeneous masses. wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Design of flexible pavements as per IRC;

Stresses in Rigid Pavements: Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses. Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacings; design of CC pavement for roads and runways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC

Design of Various Mixes, MORTH Specifications, Various Mix Designs BC, SDBC, BM, DBM

Reference Books

- 1 Pavement Analysis and Design, Yang H. Huang, 2008, Pearson Prentice Hall.
- 2 Principles of Pavement Design, E. J. Yoder, M. W. Witczak, 2015, John Wiley & Sons.
- 3 Principles of Highway Engineering and Traffic Analysis, Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, 2020, John Wiley .

- 4 Highway Engineering, Paul H. Wright and Karen K. Dixon, 2009, Wiley .

23GTE3405M - URBAN TRANSPORTATION SYSTEMS PLANNING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3405M	URBAN TRANSPORTATION SYSTEMS PLANNING	UTSP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand about the fundamentals of Intelligent Transportation Systems	2	PO1, PO3, PSO2
CO2	Understand about the use of telecommunication in transportation	2	PO1, PO3, PSO2
CO3	Understand about various ITS functional areas	2	PO1, PO3, PSO2
CO4	Understand about various services offered by ITS	2	PO1, PO3, PSO2

Syllabus

Transportation Planning: Introduction to transportation planning; systems approach to transportation planning; types of models; concept of travel demand and supply; socio-economic, land use, network, and transport system characteristics affecting transportation planning. Transportation Survey: Study area definition, zoning principles, cordon and screen lines, data collection through primary and secondary sources, sampling techniques.

Sequential modelling approach: four-stage sequential modelling approach; trip generation; trip distribution;

Sequential modelling approach: modal split; trip assignment. Advanced Modelling techniques, Traffic behavior modeling

ITS User Needs and Services, Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management, ITS Implementation, Automated Highway Systems, Vehicles in Platoons, Integration of Automated Highway Systems.

Reference Books

- 1 Urban Transportation Planning, Michael Meyer, Eric Miller, 2000, McGraw-Hill Education.
- 2 Urban Transit: Operations, Planning, and Economics, Vukan R. Vuchic, 2008, John Wiley & Sons.
- 3 Urban Transportation Planning: A Decision-Oriented Approach, Abdul R. Khan and Jovan M. Tatar, 1984, John Wiley & Sons.
- 4 Traffic and Highway Engineering, Nicholas J. Garber and Lester A. Hoel, 2019, Cengage Learning.

23GTE3406M - GEOTECHNICAL EARTHQUAKE ENGINEERING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3406M	GEOTECHNICAL EARTHQUAKE ENGINEERING	BIE	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Knowledge and understanding about the seismic phenomenon, its occurrence, tectonic theories, seismic waves and their motion in different media and measurement of ground motions.	2	PO1, PO5, PSO1
CO2	understanding about seismic hazard through deterministic and probabilistic approaches. Ability of modifying the actual ground motion records and their time and frequency domain generation.	2	PO1, PO5, PSO1
CO3	Knowledge and understanding about the dynamic soil properties and their measurements using field and laboratory tests.	2	PO1, PO5, PSO1
CO4	Knowledge and understanding about the liquefaction phenomenon and its effects and the remedial measures to be taken for soil improvement.	2	PO1, PO5, PSO1

Syllabus

"Seismology and Earthquakes: Seismic Hazards, seismic waves, internal structure of earth, Continental drift and plate tectonics, faults, elastics rebound theory, geometric notations, location of earthquakes, size of earthquakes. Strong Ground Motion: Strong ground motion measurement, ground motion parameters, estimation of ground motion parameters. Seismic Hazard Analysis: Identification and Evaluation of Earthquake Sources, deterministic seismic hazard analysis, probabilistic seismic hazard analysis."

Artificial Ground Motion Generation: Modification of actual ground motion records, time domain generation, frequency domain generation

Dynamic Soil Properties Representation of stress conditions by Mohr circle, measurement of dynamic soil properties using field and laboratory tests, stress strain

"Local Site Effects: Effect of local site conditions on ground motion, design parameters, development of design parameters. Liquefaction: Liquefaction Flow liquefaction, cyclic mobility, evaluation of liquefaction hazards, liquefaction susceptibility, initiation of liquefaction, effects of liquefaction. Soil Improvement for Remediation of Seismic Hazards: Densification techniques, Reinforcement Techniques, Grouting and Mixing techniques, Drainage techniques"

Reference Books

- 1 Geotechnical Earthquake Engineering , Steven L. Kramer , 1996, rentice Hall .
- 2 Fundamentals of Soil Dynamics and Earthquake Engineering, Braja M. Das, G.V. Ramana, 2010, CRC Press.
- 3 Earthquake Geotechnical Engineering Design, W.D. Liam Finn, K.Y. Lo, C.M. Chow, 2010, Thomas Telford Services Ltd..
- 4 Earthquake Engineering for Structural Design, Victor Gioncu and Federico M. Mazzolani, 2010, CRC Press.

23GTE3507 - TRAFFIC ENGINEERING AND MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3507	TRAFFIC ENGINEERING AND MANAGEMENT	TEM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understanding of traffic flow theory, including concepts such as traffic density, flow, and speed.	2	PO1, PO2, PSO1
CO2	Apply practical knowledge in traffic control devices, traffic signal systems, and intersection design.	3	PO1, PO2, PSO1
CO3	Employ various methods of traffic data collection, including manual counting, automated sensors, and video analysis.	3	PO1, PO2, PSO1
CO4	Discuss the broader context of transportation planning and policy.	2	PO1, PO2, PSO1

Syllabus

Introduction to Traffic Engineering Definition and scope of traffic engineering Historical development and importance
Basic concepts: traffic flow, density, speed, and volume Traffic engineering objectives and goals

Traffic Analysis and Data Collection Methods of traffic data collection (manual and automated) Traffic volume studies: turning movement counts, spot speed studies Traffic flow characteristics and analysis techniques Introduction to traffic simulation models

Traffic Control Devices and Systems Traffic signs: types, colors, and meanings Traffic signals: types, phasing, timing, and coordination Road markings: standards and applications Intelligent Transportation Systems (ITS) and their role in traffic management

Traffic Safety and Accident Analysis Factors affecting traffic safety Roadway design considerations for safety Accident data collection and analysis techniques Countermeasures for improving traffic safety: engineering, education, and enforcement

Traffic Management and Transportation Planning Principles of traffic management Traffic calming techniques Parking management strategies Introduction to transportation planning: demand forecasting, modal split analysis, and network optimization

Reference Books

- 1 Traffic Engineering, Roger P. Roess, Elena S. Prassas, William R. McShane, 2020, Pearson Education.
- 2 Transportation Engineering, C.J. Khisty, B.K. Lall, 2016, prentice hall.
- 3 Principles of Highway Engineering and Traffic Analysis, Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, 2018, wiley.
- 4 Traffic Flow Fundamentals, Adolf D. May, 2015, Prentice Hall.

23GTE3508 - DESIGN OF EARTH RETAINING STRUCTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23GTE3508	DESIGN OF EARTH RETAINING STRUCTURES	DERS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Earth pressure theories on Earth retaining structures for different field and soil conditions.	3	PO1, PO3, PO10, PSO1
CO2	Apply the earth pressures on Retaining walls at different field and soil conditions.	3	PO1, PO3, PO10, PSO1
CO3	Analyse the stability analysis of sheet piles and check for the stability of cofferdam..	4	PO1, PO3, PO10, PSO1
CO4	Analyze the stability of slopes various dams using different soils .	4	PO1, PO3, PO10, PSO1

Syllabus

Earth pressure, introduction, earth pressure as a stability problem, concept of strain dependence of developed stresses, active, at rest and passive condition, Apply plastic equilibrium, various theories related with E.P. Distillation, Rankine, Analyse the Coulomb and Hansen theoretical derivation and graphical construction with different geometric and boundary conditions.

Introduction about Retaining wall - types, material, method of construction, nature of forces acting. Comparison of different earth pressure theories and application in retaining wall, Stability analysis and design aspects, application of theory of elasticity, analysis of earth pressure distribution at different conditions.

Introduction about Sheet pile and cofferdam, Type, material, method of construction, distribution of earth pressure and related approximation, Apply and Distinction between Sheet Pile and Retaining wall, analysis, and design. of sheet pile wall and retaining wall

Introduction of Earth - structure - Definition, Features of an earth dam, stability analysis of slope, total - vs. - effective stress analysis, limit equilibrium method of slices based on circular failure surfaces, Apply based on general failure surfaces, introduction to analysis based on general failure surfaces. Stability of earth dams during different stages, Analysis During and at end of construction, steady seepage, sudden draw down, estimation of pore water pressure - use of stability charts.

Reference Books

- 1 Geotechnical Engineering , N Sivakugan and Braga M Das, 2009, J. Ross publishing..
- 2 Foundation analysis and design , Mc Graw-Hill International Editions , 1996, MacGraw Hill,.
- 3 Foundation Analysis and Design, J.E. Bowles, 1996, MacGraw Hill,.
- 4 Soil Mechanics and Foundation Engineering , V. N. S. Murthy, 2007, CBS Publishers & Distributors, New Delhi..

23HDA3101A - INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3101A	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	ISDPDD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply foundational AI and ML concepts to design healthcare systems, develop disease prediction models, and perform data preparation and feature engineering.	3	PO1, PO5, PO12, PSO1
CO2	Analyze machine learning algorithms to develop models for disease prediction and drug discovery, and evaluate their performance using appropriate metrics.	4	PO1, PO5, PO12, PSO1
CO3	Analyze and evaluate the application of AI techniques across various stages of drug discovery, from high-throughput screening to clinical trials.	4	PO1, PO5, PO12, PSO1
CO4	Apply and interpret advanced healthcare data using time series, NLP, imaging, and sensor techniques, ensuring compliance with ethical and regulatory standards.	3	PO1, PO5, PO12, PSO1
CO5	Analyze the explainability, ethics, and interdisciplinary aspects of AI in healthcare, exploring emerging trends, research challenges, and applications in personalized medicine.	4	PO1, PO5, PO12, PSO1
CO6	Analyze case studies where AI and data science have successfully accelerated drug discovery and development.	5	PO1, PO5, PO12, PSO1
CO7	Develop frameworks for analyzing the outcomes and impacts of AI-driven drug discovery projects.	6	PO1, PO5, PO12, PSO1

Syllabus

Introduction to AI and ML in Healthcare, Types of AI Systems in Healthcare, Key Concepts in Disease Prediction, Key Concepts in Drug Discovery, Data Types in Healthcare, Data Cleaning Techniques, Data Normalization Techniques, Data Integration and Transformation, Feature Engineering and Dimensionality Reduction

Overview of ML Algorithms, Regression Techniques, Classification Techniques, Ensemble Methods, Neural Networks and Deep Learning, Evaluation Metrics for Disease Prediction, Predictive Analytics for Chronic Diseases, Predictive Analytics for Infectious Diseases, Genomic Data Analysis for Disease Prediction

Introduction to Drug Discovery Process, High-Throughput Screening (HTS), QSAR Modeling, Virtual Screening, De Novo Drug Design, Predictive Toxicology, AI for Target Identification, AI for Lead Optimization, AI in Clinical Trials

Time Series Analysis for Disease Prediction, Natural Language Processing (NLP) in Healthcare, Image Analysis for Disease Prediction, Sensor Data Analysis in Healthcare, Ethical Issues in AI for Healthcare, Regulatory Aspects

Transparency and Explainability, Emerging Trends in AI for Healthcare, Research Opportunities and Challenges, Ethical Considerations in AI for Healthcare, Interdisciplinary Collaboration in AI Research, AI and Personalized Medicine

Reference Books

- 1 Artificial Intelligence in Healthcare, Adam Bohr, Kaveh Memarzadeh, 2020, Academic Press.
- 2 Healthcare Data Analytics, Chandan K. Reddy, Charu C. Aggarwal, 2015, Chapman and Hall/CRC.
- 3 Machine Learning for Healthcare Technologies, David Clifton, 2016, IET.
- 4 Artificial Intelligence in Drug Discovery, Nathan Brown, 2020, Royal Society of Chemistry.
- 5 Machine Learning and AI for Healthcare, Arjun Panesar, 2021, Apress.
- 6 Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, Eric Topol, 2019, Basic Books.

23HDA3101E - INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3101E	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	ISDPDD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply AI-powered healthcare systems to analyze data for disease prediction and personalized care, but ensure ethical considerations and clean data preparation	3	PO1, PO5, PO12, PSO1
CO2	Apply the various Supervised learning algorithms(Logistic Regression, Decision Trees, SVMs, Neural Networks) to build disease prediction models, optimize with key metrics, and unlock insights from real-world data.	3	PO1, PO5, PO12, PSO1
CO3	Analyze the traditional drug discovery process, evaluating the significance of computational methods, including AI, in drug discovery, and synthesizing their understanding to identify, validate drug targets, and apply virtual screening and molecular docking techniques effectively.	4	PO1, PO5, PO12, PSO1
CO4	Analyze QSAR modeling, utilize deep learning approaches in drug discovery, assess challenges and future directions, navigate regulatory considerations in healthcare AI, address bias and fairness issues, and analyze emerging trends in the field.	4	PO1, PO5, PO12, PSO1
CO5	Analyze the explainability, ethics, and interdisciplinary aspects of AI in healthcare, exploring emerging trends, research challenges, and applications in personalized medicine.	4	PO1, PO5, PO12, PSO1
CO6	Analyze case studies where AI and data science have successfully accelerated drug discovery and development.	5	PO1, PO5, PO12, PSO1
CO7	Develop frameworks for analyzing the outcomes and impacts of AI-driven drug discovery projects.	6	PO1, PO5, PO12, PSO1

Syllabus

Introduction to Intelligent Systems in Healthcare Overview of artificial intelligence and machine learning in healthcare
 Applications of intelligent systems in disease prediction and drug discovery Ethical considerations and challenges Data
 Preprocessing for Healthcare Data Data cleaning and normalization techniques

Machine Learning Algorithms for Disease Prediction Logistic regression Decision trees and ensemble methods Support
 vector machines Neural networks for healthcare data Predictive Modeling in Disease Diagnosis Supervised learning
 approaches Evaluation metrics for predictive models Case studies in disease prediction using real-world datasets

Introduction to Drug Discovery Traditional drug discovery process Role of computational methods in drug discovery Drug
 target identification and validation AI in Drug Discovery Virtual screening and molecular docking

QSAR (Quantitative Structure-Activity Relationship) modeling Deep learning approaches in drug discovery Challenges and
 Future Directions Regulatory considerations in using AI for healthcare Bias and fairness issues in healthcare AI Emerging
 trends and future directions in the field

Introduction to Healthcare Data Analysis, Disease Prediction Models, Data Preprocessing Techniques Model Construction
 and Evaluation, Supervised Learning for Disease Diagnosis, Analysis of Healthcare Datasets, Molecular Modeling and
 Simulation, Drug Target Identification and Evaluation Virtual Screening and Molecular Docking, QSAR Modeling, Deep
 Learning for Drug Discovery, Ethical and Regulatory Considerations

Reference Books

- 1 Artificial Intelligence in Medicine, Anthony C. Huang, 2020, Elsevier Science.
- 2 Introduction to Machine Learning for Healthcare, Michael P. Darcy, 2014, Springer Berlin, Heidelberg.

- 3 Artificial Intelligence in Drug Discovery, Nathan Brown, 2020, Royal Society of Chemistry (RSC) .
- 4 Artificial Intelligence for Drug Development, Precision Medicine, and Healthcare, Mark Chang , 2020, Chapman & Hall/CRC..
- 5 Computational Drug Discovery and Design, Riccardo Baron, 2012, Springer-Verlag New York.

23HDA3101R - INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3101R	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	ISDPDD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the introduction to AI and ML in healthcare, types of AI systems, key concepts in disease prediction and drug discovery, and data types, cleaning, and normalization techniques.	3	PO1, PO5, PO12, PSO1
CO2	Analyze the key concepts of ML algorithms, regression and classification techniques, ensemble methods, neural networks, and deep learning for disease prediction.	4	PO1, PO5, PO12, PSO1
CO3	Analyze AI methods to the drug discovery process, including high-throughput screening, QSAR modelling, virtual screening, de novo drug design, and predictive toxicology.	4	PO1, PO5, PO12, PSO1
CO4	Analyze the applications of NLP in healthcare, challenges in image analysis for disease prediction, and address bias, fairness, ethical, and regulatory issues in healthcare AI.	4	PO1, PO5, PO12, PSO1
CO5	Analyze case studies where AI and data science have successfully accelerated drug discovery and development.	5	PO1, PO5, PO12, PSO1
CO6	Develop frameworks for analyzing the outcomes and impacts of AI-driven drug discovery projects.	6	PO1, PO5, PO12, PSO1

Syllabus

Introduction to Intelligent Systems in Healthcare Overview of artificial intelligence and machine learning in healthcare Applications of intelligent systems in disease prediction and drug discovery Ethical considerations and challenges Data Preprocessing for Healthcare Data Data cleaning and normalization techniques

Machine Learning Algorithms for Disease Prediction Logistic regression Decision trees and ensemble methods Support vector machines Neural networks for healthcare data Predictive Modeling in Disease Diagnosis Supervised learning approaches Evaluation metrics for predictive models Case studies in disease prediction using real-world datasets

Introduction to Drug Discovery Traditional drug discovery process Role of computational methods in drug discovery Drug target identification and validation AI in Drug Discovery Virtual screening and molecular docking

QSAR (Quantitative Structure-Activity Relationship) modeling Deep learning approaches in drug discovery Challenges and Future Directions Regulatory considerations in using AI for healthcare Bias and fairness issues in healthcare AI Emerging trends and future directions in the field

Reference Books

- 1 Artificial Intelligence in Medicine, Anthony C. Huang, 2020, Elsevier Science.
- 2 Introduction to Machine Learning for Healthcare, Michael P. Darcy, 2014, Springer Berlin, Heidelberg.
- 3 Artificial Intelligence in Drug Discovery, Nathan Brown, 2020, Royal Society of Chemistry (RSC) .
- 4 Artificial Intelligence for Drug Development, Precision Medicine, and Healthcare, Mark Chang , 2020, Chapman & Hall/CRC..
- 5 Computational Drug Discovery and Design, Riccardo Baron, 2012, Springer-Verlag New York,.

23HDA3202A - BIO MEDICAL INFORMATICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3202A	BIO MEDICAL INFORMATICS	BMI	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply proficiency in acquiring, storing, and managing biomedical data from various sources to enhance data integrity and ensure efficient data retrieval for research and clinical applications.	3	PO1, PO4
CO2	Identify computational analysis techniques and modeling approaches used in biomedical informatics to interpret complex biological data and develop predictive models that can inform healthcare decisions.	3	PO1, PO6
CO3	Make use of the principles of health information systems and interoperability standards to design and implement systems that facilitate seamless data exchange and integration across diverse healthcare platforms.	3	PO1, PO4
CO4	Apply critical thinking skills to explore ethical, legal, and social issues related to biomedical informatics, ensuring that data handling practices comply with regulations and respect patient privacy.	3	PO1, PO7
CO5	Assess the real-world problem using statistical tools to derive meaningful insights and support evidence-based decision-making in biomedical research and clinical practice.	5	PO1, PO2
CO6	Evaluate the large-scale data using computational and statistical methodologies to uncover patterns, trends, and correlations that can advance our understanding of complex biological systems and diseases.	5	PO1, PO2, PSO1

Syllabus

Introduction to biomedical data sources includes understanding diverse data origins such as clinical records, genomic sequencing, and imaging modalities, emphasizing techniques for acquisition, storage solutions ensuring data integrity, quality assurance protocols, and governance frameworks.

Exploration of computational analysis techniques and modeling approaches in biomedical informatics encompasses leveraging machine learning, deep learning, and statistical methods to extract meaningful insights from complex biological datasets, aiding in disease diagnosis, drug discovery, and personalized medicine.

Understanding health information systems principles and interoperability standards involves studying the architecture of electronic health records (EHRs), the integration of clinical data across platforms, and adherence to standards like HL7 and FHIR to facilitate seamless data exchange and healthcare delivery.

Examination of ethical, legal, and social issues pertinent to biomedical informatics delves into the responsible use of patient data, privacy concerns surrounding genomic information, implications of AI-driven diagnostics on healthcare equity, and regulatory frameworks shaping the field's ethical landscape.

Statistical methods for analysis encompass a wide range of techniques including hypothesis testing, regression models, survival analysis, and Bayesian inference applied to biomedical data, enabling rigorous evaluation of experimental results, epidemiological studies, and clinical trials.

Reference Books

- 1 Biomedical Informatics: Computer Applications in Health Care and Biomedicine , Edward H. Shortliffe and James J. Cimino , 2014, Springer.
- 2 Health Informatics: An Interprofessional Approach, Ramona Nelson and Nancy Staggers, 2017, Mosby.
- 3 Biomedical Informatics An Introduction to Information Systems and Software in Medicine and Health, David J. Lubliner, 2016, CRC Press.

- 4 Biomedical Informatics: Computer Applications in Health Care and Biomedicine, Edward H. Shortliffe and James J. Cimino, 2021, Springer.

23HDA3202E - BIO MEDICAL INFORMATICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3202E	BIO MEDICAL INFORMATICS	BMI	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply proficiency in acquiring, storing, and managing biomedical data from various sources to enhance data integrity and ensure efficient data retrieval for research and clinical applications.	3	PO1, PO3
CO2	Identify computational analysis techniques and modeling approaches used in biomedical informatics to interpret complex biological data and develop predictive models that can inform healthcare decisions.	3	PO1, PO2
CO3	Make use of the principles of health information systems and interoperability standards to design and implement systems that facilitate seamless data exchange and integration across diverse healthcare platforms.	3	PO1, PO5
CO4	Apply critical thinking skills to explore ethical, legal, and social issues related to biomedical informatics, ensuring that data handling practices comply with regulations and respect patient privacy.	3	PO1, PO8
CO5	Evaluate the real-world problem using statistical tools to derive meaningful insights and support evidence-based decision-making in biomedical research and clinical practice.	5	PO1, PO2
CO6	Assess the large-scale data using computational and statistical methodologies to uncover patterns, trends, and correlations that can advance our understanding of complex biological systems and diseases.	5	PO1, PO2, PSO1

Syllabus

Introduction to biomedical data sources includes understanding diverse data origins such as clinical records, genomic sequencing, and imaging modalities, emphasizing techniques for acquisition, storage solutions ensuring data integrity, quality assurance protocols, and governance frameworks.

Exploration of computational analysis techniques and modeling approaches in biomedical informatics encompasses leveraging machine learning, deep learning, and statistical methods to extract meaningful insights from complex biological datasets, aiding in disease diagnosis, drug discovery, and personalized medicine.

Understanding health information systems principles and interoperability standards involves studying the architecture of electronic health records (EHRs), the integration of clinical data across platforms, and adherence to standards like HL7 and FHIR to facilitate seamless data exchange and healthcare delivery.

Examination of ethical, legal, and social issues pertinent to biomedical informatics delves into the responsible use of patient data, privacy concerns surrounding genomic information, implications of AI-driven diagnostics on healthcare equity, and regulatory frameworks shaping the field's ethical landscape.

Statistical methods for analysis encompass a wide range of techniques including hypothesis testing, regression models, survival analysis, and Bayesian inference applied to biomedical data, enabling rigorous evaluation of experimental results, epidemiological studies, and clinical trials.

Reference Books

- 1 Biomedical Informatics: Computer Applications in Health Care and Biomedicine , Edward H. Shortliffe and James J. Cimino , 2014, Springer.
- 2 Health Informatics: An Interprofessional Approach, Ramona Nelson and Nancy Staggers, 2017, Mosby.

- 3 Biomedical Informatics An Introduction to Information Systems and Software in Medicine and Health, David J. Lubliner, 2016, CRC Press.
- 4 Biomedical Informatics: Computer Applications in Health Care and Biomedicine, Edward H. Shortliffe and James J. Cimino, 2021, Springer.

23HDA3202R - BIO MEDICAL INFORMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3202R	BIO MEDICAL INFORMATICS	BMI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply proficiency in acquiring, storing, and managing biomedical data from various sources to enhance data integrity and ensure efficient data retrieval for research and clinical applications.	3	PO1, PO3
CO2	Identify computational analysis techniques and modeling approaches used in biomedical informatics to interpret complex biological data and develop predictive models that can inform healthcare decisions.	3	PO1, PO3
CO3	Make use of the principles of health information systems and interoperability standards to design and implement systems that facilitate seamless data exchange and integration across diverse healthcare platforms.	3	PO1, PO5, PSO1
CO4	Apply critical thinking skills to explore ethical, legal, and social issues related to biomedical informatics, ensuring that data handling practices comply with regulations and respect patient privacy.	3	PO1, PO8

Syllabus

Introduction to biomedical data sources includes understanding diverse data origins such as clinical records, genomic sequencing, and imaging modalities, emphasizing techniques for acquisition, storage solutions ensuring data integrity, quality assurance protocols, and governance frameworks.

Exploration of computational analysis techniques and modeling approaches in biomedical informatics encompasses leveraging machine learning, deep learning, and statistical methods to extract meaningful insights from complex biological datasets, aiding in disease diagnosis, drug discovery, and personalized medicine.

Understanding health information systems principles and interoperability standards involves studying the architecture of electronic health records (EHRs), the integration of clinical data across platforms, and adherence to standards like HL7 and FHIR to facilitate seamless data exchange and healthcare delivery.

Examination of ethical, legal, and social issues pertinent to biomedical informatics delves into the responsible use of patient data, privacy concerns surrounding genomic information, implications of AI-driven diagnostics on healthcare equity, and regulatory frameworks shaping the field's ethical landscape.

Reference Books

- 1 Biomedical Informatics: Computer Applications in Health Care and Biomedicine , Edward H. Shortliffe and James J. Cimino , 2014, Springer.
- 2 Health Informatics: An Interprofessional Approach , Ramona Nelson and Nancy Staggers , 2017, Mosby.
- 3 Biomedical Informatics An Introduction to Information Systems and Software in Medicine and Health, David J. Lubliner, 2016, CRC Press.
- 4 Biomedical Informatics: Computer Applications in Health Care and Biomedicine , Edward H. Shortliffe and James J. Cimino , 2021, Springer.

23HDA3203A - GENETIC PROGRAMMING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3203A	GENETIC PROGRAMMING	GP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Acquire an understanding of the fundamental concepts and principles behind genetic programming.	2	PO1, PSO1
CO2	Implement Genetic Programming in order to achieve programme evolution.	3	PO1, PSO1
CO3	Utilise Genetic Programming to find solutions to challenges involving optimisation and machine learning.	3	PO1, PO2, PSO1
CO4	Examine the application of genetic programming to a number of different models.	4	PO1, PO2, PSO1
CO5	Assess the Relationship Between Population Dynamics and Data-Based Modelling	4	PO1, PO2, PSO1

Syllabus

The Evolution of Evolutionary Computation, The Basics of Genetic Algorithms, Genetic Operators, Problem Representation

GA Theory: Schemata and Building Blocks, Parallel Genetic Algorithms, The Interplay of Genetic Operators

Introduction: Chromosome Representation, Basic Steps of the GP-Based Problem Solving Process.

Typical Applications of Genetic Programming, GP Schema Theories

Parent Analysis, Genetic Diversity, In Single-Population GAs, In Multi-Population GAs, Time Series Analysis, Classification and Genetic Propagation

Reference Books

- 1 An Introduction to Genetic Algorithms, Melanie Mitchell, 1998, First MIT Press.
- 2 A Field Guide to Genetic Programming, Riccardo Poli, William B Langdon Nicholas Freitag McPhee, 2008, Lulu.com.
- 3 Introduction to Evolutionary Computing, Agoston E Eiben, John E Smith, 2015, Springer.
- 4 Genetic Algorithms + Data Structures = Evolution Programs, Zbigniew Michalewicz, 1995, Springer.
- 5 Handbook of Genetic Programming Applications, Ammar Mohammed, Robin C. Purshouse, Peter L. Lanzi, 2015, Springer.
- 6 Genetic Algorithms and Genetic Programming Modern Concepts and Practical Applications, Michael Affenzeller, Stephan Winkler, Stefan Wagner, and Andreas Beham, 2009, CRC Taylor & Francis Group.

23HDA3203E - GENETIC PROGRAMMING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3203E	GENETIC PROGRAMMING	GP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Acquire an understanding of the fundamental concepts and principles behind genetic programming.	2	PO1, PSO1
CO2	Implement Genetic Programming in order to achieve programme evolution.	3	PO1, PSO1
CO3	Utilise Genetic Programming to find solutions to challenges involving optimisation and machine learning.	3	PO1, PSO1
CO4	Examine the application of genetic programming to a number of different models.	4	PO1, PO2, PSO1
CO5	Assess the Relationship Between Population Dynamics and Data-Based Modelling	4	PO1, PO2, PSO1

Syllabus

The Evolution of Evolutionary Computation, The Basics of Genetic Algorithms, Genetic Operators, Problem Representation

GA Theory: Schemata and Building Blocks, Parallel Genetic Algorithms, The Interplay of Genetic Operators

Introduction: Chromosome Representation, Basic Steps of the GP-Based Problem Solving Process.

Typical Applications of Genetic Programming, GP Schema Theories

Parent Analysis, Genetic Diversity, In Single-Population GAs, In Multi-Population GAs, Time Series Analysis, Classification and Genetic Propagation

Reference Books

- 1 An Introduction to Genetic Algorithms , Melanie Mitchell , 1998, Bradford Books.
- 2 Genetic Algorithms and Genetic Programming Modern Concepts and Practical Applications, Michael Affenzeller, Stephan Winkler, Stefan Wagner, and Andreas Beham , 2009, CRC Taylor & Francis Group .
- 3 A Field Guide to Genetic Programming, Riccardo Poli, William B Langdon Nicholas Freitag McPhee, 2008, Lulu.com.
- 4 Handbook of Genetic Programming Applications, Ammar Mohammed, Robin C. Purshouse, Peter L. Lanzi, 2015, Springer.

23HDA3203R - GENETIC PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3203R	GENETIC PROGRAMMING	GP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Acquire an understanding of the fundamental concepts and principles behind genetic programming.	2	PO1, PSO1
CO2	Implement Genetic Programming in order to achieve programme evolution.	3	PO1, PSO1
CO3	Utilise Genetic Programming to find solutions to challenges involving optimisation and machine learning.	3	PO1, PO2, PSO1
CO4	Examine the application of genetic programming to a number of different models.	4	PO1, PO2, PSO1

Syllabus

The Evolution of Evolutionary Computation, The Basics of Genetic Algorithms, Genetic Operators, Problem Representation

GA Theory: Schemata and Building Blocks, Parallel Genetic Algorithms, The Interplay of Genetic Operators

Introduction: Chromosome Representation, Basic Steps of the GP-Based Problem Solving Process.

Typical Applications of Genetic Programming, GP Schema Theories

Reference Books

- 1 Genetic Algorithms and Genetic Programming Modern Concepts and Practical Applications, Michael Affenzeller, Stephan Winkler, Stefan Wagner, and Andreas Beham, 2009, CRC Taylor & Francis Group.
- 2 Introduction to Evolutionary Computing, Agoston E Eiben, John E Smith, 2005, Springer.
- 3 Genetic Algorithms-In Search, optimization and Machine learning, David E. Goldberg, 1989, Pearson Education.
- 4 An Introduction to Genetic Algorithms, Melanie Mitchell, 1998, Bradford Books .
- 5 A Field Guide to Genetic Programming, Riccardo Poli, William B Langdon Nicholas Freitag McPhee, 2008, Lulu.com .

23HDA3204A - PYTHON FOR GENOMIC DATA SCIENCE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3204A	PYTHON FOR GENOMIC DATA SCIENCE	PFGDS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand genomic data and representation	2	PO2, PO3, PO5, PSO2
CO2	Demonstrate BioPython program techniques for genomic data analysis	3	PO3, PO5, PO11, PSO2
CO3	Apply statistic techniques for genomic data analysis	3	PO2, PO5, PO11, PSO2
CO4	Analyse clustering techniques in genomic data	4	PO2, PO5, PO11, PSO2
CO5	Apply machine learning algorithms in Python for genomics data analysis and prediction tasks.	3	PO2, PO5, PO11, PSO2

Syllabus

Introduction to genomics covers DNA and the central dogma. Transcriptional regulation and elements of gene regulation. High-throughput experimental methods in genomics. General idea behind high-throughput techniques and visualization and data repositories for genomics.

Genomic data analysis involves utilizing Biopython for tasks such as installing packages, handling computations, and working with various data structures. Creating plots using Biopython's base graphics. Encompasses combining multiple plots employing functions and utilizing control structures like for loops and conditional statements.

Introduction to Biopython for Genomic Data Analysis. Applying t-tests to compare mean differences in two samples correcting for multiple testing using moderated t-tests exploring relationships between variables through linear models and correlation analysis. Genomic data with Matplotlib and understanding sequence alignment algorithms.

Exploratory Data Analysis with Unsupervised and Supervised Clustering techniques. Apply Machine Learning Algorithms for Genomics Data Classification. DNA Sequence Classification using Machine Learning Algorithms. Apply Natural Language processing to DNA sequence as an unstructured text dataset.

Model production deployment using Web APIs IT application integration. Model retraining schedule and redeployment business intelligence and decisions making. Model selection and hyperparameters optimization. Model performance metrics analysis.

Reference Books

- 1 Data Science for Genomics, Amit Kumar Tyagi, Ajith Abraham, 1st Edition, 2022, eBook.
- 2 Genome Clustering From Linguistic Models to Classification of Genetic Texts, Alexander Bolshoy, Zeev Volkovich, Valery Kirzhner,, 1st Edition, 2010, Springer Berlin Heidelberg.
- 3 Deep Learning for genomics, Upendra Kumar Devisetty, 1st Edition, 2022, Packt .
- 4 Bioinformatics with Python Cookbook, Tiago Antao, 2st Edition, 2018, ebook.

23HDA3204E - PYTHON FOR GENOMIC DATA SCIENCE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3204E	PYTHON FOR GENOMIC DATA SCIENCE	PFGDS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand genomic data and representation	2	PO2, PO3, PO5, PSO2
CO2	Demonstrate BioPython program techniques for genomic data analysis	3	PO3, PO5, PO11, PSO2
CO3	Apply statistic techniques for genomic data analysis	3	PO2, PO5, PO11, PSO2
CO4	Analyse clustering techniques in genomic data	4	PO2, PO5, PO11, PSO2
CO5	Apply machine learning algorithms in Python for genomics data analysis and prediction tasks.	3	PO2, PO5, PO11, PSO2

Syllabus

Introduction to Genomic, DNA and central dogma, Transcriptional and post-transcriptional regulation, Elements of gene regulation, Transcriptional regulation, Shaping the genome: DNA mutation, High-throughput experimental methods in genomics, General idea behind high-throughput techniques, High-throughput sequencing, visualization and data repositories for genomics.

Genomic data analysis, Getting started with Biopython, Installing packages, Computations in Biopython, Data structures, Reading and writing data, Reading large files, Plotting in Biopython with base graphics, Combining multiple plots, Reading in and writing data out in Biopython, Plotting in Biopython Functions and control structures (for, if/else, etc.)

Collection of data points, Using t-test for difference of the means between two samples, Multiple testing correction, Moderated t-tests, Relationship between variables: Linear models and correlation, visualization of genomic data using Matplotlib, Sequence alignment algorithms.

Exploratory Data Analysis with Unsupervised Machine Learning, Supervised Clustering techniques, Dimensionality reduction techniques, Predictive Modelling with Supervised Machine Learning, Gradient boosting, Support Vector Machines (SVM), Neural networks and deep versions of it, Ensemble learning, Predicting continuous variables

Exploratory Data Analysis with Unsupervised and Supervised Clustering techniques, Dimensionality reduction techniques, Predictive Modelling with Supervised Machine Learning, Gradient boosting, Support Vector Machines (SVM), Neural networks and deep versions of it, Ensemble learning, Predicting continuous variables

Reference Books

- 1 Data Science for Genomics, Amit Kumar Tyagi, Ajith Abraham, 1st Edition, 2022, eBook.
- 2 Genome Clustering From Linguistic Models to Classification of Genetic Texts, Alexander Bolshoy, Zeev Volkovich, Valery Kirzhner,, 1st Edition, Springer Berlin Heidelberg.
- 3 Deep Learning for genomics, Upendra Kumar Devisetty, 1st Edition, Packt.
- 4 Bioinformatics with Python Cookbook, Tiago Antao, 1st Edition, ebook.

23HDA3204R - PYTHON FOR GENOMIC DATA SCIENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3204R	PYTHON FOR GENOMIC DATA SCIENCE	PFGDS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand genomic data and representation	2	PO2, PO3, PO5, PSO2
CO2	Demonstrate BioPython program techniques for genomic data analysis	3	PO3, PO5, PO11, PSO2
CO3	Apply statistic techniques for genomic data analysis	3	PO2, PO5, PO11, PSO2
CO4	Analyze various machine learning techniques and acquire familiarity with emerging software, tools, and technologies.	4	PO2, PO5, PO11, PSO2

Syllabus

Introduction to genomics covers DNA and the central dogma. Transcriptional regulation and elements of gene regulation. High-throughput experimental methods in genomics. General idea behind high-throughput techniques and visualization and data repositories for genomics.

Genomic data analysis involves utilizing Biopython for tasks such as installing packages, handling computations, and working with various data structures. Creating plots using Biopython's base graphics. Encompasses combining multiple plots employing functions and utilizing control structures like for loops and conditional statements.

Introduction to Biopython for Genomic Data Analysis. Applying t-tests to compare mean differences in two samples correcting for multiple testing using moderated t-tests exploring relationships between variables through linear models and correlation analysis. Genomic data with Matplotlib and understanding sequence alignment algorithms.

Exploratory Data Analysis with Unsupervised and Supervised Clustering techniques. Apply Machine Learning Algorithms for Genomics Data Classification. DNA Sequence Classification using Machine Learning Algorithms. Apply Natural Language processing to DNA sequence as an unstructured text dataset.

Reference Books

- 1 Data Science for Genomics, Amit Kumar Tyagi, Ajith Abraham, 1st Edition, 2022, eBook.
- 2 Genome Clustering From Linguistic Models to Classification of Genetic Texts, Alexander Bolshoy, ZeevVolkovich, Valery Kirzhner,, 1st Edition, 2010, Springer Berlin Heidelberg.
- 3 Deep Learning for genomics, Upendra Kumar Devisetty, 1st Edition, 2022, Packt.
- 4 Bioinformatics with Python Cookbook, Tiago Antao, 2nd Edition, 2018, ebook.

23HDA3305A - COMPUTATIONAL NEUROSCIENCE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3305A	COMPUTATIONAL NEUROSCIENCE	CNSE	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of computational neuroscience, including neural coding, synaptic plasticity, and neural network dynamics.	2	PO1, PO2, PO3, PSO1
CO2	Apply mathematical and computational models to analyze neural systems and brain function to investigate how neural systems process information and perform various functions.	3	PO1, PO2, PO3, PSO1
CO3	Develop and simulate models of neural activity using software tools and programming languages such as MATLAB or Python to extract meaningful insights from data and test hypotheses about neural function.	3	PO1, PO2, PO3, PSO1
CO4	Analyze experimental data from neuroscience studies to infer neural mechanisms and brain function to learn and critically assess the accuracy and validity of computational models in neuroscience.	4	PO1, PO2, PO3, PSO1
CO5	Evaluate the implications of computational neuroscience research for understanding brain disorders and developing treatments.	5	PO1, PO2, PO3, PSO1
CO6	Analyze innovative solutions and models that contribute to the advancement of computational neuroscience research to identify gaps in current knowledge, propose novel approaches to address these gaps.	4	PO1, PO2, PO3, PSO1
CO7	Evaluate the computational Neuroscience models in laboratory exercises and projects that involve implementing computational models, running simulations, and analyzing results.	5	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Computational Neuroscience, Definition and scope of computational neuroscience , Historical overview of the field , Interdisciplinary nature of computational neuroscience

Neurons and Neural Networks, Anatomy and physiology of neurons , Structure and function of neural networks , Types of neural networks (e.g., feedforward, recurrent)

Mathematical Foundations for Neuroscience, Linear algebra concepts for neural modeling , Differential equations and dynamical systems in neuroscience , Probability theory and statistics in neural data analysis

Computational Modeling of Neurons Hodgkin-Huxley model and its applications , Integrate-and-fire models for neural simulations , Cable theory for modeling spatial aspects of neurons

Network Dynamics Synchronization and oscillations in neural networks , Small-world and scale-free network architectures , Functional connectivity and network motifs

Reference Books

- 1 Principles of Computational Modelling in Neuroscience, David Sterratt, Bruce Graham, Andrew Gillies, David Willshaw, 2011, Cambridge University Press.
- 2 Computational Neuroscience: A First Course, Hanspeter Mallot, 2002, Springer.
- 3 Neuronal Dynamics: From Single Neurons to Networks and Models of Cognition, Wulfram Gerstner, Werner M. Kistler, Richard Naud, Liam Paninski, 2014, Cambridge University Press.
- 4 From Neuron to Cognition via Computational Neuroscience, Request exam copy View preview From Neuron to Cognition via Computational Neuroscience Edited by Michael A. Arbib and James J. Bonaiuto, 2016, MIT press.

23HDA3305E - COMPUTATIONAL NEUROSCIENCE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3305E	COMPUTATIONAL NEUROSCIENCE	CNSE	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of computational neuroscience, including neural coding, synaptic plasticity, and neural network dynamics.	2	PO1, PO2, PO3, PSO1
CO2	Apply mathematical and computational models to analyze neural systems and brain function to investigate how neural systems process information and perform various functions.	3	PO1, PO2, PO3, PSO1
CO3	Develop and simulate models of neural activity using software tools and programming languages such as MATLAB or Python to extract meaningful insights from data and test hypotheses about neural function.	3	PO1, PO2, PO3, PSO1
CO4	Analyze experimental data from neuroscience studies to infer neural mechanisms and brain function to learn and critically assess the accuracy and validity of computational models in neuroscience.	4	PO1, PO2, PO3, PSO1
CO5	Evaluate the implications of computational neuroscience research for understanding brain disorders and developing treatments.	5	PO1, PO2, PO3, PSO1
CO6	Analyze innovative solutions and models that contribute to the advancement of computational neuroscience research to identify gaps in current knowledge, propose novel approaches to address these gaps.	4	PO1, PO2, PO3, PSO1
CO7	Evaluate the computational Neuroscience models in laboratory exercises and projects that involve implementing computational models, running simulations, and analyzing results.	5	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Computational Neuroscience, Definition and scope of computational neuroscience, Historical overview
Interdisciplinary nature

Mathematical Foundations for Neuroscience . Linear algebra for neuroscience, Differential equations and dynamical systems ,Probability theory and statistics in neuroscience

Neurons and Neural Networks, Anatomy and physiology of neurons ,Structure and function of neural networks, Types of neural networks (e.g., feedforward, recurrent)

Computational Modeling of Neurons , Hodgkin-Huxley model ,Integrate-and-fire models Cable theory

Network Dynamics Synchronization and oscillations in neural networks ,Small-world and scale-free network architectures ,Functional connectivity and network motifs

Reference Books

- 1 Principles of Computational Modelling in Neuroscience, David Sterratt, Bruce Graham, Andrew Gillies, David Willshaw, 2011, Cambridge University Press.
- 2 Computational Neuroscience: A First Course, Hanspeter Mallot, 2002, Springer.
- 3 Neuronal Dynamics: From Single Neurons to Networks and Models of Cognition, Wulfram Gerstner, Werner M. Kistler, Richard Naud, Liam Paninski, 2014, Cambridge University Press.
- 4 From Neuron to Cognition via Computational Neuroscience, Michael A. Arbib and James J. Bonaiuto, 2016, MIT Press.

23HDA3305R - COMPUTATIONAL NEUROSCIENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3305R	COMPUTATIONAL NEUROSCIENCE	CNSE	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of computational neuroscience, including neural coding, synaptic plasticity, and neural network dynamics.	2	PO1, PO2, PO3, PSO1
CO2	Apply mathematical and computational models to analyze neural systems and brain function to investigate how neural systems process information and perform various functions.	3	PO1, PO2, PO3, PSO1
CO3	Develop and simulate models of neural activity using software tools and programming languages such as MATLAB or Python to extract meaningful insights from data and test hypotheses about neural function.	3	PO1, PO2, PO3, PSO1
CO4	Analyze experimental data from neuroscience studies to infer neural mechanisms and brain function to learn and critically assess the accuracy and validity of computational models in neuroscience.	4	PO1, PO2, PO3, PSO1
CO5	Evaluate the implications of computational neuroscience research for understanding brain disorders and developing treatments.	5	PO1, PO2, PO3, PSO1
CO6	Evaluate the computational Neuroscience models in laboratory exercises and projects that involve implementing computational models, running simulations, and analyzing results.	5	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Computational Neuroscience, Overview of computational neuroscience, Basic principles of neural computation, Introduction to mathematical modeling of neurons

Neural Networks and Brain Function, Introduction to neural networks, Network dynamics and stability Models of learning and memory

Sensory and Motor Systems , Computational models of sensory processing, Motor control and movement planning Sensorimotor integration

Cognitive Neuroscience , Computational approaches to studying cognition, Models of attention, perception, and decision-making Neural correlates of consciousness

Reference Books

- 1 Principles of Computational Modelling in Neuroscience, David Sterratt, Bruce Graham, Andrew Gillies, David Willshaw, 2011, Cambridge University Press.
- 2 Computational Neuroscience: A First Course, Hanspeter Mallot, 2002, Springer.
- 3 Neuronal Dynamics: From Single Neurons to Networks and Models of Cognition, Wulfram Gerstner, Werner M. Kistler, Richard Naud, Liam Paninski, 2014, Cambridge University Press.
- 4 From Neuron to Cognition via Computational Neuroscience, Michael A. Arbib and James J. Bonaiuto, 2016, MIT press.

23HDA3406M - NGS SEQUENCING AND DATA ANALYSIS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3406M	NGS SEQUENCING AND DATA ANALYSIS	NGSDA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of sequence analysis to biological specimens, understanding the principles and techniques used to analyze DNA, RNA, or protein sequences.	3	PO2, PO4
CO2	Demonstrate Data Analysis with Preprocessing and Alignment: Utilize methods for the preprocessing of raw biological data, including quality control, filtering, and alignment techniques.	3	PO2, PO4
CO3	Illustrate Variant Calling and Annotation with NGS Data Sets/graphs: Perform variant calling using next-generation sequencing (NGS) data to identify genetic variants such as single nucleotide polymorphisms (SNPs)	3	PO2, PO4
CO4	Interpret Transcriptomics and Differential Gene Expression: Engage in transcriptomic studies to explore gene expression levels under different conditions.	3	PO2, PO5

Syllabus

"Introduction to Next-Generation Sequencing (NGS): Overview of NGS technologies and platforms, Key principles and applications of NGS in genomics and transcriptomics, Sequencing library preparation techniques, and Quality control measures. "

NGS Data Analysis: Preprocessing and Alignment: Pre-processing raw NGS data: quality filtering and trimming, Introduction to read alignment algorithms, Mapping NGS reads to a reference genome, Assessing alignment quality and statistics,

Variant Calling and Annotation: Principles of variant calling from NGS data, Identification of single nucleotide variants (SNVs) and small insertions/deletions (indels), Quality assessment and filtering of variants, Annotation of variants with functional information,

NGS Data Analysis: Transcriptomics and Differential Gene Expression: Overview of transcriptomics and RNA-Seq data analysis, Gene expression quantification and normalization, Differential gene expression analysis, Functional enrichment analysis and interpretation of result

Reference Books

- 1 Next-Generation DNA Sequencing Informatics, Stuart M. Brown, 2018, Oxford University Press.
- 2 Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools, Vince Buffalo, 2015, O'Reilly Media.
- 3 NGS Data Analysis: A Practical Approach, S. Cenk Sahinalp, 2015, Chapman and Hall/CRC.
- 4 Bioinformatics A Practical Guide to Next Generation Sequencing Data Analysis, Hamid D. Ismai, 2017, Chapman and Hall/CRC.

23HDA3407M - INTRODUCTION TO GENOMIC TECHNOLOGIES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3407M	INTRODUCTION TO GENOMIC TECHNOLOGIES	IGT	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Classify Genomic Technologies, summarize the genomic data generations and describe Just enough molecular Biology	2	PO2, PO4, PSO1
CO2	Describe DNA sequence in terms of central dogma and discuss techniques of DNA measurement technologies such as chain reaction and sequencing	3	PO3, PSO2
CO3	Discover computing techniques related to Genomic technologies with respect to DNA, and relate computing and biology.	3	PO2, PSO1
CO4	Correlate Artificial Intelligence algorithms with genomic technologies and practice experimental design and implementation	4	PO1, PO3, PSO1

Syllabus

Introduction to Genomic Technologies: Overview of genomic data generation and applications, Just enough molecular biology, The genome,

Writing a DNA sequence, Central dogma, Transcription, Chain reaction and sequencing: Polymerase chain reaction (PCR), next generation sequencing, and applications of sequencing

foundations of computer science, algorithms, memory and data structures, efficiency, software engineering, and computational biology software.

Data science and Genomic Technologies: The central dogma of inference, analysis code, testing, prediction, variation, experimental design, confounding, power, sample size, correlation, causation, and degrees of freedom.

Reference Books

- 1 Introduction to Genomics, Arthur M. Lesk, Third Edition, 2017, OUP Oxford.
- 2 Bioinformatics Data Skills, Vince Buffalo, First Edition. 2015, O'Reilly.
- 3 Introduction to Molecular Genomics, Maryam Javed, Asif Nadeem, Faiz-ul Hassan, First Edition, 2021, Bentham Books.
- 4 Principles of Gene Manipulation and Genomics, Primrose, S. B., Twyman, R. M., First Edition, 2006, Blackwell Pub..
- 5 Introduction to Proteomics: Tools for the New Biology, Liebler, D. C., First Edition, 2001, Humana Press.

23HDA3509 - MOLECULAR MODELING AND DRUG DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3509	MOLECULAR MODELING AND DRUG DESIGN	MMDD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the comprehensive knowledge of various drug discovery methods, including high-throughput screening, lead optimization, and pharmacophore modeling. Introduce the concepts and techniques of molecular modeling and simulation,	3	PO2, PO5
CO2	Interpret computer-based modeling techniques to predict and analyze protein functions and structures. Gain a deep understanding of the methods used to predict protein folding	3	PO2, PO4
CO3	Demonstrate biomolecular interactions, such as protein-protein, protein-ligand, and protein-DNA/RNA interactions in biological systems	3	PO3, PO5
CO4	Apply role of various modeling and drug design methods through detailed case studies. Analyze real-world examples of drug discovery projects to understand the practical applications of theoretical concepts, methodologies,	3	PO3, PO5

Syllabus

PRACTICAL INTRODUCTION TO MOLECULAR MODELING AND DRUG DESIGN: High-Throughput Screening: Techniques for testing large numbers of compounds. Virtual Screening: Computational methods for identifying potential drug candidates. Molecular Docking: Predicting how small molecules bind to targets. Drug Metabolism and Pharmacokinetics: Absorption, distribution, metabolism, and excretion of drugs. Medicinal Chemistry: Design and development of new therapeutic compounds. Pharmaceutical Formulation: Creating drug formulations for effective delivery. Drug Design Strategies: Structure-based and ligand-based drug design approaches. Regulatory Affairs in Drug Development: Understanding FDA and EMA regulations for drug approval. Ethics in Drug Development: Ethical considerations in drug testing and research.

PREDICTION AND STRUCTURAL ANALYSIS OF MACROMOLECULES : Protein Function Prediction: Techniques for predicting the biological function of proteins from their structure. Structural Alignment and Comparison: Methods for comparing protein structures to identify similarities and differences. Structural Bioinformatics: Using computational tools and databases for analyzing macromolecular structures. Structural Genomics: Large-scale efforts to determine 3D structures of proteins and their implications for drug discovery. Proteomics: Techniques for studying the complete set of proteins expressed in an organism. Molecular Modeling Tools: Introduction to software tools for structure prediction and analysis (e.g., MODELLER, Rosetta). Advanced Visualization Techniques: Tools for detailed visualization of protein structures and interactions.

BIOMOLECULAR INTERACTIONS AND DRUG DISCOVERY METHODS: Drug Interactions Prediction: Techniques for identifying and analyzing drug-drug interactions. Cheminformatics Tools: Software and databases for drug discovery (e.g., ChemDraw, PubChem). Molecular Dynamics Simulations for Drug Discovery: Using MD simulations to study drug-target interactions. Quantitative Structure-Activity Relationship (QSAR) Models: Building and interpreting QSAR models for drug efficacy and safety. Pharmacophore Modeling: Identifying essential features for drug-receptor interactions. ADMET Prediction Tools: Tools for predicting drug Absorption, Distribution, Metabolism, Excretion, and Toxicity properties. Biological Activity Prediction: Techniques for predicting the effectiveness of compounds in biological systems. Advanced Drug Target Prediction: Methods for discovering and validating new drug targets.

METHODS IN SMALL MOLECULE DRUG ANALYSIS: Quantitative Structure-Activity Relationship (QSAR) Analysis: Developing and applying QSAR models to correlate chemical structure with biological activity. Pharmacophore Modeling: Designing models to identify essential features for drug-receptor interactions. Molecular Docking: Techniques for simulating the binding of small molecules to target proteins. Computational Chemistry Techniques: Advanced methods for analyzing small molecule interactions. Chemical Library Design: Creating and managing libraries of compounds for drug discovery. Virtual Screening Approaches: Methods for efficiently screening large chemical libraries. Synthesis and Optimization of Drug Candidates: Strategies for synthesizing and improving potential drug molecules.

Reference Books

- 1 Molecular Modeling of Proteins., Andreas Kukol, 2016, Springer New York.
- 2 Molecular Modeling: Basic Principles and Applications., Hans-Dieter Holtje, Wolfgang Sippl, Didier Rognan, Gerd Folkers., 2018, John Wiley & Sons.
- 3 Molecular Modelling Principles and Applications., Pual Clinton, 2015, Pearson Publication.
- 4 Molecular Modelling: Computational Chemistry Demystified, Bladon P, 2021, Rsc Publishing.

23HDA3510 - GENOMIC DATA SCIENCE & CLUSTERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3510	GENOMIC DATA SCIENCE & CLUSTERING	GDSC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand genomic data and representation	2	PO1, PO2, PO3, PSO1
CO2	Demonstrate R program techniques for genomic data analysis	3	PO2, PO3, PO4, PSO1
CO3	Analyse clustering techniques in genomic data	4	PO2, PO3, PO4, PSO1
CO4	Evaluate Data Analysis and Predictive Modelling with Supervised Machine Learning using R	5	PO1, PO3, PO4, PSO1

Syllabus

Genes, DNA and central dogma, Transcriptional and post-transcriptional regulation, Elements of gene regulation, Transcriptional regulation, Shaping the genome: DNA mutation, High-throughput experimental methods in genomics, The general idea behind high-throughput techniques, High-throughput sequencing, Visualization and data repositories for genomics.

Steps of (genomic) data analysis, Getting started with R, Installing packages, Computations in R, Data structures, Reading and writing data, Reading large files, Plotting in R with base graphics, Combining multiple plots, Reading in and writing data out in R, Plotting in R, Functions and control structures (for, if/else, etc.)

How to summarize collection of data points, Using t-test for difference of the means between two samples, Multiple testing correction, Moderated t-tests, Relationship between variables: Linear models and correlation

k-Means Clustering, The Lloyd Algorithm, Clustering Genes Implicated in the Diauxic Shift, Limitations of k-Means Clustering, Soft k-Means Clustering, Hierarchical Clustering, Epilogue: Clustering Tumor Samples. Exploratory Data Analysis with Unsupervised Machine Learning, Clustering techniques, Dimensionality reduction techniques, Predictive Modelling with Supervised Machine Learning, Gradient boosting, Support Vector Machines (SVM), Neural networks and deep versions of it, Ensemble learning,, Predicting continuous variables

Reference Books

- 1 Data Science for Genomics, Amit Kumar Tyagi, Ajith Abraham, 2022, eBook ISBN: 9780323985765.
- 2 Genome Clustering From Linguistic Models to Classification of Genetic Texts, Alexander Bolshoy, ZeevVolkovich, Valery Kirzhner,, 2010, Springer Berlin Heidelberg.
- 3 Deep Learning for genomics, Upendra Kumar Devisetty, 2022, Packt.
- 4 Computational Genomics with R, Altuna Akalin, 2022, eBook.
- 5 Bioinformatics and Functional Genomics, Christina Marshall, 2019, Callisto Reference.

23HDA3511 - EPI GENETIC CONTROL OF GENE EXPRESSION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HDA3511	EPI GENETIC CONTROL OF GENE EXPRESSION	ECBI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the basic epigenetics of gene expressions in normal development with its molecular mechanisms.to regulate gene expressions	2	PO1, PO3, PSO1
CO2	Classify and discuss various mechanisms of chromatin positioning with in the nucleus, and learn dosage compensation of epigenetics.	2	PO2, PSO1
CO3	Demonstrate various epigenetic techniques such as genes and repeats, reprogramming, cloning, transgenerational inheritance.	3	PO2, PO4, PSO1
CO4	Devise real world problems pertained to Epigenetics and discuss the various Epigenetic solutions by design and implementation using a case study	4	PO1, PO3, PSO2

Syllabus

An introduction to epigenetic control of gene expression and its importance in normal development; Molecular mechanisms for regulating gene expression, local level DNA.

Chromatin positioning within the nucleus; Gene silencing and activation; The role of non-coding RNA; Higher order chromatin structures; Dosage compensation: X chromosome inactivation, alternate mechanisms for dosage compensation, erasure and resetting of the epigenome, mechanisms for reprogramming.

Imprinted genes and repeats; Human epigenetics, environmental influence on the epigenome, reprogramming of somatic cells back to stem cells, cloning, and potential transgenerational epigenetic inheritance;

Case study: cancer development and progression, discuss the potential therapeutic benefits that can come from using epigenetic biomarkers, and targeting epigenetic modifiers in cancer.

Reference Books

- 1 Epigenetics, C. David Allis, Thomas Jenuwein, Danny Reinberg, and Marie-Laure Caparros, Second Edition, 2015, Cold Spring Harbor Laboratory Press.
- 2 Epigenetics: Development and Disease, Tapas Kumar Kundu, First Edition, 2013, Springer Nature Publisher.
- 3 Introduction to Genomics, Arthur M. Lesk, Third Edition, 2017, Oxford University Press.
- 4 Epigenetic Principles of Evolution, Nelson R. Cabej, Second Edition, 2018, Elsevier Publisher.
- 5 Epigenetic Gene Expression and Regulation, Suming Huang, Michael D. Litt and C. Ann Blakey, First Edition 2015, Elsevier Publisher.

23HSS3101A - INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3101A	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	ITHSCD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Fundamentals of Hardware-Software Co-Design	3	PO1
CO2	Analyze and Apply Co-Design Techniques	3	PO1, PO2
CO3	Develop Co-Design Systems Using Modeling and Simulation Tools	3	PO2, PO3
CO4	Implement Co-Design Strategies in Embedded Systems	3	PO3, PSO1
CO5	Implement hardware-software co-design strategies in embedded systems, focusing on performance, power, and cost trade-offs.	3	PO3, PSO1
CO6	Develop and optimize co-design systems using various tools and technologies	3	PO3
CO7	Provides hands-on experience in hardware-software co-design methodologies	3	PO3

Syllabus

Hardware-software co-design is an interdisciplinary approach that integrates the design of hardware and software components to optimize overall system performance. It encompasses concepts, principles, and methodologies aimed at achieving efficient system design. The importance of co-design in modern systems lies in its ability to enhance performance, reduce power consumption, and lower costs. Historically, the evolution of co-design has been driven by the increasing complexity of embedded systems and the need for tighter integration. Case studies, such as in automotive control systems and consumer electronics, demonstrate the success of co-design in achieving superior functionality and efficiency.

Analyzing co-design techniques involves evaluating methods like the Y-chart approach, which systematically addresses the co-design process by mapping system functions to hardware and software components. Co-design models, such as hardware/software partitioning and specification models, help define system components and their interactions. Design representations, including UML and SystemC, provide frameworks for visualizing and simulating co-design systems. Key criteria for hardware-software partitioning include performance, cost, power consumption, and flexibility. Understanding these techniques and models allows for their application to real-world problems, optimizing system design by balancing the strengths and limitations of hardware and software components.

Using modeling and simulation tools is essential for designing, testing, and optimizing hardware-software systems. Hardware description languages (HDLs) like VHDL and Verilog are crucial for specifying and simulating hardware components. Software integration techniques ensure seamless interaction between hardware and software parts. Co-simulation and co-verification methodologies, where both hardware and software are simulated together, enable early detection of integration issues and performance bottlenecks. High-level synthesis transforms high-level algorithmic descriptions into hardware descriptions, bridging the gap between software design and hardware implementation, ultimately enhancing the efficiency and reliability of the co-design process.

Implementing hardware-software co-design strategies in embedded systems involves optimizing performance, power, and cost trade-offs. Embedded systems, which are dedicated computing systems within larger mechanical or electrical systems, require efficient co-design strategies. The role of a Real-Time Operating System (RTOS) in co-design is crucial, as it manages scheduling, task management, and real-time constraints to ensure timely and predictable system responses.

In-depth case studies across industries like automotive and telecommunications highlight the practical applications and benefits of hardware-software co-design. In the automotive industry, co-design enhances system performance in areas such as advanced driver assistance systems (ADAS) and infotainment systems. In telecommunications, it optimizes network performance and resource management. Emerging trends, including the Internet of Things (IoT) and the integration of artificial intelligence/machine learning (AI/ML) in co-design, are driving innovation by enabling smarter, more adaptive systems. Future research opportunities focus on improving design automation, energy efficiency, and security. Ethical and societal impacts include considerations of privacy, data security, and the equitable distribution of technology benefits.

Reference Books

- 1 A Practical Introduction to Hardware/Software Codesign, Patrick R. Schaumont, 2016 , springer.
- 2 Hardware/Software Co-Design: Principles and Practice, Jorgen Staunstrup, Wayne Wolf, 1, Kluwer Academic Publishers.
- 3 Hardware/Software Co-Design: Principles and Practice, Jorgen Teich, 2012, Springer.
- 4 Embedded System Design: A Unified Hardware/Software Introduction, Frank Vahid, Tony Givargis, 2001, Wiley.
- 5 Specification and Design of Embedded Systems, Daniel D. Gajski, Frank Vahid, Sanjiv Narayan, Jie Gong, 1994, Prentice Hall.

23HSS3101E - INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3101E	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	ITHSCD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Fundamentals of Hardware-Software Co-Design	3	PO1
CO2	Analyze and Apply Co-Design Techniques	3	PO1, PO2
CO3	Develop Co-Design Systems Using Modeling and Simulation Tools	3	PO2, PO3
CO4	Implement Co-Design Strategies in Embedded Systems	3	PO3, PSO1
CO5	Implement hardware-software co-design strategies in embedded systems, focusing on performance, power, and cost trade-offs.	3	PO3, PSO1
CO6	Develop and optimize co-design systems using various tools and technologies	3	PO3
CO7	Provides hands-on experience in hardware-software co-design methodologies	3	PO3

Syllabus

Hardware-software co-design is an interdisciplinary approach that integrates the design of hardware and software components to optimize overall system performance. It encompasses concepts, principles, and methodologies aimed at achieving efficient system design. The importance of co-design in modern systems lies in its ability to enhance performance, reduce power consumption, and lower costs. Historically, the evolution of co-design has been driven by the increasing complexity of embedded systems and the need for tighter integration. Case studies, such as in automotive control systems and consumer electronics, demonstrate the success of co-design in achieving superior functionality and efficiency.

Analyzing co-design techniques involves evaluating methods like the Y-chart approach, which systematically addresses the co-design process by mapping system functions to hardware and software components. Co-design models, such as hardware/software partitioning and specification models, help define system components and their interactions. Design representations, including UML and SystemC, provide frameworks for visualizing and simulating co-design systems. Key criteria for hardware-software partitioning include performance, cost, power consumption, and flexibility. Understanding these techniques and models allows for their application to real-world problems, optimizing system design by balancing the strengths and limitations of hardware and software components.

Using modeling and simulation tools is essential for designing, testing, and optimizing hardware-software systems. Hardware description languages (HDLs) like VHDL and Verilog are crucial for specifying and simulating hardware components. Software integration techniques ensure seamless interaction between hardware and software parts. Co-simulation and co-verification methodologies, where both hardware and software are simulated together, enable early detection of integration issues and performance bottlenecks. High-level synthesis transforms high-level algorithmic descriptions into hardware descriptions, bridging the gap between software design and hardware implementation, ultimately enhancing the efficiency and reliability of the co-design process.

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In-depth case studies across industries like automotive and telecommunications highlight the practical applications and benefits of hardware-software co-design. In the automotive industry, co-design enhances system performance in areas such as advanced driver assistance systems (ADAS) and infotainment systems. In telecommunications, it optimizes network performance and resource management. Emerging trends, including the Internet of Things (IoT) and the integration of artificial intelligence/machine learning (AI/ML) in co-design, are driving innovation by enabling smarter, more adaptive systems. Future research opportunities focus on improving design automation, energy efficiency, and security. Ethical and societal impacts include considerations of privacy, data security, and the equitable distribution of technology benefits.

Reference Books

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- 2 Hardware/Software Co-Design: Principles and Practice, Jorgen Staunstrup, Wayne Wolf, 2017, Kluwer Academic Publishers.
- 3 Hardware/Software Co-Design: Principles and Practice, Jorgen Teich, 2012, Springer.
- 4 Embedded System Design: A Unified Hardware/Software Introduction, Frank Vahid, Tony Givargis, 2001, Wiley.
- 5 Specification and Design of Embedded Systems, Daniel D. Gajski, Frank Vahid, Sanjiv Narayan, Jie Gong, 1994, PHI.

23HSS3101R - INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3101R	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	ITHSCD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Fundamentals of Hardware-Software Co-Design	3	PO1, PSO1
CO2	Analyze and Apply Co-Design Techniques	3	PO1, PO2
CO3	Develop Co-Design Systems Using Modeling and Simulation Tools	3	PO2, PO3
CO4	Implement Co-Design Strategies in Embedded Systems	3	PO3, PSO1
CO5	Develop and optimize co-design systems using various tools and technologies	3	PO3
CO6	Provides hands-on experience in hardware-software co-design methodologies	3	PO3

Syllabus

Hardware-software co-design is an interdisciplinary approach that integrates the design of hardware and software components to optimize overall system performance. It encompasses concepts, principles, and methodologies aimed at achieving efficient system design. The importance of co-design in modern systems lies in its ability to enhance performance, reduce power consumption, and lower costs. Historically, the evolution of co-design has been driven by the increasing complexity of embedded systems and the need for tighter integration. Case studies, such as in automotive control systems and consumer electronics, demonstrate the success of co-design in achieving superior functionality and efficiency.

Analyzing co-design techniques involves evaluating methods like the Y-chart approach, which systematically addresses the co-design process by mapping system functions to hardware and software components. Co-design models, such as hardware/software partitioning and specification models, help define system components and their interactions. Design representations, including UML and SystemC, provide frameworks for visualizing and simulating co-design systems. Key criteria for hardware-software partitioning include performance, cost, power consumption, and flexibility. Understanding these techniques and models allows for their application to real-world problems, optimizing system design by balancing the strengths and limitations of hardware and software components.

Using modeling and simulation tools is essential for designing, testing, and optimizing hardware-software systems. Hardware description languages (HDLs) like VHDL and Verilog are crucial for specifying and simulating hardware components. Software integration techniques ensure seamless interaction between hardware and software parts. Co-simulation and co-verification methodologies, where both hardware and software are simulated together, enable early detection of integration issues and performance bottlenecks. High-level synthesis transforms high-level algorithmic descriptions into hardware descriptions, bridging the gap between software design and hardware implementation, ultimately enhancing the efficiency and reliability of the co-design process.

Implementing hardware-software co-design strategies in embedded systems involves optimizing performance, power, and cost trade-offs. Embedded systems, which are dedicated computing systems within larger mechanical or electrical systems, require efficient co-design strategies. The role of a Real-Time Operating System (RTOS) in co-design is crucial, as it manages scheduling, task management, and real-time constraints to ensure timely and predictable system responses.

Reference Books

- 1 A Practical Introduction to Hardware/Software Codesign, Patrick R. Schaumont, 2016, Springer.
- 2 Hardware/Software Co-Design: Principles and Practice, Jorgen Staunstrup, Wayne Wolf, 2017, Kluwer Academic Publishers.

- 3 Hardware/Software Co-Design: Principles and Practice, Jorgen Teich, 2012, Springer.
- 4 Embedded System Design: A Unified Hardware/Software Introduction, Frank Vahid, Tony Givargis, 2001, Wiley.
- 5 Specification and Design of Embedded Systems, Daniel D. Gajski, Frank Vahid, Sanjiv Narayan, Jie Gong, 1994, PHI.

23HSS3202A - FUNDAMENTALS OF COMPUTER SECURITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3202A	FUNDAMENTALS OF COMPUTER SECURITY	FOCS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Infer common threats and attacks targeting computer systems and list various security functional requirements based on identified risks and vulnerabilities.	2	PO1, PSO1
CO2	Apply the principles of access control to design and implement security policies for protecting resources within a system	3	PO3
CO3	Analyze the interplay between intrusion detection, and intrusion prevention systems to understand the spectrum of cyber threats and defense mechanisms	4	PO4
CO4	Examine the vulnerabilities inherent in software systems and devise effective countermeasures.	4	PO5
CO5	Evaluate the effectiveness of IT security management frameworks and methodologies in mitigating organizational risks.	5	PO5

Syllabus

Computer Security Concepts, Threats, Attacks, and Assets, Security Functional Requirements, Fundamental Security Design Principles, Attack Surfaces and Attack Trees, Computer Security Strategy, Cryptographic Tools, Confidentiality with Symmetric Encryptions, Message Authentication and Hash Functions, Public key Encryption, Digital Signature and Key Management, User Authentication, Electronic User Authentication Principles, Password Based Authentication, Token Based Authentication, Biometric Authentication, Remote User Authentication, Security Issues for User Authentication.

Access Control, Access Control Principles, Subjects, Objects, and Access Rights, Discretionary Access Control, Example Unix File Access Control, Role Based Access Control, Attribute Based Access Control, Identity, Credential, and Access Management, Trust Frameworks. Database and Cloud Security The Need for Database Security, Database Management Systems, Relational Databases, SQL Injection Attacks, Database Access Control, Inference, Data Encryptions, Malicious Software, Types of Malicious Software, Advanced Persistent Threat, Viruses, Worms, Spam E-Mail, Trojans, System Corruption, Zombie, Bots, Keyloggers, Phishing, Spyware, Backdoors, Rootkits.

Denial of Service Attacks, Flooding Attacks, Distributed Dos Attacks, Application based Bandwidth Attacks, Reflector and Amplifier Attacks, Defend Against Dos Attacks, Intruders, Intrusion Detection, Analysis Approaches, Host based Intrusion Detection, Network-Based Intrusion Detection, Hybrid Intrusion Detection, Honeypots, Snort, Firewalls, and Intrusion Prevention Systems, The Need for Firewalls, Firewall Characteristics and Access Policy, Types of Firewalls, Intrusion Prevention Systems.

SOFTWARE SECURITY AND TRUSTED SYSTEMS, Buffer Overflow, Stack Overflows, Defending Against Buffer Overflows, Other forms of Overflow Attacks, software Security Issues, Handling Program Input, Writing Safe Program Code, Interacting with the Operating System and Other Programs, Operating System Security, System security planning, operating systems hardening, Application Security, Security Maintenance, Linux Unix Security, Windows Security, Virtualization Security, The Bell-LaPadula Model for Computer Security, Other Formal Model for Computer Security, Trusted Systems, Application of Multilevel Security, Trusted Computing and the Trusted Platform Module.

IT Security Management and Risk Management, Organizational Context and Security policy, Security Risk Assessment, Detailed Security Risk Analysis, IT Security Controls, Plans, and procedures, Implementation, Security Controls, IT Security Plan, Implementation of Controls, Monitoring Risks, Silver Star Mines, Physical and Infrastructure Security, Physical Security Threats, Prevention and Mitigation Measures, Recovery From Physical Security Breaches, Corporate Physical Security Policy

Reference Books

- 1 Computer Security Principles and Practice, William Stallings, Lawrie Brown, 2015, PEARSON.
- 2 An Introduction to Computer Security: The NIST Handbook, Barbara Guttman and Edward A. Roback, 1995, NIST .
- 3 Introduction to Computer Security, Matt Bishop, 1995, Addison Wesley.
- 4 Principles of Computer Security Comptia Security and Beyond, Vincent Nestler Wm. Arthur Conklin Gregory White Matthew Hirsch, 2005, McGrawHill.
- 5 Computer Security Basics: Computer Security for the 21st Century, Rick Lehtinen, G.T. Gangemi Sr, 2006, OReilly.

23HSS3202E - FUNDAMENTALS OF COMPUTER SECURITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3202E	FUNDAMENTALS OF COMPUTER SECURITY	FOCS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Infer common threats and attacks targeting computer systems and list various security functional requirements based on identified risks and vulnerabilities.	2	PO1, PSO1
CO2	Apply the principles of access control to design and implement security policies for protecting resources within a system	3	PO3
CO3	Analyze the interplay between intrusion detection, and intrusion prevention systems to understand the spectrum of cyber threats and defense mechanisms	4	PO4
CO4	Examine the vulnerabilities inherent in software systems and devise effective countermeasures.	4	PO5
CO5	Evaluate the effectiveness of IT security management frameworks and methodologies in mitigating organizational risks.	5	PO5

Syllabus

Computer Security Concepts, Threats, Attacks, and Assets, Security Functional Requirements, Fundamental Security Design Principles, Attack Surfaces and Attack Trees, Computer Security Strategy, Cryptographic Tools, Confidentiality with Symmetric Encryptions, Message Authentication and Hash Functions, Public key Encryption, Digital Signature and Key Management, User Authentication, Electronic User Authentication Principles, Password Based Authentication, Token Based Authentication, Biometric Authentication, Remote User Authentication, Security Issues for User Authentication.

Access Control, Access Control Principles, Subjects, Objects, and Access Rights, Discretionary Access Control, Example Unix File Access Control, Role Based Access Control, Attribute Based Access Control, Identity, Credential, and Access Management, Trust Frameworks. Database and Cloud Security The Need for Database Security, Database Management Systems, Relational Databases, SQL Injection Attacks, Database Access Control, Inference, Data Encryptions, Malicious Software, Types of Malicious Software, Advanced Persistent Threat, Viruses, Worms, Spam E-Mail, Trojans, System Corruption, Zombie, Bots, Keyloggers, Phishing, Spyware, Backdoors, Rootkits.

Denial of Service Attacks, Flooding Attacks, Distributed Dos Attacks, Application based Bandwidth Attacks, Reflector and Amplifier Attacks, Defend Against Dos Attacks, Intrusion Detection, Intruders, Intrusion Detection, Analysis Approaches, Host based Intrusion Detection, Network-Based Intrusion Detection, Hybrid Intrusion Detection, Honeypots, Snort, Firewalls, and Intrusion Prevention Systems, The Need for Firewalls, Firewall Characteristics and Access Policy, Types of Firewalls, Firewall Location and Configuration, Intrusion Prevention Systems, Example Unified Threat Management Products.

SOFTWARE SECURITY AND TRUSTED SYSTEMS, Buffer Overflow, Stack Overflows, Defending Against Buffer Overflows, Other forms of Overflow Attacks, software Security Issues, Handling Program Input, Writing Safe Program Code, Interacting with the Operating System and Other Programs, Operating System Security, System security planning, operating systems hardening, Application Security, Security Maintenance, Linux Unix Security, Windows Security, Virtualization Security, The Bell-LaPadula Model for Computer Security, Other Formal Model for Computer Security, Trusted Systems, Application of Multilevel Security, Trusted Computing and the Trusted Platform Module.

IT Security Management and Risk Management, Organizational Context and Security policy, Security Risk Assessment, Detailed Security Risk Analysis, IT Security Controls, Plans, and procedures, Implementation, Security Controls, IT Security Plan, Implementation of Controls, Monitoring Risks, Silver Star Mines, Physical and Infrastructure Security, Physical Security Threats, Prevention and Mitigation Measures, Recovery From Physical Security Breaches, Corporate Physical Security Policy

Reference Books

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- 2 An Introduction to Computer Security The NIST Handbook, Barbara Guttman and Edward A. Roback, 1995, NIST.
- 3 Introduction to Computer Security, Matt Bishop, 2005, Addison Wesley.
- 4 Principles of Computer Security Comptia security and Beyond, Vincent Nestler , 2011, McGrawHill.
- 5 Computer Security Basics: Computer Security for the 21st Century, Rick Lehtinen, G.T. Gangemi Sr, 2006, O'Reilly.

23HSS3202R - FUNDAMENTALS OF COMPUTER SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3202R	FUNDAMENTALS OF COMPUTER SECURITY	FOCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Infer common threats and attacks targeting computer systems and list various security functional requirements based on identified risks and vulnerabilities	2	PO1, PSO1
CO2	Apply the principles of access control to design and implement security policies for protecting resources within a system	3	PO3
CO3	Analyze the interplay between intrusion detection, and intrusion prevention systems to understand the spectrum of cyber threats and defense mechanisms	4	PO4
CO4	Examine the vulnerabilities inherent in software systems and devise effective countermeasures.	4	PO5

Syllabus

Computer Security Concepts, Threats, Attacks, and Assets, Security Functional Requirements, Fundamental Security Design Principles, Attack Surfaces and Attack Trees, Computer Security Strategy, Cryptographic Tools, Confidentiality with Symmetric Encryptions, Message Authentication and Hash Functions, Public key Encryption, Digital Signature and Key Management, User Authentication, Electronic User Authentication Principles, Password Based Authentication, Token Based Authentication, Biometric Authentication, Remote User Authentication, Security Issues for User Authentication.

Access Control, Access Control Principles, Subjects, Objects, and Access Rights, Discretionary Access Control, Example Unix File Access Control, Role Based Access Control, Attribute Based Access Control, Identity, Credential, and Access Management, Trust Frameworks. Database and Cloud Security The Need for Database Security, Database Management Systems, Relational Databases, SQL Injection Attacks, Database Access Control, Inference, Data Encryptions, Malicious Software, Types of Malicious Software, Advanced Persistent Threat, Viruses, Worms, Spam E-Mail, Trojans, System Corruption, Zombie, Bots, Keyloggers, Phishing, Spyware, Backdoors, Rootkits.

Denial of Service Attacks, Flooding Attacks, Distributed Dos Attacks, Application based Bandwidth Attacks, Reflector and Amplifier Attacks, Defend Against Dos Attacks, Intruders, Intrusion Detection, Analysis Approaches, Host based Intrusion Detection, Network-Based Intrusion Detection, Hybrid Intrusion Detection, Honeypots, Snort, Firewalls, and Intrusion Prevention Systems, The Need for Firewalls, Firewall Characteristics and Access Policy, Types of Firewalls, Intrusion Prevention Systems.

SOFTWARE SECURITY AND TRUSTED SYSTEMS, Buffer Overflow, Stack Overflows, Defending Against Buffer Overflows, Other forms of Overflow Attacks, software Security Issues, Handling Program Input, Writing Safe Program Code, Interacting with the Operating System and Other Programs, Operating System Security, System security planning, operating systems hardening, Application Security, Security Maintenance, Linux Unix Security, Windows Security, Virtualization Security, The Bell-LaPadula Model for Computer Security, Other Formal Model for Computer Security, Trusted Systems, Application of Multilevel Security, Trusted Computing and the Trusted Platform Module.

Reference Books

- 1 Computer Security Principles and Practice, William Stallings, Lawrie Brown, 1, PEARSON.
- 2 An Introduction to Computer Security: The NIST Handbook, Barbara Guttman and Edward A. Roback, 1, NIST.
- 3 Introduction to Computer Security, Matt Bishop, 1, Addison Wesley.
- 4 Principles of Computer Security Comptia Security and Beyond, Vincent Nestler Wm. Arthur Conklin Gregory White Matthew Hirsch, 2, McGrawHill.

- 5 Cyber Security, Nina Godbole, 2011, Wiley.

23HSS3303A - HARDWARE SECURITY MECHANISMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3303A	HARDWARE SECURITY MECHANISMS	HSM	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	the fundamental concepts, techniques, and methodologies of securing hardware systems against a wide range of threats and vulnerabilities	2	PO1, PO5, PO9, PSO2
CO2	Understand the fundamentals of hardware security and its importance in modern computing systems.	3	PO1, PO5, PO9, PSO2
CO3	Learn about various hardware security threats and vulnerabilities.	3	PO1, PO5, PO9, PSO2
CO4	Explore cryptographic techniques and protocols used in hardware security.	3	PO1, PO5, PO9, PSO2
CO5	Develop skills for designing and implementing secure hardware systems.	3	PO1, PO5, PO9, PSO2
CO6	Gain insights into hardware-based authentication and access control mechanisms.	3	PO1, PO5, PO9, PSO2
CO7	Explore emerging trends and challenges in hardware security.	4	PO1, PO5, PO9, PSO2

Syllabus

CO 1: Introduction to Hardware Security, Threat Modeling and Risk Assessment Overview of hardware security concepts and terminology, Importance of hardware security in modern computing systems, Threat model and security goals for hardware systems, Common threats and vulnerabilities in hardware systems, Techniques for threat modeling and risk assessment, Case studies of real-world hardware security breaches,

CO 2: Cryptographic Hardware Security, Secure Boot and Firmware Security Introduction to cryptographic primitives and algorithms, Hardware implementations of symmetric and asymmetric cryptography, Side-channel attacks and countermeasures in cryptographic hardware, Principles of secure boot and trusted boot process, Firmware security mechanisms and best practices, Case studies of firmware-based attacks and mitigation strategies

CO 3: Hardware-based Authentication, Tamper Resistance and Physical Security Types of hardware-based authentication mechanisms, Secure elements and trusted platform modules (TPMs), Biometric authentication in hardware systems, Techniques for tamper detection and response, Design considerations for physically secure hardware, Side-channel attacks and countermeasures in tamper-resistant hardware

CO 4: Hardware-based Access Control Role-based access control (RBAC) in hardware systems, Hardware-enforced security policies and access control mechanisms, Case studies of access control mechanisms in hardware devices

CO 5: Hardware Security Evaluation and Testing Methods for evaluating and testing hardware security, Common criteria and standards for hardware security evaluation, Case studies of hardware security certification and compliance

Reference Books

- 1 "Introduction to Hardware Security and Trust" , Mohammad Tehranipoor and Cliff Wang, 4, PEARSONS.
- 2 "Hardware Security: Design, Threats, and Safeguards" , Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, 3, PEARSONS.
- 3 "Hardware Security: Design, Threats, and Safeguards", Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, 2, Morgan Kaufmann.
- 4 Hardware Security: A Hands-on Learning Approach, Bhunia and M. Tehranipoor, 1, tata mc hill.

23HSS3303E - HARDWARE SECURITY MECHANISMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3303E	HARDWARE SECURITY MECHANISMS	HSM	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	the fundamental concepts, techniques, and methodologies of securing hardware systems against a wide range of threats and vulnerabilities.	2	PO1, PO5, PO9, PSO2
CO2	Understand the fundamentals of hardware security and its importance in modern computing systems.	3	PO1, PO5, PO9, PSO2
CO3	Learn about various hardware security threats and vulnerabilities.	3	PO1, PO5, PO9, PSO2
CO4	Explore cryptographic techniques and protocols used in hardware security.	3	PO1, PO5, PO9, PSO2
CO5	Develop skills for designing and implementing secure hardware systems.	3	PO1, PO5, PO9, PSO2
CO6	Gain insights into hardware-based authentication and access control mechanisms.	3	PO1, PO5, PO9, PSO2
CO7	Explore emerging trends and challenges in hardware security.	3	PO1, PO5, PO9, PSO2

Syllabus

CO 1: Introduction to Hardware Security, Threat Modeling and Risk Assessment Overview of hardware security concepts and terminology, Importance of hardware security in modern computing systems, Threat model and security goals for hardware systems, Common threats and vulnerabilities in hardware systems, Techniques for threat modeling and risk assessment, Case studies of real-world hardware security breaches,

CO 2: Cryptographic Hardware Security, Secure Boot and Firmware Security Introduction to cryptographic primitives and algorithms, Hardware implementations of symmetric and asymmetric cryptography, Side-channel attacks and countermeasures in cryptographic hardware, Principles of secure boot and trusted boot process, Firmware security mechanisms and best practices, Case studies of firmware-based attacks and mitigation strategies

CO 3: Hardware-based Authentication, Tamper Resistance and Physical Security Types of hardware-based authentication mechanisms, Secure elements and trusted platform modules (TPMs), Biometric authentication in hardware systems, Techniques for tamper detection and response, Design considerations for physically secure hardware, Side-channel attacks and countermeasures in tamper-resistant hardware

CO 4: Hardware-based Access Control Role-based access control (RBAC) in hardware systems, Hardware-enforced security policies and access control mechanisms, Case studies of access control mechanisms in hardware devices

CO 5: Hardware Security Evaluation and Testing Methods for evaluating and testing hardware security, Common criteria and standards for hardware security evaluation, Case studies of hardware security certification and compliance

Reference Books

- 1 "Introduction to Hardware Security and Trust" , Mohammad Tehranipoor and Cliff Wang, 4, PEARSONS.
- 2 "Hardware Security: Design, Threats, and Safeguards" , Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, 3, PEARSONS.
- 3 "Hardware Security: Design, Threats, and Safeguards", Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, 2, tata mc hill.
- 4 "Introduction to Hardware Security and Trust", Mohammad Tehranipoor, Cliff Wang, 2, tata mc hill.

23HSS3303R - HARDWARE SECURITY MECHANISMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3303R	HARDWARE SECURITY MECHANISMS	HSM	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	the fundamental concepts, techniques, and methodologies of securing hardware systems against a wide range of threats and vulnerabilities.	2	PO1, PO5, PO9, PSO2
CO2	It covers principles of secure design, implementation, and evaluation of hardware security mechanisms.	3	PO1, PO5, PO9, PSO2
CO3	Understand the fundamentals of hardware security and its importance in modern computing systems.	3	PO1, PO5, PO9, PSO2
CO4	Learn about various hardware security threats and vulnerabilities.	3	PO1, PO5, PO9, PSO2
CO5	Gain insights into hardware-based authentication and access control mechanisms.	3	PO1, PO5, PO9, PSO2
CO6	Develop skills for designing and implementing secure hardware systems.	4	PO1, PO5, PO9, PSO2

Syllabus

CO 1: Introduction to Hardware Security, Threat Modeling and Risk Assessment Overview of hardware security concepts and terminology, Importance of hardware security in modern computing systems, Threat model and security goals for hardware systems, Common threats and vulnerabilities in hardware systems, Techniques for threat modeling and risk assessment, Case studies of real-world hardware security breaches,

CO 2: Cryptographic Hardware Security, Secure Boot and Firmware Security Introduction to cryptographic primitives and algorithms, Hardware implementations of symmetric and asymmetric cryptography, Side-channel attacks and countermeasures in cryptographic hardware, Principles of secure boot and trusted boot process, Firmware security mechanisms and best practices, Case studies of firmware-based attacks and mitigation strategies

CO 3: Hardware-based Authentication, Tamper Resistance and Physical Security Types of hardware-based authentication mechanisms, Secure elements and trusted platform modules (TPMs), Biometric authentication in hardware systems, Techniques for tamper detection and response, Design considerations for physically secure hardware, Side-channel attacks and countermeasures in tamper-resistant hardware

CO 4: Hardware-based Access Control Role-based access control (RBAC) in hardware systems, Hardware-enforced security policies and access control mechanisms, Case studies of access control mechanisms in hardware devices

Reference Books

- 1 "Introduction to Hardware Security and Trust" , Mohammad Tehranipoor and Cliff Wang, 3, PEARSONS.
- 2 "Hardware Security: Design, Threats, and Safeguards" , Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, 4, PEARSONS.
- 3 "Hardware Security: Design, Threats, and Safeguards", Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, 2, tata mc hill.
- 4 "Introduction to Hardware Security and Trust, Mohammad Tehranipoor, Cliff Wang, 1, tata mc hill.

23HSS3404M - SOFTWARE SECURITY PRINCIPLES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3404M	SOFTWARE SECURITY PRINCIPLES	SSP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Compare and contrast different software security models and their problems for various applications.	2	PO1, PSO1
CO2	Develop software security metrics to assess the effectiveness of security measures to identify threats	3	PO3
CO3	Inspect factors influencing software security estimation accuracy	4	PO4
CO4	Analyze the integration of security practices within the software development lifecycle	4	PO5

Syllabus

Software and Security Concepts, Security Overview, Software Perspective, Security Components, Security Characteristics, Security Types, Security Myths, Security Planning, Software Security Assurance, Software Security Models, Measurement and Metrics, Software Security Problems, Major Causes to Software Security, Sustainable Factors for Software Security, Risk Management Framework, Protracted Cigital Risk Management Framework, Security Engineering an Inclusive Approach.

Threats to Security, Threats, Security Threats, Security Threats Classification, Threat Impact Analysis, Protection and Mitigation Strategies, Software Security Metrics, Defining Good Security Metrics, Security Metrics Collection, Security Metrics Development Process, Security Metrics Development Framework, Software Security Metrics, Software Security Metrics.

Software Security Estimation, Security Risk Estimation, Vulnerability Assessment Framework, Security Profiling, Operation Ability, Security Measurement Process, Secure Software Architecture, Security Architecture Models, Security Architecture Process, Software Security Best Practices, Software Security Assurance, Information Security Assurance Framework

Secure Software Development Process, Secure Development, Microsoft Secure Development Life Cycle, OWASP Software Development Framework, Software Security Testing, Security Testing, Software Security Testing Process, An Integrated Approach, Security Test Strategy and Plan, Designing Security Test Cases, Executing Security Test Cases, Capturing Security Test Results, Test Metrics, Qualitative Assessment.

Reference Books

1. Software Security Concepts & Practices , Suhel Ahmad Khan Rajeev Kumar Raees Ahmad Khan, 2023, CRC Press.
2. Software Security Principles, Policies, and Protection, Mathias Payer, 2021, MIT Press.
3. Software Security: Building Security In, Gary McGraw, 2006, Addison Wesley Software Security.
4. The Art of Software Security Assessment Identifying and Preventing Software Vulnerabilities, Mark Dowd, John McDonald, Justin Schuh , 2006, Addison Wesley Professional.
5. Threat Modeling Designing for Security, Adam Shostack, 2014, Wiley.
6. Computer Security Principles and Practice, William Stallings, 2015, Pearson.

23HSS3405M - SECURE CO-DESIGN METHODOLOGIES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3405M	SECURE CO-DESIGN METHODOLOGIES	SCDM	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand security considerations into the design process to develop resilient systems from inception and mitigate weaknesses within systems to fortify against potential security breaches and threats	2	PO5, PSO1
CO2	Analyze risk mitigation strategies and emphasize the importance of collaboration in integrating security measures into co-design processes.	3	PO5, PSO1
CO3	Apply security controls and technologies effectively within the design process to enhance system and product security	4	PO5, PSO1
CO4	Apply security principles and make strategic decisions to enhance overall security measures effectively	4	PO5, PSO1

Syllabus

Introduction to Secure Co-design: Overview of secure co-design methodologies-Importance of integrating security into the design process- Security Threats and Vulnerabilities- Common security threats in system design-Analysis of security vulnerabilities-Case studies on security breaches

Risk Assessment and Management: Principles of risk assessment-Risk identification, analysis, and prioritization-Risk mitigation strategies- Stakeholder Collaboration- Importance of collaboration in secure co-design-Techniques for effective stakeholder engagement-Role of different stakeholders in the design process

Security-by-Design Principles: Principles of security-by-design-Designing with secure defaults-Minimizing attack surfaces- Security Controls and Technologies: Overview of security controls and technologies-Selection and implementation of security controls-Integration of security technologies into the design process

Iterative Design Process: Principles of iterative design-Conducting design iterations for security improvement-Continuous evaluation and refinement- Communication and Documentation: Effective communication of security concepts and decisions-Documentation of security requirements and design decisions-Presentation skills for communicating with stakeholders

Reference Books

- Secure System Design and Trustable Computing, Shuo Chen, Ravi Chandra Jammalamadaka, Vinod Ganapathy, Peng Liu, 1st Edition (November 17, 2016), Morgan Kaufmann.
- Engineering Secure Software and Systems: 9th International Symposium, ESSoS 2017, Bonn, Germany, July 3-5, 2017, Proceedings (Lecture Notes in Computer Science), Eric Bodden, Mathias Payer, 1st ed. 2017 Edition (May 29, 2017), Springer.
- Security and Privacy in Cyber-Physical Systems, Houbing Song, Glenn A. Fink, Sabina Jeschke, 1st Edition (November 6, 2017), Wiley-IEEE Press.
- Security-Aware Design for Cyber-Physical Systems: A Platform-Based Approach, Gasser, L., Mottola, L., Picco, G.P., R?mer, K., and Voigt, T, 1st Edition, Springer.
- Secure System Design and Virtualization, Saad, W., and Salah, K., 1st Edition, CRC Press.
- Secure Processor Design: Techniques and Tools, Koeberl, P., Schulte, M., and Yusuf, S, 1st Edition, Springer.

23HSS3406M - HARDWARE TROJAN DETECTION AND PREVENTION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3406M	HARDWARE TROJAN DETECTION AND PREVENTION	HTDAP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Recognize and classify different types of Hardware Trojans based on their design characteristics and insertion methods within integrated circuits.	2	PO1, PO2, PO5, PSO1, PSO2
CO2	Demonstrate proficiency in applying various Hardware Trojan detection techniques, including functional testing, side-channel analysis, and physical inspection, to identify potential security threats within integrated circuits.	3	PO1, PO3, PO5, PSO1, PSO2
CO3	Design and implement prevention strategies and countermeasures to mitigate the risk of Hardware Trojan attacks in integrated circuits, considering both design-level and fabrication-level approaches.	3	PO1, PO3, PO5, PSO1, PSO2
CO4	Critically analyze case studies of real-world Hardware Trojan attacks, evaluating the effectiveness of detection and prevention methods employed and proposing appropriate solutions to enhance hardware security.	4	PO2, PO5, PSO1, PSO2

Syllabus

Introduction to Hardware Trojans, Taxonomy and classification of Hardware Trojans, Anatomy of Hardware Trojans, Detection Challenges and Limitations, Ethical and Societal Implications

Functional Testing for Hardware Trojan Detection, Side-Channel Analysis Methods, Physical Inspection Techniques, Hardware Trojan Detection Tools, Case Studies and Application

Design-Level Prevention Strategies, Fabrication-Level Prevention Techniques, Post-Fabrication Verification Methods, Secure Development Practices, Case Studies and Best Practices

Emerging Trends in Hardware Trojan Research, Industry Perspectives on Hardware Trojan Security, Research Projects and Presentations, Practical Applications and Hands-On Exercises, Course Reflection and Future Directions

Reference Books

- 1 Hardware Trojans: Detecting and Preventing Unwanted Alterations in Integrated Circuits, Christian Krieg, Igor L. Markov, First Edition, Springer.
- 2 Hardware Trojan Attacks: Threat Analysis and Countermeasures, Swarup Bhunia, Mark M. Tehranipoor, First Edition, Springer.
- 3 Introduction to Hardware Security and Trust, Mohammad Tehranipoor, Cliff Wang, First Edition, Springer.
- 4 Principles of Hardware Security, Wayne Burleson, Mohammad Tehranipoor, First Edition, Springer.
- 5 Security Metrics: Replacing Fear, Uncertainty, and Doubt, Andrew Jaquith, First Edition, Addison-Wesley Professional.
- 6 Cryptographic Engineering, Niels Ferguson, Bruce Schneier, Tadayoshi Kohno, First Edition, Wiley.
- 7 Hardware Security: A Hands-On Learning Approach, Swarup Bhunia, Mark M. Tehranipoor, First Edition, Springer.

23HSS3507 - SIDE-CHANNEL ATTACKS AND COUNTERMEASURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3507	SIDE-CHANNEL ATTACKS AND COUNTERMEASURES	SCACM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Knowledge and Understanding Students will demonstrate a thorough understanding of side channel attacks and their significance in cryptographic system security. They will be able to explain the principles underlying different types of side channel attacks, including timing attacks, power analysis, electromagnetic radiation analysis, and acoustic cryptanalysis.	1	PO1, PO2, PSO2
CO2	Application and Analysis Students will be able to analyze real-world cryptographic implementations to identify potential side-channel vulnerabilities. They will apply their knowledge to assess the threat posed by side-channel attacks and evaluate the effectiveness of various countermeasures in mitigating these vulnerabilities.	2	PO1, PO2, PSO2
CO3	Synthesis and Creation Students will develop practical skills in conducting side-channel analysis using open-source tools and software. They will design and implement countermeasures to mitigate side-channel vulnerabilities in cryptographic systems, considering both hardware and software aspects.	3	PO1, PO2, PSO2
CO4	Evaluation and Reflection Students will critically evaluate the strengths and limitations of different side-channel attack techniques and countermeasures. They will reflect on the ethical implications of side-channel research and the responsibility of cybersecurity professionals to protect sensitive information against such attacks.	4	PO1, PO2, PSO2

Syllabus

Introduction to Side-Channel Attacks Overview of side-channel attacks and their significance Historical examples and real-world implications Classification of side-channel attacks; **Timing Attacks** Understanding timing leakage in cryptographic systems Techniques for exploiting timing vulnerabilities Mitigation strategies and best practices

Power Analysis Attacks Principles of power analysis and its relevance to cryptographic implementations Simple power analysis (SPA) and differential power analysis (DPA) Countermeasures against power analysis attacks; **Electromagnetic Radiation Analysis (EMA)** Introduction to electromagnetic radiation analysis Differential electromagnetic analysis (DEMA) and other EMA techniques Shielding and other countermeasures

Acoustic Cryptanalysis Overview of acoustic side-channel attacks Techniques for analyzing acoustic emissions from computing devices Countermeasures to mitigate acoustic cryptanalysis; **Combined Attacks and Advanced Techniques** Combined side-channel attacks: exploiting multiple leakage channels Advanced side-channel analysis techniques Research trends and emerging threats

Countermeasures and Implementations Hardware and software countermeasures to mitigate side-channel vulnerabilities Implementing countermeasures in cryptographic systems Practical demonstrations and case studies; **Hands-on Workshop** Conducting side-channel analysis using open-source tools (e.g., ChipWhisperer) Implementing and testing countermeasures in cryptographic software and hardware Presenting findings and discussing practical

Reference Books

- 1 Side-Channel Attacks and Countermeasures, Luca Giancane, 1st, LAP Lambert Academic Publishing.
- 2 Side-Channel Analysis of Embedded Systems, Jean-Luc Danger, Olivier Thomas, 1st, Springer.
- 3 Timing Side-Channel Attacks and Countermeasures in CPU, J. Zhang, 1st, ACM.
- 4 Survey of CPU Cache-Based Side-Channel Attacks, C. Su, 1st, Hindawi.

23HSS3508 - FORMAL METHODS FOR HARDWARE-SOFTWARE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3508	FORMAL METHODS FOR HARDWARE-SOFTWARE SECURITY	FMHSS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Course Outcome 1: Knowledge and Understanding Students will demonstrate a solid understanding of the theoretical foundations of formal methods for security analysis. They will be able to explain key concepts such as formal specification languages, model checking algorithms, theorem proving techniques, and static and dynamic analysis methods.	1	PO1, PO2, PSO2
CO2	Course Outcome 2: Application and Analysis Students will apply formal modeling techniques to specify security properties of hardware and software systems. They will analyze and evaluate security vulnerabilities using formal verification tools and methodologies, such as model checking, theorem proving, static analysis, and dynamic analysis.	2	PO1, PO2, PSO2
CO3	Course Outcome 3: Synthesis and Creation Students will synthesize theoretical knowledge with practical skills to develop formal models and verification procedures for hardware-software security. They will design and implement formal verification strategies to address real-world security challenges in hardware-software systems.	3	PO1, PO2, PSO2
CO4	Course Outcome 4: Evaluation and Reflection Students will critically evaluate the effectiveness and limitations of formal methods in addressing security challenges. They will reflect on the ethical implications of security analysis and the responsibility of cybersecurity professionals to ensure the security and integrity of hardware-software systems.	4	PO1, PO2, PSO2

Syllabus

Introduction to Formal Methods for Security Overview of formal methods and their role in security analysis Theoretical foundations: logic, automata theory, and formal verification Applications of formal methods in hardware-software security; Formal Specification of Security Properties Formal specification languages (e.g., temporal logics, process algebras) Specifying security requirements and properties using formal methods Case studies of formal specifications in security protocols and access control models

Model Checking Principles of model checking for verifying hardware and software systems Temporal logic model checking algorithms (e.g., CTL, LTL) Practical applications of model checking in security analysis; Theorem Proving Introduction to theorem proving techniques and theorem provers Deductive verification of security properties using theorem proving Case studies of theorem proving in security protocol analysis

Static Analysis Principles of static analysis for detecting security vulnerabilities Abstract interpretation and data flow analysis techniques Tools and methodologies for applying static analysis to hardware-software security; Dynamic Analysis Techniques for dynamic analysis of software and hardware systems Runtime verification and monitoring for security properties Case studies of dynamic analysis in security testing and intrusion detection

Formal Methods for Cryptographic Protocols Formal modeling and verification of cryptographic protocols Analyzing security properties (e.g., secrecy, authentication) using formal methods Case studies of formal analysis in cryptographic protocol design; Applications and Case Studies Application of formal methods to real-world security problems in hardware-software systems Case studies of successful applications of formal methods in industry and academia Future trends and emerging challenges in formal methods for security

Reference Books

- 1 Formal Methods for Software Engineering: Languages, Systems, and Applications, Marcus V. G. A. Alves, Augusto Sampaio, Adenilso da Silva Sim?o, 1st, Springer.

- 2 Formal Methods for Safety and Security, Manfred Broy, Wolfgang Damm, 1st, Springer.
- 3 6th International School on Formal Methods for the Design of Computer, Communication and Software Systems, Marco Bernardo, Alessandro Cimatti, Einar Broch Johnsen, 1st, Springer.
- 4 Formal Methods: Specification, Verification, and Synthesis, Edward A. Lee, Sanjit A. Seshia, 1st, University of California, Berkeley.

23HSS3509 - TRUSTED PLATFORM MODULES AND SECURE ELEMENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3509	TRUSTED PLATFORM MODULES AND SECURE ELEMENTS	TPMASE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Trusted Platform Modules (TPMs) and Secure Elements, including their purpose, architecture, and functionalities in enhancing hardware security.	2	PO1, PO5, PSO1, PSO2
CO2	Analyze and evaluate the security features and mechanisms provided by TPMs and Secure Elements, including secure boot, cryptographic operations, and secure storage, to ensure the integrity and confidentiality of sensitive data.	4	PO1, PO2, PSO1, PSO2
CO3	Develop practical skills in implementing TPM and Secure Element-based applications, including authentication protocols, key management systems, and secure communication channels, to protect against various security threats such as malware and unauthorized access.	3	PO3, PSO1, PSO2
CO4	Evaluate integration and deployment strategies of TPMs and Secure Elements within different computing environments, including embedded systems, IoT devices, and cloud computing platforms, considering factors such as interoperability, scalability, and regulatory compliance.	5	PO3, PSO1, PSO2

Syllabus

Introduction to Trusted Platform Modules (TPMs) and Secure Elements: Overview of Hardware Security, Introduction to TPMs, Secure Elements, Comparison between TPMs and Secure Elements

Security Features and Mechanisms: Secure Boot, Cryptographic Operations, Secure Storage, Remote Attestation

Implementation of TPM and Secure Element Applications: Authentication Protocols such as TPM-based secure login, single sign-on (SSO), and two-factor authentication (2FA), Key Management Systems, Secure Communication Channels, Malware Protection

Integration and Deployment Strategies for TPM: Embedded Systems Integration, Cloud Computing Platforms, Interoperability and Scalability, Regulatory Compliance such as GDPR, HIPAA, and industry-specific compliance mandates.

Reference Books

- 1 Trusted Computing Platforms: TPM2.0 in Context, Steven Sprague, First Edition, Apress.
- 2 Trusted Computing - Challenges and Applications, Ahmad-Reza Sadeghi, Christian St?ble, Christian Wachsmann, First Edition, Springer.
- 3 Trusted Computing Platforms: Design and Applications, Andrei Samsonov, First Edition, Wiley.
- 4 A Practical Guide to TPM 2.0: Using the Trusted Platform Module in the New Age of Security, David Challener, Kent Yoder, Second Edition, Apress.
- 5 Secure and Privacy-Preserving Data Communication in Internet of Things, Frank Zhigang Wang, First Edition, Springer.
- 6 Internet of Things Security: Fundamentals, Techniques, and Applications, Jun Shao, First Edition, Wiley.
- 7 Secure and Trustworthy Cyberspace: TPMS, Secure Elements, and Hardware Security, Patrick Traynor, Hayawardh Vijayakumar, Hadi Abdullah, Elham Shaabani, First Edition, CRC Press.

23HSS3510 - SECURE COMMUNICATION PROTOCOLS AND APIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3510	SECURE COMMUNICATION PROTOCOLS AND APIS	SCPA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	This course explores the principles and practices of secure communication protocols and APIs. Students will learn about encryption techniques, authentication methods, secure transmission protocols, and best practices for implementing secure APIs.	2	PO1, PO5, PO9, PSO2
CO2	Understand the fundamentals of secure communication protocols. Learn about encryption algorithms and their applications.	3	PO1, PO5, PO9, PSO2
CO3	Explore authentication mechanisms for ensuring secure access to resources.	3	PO1, PO5, PO9, PSO2
CO4	Gain practical knowledge of secure transmission protocols. Develop skills for designing and implementing secure APIs.	3	PO1, PO5, PO9, PSO2

Syllabus

CO 1: Introduction to Secure Communication, Encryption Algorithms Overview of security threats in communication, Principles of encryption and cryptography, Symmetric vs. asymmetric encryption, Introduction to encryption algorithms (e.g., AES, RSA), Encryption modes and padding schemes, Key management and distribution

CO 2: Authentication Methods, Secure Transmission Protocols Password-based authentication, Multi-factor authentication (MFA), Token-based authentication (JWT, OAuth), Secure Socket Layer (SSL) / Transport Layer Security (TLS), HTTPS and its significance, Perfect Forward Secrecy (PFS)

CO 3: Public Key Infrastructure (PKI), API Security Fundamentals Understanding PKI, Certificate Authorities (CAs) and certificate chains, SSL/TLS certificate management, Overview of API security challenges, Authentication and authorization in APIs, API security best practices

CO 4: API Authentication and Authorization, API Security Threats and Mitigation API keys and tokens, OAuth 2.0 framework, Role-based access control (RBAC) for APIs, Common API security vulnerabilities (e.g., injection attacks, broken authentication), Techniques for securing APIs against threats, API security testing and monitoring

Reference Books

- 1 "Cryptography and Network Security: Principles and Practice", William Stallings, 3, pearsons.
- 2 Cryptography Engineering: Design Principles and Practical Applications, Bruce Schneier, 1, pearsons.
- 3 "API Security: How to Build a Secure API", Matthias Biehl, 4, tata magrahill.
- 4 "Introduction to Modern Cryptography", Jonathan Katz, 3, crc press.

23HSS3511 - HARDWARE-SOFTWARE CO-DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3511	HARDWARE-SOFTWARE CO-DESIGN	HSCCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	This course explores case studies of successful hardware-software co-design projects across various domains, including consumer electronics, automotive, aerospace, and more	2	PO1, PO5, PO9, PSO2
CO2	Examine real-world examples of hardware-software co-design projects. Understand the principles and methodologies of hardware-software co-design.	3	PO1, PO5, PO9, PSO2
CO3	Analyze the interaction between hardware and software components in integrated systems.	3	PO1, PO5, PO9, PSO2
CO4	Evaluate the impact of co-design on system performance, power consumption, and user experience. Gain insights into best practices and lessons learned from successful co-design projects.	3	PO1, PO5, PO9, PSO2

Syllabus

CO 1: Introduction to Hardware-Software Co-Design, Microsoft Xbox Kinect Overview of hardware-software co-design principles and methodologies, Importance of synergy between hardware and software in integrated systems, Challenges and considerations in co-designing hardware and software components, Objective, approach, and outcome of Kinect's hardware-software co-design, Analysis of depth-sensing hardware and real-time motion-tracking software ,Impact on gaming experience and user interaction in console gaming,

CO 2: Apple iPhone, Tesla Autopilot Co-design strategies employed by Apple in developing the iPhone, Integration of custom-designed processors with iOS software stack, Evaluation of performance, power efficiency, and user experience enhancements, Hardware-software co-design for autonomous driving in Tesla vehicles, Analysis of sensor processing hardware and neural network algorithms, Impact on safety, reliability, and advancement of autonomous driving technology

CO 3: Google TensorFlow Processing Units (TPUs), DJI Drones Co-design of custom ASICs and TensorFlow software framework for AI acceleration, Evaluation of TPUs' performance, scalability, and efficiency in data center applications, Contribution to advancements in machine learning and artificial intelligence, Hardware-software co-design principles applied in DJI drone development, Integration of flight controllers, sensors, and intelligent software features, Analysis of performance, stability, and user experience enhancements in drone technology

CO 4: Aerospace Embedded Systems, Automotive Embedded Systems Case studies of hardware-software co-design in aerospace applications, Integration of avionics systems, flight control algorithms, and safety-critical software, Impact on aircraft performance, reliability, and safety standards, Co-design strategies for automotive electronic systems and software, Integration of ECUs, sensors, and control algorithms in modern vehicles, Evaluation of performance, efficiency, and safety improvements in automotive technology

Reference Books

- 1 "Hardware/Software Co-Design: Principles and Practice" , J?rg Henkel and Sri Parameswaran, 2, tatamagrahill.
- 2 Handbook of Hardware/Software Codesign, by Soonhoi Ha (Editor), J?rgen Teich, 1, Springer.
- 3 "Hardware/Software Co-Design: Principles and Practice" , J?rg Henkel, Samarjit Chakraborty, 1, tata mc hill.
- 4 "Embedded Systems: Hardware, Design, and Implementation, Krzysztof Iniewski, 2, Springer.

23HSS3512 - FUTURE TRENDS IN HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23HSS3512	FUTURE TRENDS IN HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY	FTHSCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Comprehend the latest trends and advancements in hardware-software co-design with a focus on security implications.	2	PO3, PO5, PSO2
CO2	Evaluate various hardware-software co-design techniques and their impact on system security.	2	PO3, PO5, PSO2
CO3	Apply co-design methodologies to develop robust and secure hardware-software systems.	3	PO5, PSO2
CO4	Identify and analyze potential security vulnerabilities in integrated hardware-software systems. Formulate innovative solutions and strategies to address security challenges in hardware-software co-design.	3	PO5, PSO2

Syllabus

Introduction to Hardware-Software Co-Design and Security Basics, Overview of Hardware-Software Co-Design, Definition and significance, Historical perspective and evolution, Key components and processes. Security Fundamentals, Basic concepts of security (Confidentiality, Integrity, Availability), Common security threats and vulnerabilities, Introduction to cryptographic principles. Hardware Security Basics, Hardware Trojans, Side-channel attacks, Secure hardware design principles. Software Security Basics, Software vulnerabilities, Secure coding practices, Security testing and assessment

Techniques and Tools for Co-Design, Co-Design Methodologies, Hardware-software partitioning, Co-simulation and co-verification techniques, Design space exploration. Hardware Description Languages and Tools, Introduction to VHDL and Verilog, High-level synthesis tools, FPGA and ASIC design flows. Software Development for Embedded Systems, Embedded operating systems and real-time operating systems (RTOS), Cross-compilation and debugging tools, Middleware and libraries for embedded systems. Integrated Development Environments (IDEs), Popular IDEs, Debugging and profiling tools, Performance analysis.

Security Integration in Co-Design, Security-aware Design Techniques, Secure boot and trusted execution environments (TEE), Hardware-based security modules (TPM, HSM), Root of trust concepts. Secure Communication Protocols, Encryption and key management, Secure communication protocols (e.g., TLS, IPsec), Wireless security protocols. Authentication and Access Control, Authentication mechanisms, Access control models (DAC, MAC, RBAC), Role of hardware in enforcing security policies. Case Studies in Secure Co-Design, Analysis of real-world systems, Lessons learned from security breaches, Best practices for secure co-design.

Future Trends and Research Directions, AI and Machine Learning in Security, Application of AI/ML in detecting and mitigating security threats, Hardware accelerators for AI/ML security applications, Case studies and current research. Quantum Computing and Post-Quantum Security, Basics of quantum computing, Quantum-resistant cryptographic algorithms, Potential impact on hardware-software co-design. IoT and Edge Computing Security, Security challenges in IoT and edge devices, Lightweight cryptography for resource-constrained devices, Secure edge-to-cloud communication. Future Directions and Emerging Technologies, Trends in 5G and beyond, Autonomous systems and security implications and Emerging standards and regulations.

Reference Books

- 1 Embedded Systems A Hardware, Software CoDesign Approach Unleash the Power of Arduino, Bashir I. Morshed, 2021 edition , Springer, 2021.
- 2 Secure System Design and Trustable Computing, Chip-Hong Chang and Miodrag Potkonjak, 1st edition, 2016, Springer, 2016.

- 3 Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development, David Kleidermacher and Mike Kleidermacher, published 2012, Elsevier Inc. 2012.
- 4 Introduction to Hardware Security and Trust, Mohammad Tehranipoor and Cliff Wang, published 2012, Springer, 2012.

23IBT3101A - PHARMACEUTICAL BIOTECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3101A	PHARMACEUTICAL BIOTECHNOLOGY	PBT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the methods of Gene transfer, Production of Secondary Metabolites, Drug Interactions, and Surgical supplies	3	PO2, PO3, PSO2
CO2	Apply the concept of Pharmaceutical dosage and products in treating diseases	3	PO2, PO3, PSO2
CO3	Apply the role of various types of Drug Delivery Application in Pharmaceutical Biotechnology	3	PO2, PO3, PSO2
CO4	Apply the role of Biologicals (Immunizing agents and allergenic extracts)	3	PO3, PO8, PSO2
CO5	Apply the concept of Production & analysis in Biopharmaceuticals	3	PO3, PO8, PSO2
CO6	Apply the principles of pharmaceutical biotechnology for development of drug dosage forms	3	PO8, PO9
CO7	Apply the skilling concepts of pharmaceutical biotechnology for development of drug dosage forms	3	PO8, PO9

Syllabus

Fundamentals of pharmaceutical practice-Pharmaceutical biotechnology: An introduction; Origin & definition; Scope & Importance of Biotechnology; their applications; Microbes in Pharmaceutical industry; Methods of Gene transfer; Biotechnology; Production of Secondary Metabolites ; Drug Interactions;Surgical supplies

Drug metabolism and pharmacokinetics- ADME-properties-Mechanism of Drug Absorption; Distribution of drugs; Drugmetabolism(Biotransformation of drugs);Excretion of drugs; Pharmacokinetics; Basic considerations; Controlled Release Medication; Design of Controlled drugdelivery systems; Drug release patterns; Oral parental; Trans-dermal ; Ophthalmic ; Intra-vaginal and Intrauterine Drug Delivery systems

Pharmaceutical dosage & blood, plasma products-Materials & Formulations; Manufacture of Tablets; Capsules; Sustained Release dosage forms; Parental solutions; Oral liquids; Emulsions;Ointments; Suppositories, Aerosols; Topical applications; Collection; Processing and storage of whole human blood; Concentrated human RBC Control of Bloodproducts; Transfusion products

Pharmaceutical products-Fundamentals of Therapeutic categories such as Analgesics, Anesthetics, Antipyretic; Anti-inflammatorydrugs; Antacids; Alkaloids; Glycosides; Hormone & Hormone antagonists; Antineoplastics and Immuno active drugs; Biologicals (Immunizing agents andallergenic extracts)

Drug manufacturing processes- Good manufacturing practices; Manufacturing facilities; Sources of Biopharmaceuticals; Production & analysis of Biopharmaceuticals

Experiment 1: Introductory Session to Pharmaceutical Biotechnology Laboratories Experiment 2: Preparation of various Polymeric Solution Experiment 3: Viscosity measurement of polymer solution Experiment 4: Development of Physical Hydrogels Experiment 5: Preparation of Chemical Hydrogels Experiment 6: Formulation of Chitosan and Gelatin-Based Hydrogels Loaded with Drug Experiment 7: Swelling Study of Hydrogels Experiment 8: Demonstration of Dissolution Apparatus Experiment 9: In vitro Hemocompatibility Testing of Physical Hydrogels Experiment 10: In vitro Hemocompatibility Testing of Chemical Hydrogels Experiment 11: Mucoadhesive analysis in Chemical Hydrogels Experiment 12: Franz diffusion cell apparatus Setup Experiment 13: In silico analysis for identifying drug interactions and their phenotypic effects Experiment 14: Iontophoresis Instrument Setup Experiment 15: Demonstration of X-Ray diffraction analysis (XRD) Experiment 16: Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Positive Bacteria Experiment 17: Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Negative Bacteria Experiment 18: Evaluating Antimicrobial Activity of Chemical Hydrogels

1) Development of Oleogels for Drug Delivery Applications 2) Phase contrast microscopy study of Oleogels 3) Development of Bigels for Drug Delivery Applications 4) Phase contrast microscopy study of Bigels 5) Role of various Surfactants for Pharmaceutical and Medicinal Aspects 6) Preparation of Emulsion Hydrogels for Drug Delivery Applications 7) Phase contrast microscopy study of Emulsion Hydrogels 8) Release study of Drug from Emulsion Hydrogels from drug dissolution apparatus 9) Release study of Drug from Oleogels from drug dissolution apparatus 10) Preparation of curcumin-piperine nanoparticles by thin film hydration method 11) Preparation of curcumin-piperine nanoparticles by solid dispersion method 12) Preparation of curcumin-piperine nanoparticles by emulsion polymerization method 13) Development of Cerium Oxide Nanoparticles 14) FTIR Analysis of Development of Cerium Oxide Nanoparticles 15) Demonstration of CO2 Incubator 16) Drug Release Kinetics 17) Explanation towards Imagej (Computer Program) 18) Explanation towards Origin (Computer Program)

Reference Books

- 1 The Theory and Practice of Industrial Pharmacy, Leon Lachman, 2013, CBS.
- 2 Pharmaceutical Biotechnology, S S Purohit, H N Kakrani, A K Saluja, 2007, ARE Books.
- 3 Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues, W Mark Saltzman, 2004, Oxford University Press .
- 4 Pharmaceutical Laboratory Procedures, Jahangir Moini , 2010, Cengage.

23IBT3101E - PHARMACEUTICAL BIOTECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3101E	PHARMACEUTICAL BIOTECHNOLOGY	PBT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the methods of Gene transfer, Production of Secondary Metabolites, Drug Interactions, and Surgical supplies	3	PO2, PO3, PSO2
CO2	Apply the concept of Pharmaceutical dosage and products in treating diseases	3	PO2, PO3, PSO2
CO3	Apply the role of various types of Drug Delivery Application in Pharmaceutical Biotechnology	3	PO2, PO3, PSO2
CO4	Apply the role of Biologicals (Immunizing agents and allergenic extracts)	3	PO3, PO8, PSO2
CO5	Apply the concept of Production & analysis in Biopharmaceuticals	3	PO3, PO8, PSO2
CO6	Apply the principles of pharmaceutical biotechnology for development of drug dosage forms	3	PO8, PO9
CO7	Apply the skilling concepts of pharmaceutical biotechnology for development of drug dosage forms	3	PO8, PO9

Syllabus

Fundamentals of pharmaceutical practice-Pharmaceutical biotechnology: An introduction; Origin & definition; Scope & Importance of Biotechnology; their applications; Microbes in Pharmaceutical industry; Methods of Gene transfer; Biotechnology; Production of Secondary Metabolites ; Drug Interactions;Surgical supplies

Drug metabolism and pharmacokinetics- ADME-properties-Mechanism of Drug Absorption; Distribution of drugs; Drugmetabolism(Biotransformation of drugs);Excretion of drugs; Pharmacokinetics; Basic considerations; Controlled Release Medication; Design of Controlled drugdelivery systems; Drug release patterns; Oral parental; Trans-dermal ; Ophthalmic ; Intra-vaginal and Intrauterine Drug Delivery systems

Pharmaceutical dosage & blood, plasma products-Materials & Formulations; Manufacture of Tablets; Capsules; Sustained Release dosage forms; Parental solutions; Oral liquids; Emulsions;Ointments; Suppositories, Aerosols; Topical applications; Collection; Processing and storage of whole human blood; Concentrated human RBC Control of Bloodproducts; Transfusion products

Pharmaceutical products-Fundamentals of Therapeutic categories such as Analgesics, Anesthetics, Antipyretic; Anti-inflammatorydrugs; Antacids; Alkaloids; Glycosides; Hormone & Hormone antagonists; Antineoplastics and Immuno active drugs; Biologicals (Immunizing agents andallergenic extracts)

Drug manufacturing processes- Good manufacturing practices; Manufacturing facilities; Sources of Biopharmaceuticals; Production & analysis of Biopharmaceuticals

Experiment 1: Introductory Session to Pharmaceutical Biotechnology Laboratories Experiment 2: Preparation of various Polymeric Solution Experiment 3: Viscosity measurement of polymer solution Experiment 4: Development of Physical Hydrogels Experiment 5: Preparation of Chemical Hydrogels Experiment 6: Formulation of Chitosan and Gelatin-Based Hydrogels Loaded with Drug Experiment 7: Swelling Study of Hydrogels Experiment 8: Demonstration of Dissolution Apparatus Experiment 9: In vitro Hemocompatibility Testing of Physical Hydrogels Experiment 10: In vitro Hemocompatibility Testing of Chemical Hydrogels Experiment 11: Mucoadhesive analysis in Chemical Hydrogels Experiment 12: Franz diffusion cell apparatus Setup Experiment 13: In silico analysis for identifying drug interactions and their phenotypic effects Experiment 14: Iontophoresis Instrument Setup Experiment 15: Demonstration of X-Ray diffraction analysis (XRD) Experiment 16: Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Positive Bacteria Experiment 17: Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Negative Bacteria Experiment 18: Evaluating Antimicrobial Activity of Chemical Hydrogels

1) Development of Oleogels for Drug Delivery Applications 2) Phase contrast microscopy study of Oleogels 3) Development of Bigels for Drug Delivery Applications 4) Phase contrast microscopy study of Bigels 5) Role of various Surfactants for Pharmaceutical and Medicinal Aspects 6) Preparation of Emulsion Hydrogels for Drug Delivery Applications 7) Phase contrast microscopy study of Emulsion Hydrogels 8) Release study of Drug from Emulsion Hydrogels from drug dissolution apparatus 9) Release study of Drug from Oleogels from drug dissolution apparatus 10) Preparation of curcumin-piperine nanoparticles by thin film hydration method 11) Preparation of curcumin-piperine nanoparticles by solid dispersion method 12) Preparation of curcumin-piperine nanoparticles by emulsion polymerization method 13) Development of Cerium Oxide Nanoparticles 14) FTIR Analysis of Development of Cerium Oxide Nanoparticles 15) Demonstration of CO2 Incubator 16) Drug Release Kinetics 17) Explanation towards Imagej (Computer Program) 18) Explanation towards Origin (Computer Program)

Reference Books

- 1 The Theory and Practice of Industrial Pharmacy, Leon Lachman, 2013, CBS.
- 2 Pharmaceutical Biotechnology, SS Purohit. HN Kakrani AK Saluja, 2007, ARE Books.
- 3 Tissue Engineering. Engineering Principles for Organs and Tissues for the Design of Replacement , W Mark Saltzman, 2004, Oxford University Press.
- 4 Pharmaceutical Laboratory Procedures, Jahangir Moini, 2010, Cengage.

23IBT3101R - PHARMACEUTICAL BIOTECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3101R	PHARMACEUTICAL BIOTECHNOLOGY	PBT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the methods of Gene transfer, Production of Secondary Metabolites, Drug Interactions, and Surgical supplies	3	PO2, PO3, PSO2
CO2	Apply the concept of Pharmaceutical dosage and products in treating diseases	3	PO2, PO3, PSO2
CO3	Apply the role of Biologicals (Immunizing agents and allergenic extracts)	3	PO2, PO3, PO8, PSO2
CO4	Apply the concept of Production & analysis in Biopharmaceuticals	3	PO3, PO8, PSO2
CO5	Apply the principles of pharmaceutical biotechnology for development of drug dosage forms	3	PO3, PO8, PO9, PSO2
CO6	Apply the skilling concepts of pharmaceutical biotechnology for development of drug dosage forms	3	PO8, PO9

Syllabus

Fundamentals of pharmaceutical practice-Pharmaceutical biotechnology: An introduction; Origin & definition; Scope & Importance of Biotechnology; their applications; Microbes in Pharmaceutical industry; Methods of Gene transfer; Biotechnology; Production of Secondary Metabolites ; Drug Interactions;Surgical supplies

Drug metabolism and pharmacokinetics- ADME-properties-Mechanism of Drug Absorption; Distribution of drugs; Drugmetabolism(Biotransformation of drugs);Excretion of drugs; Pharmacokinetics; Basic considerations; Controlled Release Medication; Design of Controlled drugdelivery systems; Drug release patterns; Oral parental; Trans-dermal ; Ophthalmic ; Intra-vaginal and Intrauterine Drug Delivery systems

Pharmaceutical products-Fundamentals of Therapeutic categories such as Analgesics, Anesthetics, Antipyretic; Anti-inflammatorydrugs; Antacids; Alkaloids; Glycosides; Hormone & Hormone antagonists; Antineoplastics and Immuno active drugs; Biologicals (Immunizing agents andallergenic extracts)

Drug manufacturing processes- Good manufacturing practices; Manufacturing facilities; Sources of Biopharmaceuticals; Production & analysis of Biopharmaceuticals

Experiment 1: Introductory Session to Pharmaceutical Biotechnology Laboratories Experiment 2: Preparation of various Polymeric Solution Experiment 3: Viscosity measurement of polymer solution Experiment 4: Development of Physical Hydrogels Experiment 5: Preparation of Chemical Hydrogels Experiment 6: Formulation of Chitosan and Gelatin-Based Hydrogels Loaded with Drug Experiment 7: Swelling Study of Hydrogels Experiment 8: Demonstration of Dissolution Apparatus Experiment 9: In vitro Hemocompatibility Testing of Physical Hydrogels Experiment 10: In vitro Hemocompatibility Testing of Chemical Hydrogels Experiment 11: Mucoadhesive analysis in Chemical Hydrogels Experiment 12: Franz diffusion cell apparatus Setup Experiment 13: In silico analysis for identifying drug interactions and their phenotypic effects

1) Development of Oleogels for Drug Delivery Applications 2) Phase contrast microscopy study of Oleogels 3) Development of Bigels for Drug Delivery Applications 4) Phase contrast microscopy study of Bigels 5) Role of various Surfactants for Pharmaceutical and Medicinal Aspects 6) Preparation of Emulsion Hydrogels for Drug Delivery Applications 7) Phase contrast microscopy study of Emulsion Hydrogels 8) Release study of Drug from Emulsion Hydrogels from drug dissolution apparatus 9) Release study of Drug from Oleogels from drug dissolution apparatus 10) Preparation of curcumin-piperine nanoparticles by thin film hydration method 11) Preparation of curcumin-piperine nanoparticles by solid dispersion method 12) Preparation of curcumin-piperine nanoparticles by emulsion polymerization method 13) Development of Cerium Oxide Nanoparticles

Reference Books

- 1 The Theory and Practice of Industrial Pharmacy, Leon Lachman, 2013, CBS.
- 2 Pharmaceutical Biotechnology, S S Purohit, H N Kakrani, A K Saluja, 2007, ARE Books.
- 3 Tissue Engineering. Engineering Principles for Organs and Tissues for the Design of Replacement, W Mark Saltzman, 2004, Oxford University Press .
- 4 Pharmaceutical Laboratory Procedures, Jahangir Moini, 2010, Cengage.

23IBT3202A - PHARMACOVIGILANCE AND SAFETY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3202A	PHARMACOVIGILANCE AND SAFETY	PCS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles and concepts of pharmacovigilance, including the importance of adverse event reporting and signal detection.	2	PO1, PO2, PO3, PSO1
CO2	Evaluate the regulatory requirements and guidelines governing pharmacovigilance activities, including pharmacovigilance obligations for pharmaceutical companies and regulatory authorities.	3	PO1, PO2, PO3, PSO1
CO3	Apply various methods and tools for adverse event detection, assessment, and risk management, including causality assessment and risk minimization strategies.	3	PO1, PO2, PO3, PSO1
CO4	Analyze case studies and real-world scenarios to identify potential drug safety issues, assess risk-benefit profiles, and propose appropriate pharmacovigilance interventions.	3	PO1, PO2, PO3, PSO1
CO5	Communicate effectively about pharmacovigilance concepts, practices, and regulatory requirements.	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Pharmacovigilance-scope of pharmacovigilance-Historical background and evolution-Pharmacovigilance regulations and guidelines

Pharmacovigilance Systems and Infrastructure-Components of pharmacovigilance systems-Pharmacovigilance databases and information management

Risk Assessment and Risk Management-Risk identification, evaluation, and characterization-Risk minimization strategies-Pharmacovigilance in risk communication

Pharmacovigilance in Clinical Trials-Safety monitoring during clinical development-Investigator reporting requirements-Post-marketing surveillance studies

Introduction to Effective Communication in Pharmacovigilance-Communicating Pharmacovigilance Concepts-Practices in Pharmacovigilance Communication-Communicating Risk and Benefit Information

Reference Books

- 1 Pharmacovigilance: Principles and Practice, Patrick Waller and June Raine, 2017, Wiley.
- 2 Introduction to Pharmacovigilance , Patrick Waller, 2017, John Wiley & Sons Ltd.
- 3 Practical Pharmacovigilance Analysis Strategies, Paul Beninger, 2019, wiley.
- 4 Textbook of Pharmacovigilance: Ensuring the Safe Use of Medicines , S. K. Gupta, 2018, Jaypee Brothers Medical Publishers.

23IBT3202E - PHARMACOVIGILANCE AND SAFETY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3202E	PHARMACOVIGILANCE AND SAFETY	PCS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Evaluation of completed ADR report forms for accuracy and completeness.	3	PO1, PO2, PO3, PSO1
CO2	Assessment of students' ability to assess ADR severity and causality using standardized criteria.	3	PO1, PO2, PO3, PSO1
CO3	Evaluation of students' data analysis skills and ability to identify potential signals of adverse drug reactions in the data set	3	PO1, PO2, PO3, PSO1
CO4	To gain knowledge on adverse drug reactions and their management.	3	PO1, PO2, PO3, PSO1
CO5	To become proficient in the use of pharmacovigilance databases and tools.	3	PO1, PO2, PO3, PSO1

Syllabus

Brief overview of adverse drug reaction reporting systems, including regulatory requirements and reporting guidelines- Introduction to ADR report forms and documentation requirements.

Group activity Students work in teams to analyze the case scenarios and complete ADR report forms for the identified adverse drug reactions.

Group discussion Students assess the severity and causality of reported ADRs using standardized assessment tools or criteria.

Types of adverse drug reactions-mechanisms behind various ADRs.-Detecting and reporting ADRs.-Strategies for managing and preventing ADRs.-regulatory requirements and guidelines for ADR management.

Introduction to Pharmacovigilance Databases-VigiBase-EudraVigilance-FAERS and Other National Databases-Data Mining and Signal Detection-Case Management and Documentation

Reference Books

- 1 Pharmacovigilance Principles and Practice, Patrick Waller, 2017, Wiley.
- 2 Introduction to Pharmacovigilance John Wiley & Sons Ltd, Patrick Waller, 2017, John Wiley & Sons Ltd.
- 3 Practical Pharmacovigilance Analysis Strategies, Thao Doan, 2003, Elsevier.
- 4 Textbook of Pharmacovigilance: Ensuring the Safe Use of Medicines, S. K. Gupta, 2019, Jaypee Brothers Medical Publishers.

23IBT3202R - PHARMACOVIGILANCE AND SAFETY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3202R	PHARMACOVIGILANCE AND SAFETY	PCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles and concepts of pharmacovigilance, including the importance of adverse event reporting and signal detection.	2	PO1, PO2, PO3, PSO1
CO2	Evaluate the regulatory requirements and guidelines governing pharmacovigilance activities, including pharmacovigilance obligations for pharmaceutical companies and regulatory authorities.	3	PO1, PO2, PO3, PSO1
CO3	Apply various methods and tools for adverse event detection, assessment, and risk management, including causality assessment and risk minimization strategies.	3	PO1, PO2, PO3, PSO1
CO4	Analyze case studies and real-world scenarios to identify potential drug safety issues, assess risk-benefit profiles, and propose appropriate pharmacovigilance interventions	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Pharmacovigilance-harmacovigilance Systems and Infrastructure

International Guidelines and Standards-Regulatory Reporting Requirements-Pharmacovigilance Inspections and Audits

Risk Assessment and Risk Management-Risk identification, evaluation, and characterization-Risk minimization strategies-Pharmacovigilance in risk communication

Pharmacovigilance in Clinical Trials-Safety monitoring during clinical development-Investigator reporting requirements-Pharmacovigilance in Public Health

Reference Books

- 1 Principles and Practice of Pharmacovigilance, Ronald D. Mann, 2014, Wiley.
- 2 Introduction to Pharmacovigilance, Patrick Waller, 2017, John Wiley & Sons Ltd.
- 3 Textbook of Pharmacovigilance, Sk Gupta, 2019, Jaypee Brothers Medical Publishers.
- 4 Textbook of Pharmacovigilance: Ensuring the Safe Use of Medicines , S. K. Gupta, 2019, Jaypee Brothers Medical Publishers.

23IBT3203A - BIOPROCESS ECONOMICS AND PLANT DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3203A	BIOPROCESS ECONOMICS AND PLANT DESIGN	BEPD	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Depreciation Methods for Analysis of Economic Performance	3	PO1, PO2, PO3, PSO1
CO2	Apply the Economics Principles in the Estimation of Manufacturing Cost of Bioprocess	3	PO1, PO2, PO3, PSO1
CO3	Apply the Mass and Energy Balance Equations for Bioprocess Equipment Design	3	PO1, PO2, PO3, PSO1
CO4	Summarize the Sterilization Techniques and Apply the Aeration and Agitation Principles for Design of Bioreactor System	3	PO1, PO2, PO3, PSO1
CO5	Optimization techniques	3	PO1, PO2, PO3, PSO1

Syllabus

Economic evaluation: Capital cost of a project. Interest calculations, nominal and effective interest rates. Basic concepts in tax and depreciation. Measures of economic performance, rate of return, payout time. Cash flow diagrams; Cost accounting-balance sheet and profit loss account. Break even and minimum cost analysis.

Introduction to bioprocess economics including elements of total production cost, total capital investment outline, equipment sizing, capital cost estimates for large-scale equipment and utilities, manufacturing cost estimates encompassing operating costs such as raw materials, utilities, fixed costs, and overhead costs, with case studies covering antibiotics, recombinant products, and single-cell protein.

Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries. Schematic representation of unit operations, design information and flow diagrams, material and energy balances, formulation of the design problem, the Hierarchy of chemical process design and integration, optimization, Health and safety Hazards, Environment protection, plant location and lay out. equipment classification, materials of construction-Mechanical properties-strength, elasticity, ductility, resilience, toughness, hardness, creep, fatigue. Metals-ferrous metals, types of iron & steels, nonferrous 33metals and Non-metals. Corrosion: Forms of corrosion and their presentation. Choice of materials.

Design conventions. Basic considerations in equipment design: General design procedure: Basic Design Problems: Design examples on continuous fermentation, aeration and agitation. Design calculation of filter for air sterilization. Design of batch and continuous sterilizers. Design calculations for immobilized enzyme kinetics. Practical considerations in designing of Bioreactor/Fermenter construction. Design exercise on trickle flow fermenter. Problems associated with design equations

General procedure for determining optimum conditions through analytical and graphical methods, comparison of graphical and analytical techniques, linear programming graphical solution including the simplex algorithm, Big-M method, and dynamic programming

Reference Books

- 1 Plant design and Economics for Chemical Engineers., Peters and Timmerhaus, 2013, McGraw Hill .
- 2 Chemical Process Design and Integration, Smith, R., 2010, Wiley Student Edition.
- 3 Biochemical Engineering, Harvey W Blanch, 1997, Taylor &Francis/bS Publication.
- 4 Bioprocess Engineering: Basic Concepts, Michael L. Shuler, Fikret Kargi, Matthew DeLisa, 2017, Pearson.

23IBT3203E - BIOPROCESS ECONOMICS AND PLANT DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3203E	BIOPROCESS ECONOMICS AND PLANT DESIGN	BEPD	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Modes of operations of Bioreactor	3	PO1, PO2, PO3, PSO1
CO2	oxygen transfer in bioreactor	3	PO1, PO2, PO3, PSO1
CO3	scale up	3	PO1, PO2, PO3, PSO1
CO4	To integrate economic and engineering principles for bioprocess optimization.	3	PO1, PO2, PO3, PSO1
CO5	To develop skills in using software tools for economic and plant design analysis.	3	PO1, PO2, PO3, PSO1

Syllabus

Batch operation (enzymatic and microbial), Continuous stirred tank , Continuous stirred tank with recycle- Fed batch and two-stage operation

Oxygen transfer to cells , mass transfer coefficients ,determination of oxygen transfer coefficients ,Factors affecting mass transfer coefficient.

Reactor scale up , Scale up criteria ,Scale down

Plant Layout and Optimization-Principles of plant layout design-Facility layout planning and optimization-Case studies of bioprocess plant layouts-Software tools for layout design

Software tools for process simulation and optimization (e.g., Aspen Plus, SuperPro Designer)

Reference Books

- 1 Plant design and Economics for Chemical Engineers. , Peters and Timmerhaus , 2017, McGraw Hill.
- 2 Chemical Process Design and Integration , Smith, R, 2018, Wiley Student Edition.
- 3 bioprocess Engineering: Basic Concepts , Michael L. Shuler, Fikret Kargi, Matthew DeLisa, 2017, Pearson.
- 4 Bioseparations Engineering: Principles, Practice, and Economics, Michael R. Ladisch, 2001, wiley.

23IBT3203R - BIOPROCESS ECONOMICS AND PLANT DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3203R	BIOPROCESS ECONOMICS AND PLANT DESIGN	BEPD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Depreciation Methods for Analysis of Economic Performance	3	PO1, PO2, PO3, PSO1
CO2	Apply the Economics Principles in the Estimation of Manufacturing Cost of Bioprocess	3	PO1, PO2, PO3, PSO1
CO3	Apply the Mass and Energy Balance Equations for Bioprocess Equipment Design	3	PO1, PO2, PO3, PSO1
CO4	Summarize the Sterilization Techniques and Apply the Aeration and Agitation Principles for Design of Bioreactor System	3	PO1, PO2, PO3, PSO1

Syllabus

Economic evaluation: Capital cost of a project. Interest calculations, nominal and effective interest rates. Basic concepts in tax and depreciation. Measures of economic performance, rate of return, payout time. Cash flow diagrams; Cost accounting-balance sheet and profit loss account. Break even and minimum cost analysis.

Introduction to bioprocess economics covering elements of total production cost, total capital investment outline, equipment sizing, capital cost estimates for large-scale equipment and utilities, manufacturing cost estimates encompassing operating costs like raw materials, utilities, fixed costs, and overhead costs, along with case studies on antibiotics, recombinant products, and single-cell protein

Introduction to process design: Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries. Schematic representation of unit operations, design information and flow diagrams, material and energy balances, formulation of the design problem, the Hierarchy of chemical process design and integration, optimization, Health and safety Hazards, Environment protection, plant location and lay out. equipment classification, materials of construction-Mechanical properties-strength, elasticity, ductility, resilience, toughness, hardness, creep, fatigue. Metals-ferrous metals, types of iron & steels, nonferrous metals and Non-metals. Corrosion: Forms of corrosion and their presentation. Choice of materials.

Basic Design Problems: Design examples on continuous fermentation, aeration and agitation. Design calculation of filter for air sterilization. Design of batch and continuous sterilizers. Design calculations for immobilized enzyme kinetics. Practical considerations in designing of Bioreactor/Fermenter construction. Design exercise on trickle flow fermenter. Problems associated with design equations

Reference Books

- 1 Plant design and Economics for Chemical Engineers, Peters and Timmerhaus, 2016 , McGraw Hill .
- 2 Chemical Process Design and Integration, Smith, R, 2004, John Wiley and Sons Inc.
- 3 BioProcess Design and Economics, Demetri Petrides, 2015 , Oxford University Press.
- 4 Bioprocess Engineering: Basic Concepts, Michael L. Shuler and Fikret Kargi, 2021, Pearson.

23IBT3304A - ENZYME ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3304A	ENZYME ENGINEERING	EE	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of protein structure, function, and kinetics to enzyme engineering.	3	PO1
CO2	Analyze the relationship between enzyme structure and function in the context of engineering enzymes for desired activities.	4	PO1, PO2
CO3	Design and utilize various protein engineering techniques for enzyme modification.	6	PO1, PO2
CO4	Evaluate the effectiveness of enzyme engineering strategies through computational and experimental methods.	5	PO1, PO2
CO5	Apply engineered enzymes for specific industrial, environmental, or bioremediation applications.	3	PO1
CO6	Effectively communicate the principles and applications of enzyme engineering in written and oral formats	5	PO2
CO7	Demonstrate an understanding of the ethical considerations and potential risks associated with enzyme engineering.	4	PO5

Syllabus

Introduction to enzymes: Structure, function, and kinetics Applications of enzymes in industry, environment, and biomedicine Fundamentals of protein structure: Primary, secondary, tertiary, and quaternary structure Protein-ligand interactions and enzyme catalysis

Protein folding and stability Site-directed mutagenesis and its impact on enzyme activity Understanding the effects of mutations on protein structure and function Computational tools for analyzing protein structure and function

Rational design and directed evolution approaches in enzyme engineering Site-directed mutagenesis techniques (PCR, gene cloning) Random mutagenesis and selection methods Enzyme immobilization techniques and their applications

Protein sequence and structure databases (e. g., UniProt, PDB) In silico protein engineering tools (docking simulations, protein stability prediction) Utilizing computational tools to design and analyze engineered enzymes (optional)

Enzyme activity assays and kinetic analysis Techniques for measuring protein expression and purification Computational and experimental methods for evaluating enzyme stability and function Case studies of successful enzyme engineering projects

Engineered enzymes for industrial biocatalysis (e. g., biofuels, biopolymers) Applications in environmental remediation and biodegradation Engineered enzymes in biomedicine and drug development Societal and ethical considerations of enzyme engineering applications

Emerging trends in enzyme engineering Directed evolution for highly specific and efficient enzymes Protein engineering for novel biocatalytic functions Ethical considerations and potential risks of releasing engineered enzymes

Reference Books

- 1 Enzyme Engineering: Methods and Protocols, Francesca Magnani, Chiara Marabelli, and Francesca Paradisi, 2, Humana, New York, NY..
- 2 Fundamentals of Enzyme Engineering, Young Je Yoo, Yan Feng, Yong-Hwan Kim, and Camila Flor J. Yagonia, 1, Springer.
- 3 Directed Enzyme Evolution: Screening and Selection Methods, Robert A. Chica, Gregory M. Bryson, and Steven D., 2, Humana, New York, NY..

- 4 Biocatalysis: An Introduction, Glenn Francis, 3, Wiley-Blackwell, Oxford, UK.

23IBT3304E - ENZYME ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3304E	ENZYME ENGINEERING	EE	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of protein structure, function, and kinetics to enzyme engineering.	3	PO1
CO2	Analyze the relationship between enzyme structure and function in the context of engineering enzymes for desired activities.	4	PO1, PO2
CO3	Design and utilize various protein engineering techniques for enzyme modification.	6	PO1, PO2
CO4	Evaluate the effectiveness of enzyme engineering strategies through computational and experimental methods.	5	PO1, PO2
CO5	Apply engineered enzymes for specific industrial, environmental, or bioremediation applications.	3	PO1
CO6	Effectively communicate the principles and applications of enzyme engineering in written and oral formats	5	PO2
CO7	Demonstrate an understanding of the ethical considerations and potential risks associated with enzyme engineering.	4	PO5

Syllabus

Introduction to enzymes: Structure, function, and kinetics Applications of enzymes in industry, environment, and biomedicine Fundamentals of protein structure: Primary, secondary, tertiary, and quaternary structure Protein-ligand interactions and enzyme catalysis

Protein folding and stability Site-directed mutagenesis and its impact on enzyme activity Understanding the effects of mutations on protein structure and function Computational tools for analyzing protein structure and function

Rational design and directed evolution approaches in enzyme engineering Site-directed mutagenesis techniques (PCR, gene cloning) Random mutagenesis and selection methods Enzyme immobilization techniques and their applications

Protein sequence and structure databases (e. g., UniProt, PDB) In silico protein engineering tools (docking simulations, protein stability prediction) Utilizing computational tools to design and analyze engineered enzymes (optional)

Enzyme activity assays and kinetic analysis Techniques for measuring protein expression and purification Computational and experimental methods for evaluating enzyme stability and function Case studies of successful enzyme engineering projects

Engineered enzymes for industrial biocatalysis (e. g., biofuels, biopolymers) Applications in environmental remediation and biodegradation Engineered enzymes in biomedicine and drug development Societal and ethical considerations of enzyme engineering applications

Emerging trends in enzyme engineering Directed evolution for highly specific and efficient enzymes Protein engineering for novel biocatalytic functions Ethical considerations and potential risks of releasing engineered enzymes

Reference Books

- 1 Enzyme Engineering: Methods and Protocols, Francesca Magnani, Chiara Marabelli, and Francesca Paradisi, 2, Humana, New York, NY..
- 2 Fundamentals of Enzyme Engineering, Young Je Yoo, Yan Feng, Yong-Hwan Kim, and Camila Flor J. Yagonia, 1, Springer.
- 3 Directed Enzyme Evolution: Screening and Selection Methods, Robert A. Chica, Gregory M. Bryson, and Steven D., 2, Humana, New York, NY..

- 4 Biocatalysis: An Introduction, Glenn Francis, 3, Wiley-Blackwell, Oxford, UK.

23IBT3304R - ENZYME ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3304R	ENZYME ENGINEERING	EE	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of protein structure, function, and kinetics to enzyme engineering.	3	PO1
CO2	Analyze the relationship between enzyme structure and function in the context of engineering enzymes for desired activities.	4	PO1, PO2
CO3	Design and utilize various protein engineering techniques for enzyme modification.	6	PO1, PO2
CO4	Evaluate the effectiveness of enzyme engineering strategies through computational and experimental methods.	5	PO1, PO2
CO5	Apply engineered enzymes for specific industrial, environmental, or bioremediation applications.	3	PO1
CO6	Demonstrate an understanding of the ethical considerations and potential risks associated with enzyme engineering.	4	PO2

Syllabus

Introduction to enzymes: Structure, function, and kinetics Applications of enzymes in industry, environment, and biomedicine Fundamentals of protein structure: Primary, secondary, tertiary, and quaternary structure Protein-ligand interactions and enzyme catalysis

Protein folding and stability Site-directed mutagenesis and its impact on enzyme activity Understanding the effects of mutations on protein structure and function Computational tools for analyzing protein structure and function

Rational design and directed evolution approaches in enzyme engineering Site-directed mutagenesis techniques (PCR, gene cloning) Random mutagenesis and selection methods Enzyme immobilization techniques and their applications

Protein sequence and structure databases (e. g., UniProt, PDB) In silico protein engineering tools (docking simulations, protein stability prediction) Utilizing computational tools to design and analyze engineered enzymes

Enzyme activity assays and kinetic analysis Techniques for measuring protein expression and purification Computational and experimental methods for evaluating enzyme stability and function Case studies of successful enzyme engineering projects

Emerging trends in enzyme engineering Directed evolution for highly specific and efficient enzymes Protein engineering for novel biocatalytic functions Ethical considerations and potential risks of releasing engineered enzymes

Reference Books

- 1 Enzyme Engineering: Methods and Protocols, Francesca Magnani, Chiara Marabelli, and Francesca Paradisi, 2, Humana, New York, NY..
- 2 Fundamentals of Enzyme Engineering, Young Je Yoo, Yan Feng, Yong-Hwan Kim, and Camila Flor J. Yagonia, 1, Springer.
- 3 Directed Enzyme Evolution: Screening and Selection Methods, Robert A. Chica, Gregory M. Bryson, and Steven D., 2, Humana, New York, NY..
- 4 Biocatalysis: An Introduction, Glenn Francis, 3, Wiley-Blackwell, Oxford, UK.

23IBT3405M - BIOPROCESS VALIDATION AND CGMP (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3405M	BIOPROCESS VALIDATION AND CGMP	BVcGMP	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the regulatory landscape governing bioprocess validation and cGMP compliance.	3	PO1, PO2, PO3, PSO1
CO2	Develop proficiency in validation methodologies and quality assurance techniques	3	PO1, PO2, PO3, PSO1
CO3	Apply validation principles to design, execute, and evaluate validation protocols effectively.	3	PO1, PO2, PO3, PSO1
CO4	Gain competence in technology transfer processes within biopharmaceutical manufacturing.	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Bioprocess Validation and cGMP-Overview of bioprocess validation-Introduction to cGMP regulations

Regulatory Requirements-FDA regulations for bioprocess validation-EMA guidelines for cGMP compliance-ICH guidelines for pharmaceutical quality systems

Validation Methodologies-Process validation-Analytical method validation-Equipment qualification

Quality Assurance Techniques-Risk management-Deviation handling-CAPA (Corrective and Preventive Action) processes

Reference Books

- 1 Process Validation in Manufacturing of Biopharmaceuticals, Jameel Feroz, 2018, CRC press.
- 2 Pharmaceutical Process Validation: An International, Robert A. Nash and Alfred Hacher, 2003, CRC Press.
- 3 Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control, Sidney H. Willig and James R. Stoker, 2012, Marcel Dekker, Inc..
- 4 Bioprocess Engineering: Basic Concepts, Michael L. Shuler and Fikret Kargi, 2017, Pearson.

23IBT3406M - FOOD TECHNOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3406M	FOOD TECHNOLOGY	FT	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the concept of food associated microbes and their classification	3	PO5
CO2	Outline the methods of food processing	3	PO8
CO3	Illustrate various strategies involved in preservation and storage	3	PO11
CO4	Implementation of microorganisms in various food industries	3	, PSO2

Syllabus

Introduction to food microbiology, covering historical developments, types of microorganisms in food, their sources, behavior, and factors affect

Exploration of biotechnology's role in the food industry, including nutritive value enhancement, bioprocessing of various food types, and flavor and production improvement.

Focus on food preservation techniques, such as irradiation, its principles, legal status, and effects on food constituents, along with sto considerations.

Emphasis on food safety and quality control measures, including preventing foodborne illness, quality assurance in processing, and the util food production, alongside characteristics of thermophilic and radiation-resistant microbes.

Reference Books

- 1 Food Microbiology: Fundamentals and Frontiers, Michael P. Doyle, Robert L. Buchanan, and David A. Golden , 2013, Springer.
- 2 Modern Food Microbiology, James M. Jay, Martin J. Loessner, and David A. Golden, 2005, Springer.
- 3 Food Processing Technology: Principles and Practice, P.J. Fellows, 2017 , Woodhead Publishing (an imprint of Elsevier).
- 4 Food Microbiology: Fundamentals and Frontiers, Michael P. Doyle and Robert L. Buchanan, 2013, ASM Press.

23IBT3507 - MICROBIAL TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3507	MICROBIAL TECHNOLOGY	MBT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of microbial technology in production of bioproducts	3	PO1
CO2	Apply the concept of medium screen out and strain development	3	PO1, PO7
CO3	Develop various strategies to produce Primary and secondary Metabolites	3	PO2, PO3, PO7
CO4	Design various strategies for the production of enzymes, recombinant proteins, and other special bioproducts.	3	PO2, PO3, PO7

Syllabus

Introduction to basics of biotechnology A historical overview on scope and development of biotechnology and their products; Biotechnology as an interdisciplinary enterprise; A brief survey of organisms, processes, products and market economics relating to modern industrial biotechnology; Concepts of tools and techniques used in biotechnology; Out line and integrated bioprocesses and various unit operations (upstream and downstream) involved in the bioprocesses. Generalized process flow sheets.

Media, Screening and Strain improvement Medium requirements for fermentation process carbon, nitrogen, minerals, vitamins and other nutrients examples of simple and complex media; Industrial substrates. Primary and Secondary screening. Strain improvement by Physical, Chemical and Molecular techniques.

Production of Primary Metabolites A brief outline of processes for the production of some commercially important Organic acids (Citric acid, Lactic acid , Acetic acid, Gluconic acid), Amino acids (Glutamic Acid, Lysine, Aspartic Acid and Phenylalanine), and Alcohols (Ethanol, 2,3 butanediol). Secondary Metabolites Study of production processes and flow sheets for various classes of low molecular weight secondary metabolites, Antibiotics beta lactams (Penicillin), aminoglycosides (Streptomycin), Macrolids (Erythromycin), Quinines and aromatics. Vitamin B12 and steroids, Dual or multiple fermentation.

Enzymes, Recombinant Proteins, Special bioproducts Enzymes Protease, Concept of SSF, Advantages and disadvantages, Production of Recombinant Proteins Insulin and Special Bioproducts Biopesticides, Biofertilizers Natural Biopreservatives (Nisin), Biopolymers (Xanthan Gum), Single cell protein, High Fructose Corn Syrup, Process of bioleaching.

Reference Books

- 1 Microbial Biotechnology, Glazer AN, Nikaido H , 2007, WH Freeman and Company.
- 2 Biochemical Engineering Fundamentals, JE Baily & DF Ollis , 2017, McGraw Hill Book Co. New York.
- 3 Microbial Biotechnology: Fundamentals of Applied Microbiology, Alexander N. Glazer and Hiroshi Nikaido, 2007, W. H. Freeman and Company.
- 4 Industrial Microbiology: An Introduction, Michael J. Waites, Neil L. Morgan, and John S. Rockey, 2002, Wiley-Blackwell.

23IBT3508 - METABOLIC ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IBT3508	METABOLIC ENGINEERING	MBE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of metabolic engineering and its applications in biotechnology.	3	PO10
CO2	Apply metabolic pathway analysis techniques to optimize cellular metabolism for desired product formation.	3	PO6
CO3	Utilize synthetic biology tools and genetic engineering techniques to design and construct engineered metabolic pathways.	3	PO3
CO4	Evaluate and integrate omics data with computational modeling approaches to predict and improve metabolic pathway performance.	3	, PSO2

Syllabus

Introduction to metabolic engineering principles and historical developments Overview of metabolic pathway analysis and optimization techniques Exploration of tools and techniques used in metabolic engineering, including genome editing and synthetic biology

In-depth study of metabolic flux analysis and constraint-based modeling approaches Application of metabolic control analysis in understanding and manipulating cellular metabolism Hands-on exercises on analyzing and optimizing metabolic pathways using computational tools

Introduction to synthetic biology concepts and their relevance to metabolic engineering Techniques for genetic manipulation of microorganisms and construction of synthetic metabolic pathways Case studies illustrating the application of genetic engineering in pathway optimization

Integration of omics data with metabolic engineering approaches Systems biology techniques for predicting and optimizing cellular behavior Exploration of industrial applications of metabolic engineering, including case studies on commercialization and regulatory considerations

Reference Books

- 1 Metabolic Engineering: Principles and Applications, Stephanopoulos, Gregory, Aristidou, Aristos A., Nielsen, Jens, 1998, Academic Press.
- 2 Synthetic Biology: Tools and Applications, Huimin Zhao, 2020, Academic Press.
- 3 Systems Metabolic Engineering, Christoph Wittmann and Sang Yup Lee, 2012, Springer.
- 4 Principles of Synthetic Biology, Pablo A. Iglesias and Joel L. Sussman, 2015, Garland Science.

23ILA3101A - INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3101A	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	IIIoT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Industry 4.0 Globalization	3	PO1, PO10, PO12, PSO2
CO2	Apply the Model and architecture of IIOT	3	PO1, PO10, PO12, PSO2
CO3	Apply the IIOT sensing techniques	3	PO1, PO10, PO12, PSO2
CO4	Apply the IIOT Computing techniques	3	PO3, PO10, PO12, PSO2
CO5	Analyse the Various Applications of IIOT	4	PO1, PO10, PO12, PSO2
CO6	Apply IIOT Systems Programming IO interfacing with various applications.	3	PO1, PO10, PO12, PSO2
CO7	Apply IIOT Systems Programming IO interfacing with various applications.	3	PO1, PO10, PO12, PSO2

Syllabus

Industry 4.0- Globalization: The Fourth Revolution, LEAN Production Systems , Sensing & actuation, Communication, Networking types.

Basics of Industrial IIOT: Industrial Processes Industrial Sensing & Actuation, Industrial IIOT: Business Model and Reference Architecture, Industrial IIOT- Layers

IIOT Sensing- sensors categories, IIOT Processing- signal conditioning circuits, IIOT Networking.

Industrial IIOT Computing: Big Data Analytics and Software Defined Networks, Data Center Networks, Industrial IIOT: Security and Fog Computing - Fog Computing in IIOT, Security in IIOT

Industrial IIOT Application Domains: Healthcare, Power Systems, Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies.

Reference Books

- 1 Sensors and Transducers, D. Patranabis , 2004, PHI.
- 2 The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj and Anupama C. Raman, 2017, CRC Press.
- 3 From Machine-to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence, Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, 2014, Academics PRESS.
- 4 Learning Internet of Things, Peter Waher, 2015, Packt Publishing.

23ILA3101E - INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3101E	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	IIIoT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Industry 4.0 Globalization	3	PO1, PO10, PO12, PSO2
CO2	Apply the Model and architecture of IIOT	3	PO1, PO10, PO12, PSO2
CO3	Apply the IIOT sensing techniques	3	PO1, PO10, PO12, PSO2
CO4	Apply the IIOT Computing techniques	3	PO3, PO10, PO12, PSO2
CO5	Analyse the Various Applications of IIOT	4	PO1, PO10, PO12, PSO2
CO6	Apply IIOT Systems Programming IO interfacing with various applications.	3	PO1, PO10, PO12, PSO2
CO7	Apply IIOT Systems Programming IO interfacing with various applications.	3	PO1, PO10, PO12, PSO2

Syllabus

Industry 4.0- Globalization: The Fourth Revolution, LEAN Production Systems , Sensing & actuation, Communication, Networking types.

Basics of Industrial IIOT: Industrial Processes Industrial Sensing & Actuation, Industrial IIOT: Business Model and Reference Architecture, Industrial IIOT- Layers

IIOT Sensing- sensors categories, IIOT Processing- signal conditioning circuits, IIOT Networking.

Industrial IIOT Computing: Big Data Analytics and Software Defined Networks, Data Center Networks, Industrial IIOT: Security and Fog Computing - Fog Computing in IIOT, Security in IIOT

Industrial IIOT Application Domains: Healthcare, Power Systems, Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies.

Reference Books

- 1 Sensors and Transducers , D. Patranabis, 2014, PHI.
- 2 From Machine-to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence , Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, 2014, Academics PRESS .
- 3 The Internet of Things: Enabling Technologies, Platforms, and Use Cases , Pethuru Raj and Anupama C. Raman , 2017, CRC Press.
- 4 Sensors and Actuators , D. Patranabis, 2013, PHI.

23ILA3101R - INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3101R	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	IIoT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Industry 4.0 Globalization	3	PO1, PO10, PO12, PSO2
CO2	Apply the Model and architecture of IIOT	3	PO1, PO10, PO12, PSO2
CO3	Apply the IIOT Computing techniques	3	PO1, PO10, PO12, PSO2
CO4	Analyse the Various Applications of IIOT	4	PO3, PO10, PO12, PSO2
CO5	apply the principals of IIOT components and exercise the behaviors of IIOT stages	3	PO1, PO10, PO12, PSO2
CO6	Apply the skill of using tools to realize IIOT applications	3	PO1, PO10, PO12, PSO2

Syllabus

Industry 4.0- Globalization: The Fourth Revolution, LEAN Production Systems , Sensing & actuation, Communication, Networking types.

Basics of Industrial IIOT: Industrial Processes Industrial Sensing & Actuation, IIOT Processing, Industrial IIOT: Business Model and Reference Architecture, Industrial IIOT- Layers

Industrial IIOT Computing: Big Data Analytics and Software Defined Networks, Data Center Networks, Industrial IIOT: Security and Fog Computing - Fog Computing in IIOT, Security in IIOT

Industrial IIOT Application Domains: Healthcare, Power Systems, Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies.

exercise the behavior of various sensors and actuators with communication capabilities to design IIOT applications

Embedded integrated development environments- arduino,wokwi, simulation and hardware skill activities to demonstrate the iiot features using esp32/raspberry PI PICO W boards

Reference Books

- 1 Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist , 2016, A press.
- 2 Industrial Internet of Things: Cybermanufacturing Systems, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, 2016, Springer.
- 3 The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj and Anupama C. Raman, 2017, CRC Press.
- 4 From Machine-to-Machine to the Internet ofThings: Introduction to a New Age of Intelligence, 2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand,StamatisKarnouskos, David Boyle, 2014, Academic Press.

23ILA3202A - INDUSTRIAL AUTOMATION AND ROBOTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3202A	INDUSTRIAL AUTOMATION AND ROBOTICS	IAR	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of automation	3	PO1, PSO1
CO2	Apply control system principles for automation	3	PO1, PSO1
CO3	Analyze characteristics of Industrial Robots	4	PO2, PSO1
CO4	Analyze the robotic end effectors and Sensors	4	PO2, PSO1
CO5	Analyze PLC programming for Robotic Drive	4	PO2, PSO1

Syllabus

Definition of industrial automation, Mechanization vs automation, advantages of automation, goals of automation, reasons for automation, social issues of automation, types of automation, current emphasis in automation, Controllers Employed in Automated Systems, Case Studies.

Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems. Industrial automation and Case studies

Specifications and Characteristics, Criteria for selection. Dynamic properties of robots-stability, control resolution, spatial resolution, accuracy, repeatability, compliance, work cell control, Interlocks Robotic Control Systems-Robot Motions, Drives, Actuators, Robot controllers, Power transmission systems.

Transducers and sensors: sensors in robotics and their classification, vision sensors, touch (tactile) sensors, proximity and range sensors, force and torque sensing. End Effectors-Types, grippers, various process tools as end effectors, Robot-End effectors interface, Active and passive compliance, Gripper selection and design.

Robot Programming: Level of robot programming, Language based programming, task level programming, Robot programming synthesis, Industrial Applications and Case Studies

Reference Books

- 1 Automation, Production Systems & Computer Integrated Manufacturing, Mikell P. Groover, 2015, PHI Learning Pvt. Ltd.
- 2 An Introduction to Robot Technology, Phillipe Collet, 2017, Prentice Hall.
- 3 Industrial Automation and Robotics, A.K Gupta, S.K. Arora, 2018, Laxmi Publication.
- 4 Industrial Automation and Robotics: An Introduction, Jean Riescher Westcott, 2021, Mercury Learning & Information.

23ILA3202E - INDUSTRIAL AUTOMATION AND ROBOTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3202E	INDUSTRIAL AUTOMATION AND ROBOTICS	IAR	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of automation	3	PO1, PSO1
CO2	Apply control system principles for automation	3	PO1, PSO1
CO3	Analyze characteristics of Industrial Robots	4	PO2, PSO1
CO4	Analyze the robotic end effectors and Sensors	4	PO2, PSO1
CO5	Analyze PLC programming for Robotic Drive	5	PO2, PSO1

Syllabus

Definition of industrial automation, Mechanization vs automation, advantages of automation, goals of automation, reasons for automation, social issues of automation, types of automation, current emphasis in automation, Controllers Employed in Automated Systems, Case Studies.

Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems. Industrial automation and Case studies

Specifications and Characteristics, Criteria for selection. Dynamic properties of robots-stability, control resolution, spatial resolution, accuracy, repeatability, compliance, work cell control, Interlocks Robotic Control Systems-Robot Motions, Drives, Actuators, Robot controllers, Power transmission systems.

Transducers and sensors: sensors in robotics and their classification, vision sensors, touch (tactile) sensors, proximity and range sensors, force and torque sensing. End Effectors-Types, grippers, various process tools as end effectors, Robot-End effectors interface, Active and passive compliance, Gripper selection and design.

Robot Programming: Level of robot programming, Language based programming, task level programming, Robot programming synthesis, Industrial Applications and Case Studie

Reference Books

- 1 Automation, Production Systems & Computer Integrated Manufacturing, Mikell P. Groover, 2015, PHI Learning Pvt. Ltd.
- 2 An Introduction to Robot Technology, Phillipe Collet, 2017, Prentice Hall.
- 3 Industrial Automation and Robotics, A.K Gupta, S.K. Arora, 2018, Laxmi Publication.
- 4 Industrial Automation and Robotics: An Introduction, Jean Riescher Westcott, 2021, Mercury Learning & Information.

23ILA3202R - INDUSTRIAL AUTOMATION AND ROBOTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3202R	INDUSTRIAL AUTOMATION AND ROBOTICS	IAR	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of automation	3	PO1, PSO1
CO2	Apply control system principles for automation	3	PO1, PSO1
CO3	Analyze characteristics of Industrial Robots	4	PO2, PSO1
CO4	Analyze the robotic end effectors and Sensors	4	PO2, PSO1

Syllabus

automation, current emphasis in automation, Controllers Employed in Automated Systems, Case Studies.

Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules
Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems.
Industrial automation and Case studies

Specifications and Characteristics, Criteria for selection. Dynamic properties of robots-stability, control resolution, spatial resolution, accuracy, repeatability, compliance, work cell control, Interlocks Robotic Control Systems-Robot Motions, Drives, Actuators, Robot controllers, Power transmission systems.

Transducers and sensors: sensors in robotics and their classification, vision sensors, touch (tactile) sensors, proximity and range sensors, force and torque sensing. End Effectors-Types, grippers, various process tools as end effectors, Robot-End effectors interface, Active and passive compliance, Gripper selection and design.

Reference Books

- 1 Automation, Production Systems & Computer Integrated Manufacturing, Mikell P. Groover, 2015, PHI Learning Pvt. Ltd.
- 2 An Introduction to Robot Technology, Phillipe Collet, 2017, Prentice Hall.
- 3 Industrial Automation and Robotics, A.K Gupta, S.K. Arora, 2018, Laxmi Publication.
- 4 Industrial Automation and Robotics: An Introduction, Jean Riescher Westcott, 2021, Mercury Learning & Information.

23ILA3203A - EDGE COMPUTING FOR INDUSTRY 4.0 (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3203A	EDGE COMPUTING FOR INDUSTRY 4.0	ECI	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Industry 4.0 Globalization	2	PO1, PO10, PO12, PSO2
CO2	Describe the Edge/Fog Computing and infer the opportunities and challenges	2	PO1, PO10, PO12, PSO2
CO3	Examine the Architecture of Edge Computing and explore the issues that are being addressed by the industry	3	PO1, PO10, PO12, PSO2
CO4	Interpret the Middleware needed for Edge Computing and its Security Requirements	3	PO1, PO10, PO12, PSO2
CO5	Assess the need for Edge/Fog Computing in various real-time projects	3	PO2, PO10, PO12, PSO2

Syllabus

Globalization impact on industry, Industry 4.0- Globalization: The Fourth Revolution, LEAN Production Systems

CYBERSECURITY IN INDUSTRY 4.0 Basics of Industrial IoT, Cloud computing features and its limitations to support low latency use cases, Edge Computing to support IoT applications case study.

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Opportunities and Challenges. Addressing the Challenges in Federating Edge Resources

Edge Architecture: Integrating IoT + Fog + Cloud Infrastructures, System Modeling, and Research Challenges, Network Slicing Management in Edge and Fog, Optimization in Fog Computing, Formal Modeling Framework for Fog Computing, Middlewares: Middleware for Fog and Edge Computing: Design Issues, State-of-the-Art Middleware Infrastructures, A Lightweight Container Middleware for Edge Cloud Architectures

Security and Data Management: Security Management for Edge Cloud Architectures, Applications, and Issues: Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking, Fog Computing Model for Evolving Smart Transportation Applications

Reference Books

- 1 Industry 4.0: The Industrial Internet of Things Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist , 2016, Apress.
- 2 Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya (Editor), Satish Narayana Sri rama(Editor), 2019, Wiley Publications.
- 3 IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, Perry Lea, 2020, Paperback.
- 4 Edge Computing: A Primer, Jie CaoQuan ZhangWeisong Sh, 2018, Springer.

23ILA3203E - EDGE COMPUTING FOR INDUSTRY 4.0 (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3203E	EDGE COMPUTING FOR INDUSTRY 4.0	ECI	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Industry 4.0 Globalization	2	PO1, PO10, PO12, PSO2
CO2	Describe the Edge/Fog Computing and infer the opportunities and challenges	2	PO1, PO10, PO12, PSO2
CO3	Examine the Architecture of Edge Computing and explore the issues that are being addressed by the industry	3	PO1, PO10, PO12, PSO2
CO4	Interpret the Middleware needed for Edge Computing and its Security Requirements	3	PO1, PO10, PO12, PSO2
CO5	Assess the need for Edge/Fog Computing in various real-time projects	3	PO2, PO10, PO12, PSO2

Syllabus

Globalization impact on industry, Industry 4.0- Globalization: The Fourth Revolution, LEAN Production Systems

CYBERSECURITY IN INDUSTRY 4.0 Basics of Industrial IoT, Cloud computing features and its limitations to support low latency use cases, Edge Computing to support IoT applications case study.

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Opportunities and Challenges. Addressing the Challenges in Federating Edge Resources

Edge Architecture: Integrating IoT + Fog + Cloud Infrastructures, System Modeling, and Research Challenges, Network Slicing Management in Edge and Fog, Optimization in Fog Computing, Formal Modeling Framework for Fog Computing, Middlewares: Middleware for Fog and Edge Computing: Design Issues, State-of-the-Art Middleware Infrastructures, A Lightweight Container Middleware for Edge Cloud Architectures

Security and Data Management: Security Management for Edge Cloud Architectures, Applications, and Issues: Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking, Fog Computing Model for Evolving Smart Transportation Applications

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- 1 Industry 4.0: The Industrial Internet of Things Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, 2016, Apress.
- 2 Fog and Edge Computing: Principles and Paradigms , Rajkumar Buyya (Editor), Satish Narayana Sri rama(Editor), 2019, Wiley Publications.
- 3 IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, Perry Lea, 2020, Paperback.
- 4 Edge Computing: A Primer, Jie CaoQuan ZhangWeisong Sh , 2018, Springer.

23ILA3203R - EDGE COMPUTING FOR INDUSTRY 4.0 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3203R	EDGE COMPUTING FOR INDUSTRY 4.0	ECI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the Edge/Fog Computing and infer the opportunities and challenges	2	PO1, PO10, PO12, PSO2
CO2	Examine the Architecture of Edge Computing and explore the issues that are being addressed by the industry	3	PO1, PO10, PO12, PSO2
CO3	Interpret the Middleware needed for Edge Computing and its Security Requirements	3	PO1, PO10, PO12, PSO2
CO4	Assess the need for Edge/Fog Computing in various real-time projects	3	PO2, PO10, PO12, PSO2

Syllabus

Industry 4.0: Cyber Physical Systems, Collaborative Platform and Product Lifecycle Management CYBERSECURITY IN INDUSTRY 4.0 Basics of Industrial IoT, Cloud computing features and its limitations to support low latency use cases, Edge Computing to support IoT applications case study.

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Opportunities and Challenges. Addressing the Challenges in Federating Edge Resources

Edge Architecture: Integrating IoT + Fog + Cloud Infrastructures, System Modeling, and Research Challenges, Network Slicing Management in Edge and Fog, Optimization in Fog Computing, Formal Modeling Framework for Fog Computing, Middlewares: Middleware for Fog and Edge Computing: Design Issues, State-of-the-Art Middleware Infrastructures, A Lightweight Container Middleware for Edge Cloud Architectures

Security and Data Management: Security Management for Edge Cloud Architectures, Applications, and Issues: Exploiting Fog Computing in Health Monitoring, Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking, Fog Computing Model for Evolving Smart Transportation Applications

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- 2 IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, Perry Lea, 2020, Paperback..
- 3 Edge Computing: A Primer, Jie CaoQuan ZhangWeisong Sh, 2018, Springer.
- 4 Fog and Edge Computing-Simply Indepth , Singh Ajit, 2022, Paperback.

23ILA3304A - INDUSTRIAL DRIVES AND CONTROL (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3304A	INDUSTRIAL DRIVES AND CONTROL	ID&C	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select and size electric drive for industrial automation application	3	PO1, PO5, PSO1
CO2	Analyze dc drives for industrial automation	4	PO2, PO5, PSO1
CO3	Analyze ac drives for industrial automation	4	PO2, PO5, PSO1
CO4	Analyze BLDC and SRM drives for industrial automation	4	PO2, PO5, PSO1
CO5	Analyze PLC control for industrial automation	4	PO2, PO5, PSO1
CO6	Test and Analyze electrical motor drives for industrial automation	4	PO2, PO5, PSO1
CO7	Test the dynamics of industrial drives using MATLAB	3	PO1, PO5, PSO1

Syllabus

Electric drive components, power converters and motors, load torque components, types of industrial loads, intermittent loads, stability, choice of drive, selection and sizing of drive case study.

Mathematical models- DC Motor, DC-DC Converter, Speed Sensing, Current sensing, Analysis of current loop, Analysis of speed loop, digital control implementation of dc drive

Induction motor torque expression, effect of harmonics in input voltage, v/f control, analog SPWM implementation, static rotor resistance control, Park's Transformation, Clarke's Transformation, three phase induction motor model in rotating frame of reference, Space vector modulation, Direct torque control.

Dynamics of SRM, BLDC Motors, Torque Expressions, Mathematical models, closed loop control, applications

PLC based control- PID control of dc drive, Bi-directional control of dc motor, induction motor starting, VFD control, temperature and vibration control.

Reference Books

- 1 Automation, Production Systems & Computer Integrated Manufacturing, Mikell P. Groover, 3rd, PHI.
- 2 Modern Power Electronics & AC Drives, B K BOSE, 1ST, PEARSON.
- 3 Industrial Automation and Robotics, A.K Gupta, S.K. Arora,, 3RD, Laxmi Publication (P) Ltd..
- 4 Fundamentals of Electrical Drives, DUBEY GOPAL K, 3rd, Alpha science Int Ltd.

23ILA3304E - INDUSTRIAL DRIVES AND CONTROL (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3304E	INDUSTRIAL DRIVES AND CONTROL	ID&C	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select and size electric drive for industrial automation application	3	PO1, PO5, PSO1
CO2	Analyze dc drives for industrial automation	4	PO2, PO5, PSO1
CO3	Analyze ac drives for industrial automation	4	PO2, PO5, PSO1
CO4	Analyze BLDC and SRM drives for industrial automation	4	PO2, PO5, PSO1
CO5	Analyze PLC control for industrial automation	4	PO2, PO5, PSO1
CO6	Test and Analyze electrical motor drives for industrial automation	4	PO2, PO5, PSO1
CO7	Test the dynamics of industrial drives using MATLAB	3	PO1, PO5, PSO1

Syllabus

Electric drive components, power converters and motors, load torque components, types of industrial loads, intermittent loads, stability, choice of drive, selection and sizing of drive case study

Mathematical models- DC Motor, DC-DC Converter, Speed Sensing, Current sensing, Analysis of current loop, Analysis of speed loop, digital control implementation of dc drive

Induction motor torque expression, effect of harmonics in input voltage, v/f control, analog SPWM implementation, static rotor resistance control, Park's Transformation, Clarke's Transformation, three phase induction motor model in rotating frame of reference, Space vector modulation, Direct torque control.

Dynamics of SRM, BLDC Motors, Torque Expressions, Mathematical models, closed loop control, applications

PLC based control- PID control of dc drive, Bi-directional control of dc motor, induction motor starting, VFD control, temperature and vibration control.

Reference Books

- 1 Automation, Production Systems & Computer Integrated Manufacturing , Mikell P. Groover, 3RD, PHI.
- 2 Modern Power Electronics & AC Drives, B K BOSE, 1ST, PEARSON.
- 3 Industrial Automation and Robotics, A.K Gupta, S.K. Arora,, 3RD, Laxmi Publication (P) Ltd..
- 4 Fundamentals of Electrical Drives, DUBEY GOPAL K, 3rd, Alpha science Int Ltd.

23ILA3304R - INDUSTRIAL DRIVES AND CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3304R	INDUSTRIAL DRIVES AND CONTROL	ID&C	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select and size electric drive for industrial automation application	3	PO1, PO5, PSO1
CO2	Analyze dc drives for industrial automation	4	PO2, PO5, PSO1
CO3	Analyze ac drives for industrial automation	4	PO2, PO5, PSO1
CO4	Analyze PLC control of industrial drives	4	PO2, PO5, PSO1
CO5	Test and Analyze practical issues of electrical drives	4	PO2, PO5, PSO1
CO6	Test the dynamics of industrial drives using MATLAB	3	PO1, PO5, PSO1

Syllabus

Electric drive components, power converters and motors, load torque components, types of industrial loads, intermittent loads, stability, choice of drive, selection and sizing of drive case study.

Mathematical models- DC Motor, DC-DC Converter, Speed Sensing, Current sensing, Analysis of current loop, Analysis of speed loop, digital control implementation of dc drive

Induction motor torque expression, effect of harmonics in input voltage, v/f control, analog SPWM implementation, static rotor resistance control, Park's Transformation, Clarke's Transformation, three phase induction motor model in rotating frame of reference, Space vector modulation, Direct torque control.

PLC based control- PID control of dc drive, Bi-directional control of dc motor, induction motor starting, VFD control, temperature and vibration control.

Reference Books

- 1 Automation, Production Systems & Computer Integrated Manufacturing, Mikell P. Groover, 3RD, PHI.
- 2 Modern Power Electronics & AC Drives, B K BOSE, IST, PEARSON.
- 3 Industrial Automation and Robotics, A.K Gupta, S.K. Arora,, 3RD, Laxmi Publication (P) Ltd..
- 4 Fundamentals of Electrical Drives, G. K. Dubey, 3RD, Alpha science Int Ltd.

23ILA3405M - INDUSTRIAL COMMUNICATION PROTOCOLS AND CYBER SECURITY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3405M	INDUSTRIAL COMMUNICATION PROTOCOLS AND CYBER SECURITY	ICPCS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Industrial data communication Technologies, it encompass a variety of methods and protocols used to enable communication and data exchange between industrial devices, systems, and components. These technologies are crucial for the operation, control, and monitoring of industrial processes, machinery, and automation systems.	2	PO1, PO5, PSO1
CO2	Understanding various industrial protocols and standards is essential for professionals in fields such as industrial automation, control systems engineering, and industrial networking.	2	PO2, PO4, PSO2
CO3	Understanding the concepts of information security and hacking tools is crucial for professionals working in cybersecurity, IT security, and related fields.	2	PO2, PO6, PSO2
CO4	Apply knowledge on concept of Cybercrimes and Malwares-Understanding cybercrimes and malwares is crucial for cybersecurity professionals and those involved in IT security.	3	PO2, PO6, PSO2

Syllabus

INDUSTRIAL DATA COMMUNICATION Dedicated and shared communication channels, switching techniques, communication channels, layered architecture and protocols, communication technologies, standards for information exchange.

PROTOCOLS and STANDARDS Modbus Protocol Overview. PROFIBUS-FMS, DP, PA and technology overview, DNP3 IP based Real Time data Transmission, Introduction to Industrial Network Technology CAN and CiA, Technical Overview, CAN Kingdom, CAN open.

INFORMATION SECURITY, HACKING TOOLS Introduction, Encryption and Decryption Authentication, Digital signature, Message digest, cyber security standards. Identifying a target-Vulnerability, Attack tools, Attack methods, Smartphone Security, Smartphone Security Guidelines, Communicating Securely through Voice and Messages with a Smartphone, Secure Voice Communication, Sending Messages Securely.

CYBER CRIMES and MALWARES Introduction to Cyber Crime, Classification of Cyber Crimes, Reasons for Commission of Cyber Crimes, Malware Types, Cyber Security Initiatives in India, Counter Cyber Security initiatives in India -Wireless Security, Major Issues With WLAN, Secure WLAN, Wi-Fi at Home.

Reference Books

- 1 Industrial Communication Systems, Hubert Kirmann, Knut Schwalenberg, and Christine Rossbach, 2016, Wiley.
- 2 Industrial Communication Technology Handbook, Richard Zurawski, 2014, CRC Press.
- 3 Industrial Cybersecurity: Efficiently Secure Critical Infrastructure Systems, Pascal Ackerman and Joel Langill, 2016, CRC Press.
- 4 Cyber Security and Industrial Communication Protocols, Rajveer Singh and Krishna Chand Gupta, 2018, Notion Press.

23ILA3406M - DIGITAL MANUFACTURING AND DESIGN (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3406M	DIGITAL MANUFACTURING AND DESIGN	DMD	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Digital thread principles to manufacturing processes	3	PO1, PSO1
CO2	Apply data analytics for digitalization of manufacturing process	3	PO1, PSO1
CO3	Analyze cybersecurity for Digitalization of manufacturing processes	4	PO2, PSO1
CO4	Analyze model based manufacturing systems for digital manufacturing	4	PO2, PSO1

Syllabus

Digital Thread: Transition to Digital Manufacturing, Manufacturing Supply Chains, Digital Manufacturing Security, Data Storage, Data Singularity, Data Security and Disaster Recovery, Interoperability and Data Formats, Technical Data Packages

Manufacturing Process Analysis & Collaborative Enterprise: Data Collection, Data Analytics-computational techniques and platforms, intelligent machining-controllers, software, Challenges and Opportunities in Advanced Manufacturing Adoption, Examples of Emerging Data Collection Technologies

Cyber security in manufacturing: Digital Manufacturing Security, Information Security Framework, Application of Information Security in Digital Manufacturing, Securing End to End Process via Security Development Life Cycle, Network Security and Authentication, Shipping, RFID tags, Mobile Device Security and Wireless Communication, Intellectual Property Protection from Threats

Model Based Systems Engineering-Introduction to Systems Engineering, Business Impacts of Systems Engineering, Model-Based Systems Engineering Methodologies, Systems Modeling Language (SysML), Model-Based Systems Engineering (MBSE) Application Strategies, The Model-Based Enterprise-Design Activities, Manufacturing Planning Activities, Quality Requirements and Quality Planning Activities

Reference Books

- 1 Digital Manufacturing and Assembly Systems in Industry 4.0 (Science, Technology, and Management), Kaushik Kumar, Divya Zindani, J. Paulo Davim, 2019, CRC press..
- 2 Automation, Production Systems & Computer Integrated Manufacturing, Mikell P. Groover, 2012, PHI Learning.
- 3 Digital Manufacturing: Design, Technology, and Innovation, Luciano Batista, J. Paulo Davim, 2015, CRC Press.
- 4 Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker, 2018, Springer.

23ILA3507 - SMART SENSORS AND SENSOR NETWORKING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3507	SMART SENSORS AND SENSOR NETWORKING	SSSN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basics of smart sensors and micromachining	2	PO1, PO3
CO2	Apply the sensor communication protocols	3	PO3, PO4
CO3	Apply the packaging, testing and reliability of smart sensors	3	PO1, PO2
CO4	Apply Power sources for WSN-Power generation-conversion	3	PO3, PO4
CO6	Demonstrate various experiments related to basics of smart sensors and sensor networking	3	PO1

Syllabus

Basics of smart sensors and micromachining: Introduction, Mechanical-Electronic transitions in sensing, nature of sensors, overview of smart sensing and control systems, integration of micromachining and microelectronics, introduction to micromachining, bulk micromachining, wafer bonding, surface micromachining, other micromachining techniques for Sensor Design

Sensor Communication and MEMS-Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Micro optics, micro-grippers, micro-probes, micro- mirrors, FEDs, communications for smart sensors-sources and standards, automotive protocols, industrial networks, office and building automation, home automation, protocols in silicon, other aspects of network communications.

Packaging, Testing and Reliability of Smart Sensors-Introduction, Semiconductor packaging applied to sensors, reliability implications, testing smart sensors. Unit Standards for Smart Sensors-Introduction, setting the standards for smart sensors and systems, IEEE 1451.1, IEEE 1451.2, IEEE P1451.3, IEEE 1451.4, extending the systems to network.

Introduction to Wireless Sensor Networks-Motivations, Applications, Performance metrics, energy harvesting wireless sensors, Power sources for WSN-Power generation-conversion

Reference Books

- 1 Understanding Smart Sensors, Randy Frank, 2013, Artech House Publications.
- 2 MEMS and Microsystems: Design and Manufacture, Tai-Ran Hsu, 2002, Pearson International Edition.
- 3 Micro and Smart Systems: Technology and modeling, G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat, V. K. Aatre, 2010, Willey Publications .
- 4 Microgrids: Architectures and Control, Nikos Hatziaargyriou (Ed.), 2014, Wiley-IEEE Press.
- 5 Control and Optimization Methods for Electric Smart Grids, Aranya Chakraborty, 2011, Springer.

23ILA3508 - PLC PROGRAMMING & CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ILA3508	PLC PROGRAMMING & CONTROL	PLCPC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Programming Logic architecture	3	PO1, PSO1
CO2	Apply PLC Programming features	3	PO1, PSO1
CO3	Apply knowledge PLC Programming for various automation cases	3	PO1, PSO1
CO4	Apply PLC programming for industrial control applications	3	PO1, PSO1

Syllabus

Introduction to PLC: Review of Sensors, actuators and controllers. PLC Overview - PLC Selection - Number Systems and Codes - IO Devices & Motor Controls - NONC & RLO Concept - Creating Relay Logic Diagrams. TIA Portal, PLC Industry hardware specifications -Siemens, ABB, Mitsubishi PLC.

PLC Programming features - Programming Logic Gate Functions - Ladder Logic -Relay type instructions - PLC Timer Instructions - PLC Counter Instructions - Math Instructions-Data manipulation and math instructions.

Programming Cases: Compare, Jump & MCR Instructions - Subroutine Functions - Logic & Bit Shift Instructions - Data Handling Instructions Communication architectures - PID modules - functions-PWM modules.

PLC Based control systems- Temperature controller, Water-level control, conveyer control, elevator control, bottle filling system, traffic light controller, Motor control.

Reference Books

- 1 Programmable Logic Controllers , F.D. Petruzella, , 2018, Tata Mc-Graw Hill .
- 2 Process/Industrial Instrument and Controls Handbook , McMillan, G.K, 2019, McGraw- Hill.
- 3 Introduction to Industrial automation , Stamatios Manesis,George Nikolakopoulos, , 2018. , CRC Press .
- 4 Programmable Logic Controllers: Resources for Measurements and Control Series, Hughes, T.A, 2004, ISA Press.

23IMP3101A - NATURAL LANGUAGE PROCESSING & APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3101A	NATURAL LANGUAGE PROCESSING & APPLICATIONS	NLPA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental concepts in NLP and review different NLP applications.	3	PO1, PSO2
CO2	Illustrate and Apply the basic structure of NLP Pipelines for text-based applications.	3	PO2, PSO2
CO3	Apply and Analyze the performance of algorithms for semantics in NLP and prioritize them for the existing applications.	4	PO1, PSO2
CO4	Apply machine learning models for finding solutions for problems in NLP and judge their performance.	3	PO2, PSO2
CO5	Apply the concept of attention in language modelling and analyze the performance of LLMs.	4	PO1, PO2, PSO2
CO6	Evaluate and Analyze the operations applied in NLP pipelines through Python code development using NLTK, SpaCY, and Tensorflow Frameworks.	5	PO1, PO2, PO3, PSO2
CO7	Create a small scale LLM for NLP Applications from scratch and Evaluate the created model against pre-trained models from Hugging Face Repository.	6	PO1, PO2, PO3, PSO2

Syllabus

NLP: Overview and Motivation. Human Language from Computers Viewpoint and language building blocks. Words, text, and document models. A Chatbot NLP pipeline. Word tokenization, Building vocabulary with tokenizer and sentiment. Challenges in NLP. Approaches in NLP using NLTK and TensorFlow frameworks.

NLP Pipeline: Data Acquisition, Text Extraction and Cleanup, Pre-Processing, Feature Engineering, Modeling

Finding meaning in word counts (semantic analysis): From word counts to topic scores, Latent semantic analysis, Singular value decomposition, Principal component analysis, Word2Vec, GloVe, Distance and similarity, Steering with feedback, Topic vector power.

Deeper learning (neural networks): Semantic queries and analogies, Word vectors, Learning meaning, Convolutional neural nets, RNNs, LSTMs, and Language Models for Text processing. Sequence-to-sequence models and attention in transformer-based Large Language models. Text Classification, summarization, Application pipeline building.

Natural Language Processing with Attention Models: BERT Transformer and CHATGPT-3: Architecture, Datasets, and Performance. Translate complete English sentences into German using an encoder-decoder attention model, Build a Transformer model to summarize text, Use T5 and BERT models to perform question-answering, and Build a chatbot using a Reformer model.

Reference Books

- 1 Practical Natural Language Processing , Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana , 2020, O'Reilly Media, Inc. ISBN: 9781492054054 .
- 2 Natural Language Processing in Action , Hobson Lane, Cole Howard, Hannes Hapke , 2019, Manning Publications. ISBN: 978161729463 .
- 3 Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit, Steven Bird, Ewan Klein, and Edward Loper, 2009, O'Reilly Media.
- 4 Neural Network Methods in Natural Language Processing, Yoav Goldberg, 2022, Morgan & Claypool Publishers.

23IMP3101E - NATURAL LANGUAGE PROCESSING & APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3101E	NATURAL LANGUAGE PROCESSING & APPLICATIONS	NLPA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental concepts in NLP and review different NLP applications.	3	PO1, PSO1
CO2	Illustrate and Apply the basic structure of NLP Pipelines for text-based applications.	3	PO1, PSO1
CO3	Apply and Analyze the performance of algorithms for semantics in NLP and prioritize them for the existing applications.	3	PO1, PO2, PSO1
CO4	Apply machine learning models for finding solutions for problems in NLP and judge their performance.	4	PO1, PO2, PSO1
CO5	Apply the concept of attention in language modelling and analyze the performance of LLMs.	4	PO1, PO2, PO3, PSO1
CO6	Evaluate and Analyze the operations applied in NLP pipelines through Python code development using NLTK, SpaCY, and Tensorflow Frameworks.	5	PO1, PO2, PO3, PSO1
CO7	Design and validate NLP applications for text summarization, classification and generation through Python code	5	PO2, PO3, PSO1

Syllabus

NLP: Overview and Motivation. Human Language from Computers Viewpoint and language building blocks. Words, text, and document models. A Chatbot NLP pipeline. Word tokenization, Building vocabulary with tokenizer and sentiment. Challenges in NLP. Approaches in NLP using NLTK and TensorFlow frameworks.

NLP Pipeline: Data Acquisition, Text Extraction and Cleanup, Pre-Processing, Feature Engineering, and Modeling. Evaluation, Post-Modeling Phases. TF-IDF vectors, Bag of words

Finding meaning in word counts (semantic analysis): From word counts to topic scores, Latent semantic analysis, Singular value decomposition, Principal component analysis, Word2Vec, GloVe, Distance and similarity, Steering with feedback, Topic vector power.

Deeper learning (neural networks): Semantic queries and analogies, Word vectors, Learning meaning, Convolutional neural nets, RNNs, LSTMs, and Language Models for Text processing. Sequence-to-sequence models and attention in transformer-based Large Language models. Text Classification, summarization, Application pipeline building.

Natural Language Processing with Attention Models: BERT Transformer and CHATGPT-3: Architecture, Datasets, and Performance. Translate complete English sentences into German using an encoder-decoder attention model, Build a Transformer model to summarize text, Use T5 and BERT models to perform question-answering, and Build a chatbot using a Reformer model.

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- 1 Practical Natural Language Processing , Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana , 2020, O'Reilly Media, Inc. ISBN: 9781492054054 .
- 2 Natural Language Processing in Action , Hobson Lane, Cole Howard, Hannes Hapke , 2019, Manning Publications. ISBN: 978161729463 .
- 3 Neural Network Methods in Natural Language Processing, Yoav Goldberg, 2022, Morgan & Claypool Publishers.
- 4 Handbook of Natural Language Processing, Nitin Indurkha and Fred J. Damerau, Chapman and Hall/CRC, 2020.

23IMP3101R - NATURAL LANGUAGE PROCESSING & APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3101R	NATURAL LANGUAGE PROCESSING & APPLICATIONS	NLPA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the fundamental concepts in NLP and review different NLP applications.	3	PO1, PSO1
CO2	Illustrate and summarize the basic structure of NLP Pipelines.	3	PO1, PSO1
CO3	Apply and Analyze the performance of algorithms for semantics in NLP and prioritize them for the existing applications.	3	PO1, PO2, PSO1
CO4	Apply machine learning models for finding solutions for problems in NLP and judge their performance.	4	PO1, PO2, PSO1
CO5	Design and validate NLP applications for text summarization, classification and generation through	5	PO2, PO3, PSO1
CO6	Evaluate NLP pipelines to build small scale applications for real time deployment.	5	PO2, PO3, PSO1

Syllabus

NLP: Overview and Motivation. Human Language from Computers Viewpoint and language building blocks. Words, text, and document models. A Chatbot NLP pipeline. Word tokenization, Building vocabulary with tokenizer and sentiment. Challenges in NLP. Approaches in NLP using NLTK and TensorFlow frameworks.

NLP Pipeline: Data Acquisition, Text Extraction and Cleanup, Pre-Processing, Feature Engineering, and Modeling

Finding meaning in word counts (semantic analysis): From word counts to topic scores, Latent semantic analysis, Singular value decomposition, Principal component analysis, Word2Vec, GloVe, Distance and similarity, Steering with feedback, Topic vector power.

Deeper learning (neural networks): Semantic queries and analogies, Word vectors, Learning meaning, Convolutional neural nets, RNNs, LSTMs, and Language Models for Text processing. Sequence-to-sequence models and attention in transformer-based Large Language models. Text Classification, summarization, Application pipeline building.

Reference Books

- 1 Practical Natural Language Processing, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana, 2020, O'Reilly Media, Inc. ISBN: 9781492054054 .
- 2 Natural Language Processing in Action, Hobson Lane, Cole Howard, Hannes Hapke, 2019, Manning Publications. ISBN: 978161729463 .
- 3 Neural Network Methods in Natural Language Processing, Yoav Goldberg, 2017, Morgan & Claypool Publishers.
- 4 Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit, Steven Bird, Ewan Klein, and Edward Loper, 2022, O'Reilly Media.

23IMP3202A - DATA ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3202A	DATA ENGINEERING	DE	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply big data use cases from selected business domains.	3	PO1, PO2
CO2	Construct NoSQL big data management	3	PO1, PO2
CO3	Install, configure, and run Hadoop and HDFS	4	PO1, PO2
CO4	Perform map-reduce analytics using Hadoop	4	PO1, PO2
CO5	Implement the lab experiments for big data application	5	PO1, PO2

Syllabus

A distributed system comprises independent computers working together, offering better scalability, reliability, performance, and cost efficiency than centralized systems. It distributes tasks across nodes to reduce failure risk and boost speed. However, it faces challenges with data consistency, communication delays, and security. Big Data involves vast volumes of rapidly generated data that traditional systems can't handle. Technologies like Hadoop, Spark, and NoSQL databases manage and analyze this data effectively. Growth in the internet, social media, IoT, and mobile devices drives Big Data, with cloud platforms providing scalable solutions for better decision-making and strategic benefits.

Big Data engineering has evolved with NoSQL databases, which address SQL databases' limitations in scalability, flexibility, and handling unstructured data. NoSQL databases, including key-value, document-based, and graph models, offer schema-less flexibility and manage complex relationships efficiently. They use distribution models like master-slave and peer-peer replication for high availability and fault tolerance, and employ sharding and replication to boost performance. While often relaxing consistency requirements, they use version stamps to manage data. The Hadoop ecosystem, with tools like HDFS, MapReduce, Hive, Pig, and HBase, supports distributed storage and processing for effective Big Data management and insights.

Hadoop is a powerful framework designed for distributed storage and processing of large datasets using the MapReduce programming model. It efficiently partitions data for parallel processing, utilizing a distributed file system (HDFS) to ensure reliability and scalability. Hadoop supports various data formats and interfaces, including Java, for seamless integration and management of data workflows. Apache Spark, with its Resilient Distributed Datasets (RDDs), enhances data processing speed by leveraging in-memory computation. Together, Hadoop and Spark form the backbone of Big Data analytics, enabling organizations to derive valuable insights and solutions from massive datasets across diverse applications and industries.

MapReduce workflows involve splitting data into smaller chunks for parallel processing in the "map" phase, followed by aggregation in the "reduce" phase. MR-Unit allows for unit testing MapReduce logic with local test data. A MapReduce job run includes input splitting, mapping, shuffling, sorting, and reducing. Classic MapReduce and YARN handle job execution and resource management, with YARN providing enhanced scalability. Failures are managed through built-in recovery mechanisms. Job scheduling prioritizes tasks, while shuffle and sort organize intermediate data. MapReduce supports various input and output formats for flexible data processing.

Setting up a Hadoop environment starts with installing VMware to create virtual machines for Hadoop components like HDFS and YARN. Basic Linux commands are crucial for managing Hadoop files. Running a simple word count MapReduce program introduces the parallel processing paradigm, while more complex tasks like finding maximum temperatures or processing patent records showcase MapReduce's efficiency in data analytics. Features like Partitioner for workload optimization and tasks such as calculating averages or matrix multiplication highlight Hadoop's versatility in distributed computing.

Reference Books

- 1 Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Michael Minelli, Michele Chambers, Ambiga Dhiraj, 3rd, 9 January 2013, Wiley.
- 2 DW 2.0: The Architecture for the Next Generation of Data Warehousing , W.H. Inmon, Derek Strauss, Genia Neushloss, 1st Edition, 2008, Publisher Morgan Kaufmann.
- 3 Agile Data Warehouse Design: Collaborative Dimensional Modeling, from Whiteboard to Star Schema Paperback, Jim Stagnitto , Lawrence Corr, 1st Edition, 2011, DecisionOne Press .
- 4 Big Data:Principles and best practices of scalable realtime data systems Paperback, James Warren , Nathan Marz, 1st Edition, 2015, Manning Publications.

23IMP3202E - DATA ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3202E	DATA ENGINEERING	DE	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply big data use cases from selected business domains.	3	PO1, PO2
CO2	Construct NoSQL big data management	3	PO1, PO2
CO3	Install, configure, and run Hadoop and HDFS	4	PO1, PO2
CO4	Perform map-reduce analytics using Hadoop 4	4	PO1, PO2
CO5	Implement the lab experiments for big data application	4	PO1, PO2

Syllabus

A distributed system comprises independent computers working together, offering better scalability, reliability, performance, and cost efficiency than centralized systems. It distributes tasks across nodes to reduce failure risk and boost speed. However, it faces challenges with data consistency, communication delays, and security. Big Data involves vast volumes of rapidly generated data that traditional systems can't handle. Technologies like Hadoop, Spark, and NoSQL databases manage and analyze this data effectively. Growth in the internet, social media, IoT, and mobile devices drives Big Data, with cloud platforms providing scalable solutions for better decision-making and strategic benefits.

Big Data engineering has advanced with NoSQL databases, overcoming SQL databases' limitations in scalability, flexibility, and handling unstructured data. NoSQL databases, such as key-value and document-based models, offer schema-less flexibility and are suited for diverse data types. Graph databases manage complex relationships efficiently. NoSQL distribution models like master-slave and peer-peer replication ensure high availability and fault tolerance, while sharding and replication enhance performance. They often relax consistency requirements for higher availability and use version stamps to manage consistency. The Hadoop ecosystem supports distributed storage and processing, with tools like HDFS, MapReduce, Hive, Pig, and HBase, enabling effective Big Data management and insights.

Hadoop is a powerful framework designed for distributed storage and processing of large datasets using the MapReduce programming model. It efficiently partitions data for parallel processing, utilizing a distributed file system (HDFS) to ensure reliability and scalability. Hadoop supports various data formats and interfaces, including Java, for seamless integration and management of data workflows. Apache Spark, with its Resilient Distributed Datasets (RDDs), enhances data processing speed by leveraging in-memory computation. Together, Hadoop and Spark form the backbone of Big Data analytics, enabling organizations to derive valuable insights and solutions from massive datasets across diverse applications and industries.

MapReduce workflows involve splitting data into smaller chunks for parallel processing in the "map" phase, followed by aggregation in the "reduce" phase. MR-Unit allows for unit testing MapReduce logic with local test data. A MapReduce job run includes input splitting, mapping, shuffling, sorting, and reducing. Classic MapReduce and YARN handle job execution and resource management, with YARN providing enhanced scalability. Failures are managed through built-in recovery mechanisms. Job scheduling prioritizes tasks, while shuffle and sort organize intermediate data. MapReduce supports various input and output formats for flexible data processing.

Setting up a Hadoop environment typically begins with installing VMware to create virtual machines for hosting Hadoop components like HDFS and YARN. Basic Linux commands such as file creation, modification, copying, and deletion are essential for managing files within the Hadoop file system (hdfs). Running a simple word count MapReduce program helps grasp the foundational MapReduce paradigm, where data is processed in parallel across a cluster. More complex tasks, like finding maximum temperatures by year or processing patent records, illustrate MapReduce's capability to handle diverse data analytics tasks efficiently. Implementing features like Partitioner usage for workload optimization and calculating averages or performing matrix multiplication demonstrates the versatility and power of Hadoop in distributed computing environments.

Reference Books

- 1 Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Michael Minelli, Michele Chambers, Ambiga Dhiraj, 3rd, 9 January 2013, Wiley.
- 2 DW 2.0: The Architecture for the Next Generation of Data Warehousing, W.H. Inmon, Derek Strauss, Genia Neushloss, 1st Edition, 2008, Publisher Morgan Kaufmann.
- 3 Agile Data Warehouse Design: Collaborative Dimensional Modeling, from Whiteboard to Star Schema Paperback, Jim Stagnitto , Lawrence Corr, 1st Edition, 2011, DecisionOne Press.
- 4 Big Data: Principles and best practices of scalable realtime data systems Paperback, James Warren , Nathan Marz, 1st Edition, 2015, Manning Publications.

23IMP3202R - DATA ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3202R	DATA ENGINEERING	DE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply big data use cases from selected business domains.	3	PO1, PO2
CO2	Construct NoSQL big data management	3	PO1, PO2
CO3	Install, configure, and run Hadoop and HDFS	4	PO1, PO2
CO4	Perform map-reduce analytics using Hadoop	4	PO1, PO2

Syllabus

A distributed system comprises independent computers working together, offering better scalability, reliability, performance, and cost efficiency than centralized systems. It distributes tasks across nodes to reduce failure risk and boost speed. However, it faces challenges with data consistency, communication delays, and security. Big Data involves vast volumes of rapidly generated data that traditional systems can't handle. Technologies like Hadoop, Spark, and NoSQL databases manage and analyze this data effectively. Growth in the internet, social media, IoT, and mobile devices drives Big Data, with cloud platforms providing scalable solutions for better decision-making and strategic benefits.

Big Data engineering has advanced with NoSQL databases, overcoming SQL databases' limitations in scalability, flexibility, and handling unstructured data. NoSQL databases, such as key-value and document-based models, offer schema-less flexibility and are suited for diverse data types. Graph databases manage complex relationships efficiently. NoSQL distribution models like master-slave and peer-peer replication ensure high availability and fault tolerance, while sharding and replication enhance performance. They often relax consistency requirements for higher availability and use version stamps to manage consistency. The Hadoop ecosystem supports distributed storage and processing, with tools like HDFS, MapReduce, Hive, Pig, and HBase, enabling effective Big Data management and insights.

Hadoop is a powerful framework designed for distributed storage and processing of large datasets using the MapReduce programming model. It efficiently partitions data for parallel processing, utilizing a distributed file system (HDFS) to ensure reliability and scalability. Hadoop supports various data formats and interfaces, including Java, for seamless integration and management of data workflows. Apache Spark, with its Resilient Distributed Datasets (RDDs), enhances data processing speed by leveraging in-memory computation. Together, Hadoop and Spark form the backbone of Big Data analytics, enabling organizations to derive valuable insights and solutions from massive datasets across diverse applications and industries.

MapReduce workflows involve splitting data into smaller chunks for parallel processing in the "map" phase, followed by aggregation in the "reduce" phase. MR-Unit allows for unit testing MapReduce logic with local test data. A MapReduce job run includes input splitting, mapping, shuffling, sorting, and reducing. Classic MapReduce and YARN handle job execution and resource management, with YARN providing enhanced scalability. Failures are managed through built-in recovery mechanisms. Job scheduling prioritizes tasks, while shuffle and sort organize intermediate data. MapReduce supports various input and output formats for flexible data processing.

Reference Books

- 1 Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Michael Minelli, Michele Chambers, Ambiga Dhiraj, 3rd, 9 January 2013, Wiley.
- 2 DW 2.0: The Architecture for the Next Generation of Data Warehousing, W.H. Inmon, Derek Strauss, Genia Neushloss, 1st Edition, 2008, Publisher Morgan Kaufmann.
- 3 Agile Data Warehouse Design: Collaborative Dimensional Modeling, from Whiteboard to Star Schema Paperback, Jim Stagnitto, Lawrence Corr, 1st Edition, 2011, DecisionOne Press.

- 4 Big Data: Principles and best practices of scalable realtime data systems Paperback, James Warren , Nathan Marz, 1st Edition, 2015, Manning Publications.

23IMP3303A - BIO MEDICAL SIGNAL AND IMAGE ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3303A	BIO MEDICAL SIGNAL AND IMAGE ANALYSIS	AMSIA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Basic concepts related to Biomedical signals and images	2	PO1, PO2, PO6, PSO2
CO2	Understand the Bio medical signal processing methods to eliminate the artefacts arise in biomedical signals	2	PO1, PO2, PO6, PSO2
CO3	Understand the Biomedical imaging and enhancement techniques	2	PO1, PO2, PO6, PSO2
CO4	Apply signal processing approaches for biomedical signals and images	3	PO1, PO2, PO6, PSO2
CO5	Evaluate biomedical signal and image processing techniques	5	PO1, PO2, PO6, PSO2
CO6	evaluate advanced signal processing approaches through matlab	5	PO1, PO2, PO6, PSO2
CO7	Analyze biomedical signals using recurrent deep learning networks and time-frequency analysis.	4	PO1, PO2, PO6, PSO2

Syllabus

An introductory exploration of biomedical signals, delving into their characteristics and various examples such as temperature, blood pressure (BP), electromyography (EMG), electrocardiography (ECG), and electroencephalography (EEG) is presented. This encompasses the rhythmic excitation of the heart and the intricate nature of heart activity. The discussion covers the objectives and difficulties associated with analyzing biomedical signals. The acquisition techniques for biomedical images such as X-ray, computerized tomography (CT), magnetic resonance imaging (MRI), and ultrasound are addressed, along with the challenges involved in image analysis

Digital filtering techniques in biomedical signal processing address noise models, pre-processing, high-frequency noise elimination, baseline wander removal, powerline interference elimination, medical signal detection, and waveform complexity measures.

Image model, sampling and quantization, image geometry, spatial domain, and Frequency domain enhancement techniques.

Advanced Applications Wavelet decomposition of physiological signals for analysis Wavelets approach for Biomedical signal and image artifact reduction techniques

Biomedical signals using recurrent deep learning networks and time-frequency analysis.

Experiments: Nature of Biomedical Signals and images Time and frequency domain analysis techniques wavelet decomposition ecg sampling and quantization wave form representation of signals

Skilling: practicing of ECG EEG EMG Signal Visualization and visualization annotation frequency, and time-frequency domains Artifact Removal and Preprocessing Feature Extraction

Reference Books

- 1 Biomedical Signal Analysis, Rangaraj M Rangayyan, John Wiley and Sons, 2016, .IEEE Press.
- 2 Biomedical Signal and Image Processing, Kayvan Najarian, Robert Splinter, 2012, CRC Press Taylor & Francis Group.

- 3 Practical Biomedical Signal Analysis Using MATLAB, K J Blinowska and J Zygiereicz, 2024, .CRC Press.
- 4 Principles of Computerized Tomographic Imaging, Society of Industrial and Applied Mathematics, Avinash C. Kak and Malcom Slaney, 2001, IEEE press.

23IMP3303E - BIO MEDICAL SIGNAL AND IMAGE ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3303E	BIO MEDICAL SIGNAL AND IMAGE ANALYSIS	AMSIA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Basic concepts related to Biomedical signals and images	2	PO1, PO2, PO6, PSO2
CO2	Understand the Bio medical signal processing methods to eliminate the artefacts arise in biomedical signals	2	PO1, PO2, PO6, PSO2
CO3	Understand the Biomedical imaging and enhancement techniques	2	PO1, PO2, PO6, PSO2
CO4	Apply signal processing approaches for biomedical signals and images	3	PO1, PO2, PO6, PSO2
CO5	Evaluate biomedical signal and image processing techniques	5	PO1, PO2, PO6, PSO2
CO6	Evaluate advanced signal processing approaches through matlab	5	
CO7	Analyze biomedical signals using recurrent deep learning networks and time-frequency analysis.	4	

Syllabus

An introductory exploration of biomedical signals, delving into their characteristics and various examples such as temperature, blood pressure (BP), electromyography (EMG), electrocardiography (ECG), and electroencephalography (EEG) is presented. This encompasses the rhythmic excitation of the heart and the intricate nature of heart activity. The discussion covers the objectives and difficulties associated with analyzing biomedical signals. The acquisition techniques for biomedical images such as X-ray, computerized tomography (CT), magnetic resonance imaging (MRI), and ultrasound are addressed, along with the challenges involved in image analysis.

Filtering techniques for Biomedical signals using Digital Signal processing: Methods for both time domain and frequency domain. Models for noise, Pre-processing, Elimination of high frequency noise, Removal of baseline wander, Elimination of powerline interference, Identifying medical signals, Evaluating waveform complexity / activity.

The model for images, sampling and quantization, geometric properties of images, enhancement techniques in the spatial domain and frequency domain for images

Advanced Applications Wavelet decomposition of physiological signals for analysis Wavelets approach for Biomedical signal and image artifact reduction techniques

Biomedical signals using recurrent deep learning networks and time-frequency analysis.

Reference Books

- 1 Biomedical Signal Analysis, Rangaraj M Rangayyan, John Wiley and Sons, 2016, .IEEE Press.
- 2 Biomedical Signal and Image Processing, Kayvan Najarian, Robert Splinter, 2012, CRC Press Taylor & Francis Group.
- 3 Practical Biomedical Signal Analysis Using MATLAB related books, K J Blinowska and J Zygierevicz, 2024, CRC Press.
- 4 Biomedical Signal and Image Processing with Artificial Intelligence, chirag panuwala, 2001, Springer International.

23IMP3303R - BIO MEDICAL SIGNAL AND IMAGE ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3303R	BIO MEDICAL SIGNAL AND IMAGE ANALYSIS	AMSIA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Basic concepts related to Biomedical signals and images	2	PO1, PO2, PO6, PSO2
CO2	Understand the Bio medical signal processing methods to eliminate the artefacts arise in biomedical signals	2	PO1, PO2, PO6, PSO2
CO3	Understand the Biomedical imaging and enhancement techniques	2	PO1, PO2, PO6, PSO2
CO4	Apply signal processing approaches for biomedical signals and images	3	PO1, PO2, PO6, PSO2
CO5	Evaluate biomedical signal and image processing techniques	5	PO1, PO2, PO6, PSO2
CO6	Evaluate advanced signal processing approaches through matlab	5	PO1, PO2, PO6, PSO2

Syllabus

An introductory exploration of biomedical signals, delving into their characteristics and various examples such as temperature, blood pressure (BP), electromyography (EMG), electrocardiography (ECG), and electroencephalography (EEG) is presented. This encompasses the rhythmic excitation of the heart and the intricate nature of heart activity. The discussion covers the objectives and difficulties associated with analyzing biomedical signals. The acquisition techniques for biomedical images such as X-ray, computerized tomography (CT), magnetic resonance imaging (MRI), and ultrasound are addressed, along with the challenges involved in image analysis

Digital filtering techniques in biomedical signal processing address noise models, pre-processing, high-frequency noise elimination, baseline wander removal, powerline interference elimination, medical signal detection, and waveform complexity measures.

Image model, sampling and quantization, image geometry, spatial domain, and Frequency domain enhancement techniques.

Advanced Applications Wavelet decomposition of physiological signals for analysis Wavelets approach for Biomedical signal and image artifact reduction techniques

Analyze biomedical signals using recurrent deep learning networks and time-frequency analysis.

Experiments: Nature of Biomedical Signals and images Time and frequency domain analysis techniques wavelet decomposition ecg sampling and quantization wave form representation of signals

Reference Books

- 1 Biomedical Signal Analysis, Rangaraj M Rangayyan, John Wiley and Sons, 2016, IEEE Press.
- 2 Biomedical Signal and Image Processing , Kayvan Najarian, Robert Splinter , 2012, CRC Press Taylor & Francis Group .
- 3 Practical Biomedical Signal Analysis Using MATLAB , K J Blinowska and J Zygiereicz , 2024, CRC Press.
- 4 Biomedical Signal and Image Processing with Artificial Intelligence, Chirag Paunwala, Mita Paunwala,, 2001, Springer International.

23IMP3404M - DATA VISUALIZATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3404M	DATA VISUALIZATION	DV	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Data science, data collection, and data preprocessing	2	PO1, PSO1
CO2	Applying descriptive statistical sampling techniques to explore various real world data sets	3	PO1, PO2, PO7, PSO1
CO3	Build data wrangling models with data science libraries like NumPy and Pandas	3	PO1, PO2, PO7, PSO1
CO4	Applying various data visualization tools to explore the data	4	PO2, PO7, PSO1

Syllabus

Data, Data Analytics, Data Mining, and Knowledge Discovery Data and Relations, The Iris Data Set, Data Scales, Set and Matrix Representations Relations, Data Visualization Using Excel: Types of Data, Meaning, Chart Elements and Chart Types, Data Labels, Using Pictures in Column Charts, Creating Combination charts, Creating Combo charts with second axis, Discriminating Series & Categorical Axis, Other charts: Band chart, Gantt chart, Waterfall chart; Pivot charts, Pivot charts with pivot table, Pivot chart without pivot table

Dissimilarity Measures, Similarity Measures, Sequence Relations, Sampling, and Quantization Data Preprocessing, Error Types, Error Handling, Filtering, Data Transformation, Data Integration.

Visualizing amounts, Visualizing distributions: Histograms and density plots, Visualizing proportions, Visualizing associations among two or more quantitative variables, Visualizing trends, Visualizing geospatial data

Handling overlapping points, Titles, captions, and tables, Redundant coding, Principal Component Analysis, Multidimensional Scaling, Sammon Mapping, Auto-encoder, Histograms, Spectral Analysis

Reference Books

- 1 Visualizing Data, Fry, 2008, O'Reilly Media.
- 2 Visualization Analysis and Design, Munzner, 2014, CRC Press.
- 3 Information Visualization: Perception for Design Data Visualization: A Practical Introduction, Ware, Morgan Kaufmann, 2013, Elsevier.
- 4 Data Visualization: A Practical Introduction, Kieran Healy, 2018, Princeton University Press.
- 5 Data Visualization: Principles and Practice, Alexandru C. Telea, 2014, Princeton University Press.

23IMP3505 - MULTI MEDIA PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3505	MULTI MEDIA PROCESSING	MMP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Emerging standards for multimedia applications	2	PO2
CO2	Image Processing Techniques for Multimedia Processing	2	PO3, PO4
CO3	Intelligent Multimedia Processing	3	PO3
CO4	Analysis On Independent Component Analysis for Multimedia Signals	3	PO1, PSO1

Syllabus

"Emerging standards for multimedia applications Introduction, Standards, Fundamentals of Video Coding, Transform Coding, Motion Compensation. Emerging Video and Multimedia Standards: H.263, H.26L, MPEG-4, MPEG-7, Standards for Multimedia Communication. An Efficient Algorithm and Architecture for Real-Time Perspective Image Warping: Introduction2.2, Fast Algorithm for Perspective Transform, Perspective Transform, Existing Approximation Methods, Constant Denominator Method, Sprite Warping Algorithm, Architecture for Sprite Warping, Implementation Issues, Memory Bandwidth Reduction, Architecture."

"Image Processing Techniques for Multimedia Processing Introduction, Color in Multimedia Processing, Color Image Filtering, Fuzzy Multichannel Filters, The Membership Functions, A Combined Fuzzy Directional and Fuzzy Median Filter, Application to Color Images, Color Image Segmentation: Histogram Thresholding, Postprocessing and Region Merging, Experimental Results, Facial Image Segmentation, Extraction of Skin-Tone Regions, Postprocessing, Shape and Color Analysis, Fuzzy Membership Functions, Meta-Data Features."

Intelligent Multimedia Processing Introduction, Neural Networks and Multimedia Processing, Focal Technical Issues, Useful Neural Network Approaches to Multimedia Data Representation Classification, and Fusion, Multimedia Data Representation, Multimedia Data Detection and Classification, Hierarchical Fuzzy Neural Networks as Linear Fusion Networks, Temporal Models for Multimodal Conversion and Synchronization, Neural Networks for IMP Applications Image Visualization and Segmentation, Personal Authentication and Recognition, Audio to Visual Conversion and Synchronization, Image and Video Retrieval, Browsing, and Content Based Indexing, Interactive Human Computer Vision, Open Issues.

Background, Principal and Independent Component Analysis, Likelihood Framework for Independent Component Analysis, Generalization and the Bias-Variance Dilemma, Noisy Mixing of White Sources, Separation Based on Time Correlation, Likelihood, Separation of Sound Signals, Sound Separation using PCA, Sound Separation using Molgedey Schuster ICA, Sound Separation using Bell Sejnowski ICA, Comparison, Separation of Image Mixtures, Image Segmentation using PCA, Image Segmentation using Molgedey Schuster ICA, Discussion, ICA for Text Representation, Text Analysis, Latent Semantic Analysis PCA. Video Modeling and Retrieval: Introduction, Modeling and Representation of Video Segmentation vs. Stratification, Practical Considerations, Rapid Similarity Retrieval from Image and Video: Introduction, Definitions, Image Indexing and Retrieval, Encoding Video Indices.

Reference Books

- 1 Multimedia image and video processing , Phillip A, Laplante , Second, CRC press .
- 2 Fundamentals of Multimedia , Ze Nian Li, and Mark S. Drew , Oct, 2003, Pearson Prentice Hall .
- 3 Signal processing for Image Enhancement and multimedia processing , Broko Furht , NA, Springer .
- 4 Pattern Recognition and Machine Learning, Christopher M. Bishop, 1st Edition, Springer.
- 5 Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, 4th Edition, Pearson.

23IMP3506 - INTRODUCTION TO QUANTUM COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IMP3506	INTRODUCTION TO QUANTUM COMPUTING	MMP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Quantum computing leverages principles like superposition and entanglement, allowing qubits to process information more efficiently than classical bits. This technology holds transformative potential in areas like cryptography, optimization, and simulation.	2	PO2
CO2	Demonstrating qubits involves showing how their quantum properties, such as superposition and entanglement, exponentially boost computational power. This enables quantum algorithms to surpass classical ones in tasks like cryptography, optimization, and simulation.	2	PO3, PO4
CO3	Quantum phase estimation, Fourier transform, and eigenvalue estimation utilize quantum mechanics to efficiently handle tasks like cryptography, simulation, and machine learning, offering advantages over classical approaches.	3	PO3, PO5
CO4	Hidden subgroup algorithms like Grover's use quantum parallelism and interference to efficiently search unsorted databases and find hidden patterns. They offer exponential speedup over classical algorithms, impacting cryptography and optimization.	4	PO3, PO12

Syllabus

Overview of traditional computing Church-Turing thesis circuit model of computation reversible computation quantum physics quantum physics and computation Dirac notation and Hilbert Spaces dual vectors operators the spectral theorem Overview of traditional computing Church Turing thesis circuit model of computation reversible computation quantum physics quantum physics and computation Dirac notation and Hilbert Spaces dual vectors operators the spectral theorem Overview of traditional computing Church-Turing thesis circuit model of computation reversible computation quantum physics quantum physics and computation Dirac

QUBITS AND QUANTUM MODEL OF COMPUTATION State of a quantum system time evolution of a closed system composite systems measurement mixed states and general quantum operations quantum circuit model quantum gates universal sets of quantum gates unitary transformations quantum circuits.

QUANTUM ALGORITHMS I Superdense coding quantum teleportation applications of teleportation probabilistic versus quantum algorithms phase kick-back the Deutsch algorithm the Deutsch Jozsa algorithm Simon's algorithm Quantum phase estimation and quantum Fourier Transform eigenvalue estimation

QUANTUM ALGORITHMS II Order-finding problem eigenvalue estimation approach to order finding Shor's algorithm for order finding finding discrete logarithms hidden subgroups Grover's quantum search algorithm amplitude amplification quantum amplitude estimation quantum counting searching without knowing the success probability

Reference Books

- 1 An introduction to Quantum Computing, P Kaye R Laflamme and M Mosca, 1999, Oxford University Press.
- 2 Quantum Computing for Computer Architects, Tzvetan S. Metodj, Arvin I. Faruque, Frederic T. Chong., 2017, MIT Publishers.
- 3 Quantum Computing: A Gentle Introduction, Eleanor Rieffel and Wolfgang Polak., 2017, MIT Publishers.
- 4 Quantum Algorithms via Linear Algebra: A Primer, Richard J. Lipton, Kenneth W. Regan, 1st, MIT Press.

23IOT3101A - INDUSTRIAL INTERNET OF THINGS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3101A	INDUSTRIAL INTERNET OF THINGS	IIOT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Industry 4.0 concepts and develop innovative solutions for emerging industrial challenges.	3	PO2, PO3, PO5, PSO1
CO2	Analyze the proficiency of key protocols including HART, BACnet, AMQP, OPC-UA.	4	PO2, PO3, PO5, PSO1
CO3	Implementing process control systems, incorporating data acquisition (DAQ) and PLC programming, within industrial applications.	3	PO2, PO3, PO5, PSO1
CO4	Understand the principles and importance of SCADA and PLCs in industrial process control with a case study on predictive maintenance.	4	PO2, PO3, PO5, PSO1
CO5	Analyse and Propose improvements and optimizations for health monitoring, IoT smart city, smart irrigation, and robot surveillance systems.	4	PO2, PO3, PO5, PSO1
CO6	Evaluate and interpret data from Industrial IoT sensors and devices to optimize process efficiency and maintenance strategies.	5	PO2, PO3, PO5, PSO2
CO7	Implement Emerging Trends and Technologies in IIoT	3	PO2, PO3, PO5, PSO2

Syllabus

This module is designed to provide you with a comprehensive understanding of the key concepts, technologies, and applications driving Industry 4.0.

This module empowers to proficiently apply and compare various IIoT protocols including MQTT, CoAP, OPC-UA, AMQP, HTTP/HTTPS, DDS, Modbus (RTU/TCP/IP), DNP3, and Zigbee for effective industrial communication and data exchange.

This course provides a comprehensive exploration of data acquisition systems and their pivotal role in modern industrial processes.

This module provides an in-depth exploration of SCADA (Supervisory Control and Data Acquisition) systems, focusing on their architecture, software components, and functionalities essential for industrial automation and process control.

This module offers an in-depth examination of real-world case studies showcasing the application of IIoT technologies across various industrial sectors.

Reference Books

- 1 Industrial Automation and Process Control, Jon Stenerson, 2003, Prentice Hall.
- 2 SCADA: Supervisory Control and Data Acquisition, Stuart A. Boyer, 2004, ISA-The Instrumentation Systems and Automation Society.
- 3 Programmable Logic Controllers Principles and Applications, John W. Webb Ronald A. Reis, 2016, Pearson.
- 4 " Industrial Automation Solutions for Plc, Scada, Drive and Field Instruments ", Katariya Sanjay B, 2020, Notion Press Media Pvt Ltd.

23IOT3101E - INDUSTRIAL INTERNET OF THINGS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3101E	INDUSTRIAL INTERNET OF THINGS	IIOT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Industry 4.0 concepts and develop innovative solutions for emerging industrial challenges.	3	PO2, PO3, PO5, PSO1
CO2	Analyze the proficiency of key protocols including HART, BACnet, AMQP, OPC-UA.	4	PO2, PO3, PO5, PSO1
CO3	Implementing process control systems, incorporating data acquisition (DAQ) and PLC programming, within industrial applications.	3	PO2, PO3, PO5, PSO1
CO4	Analyze the principles of SCADA and PLCs in industrial process control with a case study on predictive maintenance.	4	PO2, PO3, PO5, PSO1
CO5	Analyse and Propose improvements and optimizations for health monitoring, IoT smart city, smart irrigation, and robot surveillance systems.	4	PO2, PO3, PO5, PSO1
CO6	Evaluate and interpret data from Industrial IoT sensors and devices to optimize process efficiency and maintenance strategies.	5	PO2, PO3, PO5, PSO1
CO7	Implement Emerging Trends and Technologies in IIoT	3	PO2, PO3, PO5, PSO1

Syllabus

This module is designed to provide you with a comprehensive understanding of the key concepts, technologies, and applications driving Industry 4.0.

This module empowers to proficiently apply and compare various IIoT protocols including MQTT, CoAP, OPC-UA, AMQP, HTTP/HTTPS, DDS, Modbus (RTU/TCP/IP), DNP3, and Zigbee for effective industrial communication and data exchange.

This module provides a comprehensive exploration of data acquisition systems and their pivotal role in modern industrial processes.

This module provides an in-depth exploration of SCADA (Supervisory Control and Data Acquisition) systems, focusing on their architecture, software components, and functionalities essential for industrial automation and process control.

This module offers an in-depth examination of real-world case studies showcasing the application of IIoT technologies across various industrial sectors.

Reference Books

- 1 Industrial Automation and Process Control, Jon Stenerson, 2003, Prentice Hall.
- 2 SCADA: Supervisory Control and Data Acquisition, Stuart A. Boyer, 2004, ISA-The Instrumentation Systems and Automation Society.
- 3 Programmable Logic Controllers Principles and Applications, John W.Webb Ronald A.Reis, 2016, Pearson.
- 4 " Industrial Automation Solutions for Plc, Scada, Drive and Field Instruments ", Katariya Sanjay B, 2020, Notion Press Media Pvt Ltd.

23IOT3101R - INDUSTRIAL INTERNET OF THINGS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3101R	INDUSTRIAL INTERNET OF THINGS	IIOT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Industry 4.0 concepts and develop innovative solutions for emerging industrial challenges.	3	PO2, PO3, PO5, PSO1
CO2	Analyze the proficiency of key protocols including HART, BACnet, AMQP, OPC-UA.	4	PO2, PO3, PO5, PSO1
CO3	Implementing process control systems, incorporating data acquisition (DAQ) and PLC programming, within industrial applications.	3	PO2, PO3, PO5, PSO1
CO4	Analyze the principles of SCADA and PLCs in industrial process control with a case study on predictive maintenance.	4	PO2, PO3, PO5, PSO1
CO5	Evaluate and interpret data from Industrial IoT sensors and devices to optimize process efficiency and maintenance strategies.	5	PO2, PO3, PO5, PSO1
CO6	Evaluate IIoT applications utilizing key technologies to enhance industrial automation and connectivity	4	PO2, PO3, PO5, PSO1

Syllabus

This module is designed to provide you with a comprehensive understanding of the key concepts, technologies, and applications driving Industry 4.0.

This module empowers to proficiently apply and compare various IIoT protocols including MQTT, CoAP, OPC-UA, AMQP, HTTP/HTTPS, DDS, Modbus (RTU/TCP/IP), DNP3, and Zigbee for effective industrial communication and data exchange.

This course provides a comprehensive exploration of data acquisition systems and their pivotal role in modern industrial processes.

This module provides an in-depth exploration of SCADA (Supervisory Control and Data Acquisition) systems, focusing on their architecture, software components, and functionalities essential for industrial automation and process control.

This module offers an in-depth examination of real-world case studies showcasing the application of IIoT technologies across various industrial sectors.

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- 2 SCADA: Supervisory Control and Data Acquisition, Stuart A. Boyer, 2004, ISA-The Instrumentation Systems and Automation Society.
- 3 Programmable Logic Controllers Principles and Applications, John W. Webb Ronald A. Reis, 2016, Pearson.
- 4 " Industrial Automation Solutions for Plc, Scada, Drive and Field Instruments ", Katariya Sanjay B, 2020, Notion Press Media Pvt Ltd.

23IOT3202A - EDGE COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3202A	EDGE COMPUTING	EC	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline the fundamental concepts and advantages of Fog and Edge Computing (FEC), infer the opportunities and applications.	2	PO1, PO5, PSO2
CO2	Apply network slicing strategies with effective management techniques to optimize resource allocation. Build network virtualization for efficient edge computing, while exploring optimization techniques for fog computing to ensure efficient data processing.	3	PO2, PO5, PSO2
CO3	Implement and analyze middleware solutions for Fog and Edge Computing, addressing security management	4	PO1, PO3, PO5, PSO2
CO4	Analyze the applicability and needs for Edge/Fog Computing in various real-time projects such as health monitoring, smart city management, and smart transportation	4	PO1, PO3, PO5, PSO2
CO5	focuses on evaluating performance metrics and deployment strategies, as well as understanding emerging trends	4	PO1, PO3, PO5, PSO2

Syllabus

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Business Model, Opportunities and Challenges. Addressing the Challenges in Federating Edge Resources

Architecture: Integrating IoT + Fog + Cloud Infrastructures, Network Slicing, and its Management in 5 G, Network Virtualization techniques in Edge computing, Optimization in Fog Computing.

Middleware for Fog and Edge Computing: A Lightweight Container Middleware for Edge Cloud Architectures. Security Management, Security Management for Edge Cloud Architectures, Blockchain and its Applications for security in Edge Cloud Architectures.

Applications, and Issues: Exploiting Fog Computing in Health Monitoring, Fog Computing Model for Smart city management. Fog Computing Model for Evolving Smart Transportation Applications.

Performance, Deployment, and Emerging Trends: Key Performance Indicators (KPIs) in Edge/Fog Computing, Benchmarking and Performance Evaluation Techniques. Strategies for scaling Edge/Fog Infrastructure, Resource Allocation and Management, Machine Learning and AI Integration with Edge Computing, Energy-efficient Edge Computing Solutions.

Reference Books

- 1 Edge Computing Simply In Depth, Ajit Singh, 2019, Wordpress.
- 2 Fog/Edge Computing For Security, Privacy, and Applications , Jie Wu, Wei Chang , 2021 , Springer.
- 3 IoT and Edge Computing for Architects , Perry Lea , 2020, Packt Publishing.
- 4 Architecting the Internet of Things, Dieter Uckelmann, Florian Michahelles, Mark Harrison , 2011, Springer.

23IOT3202E - EDGE COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3202E	EDGE COMPUTING	EC	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline the fundamental concepts and advantages of Fog and Edge Computing (FEC), infer the opportunities and applications	2	PO1, PO5, PSO2
CO2	Apply network slicing strategies with effective management techniques to optimize resource allocation. Build network virtualization for efficient edge computing, while exploring optimization techniques for fog computing to ensure efficient data processing.	3	PO2, PO5, PSO2
CO3	Implement and analyze middleware solutions for Fog and Edge Computing, addressing security management	4	PO1, PO3, PO5, PSO2
CO4	Analyze the applicability and needs for Edge/Fog Computing in various real-time projects such as health monitoring, smart city management, and smart transportation	4	PO1, PO3, PO5, PSO2
CO5	focuses on evaluating performance metrics and deployment strategies, as well as understanding emerging trends	4	PO1, PO3, PO5, PSO2

Syllabus

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Business Model, Opportunities and Challenges. Addressing the Challenges in Federating Edge Resources

Architecture: Integrating IoT + Fog + Cloud Infrastructures, Network Slicing, and its Management in 5 G, Network Virtualization techniques in Edge computing, Optimization in Fog Computing.

Middleware for Fog and Edge Computing: A Lightweight Container Middleware for Edge Cloud Architectures. Security Management, Security Management for Edge Cloud Architectures, Blockchain and its Applications for security in Edge Cloud Architectures.

Applications, and Issues: Exploiting Fog Computing in Health Monitoring, Fog Computing Model for Smart city management. Fog Computing Model for Evolving Smart Transportation Applications.

Performance, Deployment, and Emerging Trends: Key Performance Indicators (KPIs) in Edge/Fog Computing, Benchmarking and Performance Evaluation Techniques. Strategies for scaling Edge/Fog Infrastructure, Resource Allocation and Management, Machine Learning and AI Integration with Edge Computing, Energy-efficient Edge Computing Solutions.

Reference Books

- 1 Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya (Editor), Satish Narayana Sri rama , 2019, Wiley.
- 2 Edge Computing Simply In Depth , Ajit Singh , 2019, SDP.
- 3 Fog/Edge Computing For Security, Privacy, and Applications, Jie Wu, Wei Chang, 2021 , Springer.
- 4 Architecting the Internet of Things, Dieter Uckelmann, Florian Michahelles, Mark Harrison , 2011, Springer.

23IOT3202R - EDGE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3202R	EDGE COMPUTING	EC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline the fundamental concepts and advantages of Fog and Edge Computing (FEC), infer the opportunities and applications	2	PO1, PO5, PSO2
CO2	Apply network slicing strategies with effective management techniques to optimize resource allocation. Build network virtualization for efficient edge computing, while exploring optimization techniques for fog computing to ensure efficient data processing.	3	PO2, PO5, PSO2
CO3	Implement and analyze middleware solutions for Fog and Edge Computing, addressing security management	4	PO1, PO3, PO5, PSO2
CO4	Analyze the applicability and needs for Edge/Fog Computing in various real-time projects such as health monitoring, smart city management, and smart transportation	4	PO1, PO3, PO5, PSO2

Syllabus

Internet of Things (IoT) and New Computing Paradigms: Introduction, New Computing Paradigms, Fog and Edge Computing Completing the Cloud, Advantages of FEC, Hierarchy of Fog and Edge Computing, Business Model, Opportunities and Challenges. Addressing the Challenges in Federating Edge Resources.

Architecture: Integrating IoT + Fog + Cloud Infrastructures, Network Slicing, and its Management in 5 G, Network Virtualization techniques in Edge computing, Optimization in Fog Computing.

Middleware: Middleware for Fog and Edge Computing: A Lightweight Container Middleware for Edge Cloud Architectures, Security Management Security Management for Edge Cloud Architectures, Blockchain and its Applications for security in Edge Cloud Architectures.

Applications, and Issues: Exploiting Fog Computing in Health Monitoring, Fog Computing Model for Smart city management. Fog Computing Model for Evolving Smart Transportation Applications.

Reference Books

- 1 Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya (Editor), Satish Narayana Sri Rama, 2019, Wiley Publication.
- 2 IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, Perry Lea, 2020, PaperBack.
- 3 Architecting the Internet of Things, Dieter Uckelmann, Florian Michahelles, Mark Harrison, 2011, Springer.
- 4 Fog/Edge Computing For Security, Privacy, and Applications, Jie Wu, Wei Chang, 2021, Springer.

23IOT3203A - PRECISION AGRICULTURE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3203A	PRECISION AGRICULTURE	PA	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the Principles and Concepts of Precision Agriculture	2	PO1, PO3, PSO1
CO2	Elucidate the Various Technologies and Tools in Precision Agriculture	2	PO1, PO4, PO5, PSO1
CO3	Apply the strategies of Data Collection, Management, and Analysis for Decision-Making in Agriculture	3	PO1, PO3, PO4, PO5, PSO1
CO4	Demonstrate the Application of Precision Agriculture in Crop Management,	3	PO2, PO3, PO4, PO5, PSO1
CO5	Analyzing the resource Optimization, and Livestock Farming	4	PO2, PO3, PO4, PO5, PSO1

Syllabus

Introduction to Precision Agriculture Definition and scope-Historical Perspective-Benefits and challenges-Economic benefits-Environmental benefits-Farm management improvement-Recordkeeping improvement Importance of Precision Agriculture and mapping in farming for decision making- What is Precision Agriculture Decision making process-Value of maps in making decision Geographical concepts of PA Coordinate Systems-Scales- Projection-Resolution

Tools and Technologies of Precision Agriculture-Global Positioning System (GPS) and Geographic Information Systems (GIS)- GPS Basics (Space Segment, Receiver Segment, Control Segment)-Error and correction-Function and usage of GPS- Introduction to GIS-Basics of GIS- IDI devices usage in Precision Agriculture-Yield monitor -VR Application (fertilizers, seed, chemicals) Remote sensing-Aerial and satellite imagery-Above ground (non-contact) sensors Function of GIS-Use of GIS for decisions- Remote sensing techniques (satellite imagery, drones)-Sensor technology (soil sensors, weather stations)- Automation and robotics

Processes of Precision Agriculture Data Management and Analysis-Data collection methods-Data collection-Methods of data collection (traditional and new)-Data Collection by Grid Sampling-Collecting Data by Yield Monitor-Remote Sensing- Using of sensors for data collection Data storage and management systems analytics and decision support tools Data analysis- Concepts of data analysis-Resolution-Surface analysis Analysis application-a. Interpretive products (map, charts, application map etc

Precision Agricultural technology integration into a farm & business management of technology Goals based on end results of Precision Agriculture- Recordkeeping-Spatial Analysis-Variable Rate Application of negative environmental impact/technology cost optimization Economic of precision agriculture & determining equipment and software-Review of Cost/Benefit of Precision Agriculture-System vs. parcels- Making a selection

Precision Crop Management-Variable rate technology (VRT) Precision planting and seeding-Precision irrigation and fertilization-Crop health monitoring and diagnostics Precision Livestock Farming Monitoring animal health and behavior-Automated feeding and milking systems-Environmental control systems in animal housing Environmental and Socio-Economic Implications Environmental sustainability-Resource efficiency and conservation-Economic benefits and challenges-Socio-economic impacts on farmers and rural communities

Reference Books

- 1 GIS Applications in Agriculture , Francis J. Pierce, David Clay , 1, 2007, CRC Press.

- 2 Precision Farming: A New Approach h , A. K. Vyas, S. P. Sing , 1, 2014, New India Publishing Agency.
- 3 Precision Agriculture Basics , D. Kent Shannon, David E. Clay, Newell R. Kitchen 1 , 1, 2018, American Society of Agronomy.
- 4 Precision Agriculture Technology and Economic Perspectives , Minzan Li, Yingkui Li , 1, 2017, Springer.

23IOT3203E - PRECISION AGRICULTURE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3203E	PRECISION AGRICULTURE	PA	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the Principles and Concepts of Precision Agriculture	2	PO1, PO3, PSO1
CO2	Elucidate the Various Technologies and Tools in Precision Agriculture	2	PO1, PO4, PO5, PSO1
CO3	Apply the strategies of Data Collection, Management, and Analysis for Decision-Making in Agriculture	3	PO2, PO3, PO4, PO5, PSO1
CO4	Demonstrate the Application of Precision Agriculture in Crop Management,	4	PO2, PO3, PO4, PO5, PSO1
CO5	Analyzing the resource Optimization, and Livestock Farming resource Optimization, and Livestock Farming	4	PO2, PO3, PO4, PO5, PSO1

Syllabus

Introduction to Precision Agriculture Definition and scope-Historical Perspective-Benefits and challenges-Economic benefits-Environmental benefits-Farm management improvement-Recordkeeping improvement Importance of Precision Agriculture and mapping in farming for decision making- What is Precision Agriculture Decision making process-Value of maps in making decision Geographical concepts of PA Coordinate Systems-Scales- Projection-Resolution

Tools and Technologies of Precision Agriculture-Global Positioning System (GPS) and Geographic Information Systems (GIS)- GPS Basics (Space Segment, Receiver Segment, Control Segment)-Error and correction-Function and usage of GPS- Introduction to GIS-Basics of GIS- IDI devices usage in Precision Agriculture-Yield monitor -VR Application (fertilizers, seed, chemicals) Remote sensing-Aerial and satellite imagery-Above ground (non-contact) sensors Function of GIS-Use of GIS for decisions- Remote sensing techniques (satellite imagery, drones)-Sensor technology (soil sensors, weather stations)- Automation and robotics

Processes of Precision Agriculture Data Management and Analysis-Data collection methods-Data collection-Methods of data collection (traditional and new)-Data Collection by Grid Sampling-Collecting Data by Yield Monitor-Remote Sensing- Using of sensors for data collection Data storage and management systems analytics and decision support tools Data analysis- Concepts of data analysis-Resolution-Surface analysis Analysis application-a. Interpretive products (map, charts, application map etc

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- 3 Precision Agriculture Basics , D. Kent Shannon, David E. Clay, Newell R. Kitchen , 1, 2018, American Society of Agronomy.
- 4 Precision Agriculture Technology and Economic Perspectives , Minzan Li, Yingkui Li , 1, 2017, Springer.

23IOT3203R - PRECISION AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3203R	PRECISION AGRICULTURE	PA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the Principles and Concepts of Precision Agriculture	2	PO1, PO3, PSO1
CO2	Elucidate the Various Technologies and Tools in Precision Agriculture	2	PO1, PO4, PO5, PSO1
CO3	Apply the strategies of Data Collection, Management, and Analysis for Decision-Making in Agriculture	3	PO2, PO3, PO4, PO5, PSO1
CO4	Analyzing the Application of Precision Agriculture in Crop Management, Resource Optimization, and Livestock Farming	4	PO3, PO4, PO5, PSO1

Syllabus

Introduction to Precision Agriculture Definition and scope-Historical Perspective-Benefits and challenges-Economic benefits-Environmental benefits-Farm management improvement-Recordkeeping improvement Importance of Precision Agriculture and mapping in farming for decision making- What is Precision Agriculture Decision making process-Value of maps in making decision Geographical concepts of PA Coordinate Systems-Scales- Projection-Resolution

Tools and Technologies of Precision Agriculture-Global Positioning System (GPS) and Geographic Information Systems (GIS)- GPS Basics (Space Segment, Receiver Segment, Control Segment)-Error and correction-Function and usage of GPS- Introduction to GIS-Basics of GIS- IDI devices usage in Precision Agriculture-Yield monitor -VR Application (fertilizers, seed, chemicals) Remote sensing-Aerial and satellite imagery-Above ground (non-contact) sensors Function of GIS-Use of GIS for decisions- Remote sensing techniques (satellite imagery, drones)-Sensor technology (soil sensors, weather stations)- Automation and robotics

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- 4 Precision Agriculture Technology and Economic Perspectives, Minzan Li, Yingkui Li, 1, 2017, Springer.

23IOT3204A - SMART FARMING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3204A	SMART FARMING	SF	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and components of smart farming systems	2	PO2
CO2	Apply with key technologies used in smart agriculture, including IoT, AI, and robotics	3	PO1
CO3	Apply knowledge on how to collect, manage, and analyze agricultural data for decision-making	3	PO3, PSO1
CO4	Explore applications of smart farming in crop management, livestock monitoring, and resource optimization	3	PO4, PSO1
CO5	Apply knowledge on the potential benefits, challenges, and ethical considerations of smart farming	3	PO4

Syllabus

Introduction to Smart Farming Definition and scope of smart farming Evolution of agricultural technology Benefits and challenges of smart farming Key Technologies in Smart Farming Internet of Things (IoT) devices and sensors Unmanned Aerial Vehicles (UAVs) and drones Artificial Intelligence (AI) and machine learning Robotics and automation

Data Collection and Management Sensor networks and data acquisition Data storage and cloud computing for crop monitoring Variable rate technology (VRT) for inputs optimization Livestock Monitoring and Management Wearable sensors for animal health monitoring Automated feeding and milking systems Environmental monitoring in animal housing

Farm Management Systems Integrated farm management software-Decision support systems for planning and optimization Supply chain management and traceability Data Analytics and Decision Support Predictive analytics for yield forecasting-Disease detection and pest management-Optimization algorithms for resource allocation

Emerging Trends in Smart Farming Blockchain technology for transparency and traceability-Vertical farming and urban agriculture Sustainable agriculture practices and regenerative farming Case Studies and Applications Real-world examples of smart farming implementation-Success stories and lessons learned from smart farms

Data standards and interoperability Precision Agriculture GPS/GIS applications in precision agriculture Remote sensing techniques , Monitoring crop health (NDVI - Normalized Difference Vegetation Index), assessing soil moisture, detecting pests or diseases early, and evaluating overall field conditions

Reference Books

- 1 Smart Farming: IoT Applications in Agriculture, Vinayak Pachori, 1, 2009, CRC.
- 2 Sustainable Agriculture Reviews, Eric Lichtfouse, 1, 2013, Springer.
- 3 Agricultural Internet of Things and Decision Support for Precision Smart Farming, Muhammad Iqbal, 2, 2017, Wiley.
- 4 Internet of Things in Agriculture: Smart Farming, M. Usha , 1, 2011, Springer.

23IOT3204E - SMART FARMING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3204E	SMART FARMING	SF	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and components of smart farming systems	2	PO2
CO2	Apply knowledge with key technologies used in smart agriculture, including IoT, AI, and robotics	3	PO1, PSO1
CO3	Apply knowledge on Learn how to collect, manage, and analyze agricultural data for decision-making	3	PO3, PSO1
CO4	Applications of smart farming in crop management, livestock monitoring, and resource optimization	3	PO4
CO5	Apply knowledge on the potential benefits, challenges, and ethical considerations of smart farming	3	PO4

Syllabus

Introduction to Smart Farming Definition and scope of smart farming Evolution of agricultural technology Benefits and challenges of smart farming Key Technologies in Smart Farming Internet of Things (IoT) devices and sensors Unmanned Aerial Vehicles (UAVs) and drones Artificial Intelligence (AI) and machine learning Robotics and automation

Data Collection and Management Sensor networks and data acquisition Data storage and cloud computing Data standards and interoperability Precision Agriculture GPS/GIS applications in precision agriculture Remote sensing techniques for crop monitoring Variable rate technology (VRT) for inputs optimization

Wearable sensors for animal health monitoring Automated feeding and milking systems Environmental monitoring in animal housing, Farm Management Systems Integrated farm management software-Decision support systems for planning and optimization Supply chain management and traceability

Data Analytics and Decision Support Predictive analytics for yield forecasting-Disease detection and pest management-Optimization algorithms for resource allocation, Emerging Trends in Smart Farming Blockchain technology for transparency

Traceability-Vertical farming and urban agriculture Sustainable agriculture practices and regenerative farming Case Studies and Applications Real-world examples of smart farming implementation-Success stories and lessons learned from smart farms

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- 1 Smart Farming: IoT Applications in Agriculture, Vinayak Pachori, 1, CRC.
- 2 Sustainable Agriculture Reviews, Eric Lichtfouse, 1, Springer.
- 3 Agricultural Internet of Things and Decision Support for Precision Smart Farming, Muhammad Iqbal, 2, Wiley.
- 4 Internet of Things in Agriculture: Smart Farming, M. Usha, 1, Springer.

23IOT3204R - SMART FARMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3204R	SMART FARMING	SF	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and components of smart farming systems	2	PO2
CO2	Familiarize with key technologies used in smart agriculture, including IoT, AI, and robotics	2	PO1
CO3	Apply knowledge on how to collect, manage, and analyze agricultural data for decision-making	3	PO3, PSO1
CO4	Discuss the potential benefits, challenges, and ethical considerations of smart farming	2	PO4, PSO1

Syllabus

Introduction to Smart Farming Definition and scope of smart farming Evolution of agricultural technology Benefits and challenges of smart farming Key Technologies in Smart Farming Internet of Things (IoT) devices and sensors Unmanned Aerial Vehicles (UAVs) and drones Artificial Intelligence (AI) and machine learning Robotics and automation

Data Collection and Management Sensor networks and data acquisition Data storage and cloud computing Data standards and interoperability Precision Agriculture GPS/GIS applications in precision agriculture Remote sensing techniques for crop monitoring Variable rate technology (VRT) for inputs optimization

Farm Management Systems Integrated farm management software-Decision support systems for planning and optimization Supply chain management and traceability

Case Studies and Applications Real-world examples of smart farming implementation-Success stories and lessons learned from smart farms

Reference Books

- 1 Smart Farming: IoT Applications in Agriculture, Vinayak Pachori, 1, CRC.
- 2 Sustainable Agriculture Reviews, Eric Lichtfouse, 1, Springer.
- 3 Agricultural Internet of Things and Decision Support for Precision Smart Farming, Muhammad Iqbal, 2, Wiley.
- 4 Internet of Things in Agriculture: Smart Farming, M. Usha, 1, Springer.

23IOT3305A - DEEP LEARNING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3305A	DEEP LEARNING	DL	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply optimization algorithms to solve neural networks, enhancing model performance through weight adjustment. Develop the ability to select and implement appropriate optimization techniques for various neural network architectures and problems.	3	PO1, PO2, PSO1
CO2	Apply CNN models and their variants to real-time data, including LeNet, AlexNet, ZF-Net, and VGGNet. Gain proficiency in implementing and optimizing these models for various real-time data scenarios.	3	PO1, PO2, PSO1
CO3	Apply RNN, Long Short Term Memory (LSTM), and autoencoders to relevant data tasks. Acquire the ability to design, train, and optimize these models for various sequential and feature extraction problems.	3	PO2, PO3, PSO1
CO4	Demonstrate variational autoencoders and generative neural models for data generation tasks. Develop expertise in building, training, and evaluating these models to create realistic synthetic data.	3	PO2, PO3, PSO1
CO5	Apply advanced deep learning models to complex data problems. Gain proficiency in implementing and optimizing cutting-edge neural network architectures for improved performance and accuracy.	3	PO2, PO3, PSO2
CO6	Apply and implement deep learning models on various datasets. Acquire the skills to adapt and optimize these models for diverse data types and applications.	3	PO2, PO3, PSO2
CO7	Develop, implement, and evaluate deep learning models on case studies using Keras and PyTorch. Gain expertise in applying these frameworks to real-world problems, ensuring effective and efficient model performance.	5	PO2, PO3, PSO2

Syllabus

Introduction to Deep learning, History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron's, Perceptron Learning Algorithm and Convergence, Multilayer Perceptron's (MLPs), Representation Power of MLPs, Sigmoid Neurons,

Bias Variance Tradeoff, L2 regularization, Early stopping, . Batch Normalization, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Dropout, Greedy Layer wise Pre-training

Better activation functions, better weight initialization methods, Learning Vectorial Representations of Words Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation,

Deep Dream, Deep Art, Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Loss Functions in RNNs, Sequence Prediction, Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs, Encoder Decoder Models: Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders.

Attention Mechanism, Attention over images, Deep Belief networks, Markov Networks. Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Variational autoencoders, Autoregressive Models: NADE, MADE, PixelRNN, Generative Adversarial Networks (GANs) Cycle GAN, Super resolution and Conditional GAN models, Deep Reinforcement learning

Reference Books

- 1 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courvill, 2016, MIT Press.
- 2 Grokking Deep Learning, Andrew Trask, 2019, Manning publications.
- 3 Deep Learning: A Practitioner's Approach, Adam Gibson and Josh Patterson, 2023, O'Reilly Media.
- 4 Deep Learning with PyTorch , Eli Stevens, Luca Antiga, and Thomas Viehmann. , 2020 , Manning

23IOT3305E - DEEP LEARNING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3305E	DEEP LEARNING	DL	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply optimization algorithms to solve neural networks, enhancing model performance through weight adjustment. Develop the ability to select and implement appropriate optimization techniques for various neural network architectures and problems.	3	PO1, PO2, PSO1
CO2	Apply CNN models and their variants to real-time data, including LeNet, AlexNet, ZF-Net, and VGGNet. Gain proficiency in implementing and optimizing these models for various real-time data scenarios.	3	PO1, PO2, PSO1
CO3	Apply RNN, Long Short Term Memory (LSTM), and autoencoders to relevant data tasks. Acquire the ability to design, train, and optimize these models for various sequential and feature extraction problems.	3	PO2, PO3, PSO1
CO4	Demonstrate variational autoencoders and generative neural models for data generation tasks. Develop expertise in building, training, and evaluating these models to create realistic synthetic data.	3	PO2, PO3, PSO1
CO5	Apply advanced deep learning models to complex data problems. Gain proficiency in implementing and optimizing cutting-edge neural network architectures for improved performance and accuracy.	3	PO2, PO3, PSO2
CO6	Apply and implement deep learning models on various datasets. Acquire the skills to adapt and optimize these models for diverse data types and applications.	5	PO2, PO3, PSO2
CO7	Develop, implement, and evaluate deep learning models on case studies using Keras and PyTorch. Gain expertise in applying these frameworks to real-world problems, ensuring effective and efficient model performance.	6	PO2, PO3, PSO2

Syllabus

NN model and its variants to real time data like LeNet, AlexNet, ZF-Net, VGGNet models, Apply RNN, Long Short Term Memory (LSTM) and autoencoder, Better activation functions, better weight initialization methods, Learning Vectorial Representations of Words Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation,

Attention Mechanism, Attention over images, Deep Belief networks, Markov Networks. Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Variational autoencoders, Autoregressive Models:NADE, MADE, PixelRNN , Generative Adversarial Networks (GANs) Cycle GAN

Real time application of Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation, Recurrent Units (GRUs), Long Short TermMemory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs , Encoder Decoder Models:Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders,

real time applications of on Attention Mechanism, Attention over images, Deep Belief networks, Markov Networks. Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Variational autoencoders, Autoregressive Models:NADE, MADE, PixelRNN , Generative Adversarial Networks (GANs) Cycle GAN , Super resolution and Conditional GAN models, Deep Reinforcement learning

Attention Mechanism, Attention over images, Deep Belief networks, Markov Networks. Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Variational autoencoders, Autoregressive Models:NADE, MADE, PixelRNN , Generative Adversarial Networks (GANs) Cycle GAN ,Super resolution and Conditional GAN models, Deep Reinforcement learning

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- 2 Grokking Deep Learning, Andrew Trask, 2019, Manning publications.
- 3 Deep Learning: A Practitioner's Approach, Adam Gibson and Josh Patterson, 2023, O'Reilly Media.
- 4 Deep Learning with PyTorch , Eli Stevens, Luca Antiga, and Thomas Viehmann. , 2020 , Manning

23IOT3305R - DEEP LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3305R	DEEP LEARNING	DL	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and apply optimization algorithms to solve neural networks, enhancing model performance through weight adjustment. Develop the ability to select and implement appropriate optimization techniques for various neural network architectures and problems	3	PO1, PO2, PSO1
CO2	Apply CNN models and their variants to real-time data, including LeNet, AlexNet, ZF-Net, and VGGNet. Gain proficiency in implementing and optimizing these models for various real-time data scenarios.	3	PO1, PO2, PSO1
CO3	Apply RNN, Long Short Term Memory (LSTM), and autoencoders to relevant data tasks. Acquire the ability to design, train, and optimize these models for various sequential and feature extraction problems.	3	PO1, PO2, PSO1
CO4	Apply variational autoencoders and generative neural models for data generation tasks. Develop skills in constructing, training, and optimizing these models to create high-quality synthetic data.	3	PO2, PO3, PSO2
CO5	Apply and implement basic Neural Networks, various types of auto encoders, batch normalization, convolutional neural networks	3	PO2, PO3, PSO2
CO6	Construct , Design and develop basic and advanced neural networks, various types of autoencoders, batch normalization, and convolutional neural networks. Gain proficiency in constructing, training, and optimizing these models for diverse applications. Develop the ability to enhance model performance using advanced techniques.	5	PO2, PO3, PSO2

Syllabus

Introduction to Deep learning, History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron\\ , Introduction to Deep learning, History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron\\ Bias Variance Tradeoff, L2 regularization, Early stopping, . Batch Normalization, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Dropout,

Greedy Layer wise Pre-training, etter activation functions, better weight initialization methods, Learning Vectorial Representations of Words Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation,

Deep Dream, Deep Art, Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Loss Functions in RNNs, Sequence Prediction, Gated Recurrent Units (GRUs), Long Short TermMemory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs , Encoder Decoder Models:Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders.

Attention Mechanism, Attention over images, Deep Belief networks, Markov Networks. Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Variational autoencoders, Autoregressive Models:NADE, MADE, PixelRNN , Generative Adversarial Networks (GANs) Cycle GAN ,Super resolution and Conditional GAN models, Deep Reinforcement learning

Reference Books

- 1 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courvill, 2016, MIT Press.
- 2 Grokking Deep Learning, Andrew Trask, 2019, Manning publications.

- 3 Deep Learning with Python,, Francois Chollet,, 2018, Manning publications,.
- 4 Deep Learning: A Practitioner's Approach, Adam Gibson and Josh Patterson, 2023, O'Reilly Media.

23IOT3406M - DATA VISUALIZATION TECHNIQUES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3406M	DATA VISUALIZATION TECHNIQUES	DVT	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the modelling of various types of data and comprehend the fundamentals of data visualization.	2	PO5, PSO2
CO2	Apply the methods and tools for non-spatial data visualization and utilize these methods and tools in practical scenarios.	3	PO5, PSO2
CO3	Apply the methods for scientific/spatial data visualization and web data visualization, and implement these methods in real-world applications.	3	PO5, PSO2
CO4	Analyze dashboards and their categories, apply visual analytics techniques to dashboards, and evaluate and assess dashboards and their categories to enhance their effectiveness through visual analytics.	4	PO5, PSO2

Syllabus

Visualization Fundamentals, Design principles, The Process of Visualization, Data Abstraction, Visual Encodings, Use of Color, Perceptual Issues, Designing Views, Interacting with Visualizations, Filtering and Aggregation Design Studies Information / Non-Spatial Data Visualization, Tabular Data, Tree Data, Graph Data, Text Data, Flow Data, Time-Series Data, Topological Visualization, Uncertainty, Visual Analytics.

Scientific / Spatial Data Visualization, Scalar Volumes, Iso-surfacing, Volume Rendering, Transfer Function Design, Vector Fields, Maps, Spatial Uncertainty Web data visualization: web structure data, web usage data ,web content data multimedia data visualization Information dashboard

categorizing dashboards,typical dashboard data, dashboard design issues and best practices, visual perception,limits of short term memory visually encoding data, Gestalt principles, principles of visual perception for dashboard design

Characteristics of dashboards, key goals in visual design process, dashboard display media, designing dashboards for usability, meaningful organization, maintaining consistency aesthetics of dashboards, testing for usability

Reference Books

- 1 Visualizing Data, Ben Fry, December 2007, O'Reilly Media.
- 2 Visualization Analysis and Design, Tamara Munzner , November 2014, A.K.Peter visualization series.
- 3 Information Visualization: Perception for Design, Colin Ware (Author), 4th Edition, Elsevier.
- 4 Information Dashboard Design: The Effective Visual Communication of Data, Stephen Few, January 2001, O'Reilly Media.

23IOT3407M - APPLIED MACHINE LEARNING FOR AGRICULTURE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3407M	APPLIED MACHINE LEARNING FOR AGRICULTURE	AMLA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the principles of machine learning and its applications in agriculture	2	PO1, PO3, PSO1
CO2	Apply the Data Preprocessing and Analysis for Agricultural Machine Learning	3	PO1, PO4, PO5, PSO1
CO3	Exercising the Machine Learning Algorithms for Agriculture	3	PO2, PO3, PO4, PO5, PSO1
CO4	Deployment the Machine Learning Models for Agricultural Tasks	3	PO3, PO4, PO5, PSO1

Syllabus

Introduction to Machine Learning in Agriculture Definition and scope of machine learning-Applications of machine learning in agriculture Benefits and challenges of applying machine learning in agriculture Data Collection and Preprocessing Sources of agricultural data (satellite imagery, sensor data, weather data, etc.)-Data cleaning and preprocessing techniques-Feature engineering for agricultural datasets

Supervised Learning Techniques Regression for yield prediction-Classification for crop disease detection-Ensemble methods and model selection Unsupervised Learning Techniques Clustering for crop segmentation-Dimensionality reduction for data visualization Anomaly detection for pest or disease outbreak detection

Deep Learning for Agriculture Convolutional Neural Networks (CNNs) for image-based tasks (crop recognition, disease detection)-Recurrent Neural Networks (RNNs) for time-series data (weather forecasting, yield prediction)-Transfer learning and pre-trained models Model Evaluation and Validation Performance metrics for regression and classification tasks-Cross-validation techniques-Overfitting and regularization

Practical Applications of Machine Learning in Agriculture Crop yield prediction-Disease and pest detection-Weed identification and management

Reference Books

- 1 Computer Vision and Machine Learning in Agriculture, Jagdish Chand Bansal, Mohammad Shorif Uddin, 2, 2022, Springer Singapore.
- 2 Machine Learning and Artificial Intelligence for Agricultural Economics, Annamaria Olivieri, 1, 2021, Routledge.
- 3 Agri-Food 4.0 Innovations, Challenges and Strategies, , Anupama Singh, Dinesh Kumar, Rahul S. Mor, 1, 2022, Emerald Publishing Limited.
- 4 Application of Machine Learning in Agriculture, Mohammad Aslam Ansari, Mohammad Ayoub Khan, Rijwan Khan, 1, 2022, Elsevier Science.

23IOT3508 - BIG DATA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IOT3508	BIG DATA ANALYTICS	BDA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the data transmit emanated from different embedded and IOT devices	2	PO2, PO4, PO5, PSO2
CO2	Analyze the use of HADOOP and MAP reduce tools in the process of undertaking Analytics	4	PO3, PO4, PO5, PSO2
CO3	Analyze and develop data Modeling, Structuring and Analytics using R Programming Language	4	PO3, PO4, PO5, PSO2
CO4	Analyze and conduct various kinds of analytics on the big data especially using text and build big data and analytics applications	4	PO3, PO4, PO5, PSO2

Syllabus

Big data encompasses vast volumes of structured and unstructured data generated from various sources such as web data, transactional records, and multimedia content, with embedded systems and IoT devices capturing video, audio, and spectral data. Analysts utilize data repositories to aggregate, store, and retrieve data efficiently, leveraging advanced analytics and modern architectures like distributed computing and cloud storage.

Big Data Analytics involves understanding vast amounts of data generated from various sources, leveraging advanced statistical methods and AI to extract insights, and applying these techniques across different industry verticals. The data analytics lifecycle includes stages like discovery, data preparation, modeling, evaluation, and deployment, ensuring comprehensive and effective analysis. Modern practices in analytics utilize cutting-edge tools and architectures to handle and process big data efficiently, driving innovations and informed decision-making across industries.

Initial analysis of data using R involves understanding its graphical user interface and mastering data import and export functionalities. It includes recognizing attributes and data types, performing descriptive statistics, and conducting exploratory data analysis (EDA). EDA involves visualizing data before formal analysis, handling dirty data, visualizing single and multiple variables, and distinguishing between data exploration and presentation, ensuring a thorough understanding and accurate interpretation of the dataset.

Statistical evaluation methods in data analytics include hypothesis testing, difference of means, ranking tests, sampling, and ANOVA to assess and validate data patterns. The introduction of HADOOP and MapReduce provides powerful tools for processing and analyzing large datasets efficiently. Text analysis involves steps like collecting raw text, representing it through techniques like TFIDF, categorizing documents by topics, and determining sentiments to gain valuable insights. Example applications demonstrate the practical use of these techniques in real-world scenarios.

Reference Books

- 1 MapReduce Design Patterns, Donald Miner, 2012, O Reilly.
- 2 Agile data science: building data analytics applications with Hadoop, Russell Journey, 2013, O Reilly.
- 3 An Introduction to Applied Multivariate Analysis with R, Brian Everett, Torstein Hothorn, 2011, Springer.
- 4 Statistical Modeling and Analysis for Database Marketing: Effective Techniques for Mining Big Data, Bruce Ratner, 2003, Chapman and Hall CRC.

23MBT3101A - STEM CELL TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3101A	STEM CELL TECHNOLOGY	SCT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the strategies for isolation and maintenance of embryonic stem cells	3	PO4
CO2	Apply the aspects of stem cell niche to understand regulation of stemness	3	PO3
CO3	Apply different cues and strategies for stem cell differentiation and characterization	3	PO6
CO4	Apply the aspects of stem cell biology in therapy and organ development	3	
CO5	Apply the principles of stem cell technology for upskilling on the practical front	3	
CO6	Apply the cell culture techniques to maintain the cells in aseptic conditions and analyze their metabolic activity	4	
CO7	Apply the principles of cell culture in analyzing the mechanism of Tissue healing	4	PO6

Syllabus

Human embryonic development Stem cells classification Stem cell properties Embryonic stem cells (ESCs) Embryo preparation IVF SCNT Inner cell mass isolation ESC maintenance role of feeder layer Feeder free culture media requirement Molecular basis of pluripotency transcription factors signaling pathways Cell surface markers Human vs mouse stem cells

Adult stem cells Adult mammalian stem cell niche basic design Epidermal stem cell niche Stem cell niche in wound regeneration Intestinal stem cell niche Hematopoietic stem cell niche iPSCs small molecules in iPSC generation

Epigenetic factors in stem cell biology Characterization of stem cells Stem cell differentiation differentiation methods Factors affecting differentiation Biophysical Biochemical and Mechanobiological

Tissue engineering and Stem cell therapy heart diseases diabetes burns and skin ulcers muscular dystrophy orthopedic applications neurodegenerative diseases Stem cells and Biopharming Genetic manipulation of Stem cell Ethics of human cell research immortal cells and moral selves Ethical considerations stem cell-based therapies FDA products and preclinical regulatory considerations

Cell based therapies using Tissue engineering triad, High-throughput screening using stem cell-derived cells Identifying drug targets and testing drug efficacy Case studies: pharmaceutical applications and industry impact

Reference Books

- 1 Essentials of Stem cell biology, Rober Lanza, 2015, Elsevier academic press 2015.
- 2 Tissue engineering and artificial organs Biomedical engineering hand book, Joseph D. Bronzino, 2000, CRC Press.
- 3 Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues, W Mark Saltzman, 2004, Oxford University Press.
- 4 Stem Cell Biology: A Practical Laboratory Manual, Dr. Indumathi Soma Dr. Dhanasekaran Marappagounder Dr. Pankaj Kaingade, 2020, Evincepub Publishing.

23MBT3101E - STEM CELL TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3101E	STEM CELL TECHNOLOGY	SCT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the strategies for isolation and maintenance of embryonic stem cells	3	PO4
CO2	Apply the aspects of stem cell niche to understand regulation of stemness	3	PO3
CO3	Apply different cues and strategies for stem cell differentiation and characterization	3	PO6
CO4	Apply the aspects of stem cell biology in therapy and organ development	3	
CO5	Apply the cell culture techniques to maintain the cells in aseptic conditions and analyze their metabolic activity	3	PO7
CO6	Apply the principles of cell culture in analyzing the mechanism of Tissue healing	4	
CO7	Apply the principles of cell culture in analyzing the mechanism of Tissue healing	4	

Syllabus

Human embryonic development Stem cells classification Stem cell properties Embryonic stem cells ESCs Embryo preparation IVF SCNT Inner cell mass isolation ESC maintenance role of feeder layer Feeder free culture media requirement, Molecular basis of pluripotency transcription factors, signaling pathways Cell surface markers Human vs mouse stem cells

Adult stem cells Adult mammalian stem cell niche basic design Epidermal stem cell niche Stem cell niche in wound regeneration Intestinal stem cell niche Hematopoietic stem cell niche iPSCs small molecules in iPSC generation

Epigenetic factors in stem cell biology Characterization of stem cells Stem cell differentiation differentiation methods Factors affecting differentiation Biophysical Biochemical and Mechanobiological

Tissue engineering and Stem cell therapy heart diseases diabetes burns & skin ulcers muscular dystrophy orthopedic applications neurodegenerative diseases Stem cells and Biopharming Genetic manipulation of Stem cell Ethics of human cell research-immortal cells and moral selves Ethical considerations stem cell-based therapies FDA products and preclinical regulatory considerations

Cell based therapies using Tissue engineering triad, Cell based therapies using Tissue engineering triad, High-throughput screening using stem cell-derived cells Identifying drug targets and testing drug efficacy Case studies: pharmaceutical applications and industry impact

Cell based therapies with respect to case studies in upskilling using practical front

Reference Books

- 1 Essentials of Stem cell biology, Rober Lanza, 2015, Elsevier academic press.
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- 3 Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues , W Mark Saltzman , 2004, Oxford University Press .
- 4 Stem Cell Biology A Practical Laboratory Manual , Dr. Indumathi Somasundaram Dr. Dhanasekaran Marappagounder Dr. Pankaj Kaingade, 2020, Evincepub Publishing.

23MBT3101R - STEM CELL TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3101R	STEM CELL TECHNOLOGY	SCT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the strategies for isolation and maintenance of embryonic stem cells	3	PO4
CO2	Apply the aspects of stem cell niche to understand regulation of stemness	3	PO3
CO3	Apply different cues and strategies for stem cell differentiation and characterization	3	PO6
CO4	Apply the aspects of stem cell biology in therapy and organ developmen	3	
CO5	Apply the principles of stem cell culture for upskilling on the practical front	4	PO7
CO6	Apply the principles of cell culture in analyzing the mechanism of Tissue healing	4	

Syllabus

Human embryonic development Stem cells classification Stem cell properties Embryonic stem cells (ESCs) Embryo preparation IVF SCNT Inner cell mass isolation ESC maintenance role of feeder layer Feeder free culture media requirement Molecular basis of pluripotency transcription factors signaling pathways Cell surface markers Human vs mouse stem cells

Adult stem cells Adult mammalian stem cell niche basic design Epidermal stem cell niche Stem cell niche in wound regeneration Intestinal stem cell niche Hematopoietic stem cell niche iPSCs small molecules in iPSC generation.

Epigenetic factors in stem cell biology Characterization of stem cells Stem cell differentiation differentiation methods Factors affecting differentiation Biophysical Biochemical and Mechanobiological

Tissue engineering and Stem cell therapy heart diseases diabetes burns and skin ulcers muscular dystrophy orthopedic applications neurodegenerative diseases Stem cells and Biopharming Genetic manipulation of Stem cell Ethics of human cell research-immortal cells and moral selves, Ethical considerations stem cell-based therapies FDA products and preclinical regulatory considerations

Cell based therapies using Tissue engineering triad, High-throughput screening using stem cell-derived cells Identifying drug targets and testing drug efficacy Case studies: pharmaceutical applications and industry impact

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- 4 Stem Cell Biology A Practical Laboratory Manual, Dr. Indumathi Somasundaram Dr. Dhanasekaran Marappagounder Dr. Pankaj Kaingade, 2020, Evincepub Publishing.

23MBT3202A - VIROLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3202A	VIROLOGY	VR	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Viral Structure and Function	2	PO1, PO2, PO4, PSO1
CO2	Analyzing Viral Pathogenesis and Host Interactions: investigate and analyze the mechanisms of viral pathogenesis, including viral entry, immune evasion	3	PO1, PO2, PO4, PSO1
CO3	Exploring Antiviral Strategies and Therapeutics: explore and apply various antiviral strategies, including the development and testing of antiviral drugs	3	PO1, PO2, PO4, PSO1
CO4	Investigating Emerging Viral Diseases and Public Health Impact: investigate emerging viral diseases by analyzing epidemiological data, transmission dynamics	3	PO1, PO2, PO4, PSO1
CO5	Applying Virological Principles in Research and Healthcare: apply fundamental virological principles in the design and execution of research studies and healthcare applications	3	PO1, PO2, PO4, PSO1

Syllabus

Introduction to Virology History of virology Classification and nomenclature of viruses Viral structure and composition

Viral Replication Viral entry mechanisms Genome replication and transcription Viral protein synthesis and assembly

Viral Pathogenesis Mechanisms of viral pathogenesis Host immune responses to viral infections Viral evasion of host immunity

Viral Diseases Common viral diseases (e.g., influenza, HIV/AIDS, hepatitis) Emerging viral diseases and pandemics Zoonotic viruses and cross-species transmission

Antiviral Strategies Antiviral drugs and mechanisms of action Vaccine development and immunization strategies Immune-based therapies for viral infections Epidemiology and Public Health Epidemiological principles in viral diseases Global viral surveillance and monitoring Outbreak investigation and control measures

Reference Books

- 1 Principles of Virology volume 1: Molecular Biology, Theodora Hatzioannou, Vincent R. Racaniello, Glenn F. Rall, S. Jane Flint, Anna Marie Skalka, 2020, John Wiley & Sons.
- 2 Fields Virology, David M. Knipe et al., 2013, Lippincott Williams & Wilkins.
- 3 Clinical Virology, Richman, 2017, Taylor & Francis.
- 4 Principles of Virology volume 2: Pathogenesis and Control, S. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka, 2020, John Wiley & Sons.

23MBT3202E - VIROLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3202E	VIROLOGY	VR	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Viral Structure and Function	2	PO1, PO2, PO4, PSO1
CO2	Exploring Antiviral Strategies and Therapeutics: explore and apply various antiviral strategies, including the development and testing of antiviral drugs	3	PO1, PO2, PO4, PSO1
CO3	Analyzing Viral Pathogenesis and Host Interactions: investigate and analyze the mechanisms of viral pathogenesis	3	PO1, PO2, PO4, PSO1
CO4	Investigating Emerging Viral Diseases and Public Health Impact: investigate emerging viral diseases by analyzing epidemiological data, transmission dynamics	3	PO1, PO2, PO4, PSO1
CO5	Applying Virological Principles in Research and Healthcare: apply fundamental virological principles in the design and execution of research studies and healthcare applications	3	PO1, PO2, PO4, PSO1

Syllabus

Introduction to Virology History of virology Classification and nomenclature of viruses Viral structure and composition

Viral Replication Viral entry mechanisms Genome replication and transcription Viral protein synthesis and assembly

Viral Pathogenesis Mechanisms of viral pathogenesis Host immune responses to viral infections Viral evasion of host immunity

Viral Diseases Common viral diseases (e.g., influenza, HIV/AIDS, hepatitis) Emerging viral diseases and pandemics Zoonotic viruses and cross-species transmission Antiviral Strategies Antiviral drugs and mechanisms of action Vaccine development and immunization strategies Immune-based therapies for viral infections

Epidemiology and Public Health Epidemiological principles in viral diseases Global viral surveillance and monitoring Outbreak investigation and control measures

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- 2 Fields Virology, David M. Knipe et al., 2013, Lippincott Williams & Wilkins.
- 3 Clinical Virology, Richman, 2017, Taylor & Francis.
- 4 Principles of Virology, S. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka, 2020, John Wiley & Sons.

23MBT3202R - VIROLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3202R	VIROLOGY	VR	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Viral Structure and Function	2	PO1, PO3, PO5, PSO1
CO2	Analyzing Viral Pathogenesis and Host Interactions: investigate and analyze the mechanisms of viral pathogenesis, including viral entry, immune evasion	3	PO1, PO3, PO5, PSO1
CO3	Exploring Antiviral Strategies and Therapeutics: explore and apply various antiviral strategies, including the development and testing of antiviral drugs	3	PO1, PO3, PO5, PSO1
CO4	Applying Virological Principles in Research and Healthcare: apply fundamental virological principles in the design and execution of research studies and healthcare applications	3	PO1, PO3, PO5, PSO1

Syllabus

Introduction to Virology History of virology Classification and nomenclature of viruses Viral structure and composition

Viral Replication Viral entry mechanisms Genome replication and transcription Viral protein synthesis and assembly
Viral Pathogenesis Mechanisms of viral pathogenesis Host immune responses to viral infections Viral evasion of host immunity

Viral Diseases Common viral diseases (e.g., influenza, HIV/AIDS, hepatitis) Emerging viral diseases and pandemics
Zoonotic viruses and cross-species transmission Antiviral Strategies Antiviral drugs and mechanisms of action Vaccine development and immunization strategies Immune-based therapies for viral infections

Epidemiology and Public Health Epidemiological principles in viral diseases Global viral surveillance and monitoring
Outbreak investigation and control measures

Reference Books

- 1 Principles of Virology volume 1: Molecular Biology, S. Jane Flint et al., 2020, John Wiley & Sons.
- 2 Fields Virology, David M. Knipe et al., 2013, Lippincott Williams & Wilkins.
- 3 Clinical Virology, Richman, 2017, Taylor & Francis.
- 4 Principles of Virology, Front Cover S. Jane Flint, Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka, 2020, John Wiley & Sons.

23MBT3203A - NANOBIO TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3203A	NANOBIO TECHNOLOGY	NBT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Nanobiotechnology Fundamentals	2	PO1, PO2, PO3, PSO1
CO2	Exploring Nanomaterials in Biomedical Applications: investigate and apply nanomaterials in biomedical applications such as targeted drug delivery, medical imaging, and tissue engineering	3	PO1, PO2, PO3, PSO1
CO3	Applying Nanobiotechnology in Biotechnology and Environmental Science: apply nanobiotechnology methods to address challenges in biotechnology and environmental science	3	PO1, PO2, PO3, PSO1
CO4	Investigating Nanosensors and Nanodevices: explore the design, fabrication, and application of nanosensors and nanodevices for detecting biological and chemical substances.	3	PO1, PO2, PO4, PSO1
CO5	Applying Nanobiotechnology in Biotechnology and Environmental Science in aspect of negative and positive effect	3	PO1, PO2, PO3, PSO1

Syllabus

Introduction to Nanobiotechnology Definition and scope of nanobiotechnology Historical perspective and key milestones Ethical and safety considerations in nanobiotechnology

Nanomaterials in Biomedical Applications Types of nanomaterials (nanoparticles, nanotubes, nanowires) Synthesis methods and characterization techniques Applications in drug delivery, imaging, tissue engineering, and regenerative medicine

Nanobiotechnology Techniques Nanoparticle synthesis and surface functionalization Bioconjugation methods for biomolecule-nanomaterial interactions Nanoparticle tracking, imaging, and analysis techniques

Nanosensors and Nanodevices Principles of biosensors and nanobiosensors Design, fabrication, and characterization of nanosensors Applications in biological sensing, diagnostics, and environmental monitoring

Biomedical Applications of Nanobiotechnology Nanomedicine and targeted drug delivery systems Nanomaterials for medical imaging (MRI, CT, fluorescence imaging) Nanotechnology in cancer therapy, tissue regeneration, and neuroengineering Nanobiotechnology in Biotechnology and Environmental Science Nanoparticles in biofuel production and bioremediation Agricultural nanotechnology and crop enhancement Nanotoxicology studies and environmental impact assessment

Reference Books

- 1 Nanobiotechnology: Concepts, Applications and Perspectives, Prof. Dr. Christof M. Niemeyer, Prof. Dr. Chad A. Mirkin, 2004, Wiley.
- 2 Nanobiotechnology: Principles and Applications, Juhi Saxena, Abhijeet Singh, Anupam Jyoti, 2023, Bentham.
- 3 Introduction to nano : basics to nanoscience and nanotechnology , Sengupta, Amretashis, editor.; Sarkar, Chandan Kumar, editor.; , 2015, Springer.
- 4 Nanobiotechnology, Subbiah Balaji, 2019, MJP Publisher.

23MBT3203E - NANOBIO TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3203E	NANOBIO TECHNOLOGY	NBT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Nanobiotechnology Fundamentals	2	PO1, PO2, PO3, PSO1
CO2	Exploring Nanomaterials in Biomedical Applications: investigate and apply nanomaterials in biomedical applications such as targeted drug delivery, medical imaging, and tissue engineering	3	PO1, PO2, PO3, PSO1
CO3	Applying Nanobiotechnology in Biotechnology and Environmental Science: apply nanobiotechnology methods to address challenges in biotechnology and environmental science	3	PO1, PO2, PO3, PSO1
CO4	Investigating Nanosensors and Nanodevices: explore the design, fabrication, and application of nanosensors and nanodevices for detecting biological and chemical substances.	3	PO1, PO2, PO3, PSO1
CO5	Applying Nanobiotechnology in Biotechnology and Environmental Science in aspect of negative and positive effect	3	PO1, PO2, PO3

Syllabus

Introduction to Nanobiotechnology Definition and scope of nanobiotechnology Historical perspective and key milestones
Ethical and safety considerations in nanobiotechnology

Nanomaterials in Biomedical Applications Types of nanomaterials (nanoparticles, nanotubes, nanowires) Synthesis methods and characterization techniques Applications in drug delivery, imaging, tissue engineering, and regenerative medicine

Nanobiotechnology Techniques Nanoparticle synthesis and surface functionalization Bioconjugation methods for biomolecule-nanomaterial interactions Nanoparticle tracking, imaging, and analysis techniques

Nanosensors and Nanodevices Principles of biosensors and nanobiosensors Design, fabrication, and characterization of nanosensors Applications in biological sensing, diagnostics, and environmental monitoring

Biomedical Applications of Nanobiotechnology Nanomedicine and targeted drug delivery systems Nanomaterials for medical imaging (MRI, CT, fluorescence imaging) Nanotechnology in cancer therapy, tissue regeneration, and neuroengineering Nanobiotechnology in Biotechnology and Environmental Science Nanoparticles in biofuel production and bioremediation Agricultural nanotechnology and crop enhancement Nanotoxicology studies and environmental impact assessment

Reference Books

- 1 Nanobiotechnology: Concepts, Applications and Perspectives, Prof. Dr. Christof M. Niemeyer, Prof. Dr. Chad A. Mirkin, 2004, Wiley.
- 2 Nanobiotechnology: Principles and Applications, Juhi Saxena, Abhijeet Singh, Anupam Jyoti, 2023, Bentham.
- 3 Introduction to nano : basics to nanoscience and nanotechnology , Sengupta, Amretashis, editor.; Sarkar, Chandan Kumar, editor.; , 2015, SpringerLink.
- 4 Nanobiotechnology, Subbiah Balaji , 2019, MJP Publisher.

23MBT3203R - NANOBIO TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3203R	NANOBIO TECHNOLOGY	NBT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Nanobiotechnology Fundamentals	2	PO1, PO2, PO4, PSO1
CO2	Exploring Nanomaterials in Biomedical Applications	3	PO1, PO2, PO4, PSO1
CO3	Investigating Nanosensors and Nanodevices	3	PO1, PO2, PO4, PSO1
CO4	Applying Nanobiotechnology in Biotechnology and Environmental Science	3	PO1, PO2, PO4, PSO1

Syllabus

Introduction to Nanobiotechnology Definition and scope of nanobiotechnology Historical perspective and key milestones
Ethical and safety considerations in nanobiotechnology

Nanomaterials in Biomedical Applications Types of nanomaterials (nanoparticles, nanotubes, nanowires) Synthesis methods and characterization techniques Applications in drug delivery, imaging, tissue engineering, and regenerative medicine

Nanobiotechnology Techniques Nanoparticle synthesis and surface functionalization Bioconjugation methods for biomolecule-nanomaterial interactions Nanoparticle tracking, imaging, and analysis techniques

Nanosensors and Nanodevices Principles of biosensors and nanobiosensors Design, fabrication, and characterization of nanosensors Applications in biological sensing, diagnostics, and environmental monitoring

Biomedical Applications of Nanobiotechnology Nanomedicine and targeted drug delivery systems Nanomaterials for medical imaging (MRI, CT, fluorescence imaging) Nanotechnology in cancer therapy, tissue regeneration, and neuroengineering Nanobiotechnology in Biotechnology and Environmental Science Nanoparticles in biofuel production and bioremediation Agricultural nanotechnology and crop enhancement Nanotoxicology studies and environmental impact assessment

Reference Books

- 1 Nanobiotechnology: Concepts, Applications and Perspectives, Prof. Dr. Christof M. Niemeyer, Prof. Dr. Chad A. Mirkin, 2004, Wiley.
- 2 Nanobiotechnology: Principles and Applications, Juhi Saxena, Abhijeet Singh, Anupam Jyoti, 2023, Bentham.
- 3 Introduction to nano : basics to nanoscience and nanotechnology , Sengupta, Amretashis, editor.; Sarkar, Chandan Kumar, editor.; , 2015, Springer.
- 4 Nanobiotechnology, Subbiah Balaji, 2019, MJP Publisher.

23MBT3304A - HEALTHCARE BIOTECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3304A	HEALTHCARE BIOTECHNOLOGY	HBT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of simple proteins and therapeutic agents	3	PO2, PO3
CO2	Apply the knowledge of Healthcare Biotechnology to understand Human diseases	3	PO2, PO3
CO3	Apply the concepts of various vaccines used for diseases	3	PO2, PO3
CO4	Apply the applications of genetic engineering in healthcare	3	PO3, PO8
CO5	Apply the role of Recombinant Proteins in therapeutic and diagnostic applications	3	PO3, PO8
CO6	Apply the Role Biotechnology in Healthcare Experiments	3	PO8, PO9
CO7	Apply the Role of various skilling in Healthcare Biotechnology Experiments	3	PO8, PO9

Syllabus

Proteins as therapeutic agents - Choice of expression systems and optimizing gene expression - Applications, delivery and targeting of therapeutic proteins - Engineering human interferons and human growth hormones - Regulatory aspects of therapeutic proteins - Enzymes as therapeutic agents - Use of genetically engineered DNase I and alginate lyase for treatment of Cystic Fibrosis Monoclonal antibodies as therapeutic agents

Production of monoclonal antibodies - Human monoclonal antibodies, its scope and limitations - Hybrid human - Mouse antibodies - Production of antibodies in E. coli - Approaches for producing HIV therapeutic agents, Human diseases: Viral and bacterial diseases - Diseases caused by protozoan and parasitic worms (helminths) - Emerging infectious diseases

Active and passive immunity, Autoimmunity, Rational of immunization, Diseases controllable by vaccination, Vaccines, designing vaccines adjuvants, Whole organisms vaccines: Attenuated viruses and bacteria Inactivation of pathogenic organisms by heat and chemical treatment Vaccines

Bacterial polysaccharides, proteins and toxins as vaccines - Recombinant vaccines- subunit, attenuated and vector vaccines - Multivalent vaccine development against AIDS - Commercial and regulatory aspects of vaccine production and its distribution Application of genetic engineering in health care

Production of Recombinant Proteins having therapeutic and diagnostic applications, recombinant vaccine

Enzyme Activity Assay, Polymerase Chain Reaction (PCR), ELISA (Enzyme-Linked Immunosorbent Assay), Gel Electrophoresis, Cell Culture, Western Blotting, DNA Extraction from Plant Tissue, Enzyme-Linked Immunospot Assay (ELISPOT), Protein Purification, RNA Extraction from Mammalian Cells, Franz diffusion cell apparatus Setup, In silico analysis for identifying drug interactions and their phenotypic effects, Ionophoresis Instrument Setup, Demonstration of X-Ray diffraction analysis (XRD), Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Positive Bacteria, Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Negative Bacteria, Evaluating Antimicrobial Activity of Chemical Hydrogels, Insilico-Drug Interaction, Ionophoresis Instrument Setup, Franz diffusion cell apparatus Setup

PCR Technique, Molecular Cloning, Gene Expression Analysis, Protein Expression and Purification, Cell Culture Techniques, Immunological Techniques, Next-Generation Sequencing (NGS), CRISPR/Cas9 Genome Editing, Drug Discovery and Development, Bioinformatics Analysis, Pharmacogenomics, Bioprocess Engineering, Biostatistics, Regulatory Affairs in Biotechnology, Quality Control and Assurance, Biosafety and Bioethics, Stem Cell Technology, Point-of-Care Diagnostics

Reference Books

- 1 Molecular Biotechnology, Principles and Application of Recombinant DNA, Glick, B. R., Pasternak, J. J., 1998, ASM press, Washington.
- 2 Technology and Future of health care, Preparing for the Next 30 years, Joseph D. Bronzino, 2006, Jhon Wiley, Singapore.
- 3 Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, 2021, W. H. Freeman.
- 4 Goodman & Gilman's The Pharmacological Basis of Therapeutics, Laurence Brunton, John Lazo, and Keith Parker, 2019, McGraw-Hill Medical.

23MBT3304E - HEALTHCARE BIOTECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3304E	HEALTHCARE BIOTECHNOLOGY	HBT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of simple proteins and therapeutic agents	3	PO2, PO3
CO2	Apply the knowledge of Healthcare Biotechnology to understand Human diseases	3	PO2, PO3
CO3	Apply the concepts of various vaccines used for diseases	3	PO2, PO3
CO4	Apply the applications of genetic engineering in healthcare	3	PO3, PO8
CO5	Apply the role of Recombinant Proteins in therapeutic and diagnostic applications	3	PO3, PO8
CO6	Apply the Role Biotechnology in Healthcare Experiments	3	PO8, PO9
CO7	Apply the Role of various skilling in Healthcare Biotechnology Experiments	3	PO8, PO9

Syllabus

Proteins as therapeutic agents - Choice of expression systems and optimizing gene expression - Applications, delivery and targeting of therapeutic proteins - Engineering human interferons and human growth hormones - Regulatory aspects of therapeutic proteins - Enzymes as therapeutic agents - Use of genetically engineered DNase I and alginate lyase for treatment of Cystic Fibrosis Monoclonal antibodies as therapeutic agents

Production of monoclonal antibodies - Human monoclonal antibodies, its scope and limitations - Hybrid human - Mouse antibodies - Production of antibodies in E. coli - Approaches for producing HIV therapeutic agents, Human diseases: Viral and bacterial diseases - Diseases caused by protozoan and parasitic worms (helminths) - Emerging infectious diseases

Active and passive immunity, Autoimmunity, Rational of immunization, Diseases controllable by vaccination, Vaccines, designing vaccines adjuvants, Whole organisms vaccines: Attenuated viruses and bacteria Inactivation of pathogenic organisms by heat and chemical treatment Vaccines

Bacterial polysaccharides, proteins and toxins as vaccines - Recombinant vaccines- subunit, attenuated and vector vaccines - Multivalent vaccine development against AIDS - Commercial and regulatory aspects of vaccine production and its distribution Application of genetic engineering in health care

Production of Recombinant Proteins having therapeutic and diagnostic applications, recombinant vaccine

Enzyme Activity Assay, Polymerase Chain Reaction (PCR), ELISA (Enzyme-Linked Immunosorbent Assay), Gel Electrophoresis, Cell Culture, Western Blotting, DNA Extraction from Plant Tissue, Enzyme-Linked Immunospot Assay (ELISPOT), Protein Purification, RNA Extraction from Mammalian Cells, Franz diffusion cell apparatus Setup, In silico analysis for identifying drug interactions and their phenotypic effects, Ionophoresis Instrument Setup, Demonstration of X-Ray diffraction analysis (XRD), Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Positive Bacteria, Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Negative Bacteria, Evaluating Antimicrobial Activity of Chemical Hydrogels, Insilico-Drug Interaction, Ionophoresis Instrument Setup, Franz diffusion cell apparatus Setup

PCR Technique, Molecular Cloning, Gene Expression Analysis, Protein Expression and Purification, Cell Culture Techniques, Immunological Techniques, Next-Generation Sequencing (NGS), CRISPR/Cas9 Genome Editing, Drug Discovery and Development, Bioinformatics Analysis, Pharmacogenomics, Bioprocess Engineering, Biostatistics, Regulatory Affairs in Biotechnology, Quality Control and Assurance, Biosafety and Bioethics, Stem Cell Technology, Point-of-Care Diagnostics

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- 2 Technology and Future of health care, Preparing for the Next 30 years, Joseph D. Bronzino, 2006, Jhon Wiley, Singapore.
- 3 Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, 2021, W. H. Freeman.
- 4 Goodman & Gilman's The Pharmacological Basis of Therapeutics, Laurence Brunton, John Lazo, and Keith Parker, 2019, McGraw-Hill Medical.

23MBT3304R - HEALTHCARE BIOTECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3304R	HEALTHCARE BIOTECHNOLOGY	HBT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of simple proteins and therapeutic agents	3	PO2, PO3
CO2	Apply the knowledge of Healthcare Biotechnology to understand Human diseases	3	PO2, PO3
CO3	Apply the applications of genetic engineering in healthcare and to Apply the concepts of various vaccines used for diseases	3	PO2, PO3, PO8
CO4	Apply the role of Recombinant Proteins in therapeutic and diagnostic applications	3	PO3, PO8
CO5	Apply the Role Biotechnology in Healthcare Experiments	3	PO3, PO8, PO9
CO6	Apply the Role of various skillings in Healthcare Biotechnology Experiments	3	PO8, PO9

Syllabus

Proteins as therapeutic agents - Choice of expression systems and optimizing gene expression - Applications, delivery and targeting of therapeutic proteins - Engineering human interferons and human growth hormones - Regulatory aspects of therapeutic proteins - Enzymes as therapeutic agents - Use of genetically engineered DNase I and alginate lyase for treatment of Cystic Fibrosis Monoclonal antibodies as therapeutic agents

Production of monoclonal antibodies - Human monoclonal antibodies, its scope and limitations - Hybrid human - Mouse antibodies - Production of antibodies in E. coli - Approaches for producing HIV therapeutic agents, Human diseases: Viral and bacterial diseases - Diseases caused by protozoan and parasitic worms (helminths) - Emerging infectious diseases

Active and passive immunity, Autoimmunity, Rational of immunization, Diseases controllable by vaccination, Vaccines, designing vaccines adjuvants, Whole organisms vaccines: Attenuated viruses and bacteria Inactivation of pathogenic organisms by heat and chemical treatment Vaccines Bacterial polysaccharides, proteins and toxins as vaccines - Recombinant vaccines- subunit, attenuated and vector vaccines - Multivalent vaccine development against AIDS - Commercial and regulatory aspects of vaccine production and its distribution Application of genetic engineering in health care

Production of Recombinant Proteins having therapeutic and diagnostic applications, recombinant vaccine

Enzyme Activity Assay, Polymerase Chain Reaction (PCR), ELISA (Enzyme-Linked Immunosorbent Assay), Gel Electrophoresis, Cell Culture, Western Blotting, DNA Extraction from Plant Tissue, Enzyme-Linked Immunospot Assay (ELISPOT), Protein Purification, RNA Extraction from Mammalian Cells, Franz diffusion cell apparatus Setup, In silico analysis for identifying drug interactions and their phenotypic effects, Ionophoresis Instrument Setup, Demonstration of X-Ray diffraction analysis (XRD), Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Positive Bacteria, Evaluating Antimicrobial Activity of Physical Hydrogels against Gram-Negative Bacteria, Evaluating Antimicrobial Activity of Chemical Hydrogels, In silico-Drug Interaction, Ionophoresis Instrument Setup, Franz diffusion cell apparatus Setup

PCR Technique, Molecular Cloning, Gene Expression Analysis, Protein Expression and Purification, Cell Culture Techniques, Immunological Techniques, Next-Generation Sequencing (NGS), CRISPR/Cas9 Genome Editing, Drug Discovery and Development, Bioinformatics Analysis, Pharmacogenomics, Bioprocess Engineering, Biostatistics, Regulatory Affairs in Biotechnology, Quality Control and Assurance, Biosafety and Bioethics, Stem Cell Technology, Point-of-Care Diagnostics

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- 2 Technology and Future of health care, Preparing for the Next 30 years, Joseph D. Bronzino , 2006, Jhon Wiley, Singapore.
- 3 Lehninger Principles of Biochemistry, David L. Nelson and Michael M. Cox, 2021, W. H. Freeman.
- 4 Goodman & Gilman's The Pharmacological Basis of Therapeutics, Laurence Brunton, John Lazo, and Keith Parker , 2019, McGraw-Hill Medical.

23MBT3405M - CANCER BIOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3405M	CANCER BIOLOGY	CB	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge about cancer disease complex group of diseases characterized by abnormal cell growth that can invade nearby tissues and spread to other parts of the body.	3	PO1, PO2
CO2	Apply carcinogenesis that refers to the process by which normal cells are transformed into cancer cells and involves a complex interplay of genetic mutations, epigenetic changes, and environmental factors.	3	PO1, PO2
CO3	Apply of molecular biology of cancer encompasses the study of genetic and molecular alterations that drive the development and progression of cancer like genetic mutations and epigenetic changes.	2	PO1, PO2
CO4	Analyze the principles involved in Cancer metastasis and Cancer immunology that Understanding cancer metastasis and cancer immunology involves delving into complex biological processes and interactions that influence cancer progression and treatment responses.	3	PO1, PO2

Syllabus

Cancer Biology: Phenotypic characteristics of cancer cells. Basic feature of normal cell & tissues. Characteristic features of tumour cells. Control of growth in normal cells, Factors influencing the development of cancers, Nomenclature of tumour cells, Effect of cell receptors, Different phases of cell cycle. Cell cycle regulation, Different types of cancer, Role of Diet in cancer. Cell cycle regulation, Different types of cancer, Role of Diet in cancer.

CARCINOGENESIS: Chemical carcinogenesis, History, Metabolism & Targets. Physical carcinogenesis, History, Metabolism & Targets. Viral carcinogenesis, History, Retroviruses, SV40, Adenovirus, Papilloma viruses.

MOLECULAR BIOLOGY OF CANCER: Tumour suppressor genes, Role and regulatory mechanism of tumor suppressor genes- Retinoblastoma (Rb), Oncogenes- factors, EGF family, Receptor activation, Heterodimerization, Tyrosine phosphorylation, VEGF family, gene silencing and switching off the signal pathways in cancer.

CANCER METASTASIS: Cancer Metastasis. The spread of cancer, Pathogenesis of the process, Loss of cell cell cohesion, Mechanism of tumour invasion, Dissemination of tumour cells in blood stream, Patterns of metastatic spread. Role of inflammation in cancer.

Reference Books

- 1 Introduction to modern virology, Dimmock N.J, 1974, Blackwell scientific Publications, Oxford..
- 2 Cancer Biology, Roger.G.B, 2000, Prentice Hall.
- 3 Introduction to Molecular and Cellular Biology of Cancer, Margaret A Knowles and Peter.J.Shelly, 1997, Elsevier publications.
- 4 Oxford Textbook of Cancer Biology, Francesco Pezzella (ed.), Mahvash Tavassoli (ed.), David J. Kerr (ed.), 2019, Oxford.

23MBT3406M - NEUROBIOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3406M	NEUROBIOLOGY	NB	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the cells and organization of nervous system	2	PO1
CO2	Understand the physiology of the nerve impulse transmission	2	PO1
CO3	Articulate the Sensory and motor system and the underlying neurodegenerative disorders	3	PO1
CO4	Articulate the inter-connectivity between neuroscience and computational engineering	3	PO1

Syllabus

Survey of Human Neuroanatomy- Central and peripheral nervous systems; Blood Brain barrier; Meninges and Cerebrospinal fluid; Development of the nervous system; Neuronal differentiation; Characterization of neuronal cells; Structure and function of neurons; types of neurons; Synapses; Glial cells; myelination; nodes of Ranvier; Repair and Regeneration in the Nervous System

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; Chemical and electrical synaptic transmission; neurotransmitters and their release; synaptic plasticity; characteristics of neurites; hormones and their effect on neuronal function

Properties of sensory systems, coding and control of sensory information, Sensory organs, somatosensory, vision, auditory and chemical senses, motor systems, muscle and its control, reflexes and pattern generation, Stroke, Epilepsy, Schizophrenia, Alzheimers, and Parkinsons disease

Diagnostic tools: X-Ray, CT, PET-CT, MRI; Neuroscience Database (Allen Atlas Database); Biophysical models (Hodgkin-Huxley) of neurons and circuits with emphasis on application of commonly available modeling tools (NEURON)

Reference Books

- 1 Fundamentals of Neuroscience , Dana Park Purves et al. , 2011, Elsevier publishers .
- 2 Neuroscience , Dale, 2017, Elsevier publishers.
- 3 Neurobiology , Mathews G.G. , 2000, Blackwell Science .
- 4 Neurobiology , Gordon M. Shepherd G.M , 1994, Oxford University Press, USA .

23MBT3507 - BIOELECTRONICS & BIOSENSORS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3507	BIOELECTRONICS & BIOSENSORS	BB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Bioelectronics Principles	2	PO1, PO2, PO3, PSO1
CO2	Designing and Fabricating Biosensors: design and fabricate various types of biosensors, applying various techniques	3	PO1, PO2, PO3, PSO1
CO3	Analyzing Signal Transduction Mechanisms: investigate and analyze the mechanisms of signal transduction in biosensors	3	PO1, PO2, PO3, PSO1
CO4	Applying Bioelectronics & Biosensors in Healthcare and Biotechnology: apply bioelectronics and biosensor technologies in practical scenarios within healthcare and biotechnology	3	PO1, PO2, PO4, PSO1

Syllabus

Introduction to Bioelectronics Definition and scope of bioelectronics Interface between biology and electronics
Electrical properties of biological materials

Principles of Biosensors Types of biosensors (enzymatic, immunological, optical, electrochemical) Sensing mechanisms and transduction pathways Biomolecule immobilization techniques

Biosensor Design and Fabrication Sensor materials selection (nanomaterials, polymers, metals) Transducer integration (electrodes, optical components) Signal amplification and detection methods

Signal Transduction Mechanisms Enzymatic biosensors and substrate specificity Immunological biosensors and antigen-antibody interactions Optical biosensors and signal modulation Applications of Bioelectronics & Biosensors Healthcare applications (clinical diagnostics, disease monitoring) Environmental monitoring (pollutant detection, water quality) Biotechnological applications (bioprocess monitoring, food safety)

Bioelectronics in Neural Interfaces Neural recording and stimulation technologies Brain-machine interfaces and neuroprosthetics Ethical considerations in neural bioelectronics

Reference Books

- 1 Bioelectronics: From Theory to Applications, Prof. Dr. Itamar Willner, Dr. Eugenii Katz, 2005, Wiley.
- 2 Biosensors: Fundamentals and Applications, Bansi D. Malhotra and Chandra Mouli Pandey, 2019, De Gruyter.
- 3 Smart Biosensor Technology, By George K. Knopf , 2019, Taylor & Francis.
- 4 Biosensors and Bioelectronics, Chandran Karunakaran, Kalpana Bhargava and Robson Benjamin, 2015, ELsevier.

23MBT3508 - TISSUE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MBT3508	TISSUE ENGINEERING	NBT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of Tissue engineering Traid in Therapies	3	PO3
CO2	Apply the knowledge of Tissue culture basics in maintaining cells	3	PO2, PO10
CO3	Apply the principles of 3D Tissue organization and angiogenesis	3	PO10
CO4	Apply the role TE components in Cell based Therapies with case studies	3	PO12

Syllabus

Tissue Engineering and Cell-Based Therapies, Biomaterials. Metals, ceramics, polymers (synthetic and natural). Biodegradable materials, native matrix, Cell structure and function Cell signaling and communication Stem cells and differentiation

Primary cell culture and cell lines 2D vs. 3D cell culture Co-culture techniques, Tissue culture basics: Primary cells vs. cell lines, sterile techniques, plastics, enzymes, reactors and cryopreservation. Principals of self-assembly, ECM.

3D organization and angiogenesis. Natural Scaffold Materials, Synthetic Biomaterial Scaffolds, Scaffold Fabrication & Tailoring, Cell migration. Tissue Morphogenesis, Stem Cells and Lineages, Cell Isolation and Culture, Cell-Cell Communication, Graft Rejection/Material Biocompatibility, Cell Migration, Engineered Disease Models

Stem Cell Therapies with case studies. Liver tissue engineering. Bio artificial liver (BAL) assist device, shear forces, oxygen transport, and plasma effects. Cardiovascular tissue engineering. Introduction, blood vessels structure, vascular grafts. Skin tissue engineering. Introduction, scar vs. regeneration, split skin graft and case studies

Reference Books

- 1 The Biomedical Engineering Handbook, JD BROZINO, 2010, CRC .
- 2 Principles of tissue engineering, R P Lanza, 2000, Elsevier .
- 3 Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues, W Mark Saltzman, 2010, Oxford University Press .
- 4 Principles of Tissue Engineering , Antonios G Mikos, 2000, CRC.

23RAN3101A - ROBOT MOTION PLANNING, DYNAMICS AND CONTROL (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3101A	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	RMPDC	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles of robot trajectory planning	2	PO1, PSO1
CO2	Apply motion planning principles to a robot in the presence of obstacles	3	PO2, PSO1
CO3	Analyse motion planning and control	4	PO3, PSO1
CO4	Perform basic motion, force, and hybrid motion-force control to mobile robotics	3	PO2, PSO1
CO5	Apply optimization techniques for joint space trajectory	3	PO2, PSO1
CO6	Perform lab experiments using python/Robot simulator CoppeliaSim and python for motion planning.	4	PO5
CO7	Develop a mobile robot path planning using python/Robot simulator CoppeliaSim	4	PO5

Syllabus

Robot trajectory Control: key concepts of robot motion generation: planning a motion for a robot in the presence of obstacles, and real-time feedback control to track the planned motion, Trajectory generation, Path planning algorithms

Motion Planning: foundational material like C-space obstacles, graphs and trees, and graph search, as well as classical and modern motion planning techniques, such as grid-based motion planning, randomized sampling-based planners, and virtual potential fields.

Robot Control: PID control, motion control, force control, and hybrid motion-force control, adaptive control

Mobile Robotics: Localization and mapping, SLAM, Path planning, Control of mobile robots

Joint Space Optimization: Optimizing joint trajectories to achieve desired end-effector motions while considering joint limits, velocity, and torque constraints.

Reference Books

- 1 Robot Modeling and Control, Mark W. Spong, 2005, Wiley.
- 2 Introduction to Autonomous Robots, Nikolaus Correll, Bradley Hayes, and Jur van den Berg, 2022, MIT Press.
- 3 Robotics, Vision and Control, Peter Corke, 2017, Springer.
- 4 Planning Algorithms, Steven M. LaValle, 2021, Cambridge University Press.
- 5 Dynamic Simulations of Multibody Systems, Murilo G. Coutinho, 2001, Springer.

23RAN3101E - ROBOT MOTION PLANNING, DYNAMICS AND CONTROL (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3101E	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	RMPDC	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles of robot trajectory planning	2	PO1, PSO1
CO2	Apply motion planning principles to a robot in the presence of obstacles	3	PO2, PSO1
CO3	Analyse motion planning and control	4	PO3, PSO1
CO4	Perform basic motion, force, and hybrid motion-force control to mobile robotics	3	PO2, PSO1
CO5	Apply optimization techniques for joint space trajectory	3	PO2, PSO1
CO6	Perform lab experiments using python/Robot simulator CoppeliaSim and python for motion planning.	4	PO5
CO7	Develop a mobile robot path planning using python/Robot simulator CoppeliaSim	4	PO5

Syllabus

Robot trajectory Control: key concepts of robot motion generation: planning a motion for a robot in the presence of obstacles, and real-time feedback control to track the planned motion, Trajectory generation, Path planning algorithms

Motion Planning: foundational material like C-space obstacles, graphs and trees, and graph search, as well as classical and modern motion planning techniques, such as grid-based motion planning, randomized sampling-based planners, and virtual potential fields.

Robot Control: PID control, motion control, force control, and hybrid motion-force control, adaptive control

Mobile Robotics: Localization and mapping, SLAM, Path planning, Control of mobile robots

Joint Space Optimization: Optimizing joint trajectories to achieve desired end-effector motions while considering joint limits, velocity, and torque constraints.

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- 2 Introduction to Autonomous Robots, Nikolaus Correll, Bradley Hayes, and Jur van den Berg., 2022, MIT Press.
- 3 Robotics, Vision and Control, Peter Corke, 2017, Springer.
- 4 Planning Algorithms, Steven M. LaValle, 2021, Cambridge University Press .
- 5 Dynamic Simulations of Multibody Systems, Murilo G. Coutinho, 2001, Springer.

23RAN3101R - ROBOT MOTION PLANNING, DYNAMICS AND CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3101R	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	RMPDC	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles of robot trajectory planning	2	PO1, PSO1
CO2	Apply motion planning principles to a robot in the presence of obstacles	3	PO2, PSO1
CO3	Analyse motion planning and control	4	PO3, PSO1
CO4	Perform basic motion, force, and hybrid motion-force control to mobile robotics	3	PO2, PSO1
CO5	Perform lab experiments using python/Robot simulator CoppeliaSim for motion planning.	4	PO5
CO6	Perform skill experiments using python/Robot simulator CoppeliaSim and python for motion planning.	4	PO5

Syllabus

Robot trajectory Control: key concepts of robot motion generation: planning a motion for a robot in the presence of obstacles, and real-time feedback control to track the planned motion, Trajectory generation, Path planning algorithms

Motion Planning: foundational material like C-space obstacles, graphs and trees, and graph search, as well as classical and modern motion planning techniques, such as grid-based motion planning, randomized sampling-based planners, and virtual potential fields.

Robot Control: PID control, motion control, force control, and hybrid motion-force control, adaptive control

Mobile Robotics: Localization and mapping, SLAM, Path planning, Control of mobile robots

Reference Books

- 1 Robot Modeling and Control, Mark W. Spong, 2005, Wiley.
- 2 Introduction to Autonomous Robots, Nikolaus Correll, Bradley Hayes, and Jur van den Berg., 2022, MIT Press.
- 3 Robotics, Vision and Control, Peter Corke, 2017, Springer.
- 4 Planning Algorithms, Steven M. LaValle, 2021, Cambridge University Press.
- 5 Dynamic Simulations of Multibody Systems, Murilo G. Coutinho, 2001, Springer.

23RAN3102A - AUTONOMOUS MOBILE ROBOT SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3102A	AUTONOMOUS MOBILE ROBOT SYSTEMS	AMRS	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic mechanical and electrical systems concerning robots locomotion and manipulation.	3	PO1, PO2, PSO1
CO2	Apply the mathematical models and computational and motion control methods to mobile robotic systems.	3	PO1, PO2, PSO1
CO3	Apply the sensor systems related to state measurements, navigation, and probabilistic map based localization	3	PO1, PO2, PSO1
CO4	Analyze the A-star, Dijkstra algorithm for planning the required path for various terrains with different combinations of robot	4	PO2, PO3, PSO1
CO5	Analyze the path planning for the multiple robots with various path planning techniques	4	PO5, PSO1
CO6	Analyze different aspects of stability for a given robot model and apply the mathematical model for the desired movements	4	PO3, PO5, PSO1
CO7	Design a robot with an efficient mapping and path planning algorithm for the precise locomotion	4	PO2, PO5, PSO1

Syllabus

Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion. Types of mobile robots: ground robots (wheeled and legged robots), aerial robots, underwater robots, and water surface robots. Robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability; mobile robots.

Mobile robot kinematics and dynamics: Kinematics of wheeled mobile robot, degree of freedom, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots. Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots; Dynamics of mobile robot: Lagrange-Euler and Newton-Euler methods. Computer based dynamic (numerical) simulation of different wheeled mobile robots.

Perception: Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots magnetic and optical position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual and motion sensing systems. Doppler effect-based sensors, vision based sensors, uncertainty in sensing, filtering.

Path planning and navigation: Robot navigation: Localization, Error propagation model, Probabilistic map based localisation, Autonomous map building, Simultaneous localization and mapping (SLAM). path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP).

Centralization vs. decentralization, robot swarms, multi-robot path planning, reinforcement learning for autonomous decision-making, Graph-Based Methods, Optimization-Based Methods, Swarm Intelligence, Communication and Coordination

Reference Books

- 1 Introduction to Autonomous Mobile Robots, R. Siegwart, I. R. Nourbakhsh, 2011, MIT Press.
- 2 Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Peter Corke, 2011, Springer.

- 3 Planning Algorithms, S. M. LaValle, 2006, Cambridge University Press.
- 4 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala, 2016, Butterworth-Heinemann.
- 5 Probabilistic Robotics, Thrun, S., Burgard,W., and Fox, D, 2005, MIT Press.
- 6 Autonomous Vehicles Volume 1: Using Machine Intelligence, Romil Rawat, 2022, Wiley .

23RAN3102E - AUTONOMOUS MOBILE ROBOT SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3102E	AUTONOMOUS MOBILE ROBOT SYSTEMS	AMRS	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic mechanical and electrical systems concerning robots locomotion and manipulation	3	PO1, PO2, PSO1
CO2	Apply the mathematical models and computational and motion control methods to mobile robotic systems.	3	PO1, PO2, PSO1
CO3	Apply the sensor systems related to state measurements, navigation, and probabilistic map based localization	3	PO1, PO2, PSO1
CO4	Analyze the A-star, Dijkstra algorithm for planning the required path for various terrains with different combinations of robot	4	PO2, PO3, PSO1
CO5	Analyze the path planning for the multiple robots with various path planning techniques	4	PO5, PSO1
CO6	Analyze different aspects of stability for a given robot model and apply the mathematical model for the desired movements	4	PO3, PO5, PSO1
CO7	Develop a proper mapping and path planning algorithm for the locomotion of a given robot and analyze the performance with obstacle avoidance	4	PO2, PO5, PSO1

Syllabus

Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion. Types of mobile robots: ground robots (wheeled and legged robots), aerial robots, underwater robots, and water surface robots. Robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability; mobile robots.

Mobile robot kinematics and dynamics: Kinematics of wheeled mobile robot, degree of freedom, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots. Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots; Dynamics of mobile robot: Lagrange-Euler and Newton-Euler methods. Computer based dynamic (numerical) simulation of different wheeled mobile robots.

Perception: Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots magnetic and optical position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual and motion sensing systems. Doppler effect-based sensors, vision based sensors, uncertainty in sensing, filtering

Path planning and navigation: Robot navigation: Localization, Error propagation model, Probabilistic map based localisation, Autonomous map building, Simultaneous localization and mapping (SLAM). path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP).

Centralization vs. decentralization, robot swarms, multi-robot path planning, reinforcement learning for autonomous decision-making, Graph-Based Methods, Optimization-Based Methods, Swarm Intelligence, Communication and Coordination

Reference Books

- 1 Introduction to Autonomous Mobile Robots, R. Siegwart, I. R. Nourbakhsh, 2011, 1st Edition, MIT Press.
- 2 Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Peter Corke, 2011, 2nd Edition, Springer.

- 3 Planning Algorithms, S. M. LaValle, 2006, 1st Edition, Cambridge University Press.
- 4 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala, 2005, 1st Edition, MIT Press.
- 5 Probabilistic Robotics, Thrun, S., Burgard, W., and Fox, D., 2005. 3rd Edition, MIT Press.
- 6 Autonomous Vehicles Volume 1: Using Machine Intelligence, Romil Rawat, 2022, 1st Edition, Wiley .

23RAN3102R - AUTONOMOUS MOBILE ROBOT SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3102R	AUTONOMOUS MOBILE ROBOT SYSTEMS	AMRS	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic mechanical and electrical systems concerning robots locomotion and manipulation	3	PO1, PO2, PSO1
CO2	Apply the mathematical models and computational and motion control methods to mobile robotic systems	3	PO1, PO2, PSO1
CO3	Apply the sensor systems related to state measurements, navigation and probabilistic map based localization	3	PO1, PO2, PSO1
CO4	Analyze the A-star, Dijkstra algorithm for planning the required path with the static and dynamic obstacle avoidance.	4	PO2, PO3, PSO1
CO5	Analyze the path planning for the multiple robots using various optimized path planning techniques	4	PO5, PSO1
CO6	Analyze different aspects of stability for a given robot model and apply the mathematical model for the desired movements	4	PO3, PO5, PSO1

Syllabus

Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion. Types of mobile robots: ground robots, aerial robots, underwater robots, and water surface robots. Robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots, stability, manoeuvrability, controllability; mobile robots.

Mobile robot kinematics and dynamics: Kinematics of wheeled mobile robot, degree of freedom, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots. Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots; Dynamics of mobile robot: Lagrange-Euler and Newton-Euler methods. Computer based dynamic simulation of different wheeled mobile robots.

Perception: Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots magnetic and optical position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual and motion sensing systems. Doppler effect-based sensors, vision-based sensors, uncertainty in sensing, filtering.

Path planning and navigation: Robot navigation: Localization, Error propagation model, Probabilistic map based localization, Autonomous map building, Simultaneous localization and mapping (SLAM). path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP).

Reference Books

- 1 Introduction to Autonomous Mobile Robots, R. Siegwart, I. R. Nourbakhsh, 2011, 1st Edition, MIT Press.
- 2 Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Peter Corke , 2011, 2nd Edition, Springer.
- 3 Planning Algorithms, S. M. LaValle, 2006, 1st Edition, Cambridge University Press.
- 4 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala, 2016, 1st Edition, Butterworth-Heinemann.
- 5 Probabilistic Robotics, Thrun, S., Burgard, W., and Fox, D., 2005, 3rd Edition, MIT Press.
- 6 Autonomous Vehicles Volume 1: Using Machine Intelligence, Romil Rawat, 2022, 1st Edition, Wiley .

- 7 Introduction to Mobile Robot Control, SG Tzafestas, 2014, 1st Edition, Elsevier.

23RAN3202A - AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3202A	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	AVAE	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply vehicular dynamics and control principles, including motion, force, and feedback, to design algorithms for autonomous vehicles. This ensures stability, maneuverability, and safety across diverse driving conditions.	3	PO1, PO2, PSO1
CO2	LiDAR, radar, and GPS sensors, along with electric motors and hydraulic actuators, enable precise control of speed, steering, braking, and navigation. This integration is crucial for ensuring the safety and efficiency of modern vehicles.	3	PO1, PO2, PSO1
CO3	Automotive Electronics integrates ECUs, sensors, actuators, and communication protocols to improve performance, efficiency, safety, and comfort. This ensures seamless operation and responsiveness in modern vehicles.	3	PO1, PO2, PSO1
CO4	Wireless electronics and networking enhance autonomous vehicle reliability, safety, and intelligence through real-time V2V and V2I communication. This enables predictive maintenance, traffic management, and autonomous decision-making.	4	PO2, PO3, PSO1
CO5	Use PID, MPC, and adaptive control strategies to improve vehicle dynamics, stability, and performance. This ensures precise handling and safety.	4	PO5, PO12, PSO1

Syllabus

Introduction to Autonomous Vehicles: Technological overview concepts of Autonomous Vehicles (AVs); History of Autonomous Vehicles; Vehicle Electronics Architecture; Functional Block Diagram of typical Autonomous Vehicle System (AVS); Basic control system applied to Drive Assisted and Driverless Vehicles; Overview of the operation of Electronic Control Unit (ECUs).

Automotive Sensors and Actuators (ASA): Role of sensors and actuators in autonomous vehicles; Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Electric Motor Actuators.

Automotive Electronics (AE): Fundamentals of Automotive Electronics (FAE)- Principles of automotive systems, Advanced driver-assistance systems (ADAS)- Evolution of ABS configurations, Basics of Theory of Operation, Integration of ADAS Technology into Vehicle Electronics, Auto pilot, Advanced parking system, ADAS in Toyota and Tesla.

Automotive Wireless (AW): Wireless Networking and Applications to Vehicle Autonomy; Integration of Wireless Networking and On-Board Vehicle Networks; Automotive GPRS Vehicle Tracking (AGPRS-VT)- Vehicle Tracking System; Principle of Vehicle Tracking system, GPS and GPRS tracking system. Controlled Area Network (CAN): Basic, Block diagram of the CAN bus architecture, Types of CAN Physical Layers, Frame Format of CAN protocol, Working principle of CAN communication.

Air-fuel ratio control methodologies for efficient fuel consumption.

Reference Books

- 1 Automotive Computers and Control System, Tom Weather Jr and Cland C. Hunter, 1998, Prentice Hall Inc., New Jersey .
- 2 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala , 2016, Butterworth-Heinemann.
- 3 Autonomous Vehicles Volume 1: Using Machine Intelligence , Romil Rawat , 2022, Wiley .

- 4 Understanding Automotive Electronics: An Engineering Perspective , William Ribbens , 2017, Butterworth-Heinemann.

23RAN3202E - AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3202E	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	AVAE	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply vehicular dynamics and control principles to design algorithms for autonomous vehicles, ensuring stability, maneuverability, and safety. This leverages motion, force, and feedback systems to adapt to various driving conditions.	3	PO1, PO2, PSO1
CO2	Utilize sensors like LiDAR, radar, and GPS, along with actuators such as electric motors and hydraulics, to control vehicular parameters like speed, steering, braking, and navigation. This precision is crucial for modern vehicle safety and efficiency.	3	PO1, PO2, PSO1
CO3	Explore Automotive Electronics by integrating ECUs, sensors, actuators, and communication protocols to enhance performance, efficiency, safety, and comfort. This ensures seamless operation and responsiveness in modern vehicles.	3	PO1, PO2, PSO1
CO4	Use wireless electronics and networking to enhance the reliability, safety, and intelligence of autonomous vehicles through real-time V2V and V2I communication. This supports features like predictive maintenance, traffic management, and autonomous decision-making.	4	PO2, PO3, PSO1
CO5	Analyze and apply control strategies like PID, MPC, and adaptive control to optimize vehicle dynamics, stability, and performance. This ensures precise handling and safety across diverse driving conditions.	4	PO5, PO12, PSO1

Syllabus

Introduction to Autonomous Vehicles: Technological overview concepts of Autonomous Vehicles (AVs); History of Autonomous Vehicles; Vehicle Electronics Architecture; Functional Block Diagram of typical Autonomous Vehicle System (AVS); Basic control system applied to Drive Assisted and Driverless Vehicles; Overview of the operation of Electronic Control Unit (ECUs).

Automotive Sensors and Actuators (ASA): Role of sensors and actuators in autonomous vehicles; Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Electric Motor Actuators.

Automotive Electronics (AE): Fundamentals of Automotive Electronics (FAE)- Principles of automotive systems, Advanced driver-assistance systems (ADAS)- Evolution of ABS configurations, Basics of Theory of Operation, Integration of ADAS Technology into Vehicle Electronics, Auto pilot, Advanced parking system, ADAS in Toyota and Tesla.

Automotive Wireless (AW): Wireless Networking and Applications to Vehicle Autonomy; Integration of Wireless Networking and On-Board Vehicle Networks; Automotive GPRS Vehicle Tracking (AGPRS-VT)- Vehicle Tracking System; Principle of Vehicle Tracking system, GPS and GPRS tracking system. Controlled Area Network (CAN):Basic, Block diagram of the CAN bus architecture, Types of CAN Physical Layers, Frame Format of CAN protocol, Working principle of CAN communication.

Fuel control for maintain efficient vehicle working with optimised fuel consumption.

Reference Books

- 1 Automotive Computers and Control System , Tom Weather Jr and Cland C. Hunter, 1998, Prentice Hall Inc., New Jersey .
- 2 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems , Rahul Kala , 2016, Butterworth-Heinemann.

- 3 Autonomous Vehicles Volume 1: Using Machine Intelligence, Romil Rawat, 2022, Wiley.
- 4 Understanding Automotive Electronics: An Engineering Perspective, William Ribbens, 2017, Butterworth-Heinemann.

23RAN3202R - AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3202R	AUTONOMOUS VEHICLES & AUTOMOTIVE ELECTRONICS	AVAE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Use vehicular dynamics and control principles to design algorithms that ensure stability, maneuverability, and safety for autonomous vehicles. This approach adapts to diverse driving conditions for effective self-driving performance.	3	PO1, PO2, PSO1
CO2	LiDAR, radar, GPS, electric motors, and hydraulic systems enable precise control of speed, steering, braking, and navigation in vehicles. This integration is crucial for ensuring modern vehicle safety and efficiency.	3	PO1, PO2, PSO1
CO3	Automotive Electronics integrates ECUs, sensors, actuators, and communication protocols to boost performance, efficiency, safety, and comfort. This ensures seamless operation and responsiveness in modern vehicles.	3	PO1, PO2, PSO1
CO4	Wireless electronics and networking enhance autonomous vehicle reliability, safety, and intelligence through real-time V2V and V2I communication. This supports predictive maintenance, traffic management, and autonomous decision-making.	4	PO2, PO3, PSO1

Syllabus

Introduction to Autonomous Vehicles: Technological overview concepts of Autonomous Vehicles (AVs); History of Autonomous Vehicles; Vehicle Electronics Architecture; Functional Block Diagram of typical Autonomous Vehicle System (AVS); Basic control system applied to Drive Assisted and Driverless Vehicles; Overview of the operation of Electronic Control Unit (ECUs).

Automotive Sensors and Actuators (ASA): Role of sensors and actuators in autonomous vehicles; Accelerometers, Wheel speed, Brake pressure, Seat occupancy, Engine speed, Steering wheel angle, Vehicle speed, Throttle position, Turbine speed, Temperature, Mass air flow (MAF) rate, Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Electric Motor Actuators.

Automotive Electronics (AE): Fundamentals of Automotive Electronics (FAE)- Principles of automotive systems, Advanced driver-assistance systems (ADAS)- Evolution of ABS configurations, Basics of Theory of Operation, Integration of ADAS Technology into Vehicle Electronics, Auto pilot, Advanced parking system, ADAS in Toyota and Tesla.

Automotive Wireless (AW): Wireless Networking and Applications to Vehicle Autonomy; Integration of Wireless Networking and On-Board Vehicle Networks; Automotive GPRS Vehicle Tracking (AGPRS-VT)- Vehicle Tracking System; Principle of Vehicle Tracking system, GPS and GPRS tracking system. Controlled Area Network (CAN):Basic, Block diagram of the CAN bus architecture, Types of CAN Physical Layers, Frame Format of CAN protocol, Working principle of CAN communication.

Reference Books

- 1 Automotive Computers and Control System , Tom Weather Jr and Cland C. Hunter, 1998, Prentice Hall Inc., New Jersey .
- 2 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems, Rahul Kala , 2016, Butterworth-Heinemann.
- 3 Autonomous Vehicles Volume 1: Using Machine Intelligence, Romil Rawat , 2022, Wiley .
- 4 Understanding Automotive Electronics: An Engineering Perspective , William Ribbens , 2017, Butterworth-Heinemann.

23RAN3203A - ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3203A	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	RMWR	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the various contacts elements required for robots manipulator	2	PO1, PO2, PSO1
CO2	Analyze the concept of forces friction to find out the performance of the manipulator	4	PO1, PO2, PSO1
CO3	Apply the basic concepts used to check the performance of mobile robots	3	PO1, PO3, PSO1
CO4	Apply the concept of feedback control and odometry for Mobile robots	3	PO1, PO2, PSO1
CO5	Analyze the principles underlying advanced control techniques for wheeled mobile robots	4	PO1, PO2, PSO1

Syllabus

Grasping Contact Kinematics First-Order analysis of a Single contact, contact types Rolling, Sliding, and Breaking free, Multiple contacts, Collection of Bodies, Other types of contacts.

Manipulation Planar Graphical Methods, Form Closure. Contact Forces and Friction Friction, planar graphical methods, force closure, Duality of force and motion freedoms, manipulation

Wheeled mobile robots come in various types, including differential drive, tricycle, car-like, omnidirectional, and Ackermann steering robots. Unique capabilities of omnidirectional robots, modeling and simulation, motion planning algorithms, feedback control systems, and handling nonholonomic constraints.

Modeling, controllability, motion planning, and feedback control of odometry for wheeled mobile robots, as well as mobile manipulation involving robotic arms integrated with mobile platforms for complex task execution.

Advanced control techniques tailored for wheeled mobile robots, including Model Predictive Control (MPC), adaptive control methods, and reinforcement learning for autonomous navigation. Participants will engage in theoretical discussions and practical exercises aimed at mastering these methodologies, empowering them to optimize robot trajectories, handle uncertainties, and enable autonomous decision-making in diverse operational environments.

Reference Books

- 1 Introduction to Autonomous Mobile Robots, R. Siegwart, I. R. Nourbakhsh, 2, 2011, The MIT Press.
- 2 Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Peter Corke, 2, 2017, Springer.
- 3 Planning Algorithms, S. M. LaValle, 1, 2006, Cambridge University Press.
- 4 Probabilistic Robotics, Thrun, S., Burgard, W., and Fox, D, 1, 2005, Cambridge University Press.
- 5 Principles of Robot Motion Theory, Algorithms and Implementations, H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, 4, 2005, PHI.

23RAN3203E - ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3203E	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	RMWR	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the various contacts elements required for robots manipulator	2	PO1, PO2, PSO1
CO2	Analyze the concept of forces friction to find out the performance of the manipulator	4	PO1, PO2, PSO1
CO3	Apply the basic concepts used to check the performance of mobile robots	3	PO1, PO3, PSO1
CO4	Apply the concept of feedback control and odometry for Mobile robots	3	PO1, PO2, PSO1
CO5	Analyze the principles underlying advanced control techniques for wheeled mobile robots	4	PO1, PO2, PSO1

Syllabus

Grasping Contact Kinematics First-Order analysis of a Single contact, contact types Rolling, Sliding, and Breaking free, Multiple contacts, Collection of Bodies, Other types of contacts.

Manipulation Planar Graphical Methods, Form Closure. Contact Forces and Friction Friction, planar graphical methods, force closure, Duality of force and motion freedoms, manipulation

Wheeled mobile robots come in various types, including differential drive, tricycle, car-like, omnidirectional, and Ackermann steering robots. Unique capabilities of omnidirectional robots, modeling and simulation, motion planning algorithms, feedback control systems, and handling nonholonomic constraints.

Modeling, controllability, motion planning, and feedback control of odometry for wheeled mobile robots, as well as mobile manipulation involving robotic arms integrated with mobile platforms for complex task execution.

Advanced control techniques tailored for wheeled mobile robots, including Model Predictive Control (MPC), adaptive control methods, and reinforcement learning for autonomous navigation. Participants will engage in theoretical discussions and practical exercises aimed at mastering these methodologies, empowering them to optimize robot trajectories, handle uncertainties, and enable autonomous decision-making in diverse operational environments.

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- 3 Planning Algorithms, S. M. LaValle, 1, 2006, Cambridge University Press.
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- 5 Principles of Robot Motion Theory, Algorithms and Implementations, H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, 4, 2005, PHI.

23RAN3203R - ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3203R	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	RMWR	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the various contacts elements required for robots manipulator	2	PO1, PO2, PSO1
CO2	Analyze the concept of forces friction to find out the performance of the manipulator	4	PO1, PO2, PSO1
CO3	Apply the basic concepts used to check the performance of mobile robots	3	PO1, PO3, PSO1
CO4	Apply the concept of feedback control and odometry for Mobile robots	3	PO1, PO2, PSO1

Syllabus

Grasping Contact Kinematics First-Order analysis of a Single contact, contact types Rolling, Sliding, and Breaking free, Multiple contacts, Collection of Bodies, Other types of contacts.

Manipulation Planar Graphical Methods, Form Closure. Contact Forces and Friction Friction, planar graphical methods, force closure, Duality of force and motion freedoms, manipulation

Wheeled mobile robots come in various types, including differential drive, tricycle, car-like, omnidirectional, and Ackermann steering robots. Unique capabilities of omnidirectional robots, modeling and simulation, motion planning algorithms, feedback control systems, and handling nonholonomic constraints.

Modeling, controllability, motion planning, and feedback control of odometry for wheeled mobile robots, as well as mobile manipulation involving robotic arms integrated with mobile platforms for complex task execution.

Reference Books

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- 2 Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Peter Corke, 2, 2017, Springer.
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23RAN3304A - ADVANCED ROBOTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3304A	ADVANCED ROBOTICS	AR	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the control techniques for path planning. in flat, rough, hill, slope, sand and gravel terrains	3	PO1, PO2, PSO1
CO2	Apply the basics of DH parameters for developing the models of Advanced Robotic Manipulator	3	PO1, PO2, PSO1
CO3	Apply the functional and critical operational Robotics methods for preparing advanced level of Robotics.	3	PO1, PO2, PSO1
CO4	Analyze the concepts of Advanced Robotics Systems and Real-time environment for various applications.	4	PO2, PO3, PSO1
CO5	Analyze the fetch and frieght robots with various co-ordinate frames and joint angles in an constrained environments	4	PO3, PSO1
CO6	Analyze the kinematics and dynamics requirements using VREP robotic simulation tool	4	PO3, PO5, PSO1
CO7	Analyze the construction and various parameters of a robot using the Studica Robotic System kit	4	PO2, PO5, PSO1

Syllabus

Introduction to Robotic Systems: Introduction to Robotic Operating System (ROS), Degrees of Freedom (DoF), Six Degrees of Freedom (6DOF), Mobility formula, Three Laws of Robotics; Asimovs Laws (AL), Robotics Foundation: Dynamic Stabilization (DS), Advanced Robotics Sensors (ARS), Power Sources (PS), Force Control(FC), Ring LASER, Application of Gyro Sensor (GS), Inertial Navigation (IN), Terrain a Mapping (TaM), Direct and inverse kinematics problems, Motions and dimensions; Robotics Components.

Advanced Robotic Manipulator & Actuator (ARM & ARS): Industrial Robot Manipulator: Manipulator Structures, Kinematics of Serial and Parallel Manipulators, Velocity Analysis and Statics of Manipulators, Dynamic of Manipulators, Trajectory Planning and Generation (P&G), position and Force control of Manipulators, Modelling and Control of Flexible Manipulators, Joint Actuating System; Grippers, AR in Path Planning Algorithm, Hill-Climbing, Design Consideration Macrobiotics.

Varieties of Robots & Advanced Robotics Heterogeneity (ARH): Design Studies (Modelling and analysis) on Boston Dynamics Products: Cheetah, Atlas, Spot Mini, Legged Robots, Wheeled Robots, Tele robots, Service Robots; Design considerations on Large Robots, Miniature Robot (Swarm robotics), Auto-bots, bipeds, KUKA Collaborative Robot Series, autonomous Underwater Vehicle, Unmanned Aerial Vehicle; Reactor Pressure Vessel (RPV) Measuring Robots.

Case Studies (Applications of Advanced Robotic Systems): Robot Assembling: Assembly of robots using Lego, Vex and Tetrix Kits Five minute bot, Wall following robot; Coordinated Multi-Robot Exploration; Mapping and Localization in Non Static Environments. Programming: Programming of robots using NXT software, Robot C and python programming advanced path planning robots. Case Study of Multiple Robots, medical robots: image guided surgical robots, radiotherapy, painting robots and cancer treatment, Industrial, Home, Defence Applications.

Collaborative and Adversarial Learning: A Case Study in Robotic Soccer, Fetch and Freight Robots, service robots, Multi-Agent Reinforcement Learning (MARL), Human-Robot Collaboration, Adversarial Learning Algorithms, Adversarial Reinforcement Learning

Reference Books

- 1 Industrial Robotics Technology, Programming and Applications , M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey, 2017,1st Edition, McGraw Hill Education.

- 2 Robotics-Fundamental Concepts and Analysis, Ashitava Ghoshal, 2006,1st Edition, Oxford University Press.
- 3 Automation, Production Systems, and computer integrated Manufacturing, Mikell P Groover, 2016,1st Edition, Prentice Hall.
- 4 Digital Image Processing, Gonzalez and Woods, 2017.1st Edition, Pearson.
- 5 Automation and Robotics, Khushdeep Goyal, 2013, 2nd Edition, S.K. Kataria & Sons.

23RAN3304E - ADVANCED ROBOTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3304E	ADVANCED ROBOTICS	AR	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the control techniques for path planning. in flat, rough, hill, slope, sand and gravel terrains	3	PO1, PO2, PSO1
CO2	Apply the basics of DH parameters for developing the models of Advanced Robotic Manipulator.	3	PO1, PO2, PSO1
CO3	Apply the functional and critical operational Robotics methods for preparing advanced level of Robotics	3	PO1, PO2, PSO1
CO4	Analyze the concepts of Advanced Robotics Systems and Real-time environment for various applications	4	PO2, PO3, PSO1
CO5	Analyze the fetch and frieght robots with various co-ordinate frames and joint angles in an constrained environments	4	PO3, PSO1
CO6	Analyze the kinematics and dynamics requirements using VREP robotic simulation tool	4	PO3, PO5, PSO1
CO7	Analyze the various parameters of a different robot construction using the Studica Robotic System kit	4	PO2, PO5, PSO1

Syllabus

Introduction to Robotic Systems: Introduction to Robotic Operating System (ROS), Degrees of Freedom (DoF), Six Degrees of Freedom (6DOF), Mobility formula, Three Laws of Robotics; Asimovs Laws (AL), Robotics Foundation: Dynamic Stabilization (DS), Advanced Robotics Sensors (ARS), Power Sources (PS), Force Control(FC), Ring LASER, Application of Gyro Sensor (GS), Inertial Navigation (IN), Terrain a Mapping (TaM), Direct and inverse kinematics problems, Motions and dimensions; Robotics Components.

Advanced Robotic Manipulator & Actuator (ARM & ARS): Industrial Robot Manipulator: Manipulator Structures, Kinematics of Serial and Parallel Manipulators, Velocity Analysis and Statics of Manipulators, Dynamic of Manipulators, Trajectory Planning and Generation (P&G), position and Force control of Manipulators, Modelling and Control of Flexible Manipulators, Joint Actuating System; Grippers, AR in Path Planning Algorithm, Hill-Climbing, Design Consideration Macrobiotics

Varieties of Robots & Advanced Robotics Heterogeneity (ARH): Design Studies (Modelling and analysis) on Boston Dynamics Products: Cheetah, Atlas, Spot Mini, Legged Robots, Wheeled Robots, Tele robots, Service Robots; Design considerations on Large Robots, Miniature Robot (Swarm robotics), Auto-bots, bipeds, KUKA Collaborative Robot Series, autonomous Underwater Vehicle, Unmanned Aerial Vehicle; Reactor Pressure Vessel (RPV) Measuring Robots.

Case Studies (Applications of Advanced Robotic Systems): Robot Assembling: Assembly of robots using Lego, Vex and Tetrix Kits Five minute bot, Wall following robot; Coordinated Multi-Robot Exploration; Mapping and Localization in Non Static Environments. Programming: Programming of robots using NXT software, Robot C and python programming advanced path planning robots. Case Study of Multiple Robots, medical robots: image guided surgical robots, radiotherapy, painting robots and cancer treatment, Industrial, Home, Defence Applications.

Collaborative and Adversarial Learning: A Case Study in Robotic Soccer, Fetch and Freight Robots, service robots, Multi-Agent Reinforcement Learning (MARL), Human-Robot Collaboration, Adversarial Learning Algorithms, Adversarial Reinforcement Learning

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- 1 Industrial Robotics Technology, Programming and Applications , M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey, 2017, 1st Edition, McGraw Hill Education.

- 2 Robotics-Fundamental Concepts and Analysis, Ashitava Ghoshal, 2006,1st Edition, Oxford University Press.
- 3 Automation, Production Systems, and computer integrated Manufacturing, Mikell P Groover, 2016, 1st Edition, Prentice Hall.
- 4 Digital Image Processing, Gonzalez and Woods, 2017,1st Edition, Pearson.
- 5 Automation and Robotics, Khushdeep Goyal, 2013, 2nd Edition, S.K. Kataria & Sons.

23RAN3304R - ADVANCED ROBOTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3304R	ADVANCED ROBOTICS	AR	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the control techniques for path planning. in flat, rough, hill, slope, sand and gravel terrains	3	PO1, PO2, PSO1
CO2	Apply the basics of DH parameters for developing the models of Advanced Robotic Manipulator	3	PO1, PO2, PSO1
CO3	Apply the functional and critical operational Robotics methods for preparing advanced level of Robotics.	3	PO1, PO2, PSO1
CO4	Analyze the concepts of Advanced Robotics Systems and Real-time environment for various applications.	4	PO2, PO3, PSO1
CO5	Analyze the fetch and frieght robots with various co-ordinate frames and joint angles in an constrained environments	4	PO3, PSO1
CO6	Analyze the kinematics and dynamics requirements using VREP robotic simulation tool	4	PO3, PO5, PSO1

Syllabus

Introduction to Robotic Systems: Introduction to Robotic Operating System (ROS), Degrees of Freedom (DoF), Six Degrees of Freedom (6DOF), Mobility formula, Three Laws of Robotics; Asimov Laws (AL), Robotics Foundation: Dynamic Stabilization (DS), Advanced Robotics Sensors (ARS), Power Sources (PS), Force Control(FC), Ring LASER, Application of Gyro Sensor (GS), Inertial Navigation (IN), Terrain a Mapping (TaM), Direct and inverse kinematics problems, Motions and dimensions; Robotics Components.

Advanced Robotic Manipulator & Actuator (ARM & ARS): Industrial Robot Manipulator: Manipulator Structures, Kinematics of Serial and Parallel Manipulators, Velocity Analysis and Statics of Manipulators, Dynamic of Manipulators, Trajectory Planning and Generation (P&G), position and Force control of Manipulators, Modelling and Control of Flexible Manipulators, Joint Actuating System; Grippers, AR in Path Planning Algorithm, Hill-Climbing, Design Consideration Macrobotics.

Varieties of Robots & Advanced Robotics Heterogeneity (ARH): Design Studies (Modelling and analysis) on Boston Dynamics Products: Cheetah, Atlas, Spot Mini, Legged Robots, Wheeled Robots, Tele robots, Service Robots; Design considerations on Large Robots, Miniature Robot (Swarm robotics), Auto-bots, bipeds, KUKA Collaborative Robot Series, autonomous Underwater Vehicle, Unmanned Aerial Vehicle; Reactor Pressure Vessel (RPV) Measuring Robots.

Case Studies (Applications of Advanced Robotic Systems): Robot Assembling: Assembly of robots using Lego, Vex and Tetrix Kits Five minute bot, Wall following robot; Coordinated Multi-Robot Exploration; Mapping and Localization in Non Static Environments. Programming: Programming of robots using NXT software, Robot C and python programming advanced path planning robots. Case Study of Multiple Robots, medical robots: image guided surgical robots, radiotherapy, painting robots and cancer treatment, Industrial, Home, Defence Applications.

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- 1 Industrial Robotics Technology, Programming and Applications , M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey, 2017, 1st Edition, McGraw Hill Education.
- 2 Robotics-Fundamental Concepts and Analysis, Ashitava Ghoshal, 2006, 1st Edition, Oxford University Press.
- 3 Automation, Production Systems, and computer integrated Manufacturing, Mikell P Groover, 2016, 1st Edition, Prentice Hall.
- 4 Digital Image Processing, Gonzalez and Woods, 2017, 1st Edition, Pearson.

- 5 Automation and Robotics, Khushdeep Goyal, 2013, 2nd Edition, S.K. Kataria & Sons.

23RAN3405M - ARTIFICIAL INTELLIGENCE FOR ROBOTICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3405M	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	AIR	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Fundamentals of Artificial Intelligence, Applications and need of AI in robotics	2	PO1, PO2, PSO1
CO2	Applying various AI search techniques to solve real world problems	3	PO1, PO2, PSO1
CO3	Apply principles of AI in solutions that require process, planning and Reasoning	3	PO1, PO2, PSO1
CO4	Apply various forms of learning and knowledge representation techniques for communication, perceiving and acting for robots.	3	PO1, PO2, PSO1

Syllabus

Introduction to Artificial intelligence, History, features of Artificial intelligence, Need for Artificial intelligence in Robotics, Thinking and acting humanly, Intelligent agents, structure of agents.

Problem Solving Solving problems by searching Informed search and exploration, Constraint satisfaction problem Adversarial search, Knowledge and reasoning Knowledge representation First order logic and semantic nets and frames

Planning Planning with forward and backward State space search Partial order planning Planning graphs Planning with propositional logic Planning and acting in real world. Reasoning Uncertainty Probabilistic reasoning Filtering and prediction Hidden Markov models Kalman Filters Dynamic Bayesian Networks, Speech Recognition, Making Decisions.

Learning Forms of learning Knowledge in Learning Statistical learning methods reinforcement learning, communication, perceiving and acting, Probabilistic language processing, perception.

Reference Books

- 1 Artificial Intelligence: A modern approach, Stuart Russell, Peter Norvig, 3, 2010, Pearson Education.
- 2 Artificial Intelligence: A guide to Intelligent Systems, Negnevitsky, M, 1, 2011, Harlow: Addison-Wesley.
- 3 Artificial Intelligence: Robotics and Machine Evolution, David Jefferis, 1, 1999, Crabtree Publishing Company.
- 4 Artificial Intelligence for Robotics, Francis X. Govers, 1, 2018, Packt Publishing.
- 5 Robot Programming: A Practical Guide to Behaviour-Based Robotics, Joe Jones, Daniel Roth, and Tucker Balch, 1, 2004, McGraw Hill.

23RAN3406M - HUMAN MACHINE INTERFACE & BRAIN MACHINE INTERFACE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3406M	HUMAN MACHINE INTERFACE & BRAIN MACHINE INTERFACE	HMIBMI	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Normans model to HMI	3	PO1, PO2
CO2	Apply different GOMS models, Fitts Laws for improving the Human Machine Interaction	3	PO1, PO4
CO3	Apply the concepts of Brainwaves for Brain Machine Interface	3	PO1, PO2
CO4	Analyze different methodologies for HMI/BMI Applications	4	PO1, PO3
CO5	Analysis of EEG Signal with BCI application	4	PO6, PO7, PSO1

Syllabus

Introduction, history and relation to Ergonomics and Human Factors Problema and challenges, Recurrent HMI themes, Concept of usability- definition and elaboration, Human Machine Interface and software engineering, GUI design and aesthetics, Prototyping techniques, Guidelines in HMI- Norman\'s model of interaction

Fitts laws, Hick-Hyman laws, Norman\'s 7 Principles. Design rules authority vs Generality Principles, Introduction to different types of models, GOMS family of models, KLM and CMN-GOMS, Guidelines in HMI- Norman\'s model of inetraction, Heuristic evaluation, contextual inquiry, cognitive walkthrough

Alpha, Beta, Theta, Gamma wave, Brain-Control interface, ARMA model, Introduction to Brain Control Interface Fundamentals of BCI Brain signal acquisition, Experiment design and data analysis (with explanation of one-way ANOVA), ARMA model

Hierarchical Task Analysis, Dialog Design, Use of FSM, Task modelling and analysis through Hierarchical Task Analysis (HTA), Dialog Design, Applications of HMI/BMIs- rovar, robotic camera, environmental control

Case studies of BCIs based on multi-neuronal activity, electrocorticography (ECoG), and electroencephalography (EEG) as well as BCI applications, pervasive computing, CSCW, virtual reality, tangible user interface, multimedia

Reference Books

- 1 Human-Machine Interface: Concepts and Design Principles , Sridharan Devarajan and S. Srinivasan , 2nd , Tata McGraw-Hill Education.
- 2 Brain-Computer Interfaces: Principles and Practice , Rajesh P. N. Rao , 1st , Oxford University Press.
- 3 Brain Computer Interfaces: Principles and practice, Jonathan Wolpaw,Elizabeth Winter Wolpaw, 1st, Oxford University Press, USA.
- 4 Human Computer Interaction, Dix A., Finlay J., Abowd G. D. , 1st, Pearson Education.

23RAN3507 - COMPUTER VISION & APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RAN3507	COMPUTER VISION & APPLICATIONS	CVA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamentals of image processing algorithms and thereby facilitating better interpretation and analysis of visual data.	3	PO1, PSO1
CO2	Apply deep network methods and techniques for image classification to discern complex patterns and variations in the image data.	3	PO2, PSO1
CO3	Apply autoencoders for image segmentation and measure performance metrics of various algorithms.	3	PO1, PSO1
CO4	Develop an appreciation for various issues in the design of computer vision and object recognition systems with analysis.	4	PO2, PO4, PSO1

Syllabus

Image Fundamentals: Introduction to Image Formation, Capture, and Representation; Image Enhancement: Linear Filtering, Features: Edge, Blobs, Corner Detection. Space and Scale Selection, HoG, LBP, Image/Deconvolution Methods; Image segmentation: thresholding and region-based segmentation, gray and color images.

CNN-based Image Classification: Building an image dataset from scratch: Horses Vs Humans, Rock Scissors paper, MS COCO, open Images, and Flowers dataset. Build a CNN model for image classification: LeNet-5, VGG, and ResNet. Training, testing, and Inferencing. Performance measurement. Visualization and Understanding CNNs: Visualization of Kernels, layer features, and calculating computational complexity of models.

Autoencoders for Image Segmentation and Generation: U-Net, Seg Net, and Mask R-CNN Model architecture, Image annotations, and ground truth modeling. Training and testing the U-Net model. Performance evaluation metrics: Pixel Accuracy, mIoU, and Dice scores. Deep Generative Models: Generative adversarial networks(GANs), Variational Autoencoders (VAEs), architecture, Training, and testing.

Applications: Siamese Network face recognition, Yolo object detection model, Image captioning models, Image super-resolution, Visual QA, Visual Dialog. Attention-based CNN models: Visual transformers. Realize using TensorFlow or PyTorch.

Reference Books

- 1 Computer Vision in Robotics and Industrial Applications, Dominik Sankowski, Jacek Nowakowski, 2014, World Scientific Publishers.
- 2 Deep Learning for Vision Systems, Mohamed Elgendy, 2020, Manning Publications.
- 3 Deep Learning In Computer Vision, Mahmoud Hassaballah and Ali Ismail Awad, 2022, Taylor & Francis/CRC Press.
- 4 Computer Vision: Algorithms and Applications (Second Edition), Richard Szeliski, 2022, Springer.

23RFM3101A - MICROWAVE ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3101A	MICROWAVE ENGINEERING	ME	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the high frequency parameter analysis for Microwave Components to study the behavior of Microwave passive components.	3	PO1, PSO1
CO2	Apply the concept of Microwave Active components and Microwave tubes.	3	PO1, PSO1
CO3	Analyze the solid state device concept and microwave oscillators.	4	PO2, PSO1
CO4	Analyze the measurement techniques for Microwave solid state devices.	4	PO2, PSO1
CO5	Analyze the advanced microwave equipment and its S Parameters.	4	PO2, PSO1
CO6	Analyze and design the applications of microwave active and passive components using hardware.	4	PO2, PO3, PO5, PSO1
CO7	Analyze and design the applications of microwave active and passive components using EM tools.	5	PO2, PO3, PO5, PSO1

Syllabus

Passive microwave devices: Scattering matrix, Passive microwave devices: Microwave hybrid circuits, Terminations, Attenuators, Directional couplers: Two-hole directional couplers, S- Matrix of a directional coupler, Hybrid couplers, Isolators.

Microwave tubes: Microwave tubes: Limitations of conventional active devices at microwave frequency, two cavity Klystron, Reflex Klystron, Magnetron, Traveling wave tube, Backward wave oscillators.

Solid state amplifiers and oscillators: Transferred electron devices, Gunn-effect diodes and modes of operation. Avalanche transit time devices, IMPATT diode, TRAPPAT diode, Pin diode.

Microwave Measurements: Microwave power measurement, Insertion loss and attenuation measurement, Return loss measurement by a reflectometer, VSWR measurement, Frequency measurement, measurement of cavity Q, EM radiation & measurement.

Advanced Microwave Equipment: Spectrum analyzer, Network analyzer, Tunable detector, Slotted line carriage.

Reference Books

- 1 Microwave Engineering, G. S. Raghuvanshi, 2011, Cengage.
- 2 Microwave Devices & Circuits, S.Y. Liao, 2003, PHI.
- 3 Microwave Engineering, A Das and S.K. Das, 2003, McGraw Hill Education.
- 4 Introduction to Radar Engineering , M.I. Skolnik, 2002, TMH.
- 5 Microwave Engineering and Applications, Om P. Gandhi, 2008, Pergamon Press.

23RFM3101E - MICROWAVE ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3101E	MICROWAVE ENGINEERING	ME	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the high frequency parameter analysis for Microwave Components to study the behavior of Microwave passive components.	3	PO1, PSO1
CO2	Apply the concept of Microwave Active components and Microwave tubes	3	PO1, PSO1
CO3	Analyze the solid state device concept and microwave oscillators	4	PO2, PSO1
CO4	Analyze the measurement techniques for Microwave solid state devices	4	PO2, PSO1
CO5	Analyze advanced microwave equipments and its S parameters	4	PO2, PSO1
CO6	Analyze and design the applications of microwave active and passive components using hardware.	4	PO2, PO3, PO5, PSO1
CO7	Analyze and design the applications of microwave active and passive components using EM tools	5	PO2, PO3, PO5, PSO1

Syllabus

Passive microwave devices: Scattering matrix, Passive microwave devices: Microwave hybrid circuits, Terminations, Attenuators, Directional couplers: Two-hole directional couplers, S Matrix of a directional coupler, Hybrid couplers, Isolators.

Microwave tubes: Microwave tubes: Limitations of conventional active devices at microwave frequency, two cavity Klystron, Reflex Klystron, Magnetron, Traveling wave tube, Backward wave oscillators.

Solid state amplifiers and oscillators: Transferred electron devices, Gunn-effect diodes and modes of operation. Avalanche transit time devices: IMPATT diode, TRAPPAT diode, Pin diode.

Microwave Measurements: Microwave power measurement, Insertion loss and attenuation measurement, Return loss measurement by a reflectometer, VSWR measurement, Frequency measurement, measurement of cavity Q, EM radiation & measurement.

Advanced Microwave Equipment: Spectrum analyzer, Network analyzer, Tunable detector, Slotted line carriage.

Reference Books

- 1 Microwave Devices & Circuits, S.Y. Liao, 2003, PHI.
- 2 Microwave Engineering, G. S. Raghuvanshi, 2011, Cengage.
- 3 Microwave Engineering, A Das and S.K. Das, 2003, McGraw Hill Education.
- 4 Microwave Engineering and Applications, Om P. Gandhi, 2008, Pergamon Press.
- 5 Introduction to Radar Engineering , M.I. Skolnik, 2002, TMH.

23RFM3101R - MICROWAVE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3101R	MICROWAVE ENGINEERING	ME	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the high frequency parameter analysis for Microwave Components to study the behavior of Microwave passive components.	3	PO1, PSO1
CO2	Apply the concept of Microwave Active components and Microwave tubes	3	PO1, PSO1
CO3	Analyze the solid state device concept and microwave oscillators	4	PO2, PSO1
CO4	Analyze the measurement techniques for Microwave solid state devices.	4	PO2, PSO1
CO6	Analyze and design the applications of microwave active and passive components using hardware	4	PO2, PSO1
CO7	Analyze and design the applications of microwave active and passive components using EM tools	4	PO2, PSO1

Syllabus

Passive microwave devices: Scattering matrix, Passive microwave devices: Microwave hybrid circuits, Terminations, Attenuators, Directional couplers: Two-hole directional couplers, S- Matrix of a directional coupler, Hybrid couplers, Isolators.

Microwave tubes: Microwave tubes: Limitations of conventional active devices at microwave frequency, two cavity Klystron, Reflex Klystron, Magnetron, Traveling wave tube, Backward wave oscillators.

Solid state amplifiers and oscillators: Transferred electron devices, Gunn-effect diodes and modes of operation. Avalanche transit time devices: IMPATT diode, TRAPPAT diode, Pin diode.

Microwave Measurements: Microwave power measurement, Insertion loss and attenuation measurement, Return loss measurement by a reflectometer, VSWR measurement, Frequency measurement, measurement of cavity Q, EM radiation & measurement.

Reference Books

- 1 Microwave Engineering, A Das and S.K. Das, 2003, McGraw Hill Education.
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- 4 Microwave Engineering and Applications, Om P. Gandhi, 2008, Pergamon Press.
- 5 Introduction to Radar Engineering , M.I. Skolnik, 2002, TMH.

23RFM3202A - ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3202A	ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS	AADWA	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Intreprete Antenna design for wireless and 5G Applications	3	PO1, PSO1, PSO2
CO2	Understand and intreprete the basic Concepts for 5G FR1 Single Band and Multi-Band Mobile Antenna Design	3	PO1, PSO1, PSO2
CO3	Apply the concept of the different MIMO-Based 5G FR1 Band Mobile Antennas for 5G and Wireless Apllication	3	PO1, PSO1, PSO2
CO4	Analyze the different Antenna-in-Package for 5G and Mobile Antennas	4	PO2, PSO1, PSO2
CO5	Design of different patch antennas using EM tools and verify the characteristics	5	PO3, PO5, PSO1, PSO2

Syllabus

Frequency Characteristics and Channel Models, 5G Network Architecture, Evolution of Mobile Devices, Antenna Materials for 5G smart phone.

Smartphone Components and Their Effects, Antenna Element Design and Topologies, Slot Antenna Design, Monopole Antenna Design, Loop Antenna, Inverted-F Antenna, Planar Antenna Design Topologies, Hybrid Antenna Design Topologies.

Motivation and Requirements, Channel Capacity, Envelope Correlation Coefficient, Diversity Gain, Mean Effective Gain, Total Active Reflection Coefficient, Channel Capacity Loss, Antenna Isolation Techniques, Spatial and Polarization Diversity.

Miniaturized Antenna-in-Package Technology, Background and Challenges, Planar Folded Slot Antenna with Electrically Small and Low Profile, Low-Loss Interconnect Technology, Flip-Chip-Based Packaging of mmWave AiP, Multi-Modal AiP Technology, Block Cell Antennas, Modular, Controllable Block Cell Arrays.

Channels in 5G NR Physical Layer Data Channels in 5G NR Downlink Physical Channel and Uplink Physical Channels - Propagation Channel models for 5G ,Device-to-Device (D2D) Communication - 5G for Massive Machine Type Communication and Massive IoT- V2X Communication - Full Duplex and Green Communication -mmWave Communications Massive MIMO and Beamforming Techniques

Reference Books

- 1 Microwave and Millimeter-wave Antenna Design for 5G Smartphone Applications , Wonbin Hong,?Chow-Yen Desmond Sim , 2022, Wiley-IEEE Press.
- 2 MIMO Antennas for Wireless Communication: Theory and design , L malviya, RK Panigrahi, MV Kartikeya , 2022, CRC Press.
- 3 Antennas: From Theory to Practice, Yi Huang, 2021, Wiley.
- 4 Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, 2015 1st edition, Wiley.

23RFM3202E - ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3202E	ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS	AADWA	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Intreprete Antenna design for wireless and 5G Applications	3	PO1, PSO1, PSO2
CO2	Understand and intreprete the basic Concepts for 5G FR1 Single Band and Multi-Band Mobile Antenna Design	3	PO1, PSO1, PSO2
CO3	Apply the concept of the different MIMO-Based 5G FR1 Band Mobile Antennas for 5G and Wireless Apllication	3	PO1, PSO1, PSO2
CO4	Analyze the different Antenna-in-Package for 5G and Mobile Antennas	4	PO2, PSO1, PSO2
CO5	Design of different patch antennas using EM tools and verify the characteristics	5	PO3, PO5, PSO1, PSO2

Syllabus

Frequency Characteristics and Channel Models, 5G Network Architecture, Evolution of Mobile Devices, Antenna Materials for 5G smart phone.

Smartphone Components and Their Effects, Antenna Element Design and Topologies, Slot Antenna Design, Monopole Antenna Design, Loop Antenna, Inverted-F Antenna, Planar Antenna Design Topologies, Hybrid Antenna Design Topologies.

Motivation and Requirements, Channel Capacity, Envelope Correlation Coefficient, Diversity Gain, Mean Effective Gain, Total Active Reflection Coefficient, Channel Capacity Loss, Antenna Isolation Techniques, Spatial and Polarization Diversity.

Miniaturized Antenna-in-Package Technology, Background and Challenges, Planar Folded Slot Antenna with Electrically Small and Low Profile, Low-Loss Interconnect Technology, Flip-Chip-Based Packaging of mmWave AiP, Multi-Modal AiP Technology, Block Cell Antennas, Modular, Controllable Block Cell Arrays.

Channels in 5G NR Physical Layer Data Channels in 5G NR Downlink Physical Channel and Uplink Physical Channels
Propagation Channel models for 5G ,Device-to-Device (D2D) Communication - 5G for Massive Machine Type Communication and Massive IoT- V2X Communication - Full Duplex and Green Communication -mmWave Communications Massive MIMO and Beamforming Techniques

Reference Books

- 1 Microwave and Millimeter-wave Antenna Design for 5G Smartphone Applications , Wonbin Hong,?Chow-Yen Desmond Sim , 2022, Wiley-IEEE Press.
- 2 MIMO Antennas for Wireless Communication: Theory and design , L malviya, RK Panigrahi, MV Kartikeya , 2022, CRC Press.
- 3 Antennas: From Theory to Practice, Yi Huang, 2021, Wiley.
- 4 Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, 2015 1st edition, Wiley.

23RFM3202R - ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3202R	ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS	AADWA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Intreprete Antenna design for wireless and 5G Applications	3	PO1, PSO1, PSO2
CO2	Understand and intreprete the basic Concepts for 5G FR1 Single Band and Multi-Band Mobile Antenna Design	3	PO1, PSO1, PSO2
CO3	Apply the concept of the different MIMO-Based 5G FR1 Band Mobile Antennas for 5G and Wireless Apllication	3	PO1, PSO1, PSO2
CO4	Analyze the different Antenna-in-Package for 5G and Mobile Antennas	4	PO2, PSO1, PSO2
CO5	Design of different patch antennas using EM tools and verify the characteristics	5	PO3, PO5, PSO1, PSO2

Syllabus

Physical concept of radiation, Radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions, Frequency Characteristics and Channel Models, 5G Network Architecture, Evolution of Mobile Devices, Antenna Materials for 5G smart phone.

Smartphone Components and Their Effects, Antenna Element Design and Topologies, Slot Antenna Design, Monopole Antenna Design, Loop Antenna, Inverted-F Antenna, Planar Antenna Design Topologies, Hybrid Antenna Design Topologies.

Motivation and Requirements, Channel Capacity, Envelope Correlation Coefficient, Diversity Gain, Mean Effective Gain, Total Active Reflection Coefficient, Channel Capacity Loss, Antenna Isolation Techniques, Spatial and Polarization Diversity.

Miniaturized Antenna-in-Package Technology, Background and Challenges, Planar Folded Slot Antenna with Electrically Small and Low Profile, Low-Loss Interconnect Technology, Flip-Chip-Based Packaging of mmWave AiP, Multi-Modal AiP Technology, Block Cell Antennas, Modular, Controllable Block Cell Arrays.

Channels in 5G NR Physical Layer Data Channels in 5G NR Downlink Physical Channel and Uplink Physical Channels Propagation Channel models for 5G ,Device-to-Device (D2D) Communication - 5G for Massive Machine Type Communication and Massive IoT- V2X Communication - Full Duplex and Green Communication -mmWave Communications Massive MIMO and Beamforming Techniques

Reference Books

- 1 Microwave and Millimeter-wave Antenna Design for 5G Smartphone Applications , Wonbin Hong,?Chow-Yen Desmond Sim , 2022, Wiley-IEEE Press.
- 2 MIMO Antennas for Wireless Communication: Theory and design , L malviya, RK Panigrahi, MV Kartikeya , 2022, CRC Press.
- 3 Antennas: From Theory to Practice, Yi Huang, 2021, Wiley.
- 4 Fundamentals of 5G Mobile Networks, Jonathan Rodrigue, 2015, Wiley.

23RFM3303A - MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3303A	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	MRSNA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the principles of operation and design of radar systems	3	PO1, PO3, PSO1
CO2	Apply the target-based concept to various types of Radars for Air Traffic Control applications.	3	PO1, PO3, PSO1
CO3	Analyse the principles of various Radar tracking systems used in different applications	4	PO1, PO3, PSO1
CO4	Analyse the concepts related to different tracking systems and sensors for navigation.	4	PO1, PO5, PSO1
CO5	Analyse the principles of various Radars systems used in different applications	4	, PSO2
CO6	Apply and analyse the various automotive concepts to design the Modern RADAR system	4	
CO7	Apply the various adaptive techniques and automotive concepts to design the Modern RADAR system.	4	

Syllabus

Basics of Radar system, Transmitters and Receivers: Basic Radar, Block Diagram of Pulse Radar, Radar equation Detection of signals in noise, Receiver noise and signal to noise ratio, integration of Radar pulses, PRF and Range Ambiguities, Doppler Effect, FM CW Radar, Altimeter, Radome. Duplexers and Receiver Protectors, Radar Displays.

MTI Radar: Introduction, Delay line cancellers, Clutter Attenuation, MTI improvement factor, N-pulse delay line canceller, non-recursive and Recursive filters.

Tracking: Sequential Lobing Radar, Conical Scan and Mono-pulse acquisition and tracking, Radars for Air Traffic Control applications.

Introduction to Navigational Aids and Various Systems: Introduction, Four Methods of Navigation Radio Ranges: LF/MF Four course Radio Range, VHF Omni Directional Range, and VOR receiving Equipment. LORAN, DECCA navigation systems. Instrument Landing System, Ground controlled Approach System, Microwave landing system, TACAN Doppler navigation-Doppler Effect, New configuration, Doppler frequency equations, and Track stabilization.

Radar Applications: SAR, LIDAR, OTH radar, Remote sensing radar, Airport surveillance radar, Weather / Meteorological radar, Ground penetration radar, Through-wall radar, Automobile radar.

Reference Books

- 1 INTRODUCTION TO RADAR SYSTEMS, M I SKOLNIK, 2008, McGraw-Hill.
- 2 Radar Systems and Radio Aids to Navigation, A. K. Sen, A. B. Bhattacharya, 2018, Mercury Learning and Information.
- 3 Fundamentals of Radar Signal Processing, Mark A. Richards, 2022, McGraw-Hill.
- 4 Modern Radar System Analysis, David K. Barton, 1988, Artech House.

23RFM3303E - MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3303E	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	MRSNA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the principles of operation and design of radar systems	3	PO1, PO3, PSO1
CO2	Apply the target-based concept to various types of Radars for Air Traffic Control applications.	3	PO1, PO3, PSO1
CO3	Analyse the principles of various Radar tracking systems used in different applications	4	PO1, PO3, PSO1
CO4	Analyse the concepts related to different tracking systems and sensors for navigation.	4	PO1, PO5, PSO1
CO5	Analyse the principles of various Radars systems used in different applications	4	, PSO2
CO6	Apply and analyse the various automotive concepts to design the Modern RADAR system	5	, PSO2
CO7	Apply the various adaptive techniques and automotive concepts to design the Modern RADAR system.	5	, PSO2

Syllabus

Basics of Radar system, Transmitters and Receivers: Basic Radar, Block Diagram of Pulse Radar, Radar equation Detection of signals in noise, Receiver noise and signal to noise ratio, integration of Radar pulses, PRF and Range Ambiguities, Doppler Effect, FM CW Radar, Altimeter, Radome. Duplexers and Receiver Protectors, Radar Displays.

MTI Radar: Introduction, Delay line cancellers, Clutter Attenuation, MTI improvement factor, N-pulse delay line canceller, non-recursive and Recursive filters.

Tracking: Sequential Lobing Radar, Conical Scan and Mono-pulse acquisition and tracking, Radars for Air Traffic Control applications.

Introduction to Navigational Aids and Various Systems: Introduction, Four Methods of Navigation Radio Ranges: LF/MF Four course Radio Range, VHF Omni Directional Range, and VOR receiving Equipment. LORAN, DECCA navigation systems. Instrument Landing System, Ground controlled Approach System, Microwave landing system, TACAN Doppler navigation-Doppler Effect, New configuration, Doppler frequency equations, and Track stabilization.

Radar Applications: SAR, LIDAR, OTH radar, Remote sensing radar, Airport surveillance radar, Weather / Meteorological radar, Ground penetration radar, Through-wall radar, Automobile radar.

Reference Books

- 1 INTRODUCTION TO RADAR SYSTEMS, M I SKOLNIK, 2008, McGraw-Hill.
- 2 Radar Systems and Radio Aids to Navigation, A. K. Sen, A. B. Bhattacharya, 2018, Mercury Learning and Information.
- 3 Fundamentals of Radar Signal Processing, Mark A. Richards, 2022, McGraw-Hill.
- 4 Modern Radar System Analysis, David K. Barton, 1998, Artech House.

23RFM3303R - MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3303R	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	MRSNA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the principles of operation and design of radar systems	3	PO1, PO3, PSO1
CO2	Apply the target-based concept to various types of Radars for Air Traffic Control applications.	3	PO1, PO3, PSO1
CO3	Analyse the principles of various Radar tracking systems used in different applications	4	PO1, PO3, PSO1
CO4	Analyse the concepts related to different tracking systems and sensors for navigation.	4	PO1, PO5, PSO1
CO5	Analyse the principles of various Radars systems used in different applications	4	, PSO2
CO6	Apply and analyse the various automotive concepts to design the Modern RADAR system	4	
CO7	Apply the various adaptive techniques and automotive concepts to design the Modern RADAR system.	4	

Syllabus

Basics of Radar system, Transmitters and Receivers: Basic Radar, Block Diagram of Pulse Radar, Radar equation Detection of signals in noise, Receiver noise and signal to noise ratio, integration of Radar pulses, PRF and Range Ambiguities, Doppler Effect, FM CW Radar, Altimeter, Radome. Duplexers and Receiver Protectors, Radar Displays.

MTI Radar: Introduction, Delay line cancellers, Clutter Attenuation, MTI improvement factor, N-pulse delay line canceller, non-recursive and Recursive filters.

Tracking: Sequential Lobing Radar, Conical Scan and Mono-pulse acquisition and tracking, Radars for Air Traffic Control applications.

Introduction to Navigational Aids and Various Systems: Introduction, Four Methods of Navigation Radio Ranges: LF/MF Four course Radio Range, VHF Omni Directional Range, and VOR receiving Equipment. LORAN, DECCA navigation systems. Instrument Landing System, Ground controlled Approach System, Microwave landing system, TACAN Doppler navigation-Doppler Effect, New configuration, Doppler frequency equations, and Track stabilization.

Reference Books

- 1 INTRODUCTION TO RADAR SYSTEMS, M I SKOLNIK, 2008, McGraw-Hill.
- 2 Radar Systems and Radio Aids to Navigation, A. K. Sen, A. B. Bhattacharya, 2018, Mercury Learning and Information.
- 3 Fundamentals of Radar Signal Processing, Mark A. Richards, 2022, McGraw-Hill.
- 4 Modern Radar System Analysis, David K. Barton, 1998, Artech House.

23RFM3404M - RF AND MILLIMETER-WAVE CIRCUIT DESIGN (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3404M	RF AND MILLIMETER-WAVE CIRCUIT DESIGN	RFMECD	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of Amplifier to different RF & mm-Wave transceivers	3	PO1, PSO2
CO2	Interpret the concept of Mixers design for RF & mm-Wave.	3	PO1, PO2, PSO2
CO3	Analyse the concept of Oscillators to design for RF Oscillators for mm-Wave.	4	PO2, PSO2
CO4	Analyse the concepts of RF and Millimetre-Wave circuits for various synthesizers.	4	PO2, PO3, PSO2
CO5	Analyse the concepts of RF and Millimetre-Wave circuits for various synthesizers.	4	PO2, PO3, PSO2

Syllabus

Introduction to RF and Millimeter-Wave Circuit Design: Wireless Systems history of wireless technologies, wireless system design, and RF system specifications. Concepts of transceivers path loss, interference signals, receiver sensitivity, and transmitter output power. the design specifications of low noise amplifiers (LNAs) and power amplifiers (PAs).

Design of Mixers: The working principle of RF mixers and their basic concepts, mixer types: down converters, up converters, harmonic mixers, SSB and DSB mixers, one-diode mixers and two diode mixers. Difference between active and passive mixers, advantages and drawbacks of balanced and unbalanced mixers, mixer's noise performance, design specifications of up and down-conversion mixers.

Design of Oscillators: Working principles of frequency oscillators and their basic concepts, condition to sustain an oscillation, different topologies of oscillators, tuning of the oscillators, impact of noise in the oscillator's signal, influence of output buffering and breakdown voltage on oscillators, design specifications of a Voltage Controlled Oscillator (VCO).

Design of Synthesizers: Working principles of frequency synthesizers and their basic concepts, importance of using synthesizers in modern wireless communications, the Phase-Locked Loop (PLL) types I and II, the advantages and drawbacks of using All-Digital PLL, and

RF phase locked loop: Impact of the PLL frequency synthesizer on the signal's noise performance. the architecture and usage of Fractional-N PLL frequency synthesizers, design specifications of a frequency divider and a phase detector.

Reference Books

- 1 Wireless Communication Electronics: Introduction to RF Circuits and Design Techniques , Robert Sobot, 3rd, Springer.
- 2 RF Circuits for 5G Applications: Designing with mm-Wave Circuitry, Sangeeta Singh, 3rd, Wiley.
- 3 Handbook of RF, Microwave, and Millimeter-Wave Components , Leonid A. Belov, 3rd, Artech House .
- 4 Microwave Engineering , David M Pozar, 4th, Wiley..

23RFM3505 - SATELLITE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23RFM3505	SATELLITE DESIGN	SD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	UNDERSTAND AND ANALYSE THE KEPLER'S LAW AND CONCEPTS OF SATELLITE DESIGN	3	PO1, PSO2
CO2	Analyse the subsystems and payload requirements of a satellite	3	PO1, PSO2
CO3	Understand and Analyse Structural requirements and specifications of a satellite	3	PO1, PSO2
CO4	Apply the concepts for mission planning and designing of cubesats	4	PO2, PSO2

Syllabus

Introduction and Fundamentals: Overview of satellite design and its historical background, Types of satellites and their applications, Satellite design process, Kepler's laws and orbital parameters, Basic orbital maneuvers, Orbital perturbations and their effects

Subsystems and Payload Design: Power subsystem, Communications subsystem, Attitude control subsystem, Thermal control subsystem, Payload subsystem, Types of payloads and their applications, Payload requirements and specifications, Payload design considerations, Payload performance analysis and testing

Structural Design: Launch, and Ground Segment, Structural requirements and specifications, Materials and manufacturing processes, Finite element analysis and simulation, Vibration and shock testing, Launch vehicle selection and integration, Launch and deployment procedures, Post-deployment operations and testing, Ground station design and operation, Telemetry, tracking, and command systems, Data processing and storage

Mission Planning, Space Environment, and Advanced Topics: Mission requirements and planning, Orbit maintenance and maneuver planning, Emergency procedures and contingency planning, End-of-life considerations and disposal, Space environment and its effects on spacecraft, Radiation effects and mitigation, Micrometeoroid and debris impact, Spacecraft reliability and failure modes, CubeSat and SmallSat design considerations, Emerging technologies and future trends in satellite design, Case studies of successful and failed satellite missions

Reference Books

- 1 Satellite Communications , Dennis Roddy , 4, Mc-Graw Hill.
- 2 Space Mission Analysis and Design , James R. Wertz and Wiley J. Larson, 3, Springer Netherlands.
- 3 Handbook of Space Technology , Wilfried Ley and Klaus Wittmann, 2, John Wiley & Sons.
- 4 Intelligent Satellite Design and Implementation, Jing Li, Jianjun Zhang, 1, Wiley-IEEE Press.

23SCI3101A - SPATIAL DATA VISUALIZATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3101A	SPATIAL DATA VISUALIZATION	SDV	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the spatial data, perform geospatial analysis, and create visually appealing maps.	2	PO1, PO2, PO3, PSO2
CO2	Understand the principles of cartography, color theory, and design aesthetics to effectively communicate spatial information.	3	PO1, PO2, PO3, PSO2
CO3	Will learn to integrate spatial data with interactive elements like tooltips, pop-ups, and user interactions	3	PO1, PO2, PO3, PSO2
CO4	Apply these techniques to solve real-world problems and make informed decisions based on spatial data.	3	PO1, PO2, PO3, PSO2
CO5	Analysing audience needs, and selecting appropriate visualization techniques to convey insights clearly and persuasively.	3	PO1, PO2, PO3, PSO2
CO6	Students will understand the principles of effective design for spatial data visualization, including color theory, symbology, map layout, and typography. They will learn how to apply design principles to create clear, intuitive, and aesthetically pleasing spatial visualizations that facilitate understanding and interpretation.	3	PO1, PO2, PO3, PSO2
CO7	Students will apply their knowledge and skills to real-world spatial data sets and case studies across various domains, including urban planning, environmental science, public health, and disaster management. They will analyze and visualize spatial data to address practical problems and make informed decisions.	3	PO1, PO2, PO3, PSO2

Syllabus

Explore manipulating spatial data, geospatial analysis, and creating visually engaging maps. Learn to use GIS software like ArcGIS and QGIS to import, clean, and manage datasets. Apply techniques such as spatial queries, proximity analysis, and raster analysis to solve real-world problems. Focus on cartographic principles and design aesthetics to create effective maps. By the end, students will be proficient in spatial data manipulation, geospatial analysis, and map design.

Dive into cartography, color theory, and design aesthetics for effective map communication. Learn fundamental principles like scale, symbolization, and generalization. Explore color theory and its application in map design. Create visually compelling maps with a focus on layout, typography, and visual hierarchy. Tailor map designs to audience needs and preferences.

Gain training in integrating spatial data with interactive elements to create dynamic maps. Learn to use web-based mapping libraries like Leaflet.js, Mapbox, and Google Maps API. Incorporate interactive elements to enhance user experience. Design responsive interactive map interfaces for various devices. By the end, students will create engaging interactive maps.

Apply spatial data visualization techniques to real-world problems. Study case examples from urban planning, environmental management, and public health. Identify spatial problems, collect and preprocess data, and apply geospatial analysis. Focus on interpreting analysis results and communicating findings. Explore ethical considerations and best practices for using spatial data responsibly.

Analyze audience needs and select effective visualization techniques. Understand audience analysis fundamentals, including demographics and communication preferences. Learn visualization techniques across mediums like static maps, interactive dashboards, and storytelling platforms. Test and iterate on visualizations based on feedback to enhance understanding and engagement.

Focus on effective design principles for spatial data visualization. Emphasize clear communication, visual hierarchy, and aesthetic appeal. Apply design principles to create visually compelling and informative spatial visualizations that facilitate understanding.

Reference Books

- 1 "Cartography and Visualization of Spatial Data" , Menno-Jan Kraak and Ferjan Ormeling, 4, pearson.
- 2 Making Maps: A Visual Guide to Map Design for GIS, John Krygier and Denis Wood , 5, tech.
- 3 The Big Book of Dashboards, Steve Wexler, Jeffrey Shaffer, and Andy Cotgreave, 1, Wiley.
- 4 Data Visualization with D3 and AngularJS, Christoph K?rner, 1, PACKT.

23SCI3101E - SPATIAL DATA VISUALIZATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3101E	SPATIAL DATA VISUALIZATION	SDV	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding spatial data visualization to proficiently use industry-standard GIS software. Students will select appropriate data visualization techniques, manipulate spatial datasets, and design clear, visually appealing maps and interactive visualizations to communicate complex spatial information to diverse audiences..	2	PO1, PO2, PO3, PSO1
CO2	Apply skills to leverage tools and techniques for spatial data visualization. Participants will interpret spatial data, select suitable visualization methods, and use relevant software to create compelling maps and interactive visualizations that effectively communicate spatial insights to stakeholders.	3	PO1, PO2, PO3, PSO1
CO3	Will learn to integrate spatial data with interactive elements like tooltips, pop-ups, and user interactions	3	PO1, PO2, PO3, PSO1
CO4	Apply these techniques to solve real-world problems and make informed decisions based on spatial data.	3	PO1, PO2, PO3, PSO1
CO5	Analysing audience needs, and selecting appropriate visualization techniques to convey insights clearly and persuasively.	3	PO1, PO2, PO3, PSO1
CO6	Apply the Interactive and Web-based Visualization practically	3	PO1, PO2, PO3, PSO1
CO7	Applying acquired skills and knowledge to real-world spatial data visualization challenges, fostering practical experience and skill development.	3	PO1, PO2, PO3, PSO1

Syllabus

This practical module equips participants with tools and techniques for effective spatial data visualization. Participants will learn to interpret spatial data, choose suitable visualization methods, and use relevant software to create visually compelling maps and interactive visualizations. By the end of this module, they will be able to communicate spatial patterns and insights to stakeholders across various fields.

In this skill module, students will master industry-standard GIS software for creating informative and visually appealing spatial visualizations. They will learn to select appropriate data visualization techniques, manipulate spatial datasets, and design clear maps and interactive visualizations to communicate complex spatial information to diverse audiences.

This module provides training in integrating spatial data with interactive elements to create engaging maps and visualizations. Students will start with web-based mapping libraries like Leaflet.js, Mapbox, and Google Maps API. They will learn to incorporate interactive elements such as tooltips, pop-ups, and legends, and ensure responsive design for different devices. By the end, students will be skilled in creating interactive maps that effectively communicate spatial information.

This module takes a practical approach to applying spatial data visualization techniques to solve real-world problems. Students will explore case studies in urban planning, environmental management, and public health. They will learn to identify spatial problems, collect and preprocess data, apply geospatial analysis techniques, and communicate findings to stakeholders. Ethical considerations and best practices for using spatial data responsibly will also be covered.

Module 6 Focus on effective design principles for spatial data visualization. Emphasize clear communication, visual hierarchy, and aesthetic appeal. Apply design principles to create visually compelling and informative spatial visualizations that facilitate understanding.

Reference Books

- 1 "Cartography and Visualization of Spatial Data", Menno-Jan Kraak and Ferjan Ormeling, 4, pearson.
- 2 Making Maps: A Visual Guide to Map Design for GIS, John Krygier and Denis Wood, 5, tech.
- 3 The Big Book of Dashboards, Steve Wexler, Jeffrey Shaffer, and Andy Cotgreave, 1, Wiley.
- 4 Data Visualization with D3 and AngularJS, Christoph Kerner, 1, PACKT.
- 5 Create static and interactive maps using Folium. Conduct spatial analysis and visualize results with Matplotlib., Jeffrey Shaffer, 1, Wiley.

23SCI3101R - SPATIAL DATA VISUALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3101R	SPATIAL DATA VISUALIZATION	SDV	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand spatial data, perform geospatial analysis, and create visually appealing maps.	2	PO1, PSO1
CO2	Understanding principles of cartography, color theory, and design aesthetics to effectively communicate spatial information.	3	PO2, PSO1
CO3	Analyze to integrate spatial data with interactive elements like tooltips, pop-ups, and user interactions	3	PO3, PSO1
CO4	Apply these techniques to solve real-world problems and make informed decisions based on spatial data.	3	PO4, PSO1
CO5	Students will understand the principles of effective design for spatial data visualization, including color theory, symbology, map layout, and typography. They will learn how to apply design principles to create clear, intuitive, and aesthetically pleasing spatial visualizations that facilitate understanding and interpretation.	3	PO5, PSO1
CO6	Students will apply their knowledge and skills to real-world spatial data sets and case studies across various domains, including urban planning, environmental science, public health, and disaster management. They will analyze and visualize spatial data to address practical problems and make informed decisions.	3	PO6, PSO1

Syllabus

This course offers an in-depth exploration of manipulating spatial data, conducting geospatial analysis, and creating visually engaging maps. Students will start with an introduction to Geographic Information Systems (GIS) and spatial data types, learning to import, clean, and manage spatial datasets using software like ArcGIS and QGIS. They will explore geospatial analysis techniques such as spatial queries, proximity analysis, and raster analysis. Through hands-on exercises, students will solve real-world problems in fields like urban planning, environmental science, and public health. The course emphasizes cartographic principles and design aesthetics to create effective maps. By the end, students will have valuable skills in spatial data manipulation, geospatial analysis, and map design, preparing them for careers in geography, urban planning, and related fields.

This module delves into the principles of cartography, colour theory, and design aesthetics for effective map and visualization communication. Starting with the history and evolution of cartography, students will learn fundamental principles like scale, symbolization, and generalization. The module covers colour theory in map design, including colour schemes, perception, and data classification. Through projects, students will create visually compelling maps adhering to design aesthetics, focusing on layout, typography, and visual hierarchy. By understanding target audience needs, students will tailor their map designs accordingly.

This module focuses on integrating spatial data with interactive elements to create dynamic maps and visualizations. Students will learn to use web-based mapping libraries like Leaflet.js, Mapbox, and Google Maps API. They will incorporate interactive elements such as tooltips, pop-ups, and legends to enhance user experience. Projects will teach students to design interactive map interfaces with features like pan, zoom, and filter, ensuring responsive design for different devices. By the end, students will create compelling interactive maps that effectively communicate spatial information.

This module applies spatial data visualization techniques to real-world problems for data-driven decision-making. Students will explore case studies in domains like urban planning, environmental management, and public health. They will learn to identify spatial problems, collect and preprocess data, and apply geospatial analysis techniques. Emphasis will be on interpreting analysis results and communicating findings to stakeholders. The module also covers ethical considerations and best practices for using spatial data responsibly. By the end, students will be equipped to solve real-world problems and make informed decisions using spatial data visualization.

Reference Books

- 1 "Cartography and Visualization of Spatial Data" , Menno-Jan Kraak and Ferjan Ormeling, 5, pearson.
- 2 Making Maps: A Visual Guide to Map Design for GIS , John Krygier and Denis Wood , 5 , tech.
- 3 The Big Book of Dashboards , Steve Wexler, Jeffrey Shaffer, and Andy Cotgreave , 1, Wiley.
- 4 Data Visualization with D3 and AngularJS , Christoph K?rner , 1 , PACKT.
- 5 Visualizing Data: Exploring and Explaining Data with the Processing Environment, Ben Fry, 1, O'Reilly Media.

23SCI3202A - SPATIAL COMPUTING FOR MULTIPLAYER GAMES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3202A	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	SCMG	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Spatial Concepts in Multiplayer Game	2	PO1, PO2, PO10, PSO1
CO2	Implementing Multiplayer Networking Systems	3	PO1, PO2, PO10, PSO1
CO3	Apply and Create interactive environments in multiplayer games	3	PO1, PO2, PO10, PSO1
CO4	Apply the performance and scalability of multiplayer games through efficient spatial computing	3	PO1, PO2, PO10, PSO1
CO5	analyzing spatial data generated by multiplayer games	4	PO1, PO2, PO10, PSO1

Syllabus

Overview of spatial computing concepts Importance in multiplayer games Examples from popular games, Introduction to arrays, grids, and trees Spatial indexing techniques: grid-based and quad-trees Implementation focus,, Basics in 2D and 3D environments Algorithms: bounding boxes, spheres Practical implementation

Design and implement client-server and peer-to-peer networking architectures for multiplayer games. Understand synchronization techniques for maintaining game state consistency across multiple clients and servers. Implement latency compensation strategies to ensure smooth gameplay experiences. Develop scalable and efficient networking solutions for various game genres and platforms, Basics of client-server architecture Design considerations for client-server networking in games Implementing a basic client-server networking system

create immersive and interactive environments in multiplayer games. It covers topics such as implementing environmental effects like weather and lighting, creating mechanics for object manipulation, generating dynamic terrains, and designing player interaction systems. Through hands-on projects and practical exercises, students will learn how to develop multiplayer game environments that respond dynamically to player actions, enhancing the overall gameplay experience.

optimizing the performance and scalability of multiplayer games by leveraging efficient spatial computing techniques. Students will learn how to implement spatial data structures and algorithms to enhance game performance, manage server-client interactions, and scale multiplayer systems. Through practical exercises and projects, students will develop skills in analyzing and optimizing code for performance, managing network bandwidth, and implementing strategies to support large numbers of concurrent players while maintaining smooth and responsive gameplay experiences.

to derive insights from spatial data, such as heatmaps, spatial clustering, and predictive modeling. They will gain skills in analyzing player behavior, optimizing game balance, and predicting future player actions. Additionally, students will explore the application of spatial analytics in enhancing gameplay experiences and improving overall game design.

Reference Books

- 1 Multiplayer Game Programming: Architecting Networked Games, Josh Glazer, Sanjay Madhav, first/2015, Addison-Wesley Professional.
- 2 Real-Time Collision Detection, Christer Ericson, first/2004, Morgan Kaufmann.
- 3 Interactive Computer Graphics: A Top-Down Approach with WebGL, Edward Angel, Dave Shreiner, seventh/2014, Addison-Wesley Professional.

- 4 Procedural Generation in Game Design, Tanya X. Short, Tarn Adams, first/2017, CRC Press.
- 5 Unity in Action: Multiplatform Game Development in C#, Joe Hocking, second/2015, Manning Publications.

23SCI3202E - SPATIAL COMPUTING FOR MULTIPLAYER GAMES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3202E	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	SCMG	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Spatial Concepts in Multiplayer Game	2	PO1, PO4, PO8, PSO1
CO2	Implementing Multiplayer Networking Systems	3	PO1, PO4, PO8, PSO1
CO3	Apply and Create interactive environments in multiplayer games	3	PO1, PO4, PO8, PSO1
CO4	Apply the performance and scalability of multiplayer games through efficient spatial computing	3	PO1, PO4, PO8, PSO1
CO5	analyzing spatial data generated by multiplayer games	4	PO1, PO4, PO8, PSO1
CO6	Implement and optimize spatial data structures for real-time multiplayer game environments.	4	PO1, PO4, PO8, PSO1
CO7	Design and deploy scalable server architectures for handling spatial queries in multiplayer game settings	4	PO1, PO4, PO8, PSO1

Syllabus

Overview of spatial computing concepts Importance in multiplayer games Examples from popular games, Introduction to arrays, grids, and trees Spatial indexing techniques: grid-based and quad-trees Implementation focus,, Basics in 2D and 3D environments Algorithms: bounding boxes, spheres Practical implementation

Design and implement client-server and peer-to-peer networking architectures for multiplayer games. Understand synchronization techniques for maintaining game state consistency across multiple clients and servers. Implement latency compensation strategies to ensure smooth gameplay experiences. Develop scalable and efficient networking solutions for various game genres and platforms, Basics of client-server architecture Design considerations for client-server networking in games Implementing a basic client-server networking system

create immersive and interactive environments in multiplayer games. It covers topics such as implementing environmental effects like weather and lighting, creating mechanics for object manipulation, generating dynamic terrains, and designing player interaction systems. Through hands-on projects and practical exercises, students will learn how to develop multiplayer game environments that respond dynamically to player actions, enhancing the overall gameplay experience.

optimizing the performance and scalability of multiplayer games by leveraging efficient spatial computing techniques. Students will learn how to implement spatial data structures and algorithms to enhance game performance, manage server-client interactions, and scale multiplayer systems. Through practical exercises and projects, students will develop skills in analyzing and optimizing code for performance, managing network bandwidth, and implementing strategies to support large numbers of concurrent players while maintaining smooth and responsive gameplay experiences.

to derive insights from spatial data, such as heatmaps, spatial clustering, and predictive modeling. They will gain skills in analyzing player behavior, optimizing game balance, and predicting future player actions. Additionally, students will explore the application of spatial analytics in enhancing gameplay experiences and improving overall game design.

Reference Books

- 1 Real-Time Collision Detection, Christer Ericson, first/2017, Morgan Kaufmann .

- 2 Interactive Computer Graphics: A Top-Down Approach with WebGL, Edward Angel, Dave Shreiner, seventh/2018, Addison-Wesley Professional.
- 3 Procedural Generation in Game Design, Tanya X. Short, Tarn Adams first/2018, CRC Press.
- 4 3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics, David H. Eberly, 2/2019, Morgan Kaufmann.
- 5 Introduction to Game Development, Steve Rabin (Editor), 2/2019, Cengage Learning.
- 6 Programming Massively Parallel Processors: A Hands-on Approach, David B. Kirk, Wen-mei W. Hwu, 3/2022, Morgan Kaufmann.

23SCI3202R - SPATIAL COMPUTING FOR MULTIPLAYER GAMES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3202R	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	SCMG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Spatial Concepts in Multiplayer Game	2	PO1, PO8, PO11, PSO1
CO2	Implementing Multiplayer Networking Systems	3	PO1, PO8, PO11, PSO1
CO3	Apply and Create interactive environments in multiplayer games	3	PO1, PO8, PO11, PSO1
CO4	Apply the performance and scalability of multiplayer games through efficient spatial computing	3	PO1, PO8, PO11, PSO1

Syllabus

Overview of spatial computing concepts Importance in multiplayer games Examples from popular games, Introduction to arrays, grids, and trees Spatial indexing techniques: grid-based and quad-trees Implementation focus,, Basics in 2D and 3D environments Algorithms: bounding boxes, spheres Practical implementation

Design and implement client-server and peer-to-peer networking architectures for multiplayer games. Understand synchronization techniques for maintaining game state consistency across multiple clients and servers. Implement latency compensation strategies to ensure smooth gameplay experiences. Develop scalable and efficient networking solutions for various game genres and platforms, Basics of client-server architecture Design considerations for client-server networking in games Implementing a basic client-server networking system

create immersive and interactive environments in multiplayer games. It covers topics such as implementing environmental effects like weather and lighting, creating mechanics for object manipulation, generating dynamic terrains, and designing player interaction systems. Through hands-on projects and practical exercises, students will learn how to develop multiplayer game environments that respond dynamically to player actions, enhancing the overall gameplay experience.

optimizing the performance and scalability of multiplayer games by leveraging efficient spatial computing techniques. Students will learn how to implement spatial data structures and algorithms to enhance game performance, manage server-client interactions, and scale multiplayer systems. Through practical exercises and projects, students will develop skills in analyzing and optimizing code for performance, managing network bandwidth, and implementing strategies to support large numbers of concurrent players while maintaining smooth and responsive gameplay experiences.

Reference Books

- 1 Multiplayer Game Programming: Architecting Networked Games, Josh Glazer, Sanjay Madhav, first/2017, Addison-Wesley Professional .
- 2 Real-Time Collision Detection, Christer Ericson, first/2018, Morgan Kaufmann.
- 3 Procedural Generation in Game Design, Tanya X. Short, Tarn Adams, first/2021, CRC Press .
- 4 Unity in Action: Multiplatform Game Development in C#, Joe Hocking, second/2022, Manning Publications.

23SCI3303A - SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3303A	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	SCPD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying Spatial Computing concepts in different fields.	3	PO2, PO4, PSO1
CO2	Understanding Spatial Computing Techniques using Unity Tool	2	PO2, PO4, PSO2
CO3	Applying Spatial Interaction Design for AR/VR Environments	3	PO2, PO4, PSO1
CO4	Applying Spatial Computing Development Workflow in Applications	3	PO2, PO4, PSO2
CO5	Applying advanced interaction techniques in Spatial Computing	3	PO2, PO4, PSO1
CO6	Applying different concepts for spatial computing platforms.	3	PO2, PO4, PSO2
CO7	Applying spatial computing ideas in Unity tool	3	PO2, PO4, PSO2

Syllabus

Overview of Spatial Computing ,Definition and Importance of Spatial Computing ,Applications of Spatial Computing in Various Industries ,Concepts of Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR) ,Underlying Technologies: Depth Sensing, Computer Vision, Simultaneous Localization and Mapping (SLAM)

Overview of Spatial Computing Platforms: Unity MARS, Microsoft HoloLens, Oculus Rift, Magic Leap, Google ARCore/ARKit,Features and Capabilities of Different Platforms,Target Applications and Industries for Each Platform,Development Tools and SDKs Provided by Spatial Computing Platforms,Case Studies of Successful Applications Developed on Different Platforms

Principles of Spatial Interaction Design,User Interface (UI) Design for AR/VR Environments,Spatial Interaction Techniques: Gesture Recognition, Spatial Gestures, Voice Commands,User Experience,(UX) Considerations in Spatial Computing,Designing for Spatial Context, User Comfort, and Minimizing Cognitive Load

Overview of Spatial Computing Development Workflow,Ideation and Concept Development for Spatial Computing Applications,Prototyping Techniques for Spatial Experiences,Asset Creation: 3D Modeling, Texturing, Animation,Coding and Scripting with Unity or Unreal Engine for Spatial Computing,Testing, Iteration, and User Feedback in Spatial Computing Development

Emerging Trends in Spatial Computing,Advanced Spatial Interaction Techniques,Optimization Techniques for Performance in Spatial Computing Applications,Ethical and Social Implications of Spatial Computing,Future Directions and Opportunities in Spatial Computing

Reference Books

- 1 Understanding Augmented Reality: Concepts and Applications, Alan B. Craig, 1,2013, Morgan Kaufmann.
- 2 Virtual Reality: Concepts and Technologies, William R. Sherman and Alan B. Craig, 1,2026, CRC Press.
- 3 Augmented Human: How Technology Is Shaping the New Reality, Helen Papagiannis, 1,2017, O'Reilly Media.
- 4 Unity Virtual Reality Projects, Jonathan Linowes, 1,2015, Packt Publishing.

23SCI3303E - SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3303E	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	SCPD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying Spatial Computing concepts in different fields.	3	PO2, PO4, PSO1
CO2	Understanding Spatial Computing Techniques using Unity Tool	2	PO2, PO4, PSO2
CO3	Applying Spatial Interaction Design for AR/VR Environments	3	PO2, PO4, PSO1
CO4	Applying Spatial Computing Development Workflow in Applications	3	PO2, PO4, PSO2
CO5	Applying advanced interaction techniques in Spatial Computing	3	PO2, PO4, PSO1
CO6	Applying different concepts for spatial computing platforms.	3	PO2, PO4, PSO2
CO7	Applying spatial computing ideas in Unity tool	3	PO2, PO4, PSO2

Syllabus

Overview of Spatial Computing ,Definition and Importance of Spatial Computing ,Applications of Spatial Computing in Various Industries ,Concepts of Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR) ,Underlying Technologies: Depth Sensing, Computer Vision, Simultaneous Localization and Mapping (SLAM)

Overview of Spatial Computing Platforms: Unity MARS, Microsoft HoloLens, Oculus Rift, Magic Leap, Google ARCore/ARKit,Features and Capabilities of Different Platforms,Target Applications and Industries for Each Platform,Development Tools and SDKs Provided by Spatial Computing Platforms,Case Studies of Successful Applications Developed on Different Platforms

Principles of Spatial Interaction Design,User Interface (UI) Design for AR/VR Environments,Spatial Interaction Techniques: Gesture Recognition, Spatial Gestures, Voice Commands,User Experience,(UX) Considerations in Spatial Computing,Designing for Spatial Context, User Comfort, and Minimizing Cognitive Load

Overview of Spatial Computing Development Workflow,Ideation and Concept Development for Spatial Computing Applications,Prototyping Techniques for Spatial Experiences,Asset Creation: 3D Modeling, Texturing, Animation,Coding and Scripting with Unity or Unreal Engine for Spatial Computing,Testing, Iteration, and User Feedback in Spatial Computing Development

Emerging Trends in Spatial Computing,Advanced Spatial Interaction Techniques,Optimization Techniques for Performance in Spatial Computing Applications,Ethical and Social Implications of Spatial Computing,Future Directions and Opportunities in Spatial Computing

Reference Books

- 1 Understanding Augmented Reality: Concepts and Applications, Alan B. Craig, 1,2013, Morgan Kaufmann.
- 2 Virtual Reality: Concepts and Technologies, William R. Sherman and Alan B. Craig, 1,2016, CRC Press.
- 3 Augmented Human: How Technology Is Shaping the New Reality, Helen Papagiannis, 1,2017, O'Reilly Media.
- 4 Unity Virtual Reality Projects, Jonathan Linowes, 1,2015, Packt Publishing.

23SCI3303R - SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3303R	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	SCPD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying Spatial Computing concepts in different fields.	3	PO2, PO4, PSO1
CO2	Understanding Spatial Computing Techniques using Unity Tool.	2	PO2, PO4, PSO2
CO3	Applying Spatial Interaction Design for AR/VR Environments	3	PO2, PO4, PSO1
CO4	Applying Spatial Computing Development Workflow in Applications.	3	PO2, PO4, PSO2
CO5	Applying different concepts for spatial computing platforms.	3	PO2, PO4, PSO1
CO6	Applying spatial computing ideas in Unity tool	3	PO2, PO4, PSO2

Syllabus

Overview of Spatial Computing ,Definition and Importance of Spatial Computing ,Applications of Spatial Computing in Various Industries ,Concepts of Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR) ,Underlying Technologies: Depth Sensing, Computer Vision, Simultaneous Localization and Mapping (SLAM)

Overview of Spatial Computing Platforms: Unity MARS, Microsoft HoloLens, Oculus Rift, Magic Leap, Google ARCore/ARKit,Features and Capabilities of Different Platforms,Target Applications and Industries for Each Platform,Development Tools and SDKs Provided by Spatial Computing Platforms,Case Studies of Successful Applications Developed on Different Platforms

Principles of Spatial Interaction Design,User Interface (UI) Design for AR/VR Environments,Spatial Interaction Techniques: Gesture Recognition, Spatial Gestures, Voice Commands,User Experience,(UX) Considerations in Spatial Computing,Designing for Spatial Context, User Comfort, and Minimizing Cognitive Load

Overview of Spatial Computing Development Workflow,Ideation and Concept Development for Spatial Computing Applications,Prototyping Techniques for Spatial Experiences,Asset Creation: 3D Modeling, Texturing, Animation,Coding and Scripting with Unity or Unreal Engine for Spatial Computing,Testing, Iteration, and User Feedback in Spatial Computing Development

Emerging Trends in Spatial Computing,Advanced Spatial Interaction Techniques,Optimization Techniques for Performance in Spatial Computing Applications,Ethical and Social Implications of Spatial Computing,Future Directions and Opportunities in Spatial Computing

Reference Books

- 1 Understanding Augmented Reality: Concepts and Applications, Alan B. Craig, 1,2013, Morgan Kaufmann.
- 2 Virtual Reality: Concepts and Technologies, William R. Sherman and Alan B. Craig, 1,2016, CRC Press.
- 3 Augmented Human: How Technology Is Shaping the New Reality, Helen Papagiannis, 1,2017, O'Reilly Media.
- 4 Unity Virtual Reality Projects, Jonathan Linowes, 1,2015, Packt Publishing.

23SCI3404M - SPATIAL AND SOCIAL IMPLICATIONS OF IMMERSIVE TECHNOLOGIES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3404M	SPATIAL AND SOCIAL IMPLICATIONS OF IMMERSIVE TECHNOLOGIES	SSIIT	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying Immersive Concepts in different Fields	3	PO2, PO4, PS01
CO2	Understanding the Spatial Implications of Immersive Technology	2	PO2, PO4, PS02
CO3	Applying Social Implications in Application	3	PO2, PO4, PS02
CO4	Applying the Principles of Spatial Design in Creating Immersive Experiences	3	PO2, PO4, PS01

Syllabus

Understanding Immersive Technologies, Role of Immersive Technologies in Society, Basic Principles of Immersive Technologies, Evolution of Immersive Technologies

Understanding Spatial Computing, Role of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) in Spatial Design, Case Studies of Spatial Applications of Immersive Technologies, Hands-on: Exploring Spatial Applications of VR, AR, and MR

Understanding the Impact of Immersive Technologies on Society, Role of Immersive Technologies in Social Interactions, Case Studies of Social Applications of Immersive Technologies, Hands-on: Exploring Social Applications of VR, AR, and MR

Principles of Designing Immersive Experiences, User Experience and User Interface Design for Immersive Technologies, Case Studies of Effective Immersive Experiences, Hands-on Designing an Immersive Experience

Reference Books

- 1 Virtual Reality: Representations in Contemporary Media, Melanie Chan, 1,2020, Bloomsbury Academic.
- 2 Augmented Reality: Principles and Practice, Dieter Schmalstieg and Tobias Hollerer, 1,2016, Addison-Wesley Professional.
- 3 Immersive Realities: Transformations and Continuities, Carole M. Cusack and Pavol Kosnac, 1,2020, Brill.
- 4 The Virtual Reality Industry: An Introduction to VR Software and Hardware, Alexander Bobenko and Andrei Sherstyuk, 1,2020, Apress.

23SCI3405M - SPATIAL AUDIO DESIGN FOR GAMES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3405M	SPATIAL AUDIO DESIGN FOR GAMES	SADG	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Spatial Audio	3	PO1, PSO1
CO2	Sound Design and Spatial Audio Techniques	3	PO2, PSO1
CO3	Setting the Atmosphere with Sound	3	PO3, PSO1
CO4	Enhancing Immersion with Sound	3	PO4, PSO1

Syllabus

Fundamentals of Sound: Properties of sound waves Perception of sound by humans, Basic principles of acoustics Stereo Sound: Principles of stereo recording and reproduction, Stereo imaging and localization Multichannel Audio: Introduction to surround sound systems Formats like 5.1, 7.1, etc., Surround sound mixing techniques Binaural Audio: Understanding binaural recording and playback Head-related transfer functions (HRTFs), Virtual auditory space Ambisonics: Theory and principles of ambisonic recording Ambisonic microphone techniques, Ambisonic decoding and spatial rendering 3D Audio Rendering: Spatial audio reproduction techniques Wavefield synthesis, Object-based audio Applications of Spatial Audio: Virtual reality (VR) and augmented reality (AR) Gaming and immersive experiences Live performances and installations, Spatial Audio Production Tools: Overview of software and hardware tools Digital audio workstations (DAWs) Spatial audio plugins and processors, Case Studies and Projects: Analyzing spatial audio in existing media Hands-on projects involving spatial audio recording and mixing Presentation of student projects.

This course explores the principles and techniques of sound design within the context of spatial audio, focusing on creating immersive and interactive auditory experiences. Students will learn the fundamentals of sound design, spatial audio principles, and how to apply them in various mediums such as film, gaming, virtual reality, and live performances.

This course delves into the art and science of using sound to create immersive atmospheres in various contexts, including film, theater, gaming, and virtual environments. Students will explore techniques for designing and implementing soundscapes that enhance storytelling, evoke emotions, and engage audiences on a deeper sensory level.

This course focuses on the theory and practice of using sound to deepen immersion in various media forms, including film, gaming, virtual reality, and live experiences. Students will explore advanced techniques for designing and implementing soundscapes that engage audiences on a visceral level, enhancing storytelling and creating unforgettable immersive experiences. Sound as a Tool for Enhancing Immersion, Integration of 3D Audio Technology in Game Design, Practical Exercises in Creating Immersive Audio for Games.

Reference Books

- 1 Principles of Game Audio and Sound Design, Jean-Luc Sinclair, 6, Focal Press.
- 2 Game Audio Implementation: A Practical Guide Using the Unreal Engine, Richard Stevens and Dave Raybould, 1, CRC Press.
- 3 3D Audio Programming for Virtual Worlds: Tools, Techniques, and Algorithms, Durand Begault, 1, Springer.
- 4 Spatial Audio Processing: MPEG Surround and Other Applications, J?rgen Herre and Christof Faller, 1, John Wiley and Sons.

23SCI3506 - SPATIAL USER INTERFACE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3506	SPATIAL USER INTERFACE DESIGN	SUID	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Spatial User Interface Design	3	PO1, PSO1
CO2	Designing Spatial User Interfaces	3	PO2, PSO1
CO3	Advanced Concepts in Spatial User Interface Design	3	PO3, PSO1
CO4	Future of Spatial User Interface Design	3	PO4, PSO1

Syllabus

Understanding Spatial User Interface Design, Role of Spatial Design in User Experience, Basic Principles of Spatial Design, Evolution of Spatial User Interfaces and This course provides an introduction to the theory and practice of designing spatial user interfaces (SUIs) for virtual and augmented reality environments. Students will learn fundamental principles of spatial design, interaction techniques, and user experience considerations to create intuitive and immersive interfaces for a variety of applications.

Techniques for Designing Spatial User Interfaces, Realistic vs Abstract Design Styles, Case Studies of Effective Spatial User Interface Design, Hands-on: Designing a Basic Spatial User Interface. This course provides an in-depth exploration of the principles, techniques, and best practices involved in designing effective spatial user interfaces (SUIs) for virtual and augmented reality environments. Students will learn how to conceptualize, prototype, and evaluate spatial interfaces that enhance user experience and interaction in immersive settings.

Immersive Spatial Interfaces Role of Virtual and Augmented, Reality in Spatial Design, Designing for Different Senses (Visual, Auditory, Haptic), Hands-on: Designing an Immersive Spatial User Interface. This course delves into advanced theories, techniques, and emerging trends in spatial user interface (SUI) design for virtual and augmented reality environments. Students will explore cutting-edge concepts such as spatial computing, multimodal interaction, and adaptive interfaces, and gain hands-on experience in designing innovative spatial interfaces for immersive experiences.

Emerging Trends in Spatial User Interface Design, Role of AI and Machine Learning in Spatial Design, Ethical Considerations in Spatial Design, Hands-on: Designing a Spatial User Interface for an Emerging Technology. This course offers an interdisciplinary exploration of speculative and emerging trends in spatial user interface (SUI) design, focusing on envisioning and shaping the future of human-computer interaction in virtual and augmented reality environments. Students will engage in critical discussions, hands-on experiments, and speculative design projects to explore innovative concepts and possibilities in spatial UI design.

Reference Books

- 1 Designing Spatial User Interfaces: Principles and Practices, Alexandru C. Telea, 1, AK Peters/CRC Press.
- 2 3D User Interfaces: Theory and Practice, Doug A. Bowman, Ernst Kruijff, Joseph J. LaViola Jr., Ivan Poupyrev, 2, Addison-Wesley Professional.
- 3 Virtual Reality and Augmented Reality: Myths and Realities, Philippe Fuchs, Guillaume Moreau, 1, CRC Press.
- 4 Virtual Reality Technology and Applications, Yuichi Ohta, Koji Nakamura, and Masayuki Tanimoto, 1, Springer.

23SCI3507 - INTRODUCTION TO SPATIAL COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SCI3507	INTRODUCTION TO SPATIAL COMPUTING	ITSC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Spatial Computing	3	PO1, PSO1
CO2	Technologies in Spatial Computing	3	PO2, PSO1
CO3	Designing Spatial Computing Applications	3	PO3, PSO1
CO4	Future of Spatial Computing	3	PO4, PSO1

Syllabus

Understanding Spatial Computing, Role of Spatial Computing in Technology, Basic Principles of Spatial Computing, Evolution of Spatial Computing

Overview of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), Understanding 3D Graphics and Immersive Interfaces, Role of AI and Machine Learning in Spatial Computing, Hands-on: Working with VR, AR, and MR Tools

Principles of Designing Spatial Computing Applications, User Experience and User Interface Design for Spatial Computing, Case Studies of Effective Spatial Computing Applications, Hands-on: Designing a Basic Spatial Computing Emerging Trends in Spatial Computing, Role of Spatial Computing in Different Industries, Ethical Considerations in Spatial Computing, Hands-on: Designing a Spatial Computing Solution for an Emerging Trend

Reference Books

- 1 Spatial Computing and Mixed Reality: A Primer, Phil Chu and Bernard Kress, 1, Wiley.
- 2 Spatial Computing: Technology, Hardware, and Applications, RajVikram Singh, 1, Springer.
- 3 Introduction to Spatial Computing: A Hands-on Guide with Examples in Python, Paolo Tagliolato, 1, O'Reilly Media.
- 4 Spatial Computing: An Introduction, David Weintrop, 1, MIT Press.

23SDM3101A - SENTIMENT ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3101A	SENTIMENT ANALYSIS	SA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the sentiment analysis techniques for classifying opinions and emotions from text data	3	PO4, PO5, PSO1
CO2	Choose the methods for identifying subjective sentences, classifying sentiment and extracting aspects of that sentiment within text data.	3	PO4, PO5, PSO1
CO3	Analyze the sentiment lexicons, compare sentiment within text data, and techniques for summarizing opinions on specific aspects.	4	PO2, PO4, PO5, PSO1
CO4	Analyze the concept of debate analysis, intention mining, and fake-opinion detection.	4	PO2, PO4, PO5, PSO1
CO5	Outline the concepts of language constructs, express opinions, sentiments and emotions, intention mining, fake opinion detection	5	PO4, PO5, PSO1
CO6	Examine sentiment analysis techniques in Python using NLTK, TextBlob, and VADER, exploring feature importance with Random Forest, installation and lexicon setup,	4	PO4, PO5, PSO2
CO7	Experiment applications with Python for sentiment analysis: analyzing stock market influence, finding job opportunities on Twitter, and mapping emotional trends on the platform.	4	PO4, PO5, PSO2

Syllabus

Introduction Sentiment analysis: applications, Sentiment analysis research, Sentiment analysis as mini-NLP, The Problem of Sentiment Analysis, Definition of opinion, Definition of opinion summary, different types of opinions, Document Sentiment Classification, Supervised sentiment classification, Unsupervised sentiment classification, Sentiment rating prediction

Sentence Subjectivity and Sentiment Classification :Sentence Subjectivity and Sentiment Classification, Subjectivity, Sentence Subjectivity,Classification, Sentence Sentiment Classification, Aspect Sentiment Classification, Rules of Sentiment composition, Negation and Sentiment, Aspect and Entity Extraction, Frequency based aspect extraction, Exploring syntactic relations, Using supervised learning

Sentiment Lexicon Generation, Dictionary based approach, Corpus based approach, Sentiment word embedding, Analysis of Comparative Opinions, Problem definition, Identifying comparative sentences, Identifying the preferred entity set, Special types of comparison, Opinion Summarization and Search, Aspect based opinion summarization, enhancements to aspect based summaries, Traditional summarization

Analysis of Debates and Comments, Recognizing stances in debates, Modeling debates/Discussions, Modeling comments, Mining Intents, Problem of intent mining, Intent classification, Fine grained mining of intent, Detecting Fake or Deceptive Opinions, Different types of Spam, Supervised fake review detection, Automated discovery of abnormal patterns, Model based behavioral analysis, Group spam detection, Quality of Reviews, Quality prediction as a regression problem

Implement the concepts of language constructs, express opinions, sentiments and emotions, intention mining, fake opinion detection

Reference Books

- 1 Sentiment Analysis: Mining Opinions, Sentiments, and Emotions, Bing Liu, Second, Morgan & Claypool Publishers.
- 2 Sentiment Analysis for Social Media , Antonio Moreno, Carlos A. Iglesias , first, Morgan Kaufmann.

- 3 New Opportunities for Sentiment Analysis and Information Processing , Aakansha Sharaaff, G. R. Sinha, Surbhi Bhatia , first, Engineering Science Reference.
- 4 Sentiment Analysis and Knowledge Discovery in Contemporary Business , Dharmendra Singh Rajput, Ramjeevan Singh Thakur, S. Muzamil Basha , first, IGI Global.
- 5 Sentiment Analysis in Social Networks, Federico Pozzi, Elisabetta Fersini, Enza Messina, Bing Liu , first, Morgan Kaufmann Publishers Inc..

23SDM3101E - SENTIMENT ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3101E	SENTIMENT ANALYSIS	SA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the sentiment analysis techniques for classifying opinions and emotions from text data	3	PO2, PO5, PSO1
CO2	Choose the methods for identifying subjective sentences, classifying sentiment and extracting aspects of that sentiment within text data.	3	PO2, PO5, PSO1
CO3	Analyze the sentiment lexicons, compare sentiment within text data, and techniques for summarizing opinions on specific aspects.	4	PO2, PO4, PO5, PSO1
CO4	Analyze the concept of debate analysis, intention mining, and fake-opinion detection.	4	PO2, PO4, PO5, PSO1
CO5	Outline the concepts of language constructs, express opinions, sentiments and emotions, intention mining, fake opinion detection	5	PO2, PO5, PSO1
CO6	Examine sentiment analysis techniques in Python using NLTK, TextBlob, and VADER, exploring feature importance with Random Forest, installation and lexicon setup,	4	PO2, PO5, PSO2
CO7	Experiment applications with Python for sentiment analysis: analyzing stock market influence, finding job opportunities on Twitter, and mapping emotional trends on the platform.	4	PO2, PO4, PO5, PSO2

Syllabus

Introduction Sentiment analysis: applications, Sentiment analysis research, Sentiment analysis as mini-NLP, The Problem of Sentiment Analysis, Definition of opinion, Definition of opinion summary, different types of opinions, Document Sentiment Classification, Supervised sentiment classification, Unsupervised sentiment classification, Sentiment rating prediction

Sentence Subjectivity and Sentiment Classification :Sentence Subjectivity and Sentiment Classification, Subjectivity, Sentence Subjectivity,Classification, Sentence Sentiment Classification, Aspect Sentiment Classification, Rules of Sentiment composition, Negation and Sentiment, Aspect and Entity Extraction, Frequency based aspect extraction, Exploring syntactic relations, Using supervised learning

Sentiment Lexicon Generation, Dictionary based approach, Corpus based approach, Sentiment word embedding, Analysis of Comparative Opinions, Problem definition, Identifying comparative sentences, Identifying the preferred entity set, Special types of comparison, Opinion Summarization and Search, Aspect based opinion summarization, enhancements to aspect based summaries, Traditional summarization

Analysis of Debates and Comments, Recognizing stances in debates, Modeling debates/Discussions, Modeling comments, Mining Intents, Problem of intent mining, Intent classification, Fine grained mining of intent, Detecting Fake or Deceptive Opinions, Different types of Spam, Supervised fake review detection, Automated discovery of abnormal patterns, Model based behavioral analysis, Group spam detection, Quality of Reviews, Quality prediction as a regression problem

Implement the concepts of language constructs, express opinions, sentiments and emotions, intention mining, fake opinion detection

Reference Books

- 1 Sentiment Analysis: Mining Opinions, Sentiments, and Emotions , Bing Liu , Second , Morgan & Claypool Publishers .
- 2 Sentiment Analysis for Social Media , Antonio Moreno, Carlos A. Iglesias , first, Morgan Kaufmann .

- 3 New Opportunities for Sentiment Analysis and Information Processing , Aakansha Sharaff, G. R. Sinha, Surbhi Bhatia , first, Engineering Science Reference .
- 4 Sentiment Analysis and Knowledge Discovery in Contemporary Business , Dharmendra Singh Rajput, Ramjeevan Singh Thakur, S. Muzamil Basha , first, IGI Global .
- 5 Sentiment Analysis in Social Networks , Federico Pozzi, Elisabetta Fersini, Enza Messina, Bing Liu first Morgan Kaufmann Publishers Inc. , first, Morgan Kaufmann Publishers Inc. .

23SDM3101R - SENTIMENT ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3101R	SENTIMENT ANALYSIS	SA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the sentiment analysis techniques for classifying opinions and emotions from text data	3	PO2, PO5, PSO1
CO2	Choose the methods for identifying subjective sentences, classifying sentiment and extracting aspects of that sentiment within text data.	3	PO2, PO5, PSO1
CO3	Analyze the sentiment lexicons, compare sentiment within text data, and techniques for summarizing opinions on specific aspects.	4	PO2, PO4, PO5, PSO1
CO4	Analyze the concept of debate analysis, intention mining, and fake-opinion detection.	4	PO2, PO4, PO5, PSO1
CO5	Examine sentiment analysis techniques in Python using NLTK, TextBlob, and VADER, exploring feature importance with Random Forest, installation and lexicon setup	4	PO2, PO5, PSO1
CO6	Experiment applications with Python for sentiment analysis: analyzing stock market influence, finding job opportunities on Twitter, and mapping emotional trends on the platform.	4	PO2, PO5, PSO2

Syllabus

Introduction Sentiment analysis: applications, Sentiment analysis research, Sentiment analysis as mini-NLP, The Problem of Sentiment Analysis, Definition of opinion, Definition of opinion summary, different types of opinions, Document Sentiment Classification, Supervised sentiment classification, Unsupervised sentiment classification, Sentiment rating prediction

Sentence Subjectivity and Sentiment Classification :Sentence Subjectivity and Sentiment Classification, Subjectivity, Sentence Subjectivity,Classification, Sentence Sentiment Classification, Aspect Sentiment Classification, Rules of Sentiment composition, Negation and Sentiment, Aspect and Entity Extraction, Frequency based aspect extraction, Exploring syntactic relations, Using supervised learning

Sentiment Lexicon Generation, Dictionary based approach, Corpus based approach, Sentiment word embedding, Analysis of Comparative Opinions, Problem definition, Identifying comparative sentences, Identifying the preferred entity set, Special types of comparison, Opinion Summarization and Search, Aspect based opinion summarization, enhancements to aspect based summaries, Traditional summarization

Analysis of Debates and Comments, Recognizing stances in debates, Modeling debates/Discussions, Modeling comments, Mining Intents, Problem of intent mining, Intent classification, Fine grained mining of intent, Detecting Fake or Deceptive Opinions, Different types of Spam, Supervised fake review detection, Automated discovery of abnormal patterns, Model based behavioral analysis, Group spam detection, Quality of Reviews, Quality prediction as a regression problem

Reference Books

- 1 Sentiment Analysis: Mining Opinions, Sentiments, and Emotions , Bing Liu , Second , Morgan & Claypool Publishers .
- 2 Sentiment Analysis for Social Media , Antonio Moreno, Carlos A. Iglesias , first, Morgan Kaufmann .
- 3 New Opportunities for Sentiment Analysis and Information Processing , Aakansha Sharriff, G. R. Sinha, Surbhi Bhatia , first , Engineering Science Reference .
- 4 Sentiment Analysis and Knowledge Discovery in Contemporary Business , Dharmendra Singh Rajput, Ramjeevan Singh Thakur, S. Muzamil Basha , first , IGI Global .

- 5 Sentiment Analysis in Social Networks , Federico Pozzi, Elisabetta Fersini, Enza Messina, Bing Liu , first, Morgan Kaufmann Publishers Inc. .

23SDM3202A - OPINION MINING & RECOMMENDER SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3202A	OPINION MINING & RECOMMENDER SYSTEMS	OMRS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize the feature extraction tools for different opinion mining levels and their uses in real world applications	3	PO1, PO2, PO5, PSO1
CO2	Apply evaluation metrics and opinion mining techniques by using VADER and NLTK tools in opinion mining	3	PO2, PO5, PSO1
CO3	Make use of data mining methods for recommender systems, classifiers, optimization of recommender systems	3	PO2, PSO1
CO4	Examine the optimization methods for different recommender systems.	4	PO3, PO5, PSO1
CO5	To evaluate the optimization and compare the contextual information model and reinforcement learning.	5	PO3, PO5, PSO1

Syllabus

Opinion Mining, Introduction, Aspect Based Mining Opinion Mining , History- Opinion Mining Terminologies ,General Opinion Mining Tasks, Document Level Opinion Mining, Feature based Opinion Mining and Sentence Level Opinion Mining, Phrase Level Opinion Mining , Aspect based Opinion Mining, Language Models, N Gram Models, Feature Extraction and Opinion Visualisation, Probabilistic Graphical Models, PLSI Model Multinomial LDA, Parameter Estimation -Smoothing Model Selection

Evaluation Metrics , Opinion Digger A Hybrid Method for Mining Reviews Temporal Opinion Mining, Temporality Process, Aspect Extraction- Finding Frequent Noun phrases, Mining Opinion Patterns , Filtering Out Non-Aspects, Grouping Candidate Aspects, Opinion Mining Techniques Knowledge based Approaches, SentiWordNet, SentiWordNet in our Supervised Approaches, Naive Bayes , Unsupervised Approaches, Supervised versus Unsupervised, Parameter Estimation Smoothing , Model Selection Test Set Likelihood, LDA Models for Aspect based Opinion Mining , LDA , SLDA, DLDA, PLDA , SPLDA DPLDA, Inference and Estimation.

Introduction and basic taxonomy of recommender systems (RSs). Traditional and non-personalized RSs. Overview of data mining methods for recommender systems (similarity measures, classification, Bayes classifiers, ensembles of classifiers, clustering, SVMs, dimensionality reduction). Overview of convex and linear optimization principles. Content-based recommender systems The long-tail principle. Domain-specific challenges in recommender systems. Content-based recommender systems. Advantages and drawbacks. Basic components of content-based RSs. Feature selection. Item representation Methods for learning user profiles. Collaborative Filtering (CF)-based RSs: Mathematical foundations Mathematical optimization in CF RSs.

Optimization objective. Baseline predictor through least squares. Regularization and overfitting. Temporal models. Step-by-step solution of the RS problem. Collaborative Filtering (CF)-based RSs: systematic approach Nearest-neighbor collaborative filtering (CF). User-based and item-based CF, comparison. Components of neighborhood methods (rating normalization, similarity weight computation, neighborhood selection). Hybrid recommender systems.

Advanced CF methods Matrix factorization models and dimensionality reduction. Matrix Decomposition. Latent factor models. Solution via alternative projections method. Examples. The Netflix data challenge. Constraint-based RSs. Introduction to tensors and their applications. Performance evaluation of RSs Experimental settings. Working with RSs data sets. Examples. The cold-start problem. Evaluation metrics. Rating prediction and accuracy.

Reference Books

- 1 Opinion Mining and Sentiment Analysis, Greame Hrist, Bing Liu, 2012, Morgan Publications.

- 2 Recommender Systems, C.C. Aggarwal, 2016, Springer.
- 3 Temporal Opinion Mining, Haishi Bai, Boris Scholl, 2010, CRC Press.
- 4 Recommender systems handbook, Federico Pozzi, Elisabetta Fersini, Enza Messina, 2016, Morgan Publications .
- 5 New Opportunities for Sentiment Analysis and Information Processing, Aakansha Sharaff, G. R. Sinha, Surbhi Bhatia, 2021, IGI Global.

23SDM3202E - OPINION MINING & RECOMMENDER SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3202E	OPINION MINING & RECOMMENDER SYSTEMS	OMRS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To identify the underlying structure of the problem and apply the different opinion mining techniques used to express opinions, sentiments, and emotions.	3	PO1, PO2, PO5, PSO1
CO2	To apply core areas of sentiment analysis.	3	PO2, PO5, PSO1
CO3	To construct the debate analysis, intention mining, and fake-opinion detection.	3	PO2, PSO1
CO4	To examine the statistical tests for large and small samples to test the hypothesis	4	PO3, PO5, PSO1
CO5	To evaluate the optimization and compare the contextual information model and reinforcement learning.	5	PO3, PO5, PSO1

Syllabus

Opinion Mining, Introduction, Aspect Based Mining Opinion Mining , History- Opinion Mining Terminologies ,General Opinion Mining Tasks, Document Level Opinion Mining, Feature based Opinion Mining and Sentence Level Opinion Mining, Phrase Level Opinion Mining , Aspect based Opinion Mining, Language Models, N Gram Models, Feature Extraction and Opinion Visualisation, Probabilistic Graphical Models, PLSI Model Multinomial LDA, Parameter Estimation -Smoothing Model Selection

Evaluation Metrics , Opinion Digger A Hybrid Method for Mining Reviews Temporal Opinion Mining, Temporality Process, Aspect Extraction- Finding Frequent Noun phrases, Mining Opinion Patterns , Filtering Out Non-Aspects, Grouping Candidate Aspects, Opinion Mining Techniques Knowledge based Approaches, SentiWordNet, SentiWordNet in our Supervised Approaches, Naive Bayes , Unsupervised Approaches, Supervised versus Unsupervised, Parameter Estimation Smoothing , Model Selection Test Set Likelihood, LDA Models for Aspect based Opinion Mining , LDA , SLDA, DLDA, PLDA , SPLDA DPLDA, Inference and Estimation.

Introduction and basic taxonomy of recommender systems (RSs). Traditional and non-personalized RSs. Overview of data mining methods for recommender systems (similarity measures, classification, Bayes classifiers, ensembles of classifiers, clustering, SVMs, dimensionality reduction). Overview of convex and linear optimization principles. Content-based recommender systems The long-tail principle. Domain-specific challenges in recommender systems. Content-based recommender systems. Advantages and drawbacks. Basic components of content-based RSs. Feature selection. Item representation Methods for learning user profiles. Collaborative Filtering (CF)-based RSs: Mathematical foundations Mathematical optimization in CF RSs.

Optimization objective. Baseline predictor through least squares. Regularization and overfitting. Temporal models. Step-by-step solution of the RS problem. Collaborative Filtering (CF)-based RSs: systematic approach Nearest-neighbor collaborative filtering (CF). User-based and item-based CF, comparison. Components of neighborhood methods (rating normalization, similarity weight computation, neighborhood selection). Hybrid recommender systems.

Advanced CF methods Matrix factorization models and dimensionality reduction. Matrix Decomposition. Latent factor models. Solution via alternative projections method. Examples. The Netflix data challenge. Constraint-based RSs. Introduction to tensors and their applications. Performance evaluation of RSs Experimental settings. Working with RSs data sets. Examples. The cold-start problem. Evaluation metrics. Rating prediction and accuracy.

Reference Books

- 1 Opinion Mining and Sentiment Analysis, Greame Hrist, Bing Liu, 2012, Morgan Publications.
- 2 Recommender Systems, C.C. Aggarwal, 2016, Springer.

- 3 Temporal Opinion Mining, Haishi Bai, Boris Scholl, 2010, CRC Press.
- 4 Recommender systems handbook, Federico Pozzi, Elisabetta Fersini, Enza Messina, 2016, Morgan Publications.
- 5 New Opportunities for Sentiment Analysis and Information Processing, Aakansha Sharaff, G. R. Sinha, Surbhi Bhatia, 2021, IGI Global.

23SDM3202R - OPINION MINING & RECOMMENDER SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3202R	OPINION MINING & RECOMMENDER SYSTEMS	OMRS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize the feature extraction tools for different opinion mining levels and their uses in real world applications	3	PO1, PO2, PO5, PSO2
CO2	Apply evaluation metrics and opinion mining techniques by using VADER and NLTK tools in opinion mining	3	PO2, PO5, PSO2
CO3	Make use of data mining methods for recommender systems, classifiers, optimization of recommender systems	3	PO2, PO3, PSO2
CO4	Examine the optimization methods for different recommender systems.	4	PO3, PO5, PSO2

Syllabus

History- Opinion Mining Terminologies - General Opinion Mining Tasks - Levels of Opinion Mining - N-Gram Models - Feature Extraction and -Opinion Visualisation -Probabilistic Graphical Models

Evaluation Metrics , Opinion Mining Techniques Knowledge based Approaches, SentiWordNet, SentiWordNet in our Supervised Approaches, Naive Bayes , Unsupervised Approaches LDA Models for Aspect based Opinion Mining ,

Basic taxonomy of recommender systems (RSs). Content-based recommender systems. Advantages and drawbacks Item representation Methods for learning user profiles. Collaborative Filtering (CF)-based RSs

Regularization and overfitting. Temporal models. Step-by-step solution of the RS problems, Components of neighborhood methods and hybrid recommender systems.

Reference Books

- 1 Opinion Mining and Sentiment Analysis, Greame Hrist, Bing Liu, 2012, Morgan Publications.
- 2 Recommender Systems, Aggarwal, Charu C., 2016, Springer.
- 3 Temporal Opinion Mining, Haishi Bai, Boris Scholl, 2010, CRC Press.
- 4 Recommender systems handbook, Federico Pozzi, Elisabetta Fersini, Enza Messina, 2016, Morgan Publications.
- 5 New Opportunities for Sentiment Analysis and Information Processing, Aakansha Sharaff, G. R. Sinha, Surbhi Bhatia, 2021, IGI Global.

23SDM3203A - META SOCIAL MEDIA ANALYTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3203A	META SOCIAL MEDIA ANALYTICS	MSMA	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understanding of the landscape of Meta-owned social media platforms, the importance of analytics for businesses and marketers, and considerations regarding data collection and privacy.	1	PO1, PO2
CO2	apply data cleaning methods to ensure data quality.	2	PO1, PO2
CO3	exploratory data analysis (EDA) specific to social media data from Meta platforms.	3	PO1, PO2
CO4	sentiment analysis principles, sentiment lexicons, and text preprocessing methods.	5	PO1, PO2
CO5	analyze the structure and dynamics of social media networks.	6	PO1, PO2

Syllabus

Introduction to Meta Social Media Analytics Overview of Meta-owned social media platforms Importance of analytics for businesses and marketers Introduction to data collection and privacy considerations

Data Collection and Preprocessing Understanding APIs for data access Web scraping techniques Data cleaning techniques and handling missing data

Exploratory Data Analysis (EDA) Descriptive statistics for social media data Visualization techniques for insights Trend analysis and seasonality

Sentiment Analysis and Text Mining Introduction to sentiment analysis Sentiment lexicons and dictionaries Text preprocessing for social media text data

Network Analysis and Community Detection Basics of social network analysis Network metrics and visualization Community detection in social networks

Reference Books

- 1 "Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media" , Matthew Ganis, 3rd Edition, IBM Press.
- 2 "Mining the Social Web", Matthew A. Russell, 3rd Edition, O'Reilly Media.
- 3 "Social Media Mining: An Introduction", Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, 2nd Edition, Cambridge University Press.
- 4 "Analyzing Social Media Networks with NodeXL: Insights from a Connected World", Derek Hansen, Ben Shneiderman, Marc A. Smith , 2nd Edition, Morgan Kaufmann.

23SDM3203E - META SOCIAL MEDIA ANALYTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3203E	META SOCIAL MEDIA ANALYTICS	MSMA	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understanding of the landscape of Meta-owned social media platforms, the importance of analytics for businesses and marketers, and considerations regarding data collection and privacy.	1	PO1, PO2
CO2	apply data cleaning methods to ensure data quality.	2	PO1, PO2
CO3	exploratory data analysis (EDA) specific to social media data from Meta platforms.	4	PO1, PO2
CO4	sentiment analysis principles, sentiment lexicons, and text preprocessing methods.	6	PO1, PO2
CO5	analyze the structure and dynamics of social media networks.	6	PO1, PO2

Syllabus

Introduction to Meta Social Media Analytics Overview of Meta-owned social media platforms Importance of analytics for businesses and marketers Introduction to data collection and privacy considerations

Data Collection and Preprocessing Understanding APIs for data access Web scraping techniques Data cleaning techniques and handling missing data

Exploratory Data Analysis (EDA) Descriptive statistics for social media data Visualization techniques for insights Trend analysis and seasonality

Sentiment Analysis and Text Mining Introduction to sentiment analysis Sentiment lexicons and dictionaries Text preprocessing for social media text data

Network Analysis and Community Detection Basics of social network analysis Network metrics and visualization Community detection in social networks

Reference Books

- 1 Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, 1st Edition, IBM Press.
- 2 Mining the Social Web, Matthew A. Russell, 3rd Edition, O'Reilly Media.
- 3 "Social Media Mining: An Introduction", Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, 2nd Edition, Cambridge University Press.
- 4 "Analyzing Social Media Networks with NodeXL: Insights from a Connected World", Derek Hansen, Ben Shneiderman, Marc A. Smith, 2nd Edition, Morgan Kaufmann.

23SDM3203R - META SOCIAL MEDIA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3203R	META SOCIAL MEDIA ANALYTICS	MSMA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understanding of the landscape of Meta-owned social media platforms, the importance of analytics for businesses and marketers, and considerations regarding data collection and privacy.	1	PO1, PO2
CO2	apply data cleaning methods to ensure data quality.	3	PO2
CO3	exploratory data analysis (EDA) specific to social media data from Meta platforms.	4	PO2
CO4	sentiment analysis principles, sentiment lexicons, and text preprocessing methods.	5	PO2

Syllabus

Introduction to Meta Social Media Analytics Overview of Meta-owned social media platforms Importance of analytics for businesses and marketers Introduction to data collection and privacy considerations

Data Collection and Preprocessing Understanding APIs for data access Web scraping techniques Data cleaning techniques and handling missing data

Exploratory Data Analysis (EDA) Descriptive statistics for social media data Visualization techniques for insights Trend analysis and seasonality

Sentiment Analysis and Text Mining Introduction to sentiment analysis Sentiment lexicons and dictionaries Text preprocessing for social media text data

Reference Books

- 1 "Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media" , Matthew Ganis, 1st Edition, IBM Press.
- 2 "Mining the Social Web" , Matthew A. Russell, 3rd Edition, O'Reilly Media.
- 3 "Social Media Mining: An Introduction", Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, 2nd Edition, Cambridge University Press.
- 4 "Analyzing Social Media Networks with NodeXL: Insights from a Connected World", Derek Hansen, Ben Shneiderman, Marc A. Smith, 2nd Edition, Morgan Kaufmann.

23SDM3304A - SOCIAL MEDIA MARKETING ANALYTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3304A	SOCIAL MEDIA MARKETING ANALYTICS	SMMA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To build the awareness about, what social media is, the different platforms it uses, and how it fits into your marketing plan. Create content and goals for social media marketing.	2	PO1, PO3
CO2	Builds the knowledge about Creation and maintain a successful blog. Prepare Facebook and Instagram ads and have a solid grasp of social media page branding.	2	PO1, PO3
CO3	Develop the construction of a video marketing strategy and become familiar with YouTube advertising.	3	PO1, PO3
CO4	Analyze the branding of Twitter Profiles and Ads	4	PO1, PO3
CO5	Discover the use of technologies and consumer-generated content are influencing the direction of social media marketing.	4	PO1, PO3
CO6	Examine the issues in Social Media Marketing Analysis	4	PO1, PO3
CO7	Text Mining and Sentiment Analytics, Text Mining and Product Innovation Management	4	PO1

Syllabus

Social marketing uses marketing tools for social good. It aims to change behaviors for a better future, like promoting healthy habits or environmental awareness. These campaigns target specific audiences and use a marketing mix (product, price, place, promotion) with a social twist. India has seen success with social marketing in areas like polio eradication and girl's education. Challenges include grabbing attention and limited resources, but digital tools and collaboration offer exciting opportunities for even greater social impact.

Successful social marketing requires a well-defined plan. This includes understanding your target audience (segmentation) and what motivates them (research). Then you can craft a strategy with clear goals and messages delivered through the right channels. Remember, social marketing is about positive change, so act ethically and responsibly throughout the process.

Research is key to social marketing success. You need to understand the social climate, your target audience, and how your campaign performs. There are many tools available, from surveys to social listening. In India, consider the cultural context. Analyzing your audience's behaviors and beliefs is crucial to crafting messages that resonate. Finally, track your progress and measure the impact of your campaign to see if it's achieving its goals.

Social marketers have a toolbox of resources at their disposal. These include research surveys, scheduling platforms, and data analysis software. They also use a social marketing mix, focusing on the desired behavior change and how to promote it. Crafting clear messages and choosing the right channels to reach your target audience is essential. Social marketing can even go beyond campaigns to influence policy changes through advocacy.

Social marketing isn't limited to one area. It tackles various challenges like health (vaccination awareness), environment (recycling campaigns), and education (promoting early childhood learning). It can even address social issues like gender equality or domestic violence. By adapting its approach to each situation, social marketing can create positive change in many aspects of our lives.

Social media like Facebook and LinkedIn are goldmines for marketers. Facebook lets you reach a massive audience and build brand awareness, while LinkedIn is ideal for connecting with professionals in your field. To make the most of these platforms, consider creating compelling digital ads with strong visuals and targeted messaging. By mastering these social media tools, you can take your marketing efforts to the next level.

Text mining is like a detective for data! It analyzes mountains of text, like emails or social media posts, to find hidden insights. This can be useful in two ways. Sentiment analysis uses text mining to understand public opinion, like gauging customer satisfaction through reviews. Product innovation can also benefit from text mining, which can uncover customer needs and ideas for new products by analyzing things like warranty claims and social media conversations. In short, text mining helps businesses make smarter decisions based on what people are saying.

Reference Books

- 1 Social Marketing in India, Sameer Deshpande, Philip Kotler, Nancy R. Lee, 1st, 31 Oct 2013, SAGE Publications India Pvt Ltd, Dec 2013.
- 2 Marketing with social media, Linda Coles, 1st, 19 February 2015, Wiley, Dec 2014.
- 3 The Social Media Marketing Book, Dan Zarella, 1st Edition, November 2009, "O'Reilly Media, Inc.2009".

23SDM3304E - SOCIAL MEDIA MARKETING ANALYTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3304E	SOCIAL MEDIA MARKETING ANALYTICS	SMMA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To build the awareness about, what social media is, the different platforms it uses, and how it fits into your marketing plan. Create content and goals for social media marketing.	2	PO1, PO3
CO2	Builds the knowledge about Creation and maintain a successful blog. Prepare Facebook and Instagram ads and have a solid grasp of social media page branding.	2	PO1, PO3
CO3	Develop the construction of a video marketing strategy and become familiar with YouTube advertising.	3	PO1, PO3
CO4	Analyze the branding of Twitter Profiles and Ads	4	PO1, PO3
CO5	Discover the use of technologies and consumer-generated content are influencing the direction of social media marketing.	4	PO1, PO3
CO6	Examine the issues in Social Media Marketing Analysis	4	PO1, PO3

Syllabus

Social marketing uses marketing tools for social good. It aims to change behaviors for a better future, like promoting healthy habits or environmental awareness. These campaigns target specific audiences and use a marketing mix (product, price, place, promotion) with a social twist. India has seen success with social marketing in areas like polio eradication and girls' education. Challenges include grabbing attention and limited resources, but digital tools and collaboration offer exciting opportunities for even greater social impact.

Successful social marketing requires a well-defined plan. This includes understanding your target audience (segmentation) and what motivates them (research). Then you can craft a strategy with clear goals and messages delivered through the right channels. Remember, social marketing is about positive change, so act ethically and responsibly throughout the process.

Research is key to social marketing success. You need to understand the social climate, your target audience, and how your campaign performs. There are many tools available, from surveys to social listening. In India, consider the cultural context. Analyzing your audience's behaviors and beliefs is crucial to crafting messages that resonate. Finally, track your progress and measure the impact of your campaign to see if it's achieving its goals.

Social marketers have a toolbox of resources at their disposal. These include research surveys, scheduling platforms, and data analysis software. They also use a social marketing mix, focusing on the desired behavior change and how to promote it. Crafting clear messages and choosing the right channels to reach your target audience is essential. Social marketing can even go beyond campaigns to influence policy changes through advocacy.

Social marketing isn't limited to one area. It tackles various challenges like health (vaccination awareness), environment (recycling campaigns), and education (promoting early childhood learning). It can even address social issues like gender equality or domestic violence. By adapting its approach to each situation, social marketing can create positive change in many aspects of our lives.

Social media like Facebook and LinkedIn are goldmines for marketers. Facebook lets you reach a massive audience and build brand awareness, while LinkedIn is ideal for connecting with professionals in your field. To make the most of these platforms, consider creating compelling digital ads with strong visuals and targeted messaging. By mastering these social media tools, you can take your marketing efforts to the next level.

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- 2 Marketing with social media , Linda Coles, 1st, 19 February 2015, Wiley, Dec 2014 .
- 3 The Social Media Marketing Book , Dan Zarella , 1st Edition, November 2009, O'Reilly Media, Inc.2009.

23SDM3304R - SOCIAL MEDIA MARKETING ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3304R	SOCIAL MEDIA MARKETING ANALYTICS	SMMA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To build the awareness about, what social media is, the different platforms it uses, and how it fits into your marketing plan. Create content and goals for social media marketing.	2	PO1, PO3, PO4
CO2	Builds the knowledge about Creation and maintain a successful blog. Prepare Facebook and Instagram ads and have a solid grasp of social media page branding.	2	PO1, PO3
CO3	Develop the construction of a video marketing strategy and become familiar with YouTube advertising.	3	PO1, PO3
CO4	Analyze the branding of Twitter Profiles and Ads	4	PO1, PO3
CO5	Discover the use of technologies and consumer-generated content are influencing the direction of social media marketing.	4	PO1, PO3
CO6	Examine the issues in Social Media Marketing Analysis	4	PO1, PO3

Syllabus

Social marketing uses marketing tools for social good. It aims to change behaviors for a better future, like promoting healthy habits or environmental awareness. These campaigns target specific audiences and use a marketing mix (product, price, place, promotion) with a social twist. India has seen success with social marketing in areas like polio eradication and girls' education. Challenges include grabbing attention and limited resources, but digital tools and collaboration offer exciting opportunities for even greater social impact.

Successful social marketing requires a well-defined plan. This includes understanding your target audience (segmentation) and what motivates them (research). Then you can craft a strategy with clear goals and messages delivered through the right channels. Remember, social marketing is about positive change, so act ethically and responsibly throughout the process.

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Social marketers have a toolbox of resources at their disposal. These include research surveys, scheduling platforms, and data analysis software. They also use a social marketing mix, focusing on the desired behavior change and how to promote it. Crafting clear messages and choosing the right channels to reach your target audience is essential. Social marketing can even go beyond campaigns to influence policy changes through advocacy.

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Social media like Facebook and LinkedIn are goldmines for marketers. Facebook lets you reach a massive audience and build brand awareness, while LinkedIn is ideal for connecting with professionals in your field. To make the most of these platforms, consider creating compelling digital ads with strong visuals and targeted messaging. By mastering these social media tools, you can take your marketing efforts to the next level.

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- 3 The Social Media Marketing Book, Dan Zarella, 1st Edition, November 2009, "O'Reilly Media, Inc.2009".

23SDM3405M - DIGITAL MEDIA ANALYTICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3405M	DIGITAL MEDIA ANALYTICS	DMA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Data analytics and Inspect assumptions about new media as an egalitarian force	2	PO1, PO2, PSO1
CO2	Apply and implementation of analytics techniques	3	PO1, PO2, PO5, PSO1
CO3	Apply the Principles of Importing, Summarizing, and Visualizing Data using Tableau	3	PO2, PO3, PO5, PSO1
CO4	Exploring and analyzing different media analytics tools	4	PO2, PO3, PO5, PSO1

Syllabus

The process of data analytics uses statistical techniques and software tools to interpret complex data and derive actionable insights and WordPress is a content management system that simplifies the process of creating and managing websites.

Excel advanced functions include complex formulas and tools like VLOOKUP, INDEX-MATCH, and array functions. These functions enhance data analysis and automation capabilities in Excel.

Social media analytics involves analyzing data from social media platforms to understand user behavior and trends. It helps businesses make data-driven decisions to improve engagement and marketing strategies.

Voyant Tools is a web-based application for text analysis, enabling users to visualize and explore textual data interactively. It provides various analytical tools to uncover patterns and insights in text.

Reference Books

- 1 Marketing 4.0: Moving from Traditional to Digital, Philip Kotler, Philip Kotler, Hermawan Kartajaya, 1st edition, 2016, Wiley.
- 2 Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Damian Ryan, 1st Edition, 2009, Kogan Page.
- 3 Word press for web developers- An Introduction for web professionals, Stephanie Leary, Brad William, 2nd edition, 2013, Apress.
- 4 Learning Tableau 2019, Joshua N. Milligan, 3rd edition, 2019, Packt.
- 5 Introduction to Search Engine Optimization, Aakash Shrivastava, G. R. Sinha, Surbhi Bhatia, 1st edition, 2017, Hubspot.

23SDM3406M - ETHICAL SOCIAL MEDIA (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3406M	ETHICAL SOCIAL MEDIA	ESM	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the theoretical underpinnings of ethical social media.	2	PO1, PO2, PO3, PSO1
CO2	Explore advanced topics in social network analysis, sentiment analysis, and topic modeling.	3	PO2, PO3, PO4, PSO1
CO3	Apply Ethical social media techniques to real-world problems and research questions.	3	PO1, PO3, PO4, PSO2
CO4	Analyze ethical considerations and challenges in Ethical social media mining research.	4	PO1, PO3, PO4, PSO2

Syllabus

Introduction to Social Media Mining-Overview of social media platforms and their data such as Facebook, Twitter, Instagram, LinkedIn, and others, Exploration of different types of data available on different platforms, Handling multimedia data (image and video preprocessing), Data mining concepts and techniques and applications, Ethical considerations in social media mining research.

Data Collection from Ethical Social Media-Overview of social media platforms and data sources, Ethical Frameworks and Guidelines, Legal Aspects of Social Media Data Collection, Methods for collecting data from different social media platforms API usage, web scraping, and ethical considerations Data storage and management for social media datasets

Data Mining Techniques and Visual Analysis in Ethical Social Media-Classification algorithms, clustering techniques, and regression algorithms for social media data, Visualization techniques for social media data Graphical representations of networks, trends, and sentiment Tools and libraries for social media data visualization, Applications of Ethical Social Media Mining

Network Analysis in Ethical Social Media-Basics of network analysis and graph theory Social network analysis (SNA) for studying user interactions Identifying communities, Social Media Network Structures, influencers, and trends in social networks, Analytical Techniques in Network Analysis Applications of Network Analysis in Social Media, Future Trends and Challenges.

Reference Books

- 1 Social Media Mining: An Introduction, Reza Zafarani, Mohammad Ali Abbasi, and Huan Liu, 1st Edition, 2014, Cambridge University Press.
- 2 Web Scraping with Python: Collecting More Data from the Modern Web, Ryan Mitchell, 1st Edition, 2015, O'Reilly Media.
- 3 Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber, Jian Pei, 3rd Edition, 2011, Morgan Kaufmann.
- 4 Social Network Analysis: Methods and Applications, Stanley Wasserman, Katherine Faust, 1st Edition, 1994, Cambridge University Press.

23SDM3507 - INTELLIGENT SOCIAL MEDIA MONITORING SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3507	INTELLIGENT SOCIAL MEDIA MONITORING SYSTEMS	ISMMS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate The principles and concepts of intelligent social media monitoring systems	2	PO1, PO3, PO4, PSO1
CO2	Apply data collection and preprocessing techniques for social media data	3	PO1, PO2, PO3, PSO1
CO3	Apply the sentiment analysis techniques to gauge public opinion and sentiment on social media platforms	3	PO2, PO3, PO4, PSO1
CO4	Apply the user profiles and perform user behavior analysis: Develop algorithms to detect and respond to significant events and anomalies on social media platforms.	3	PO1, PO2, PO3, PSO1

Syllabus

The importance of social media monitoring for businesses, organizations. The key components and functionalities of intelligent social media monitoring systems and individuals. The principles and concepts of intelligent social media monitoring systems.

The knowledge of various data collection methods for social media platforms. The relevant features from social media data for further analysis. The data collection and preprocessing techniques for social media data

To conduct a comprehensive analysis of competitors, including their products or services, target markets, pricing strategies, distribution channels, marketing tactics, and overall business strategies.

The social media monitoring for businesses and user profiles and perform user behavior analysis: The Develop algorithms to detect and respond to significant events and anomalies on social media platforms.

Reference Books

- 1 Mining Social Media : Finding Stories in Internet Data, Lam Thuy Vo, 1st Edition,2019, Pearson.
- 2 Social Media Mining: An Introduction, Reza Zafarani, Mohammad Ali Abbasi, and Huan Liu, 1st Edition-2014, Cambridge University Press.
- 3 Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, 1st Edition-2015, Pearson.
- 4 Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Instagram, GitHub, and More, Matthew A. Russell, 3rd Edition-2018, O'Reilly Media.

23SDM3508 - SEARCH ENGINE OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SDM3508	SEARCH ENGINE OPTIMIZATION	SEO	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify the fundamentals of search engine optimization (SEO), from how search engines work to career opportunities in the field.	3	PO1, PO2, PSO1
CO2	Apply the evolution of search engine algorithms, SEO best practices, and the impact of game-changing updates like Panda and Penguin.	3	PO2, PO4, PSO1
CO3	Examine the latest SEO strategies, including Core Web Vitals, EAT, YMYL, featured snippets, BERT, and branding, to build a winning keyword strategy.	4	PO1, PO4, PSO1
CO4	Analyze detailed profile of your ideal customer to laser-focus your marketing efforts.	4	PO2, PO4, PSO1

Syllabus

Introduction to Google SEO, Introduction to Search Engine Algorithms, SEO as a Career, How Search Engines Work, Evolution of SEO

Algorithm Updates: History, Part 1, Algorithm Updates: Important Algorithms, Part 2, SEO Best Practices and Ranking Factors, Panda: The Game Changer for Content, Cleaning Up Links with Penguin

Core Web Vitals, EAT & YMYL, Featured Snippets and Rich Snippets, BERT, Evolution of Keyword Optimization, Strengthening Your Keyword Strategy, How Does Branding Influence Website Rank?

Persona Development, Marketing to Your Persona, Getting to Know Your Audience, Creating Your Ideal Buyers Persona

Reference Books

- 1 SEO for Growth: The Ultimate Guide for Marketers, Web Designers & Entrepreneurs Paperback, John Jantsch and Phil Singleton , 2016, Lioncrest Publishing. .
- 2 Search Engine Optimization All-in-One for Dummies , Bruce Clay , 2015, For Dummies .
- 3 The Art of SEO , Eric Enge , 2015, O'Reilly Media. .
- 5 SEO for Dummies, , Peter Kent , 2016, John Wiley & Sons .

23SGT3101A - DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3101A	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	DERSG	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the impact of DERs and smart grids on traditional centralized energy systems and how they contribute to decentralization, reduce transmission losses, and support local energy production.	3	PO1, PO6, PSO1
CO2	Analyze the distributed energy resource system considering factors like load demand, renewable energy sources, and grid interconnection requirements.	4	PO2, PO5, PSO2
CO3	Analyze the energy management and grid operations using smart grid technologies involves a comprehensive analysis of how these technologies optimize energy efficiency, reliability, and sustainability.	4	PO2, PO6, PSO2
CO4	Analyze the data communication Protocols in smart grid technologies to enable efficient and secure exchange of real-time data between devices, ensuring optimized grid operations and integration of renewable energy sources.	4	PO1, PO5, PSO2
CO5	Analyze the Smart Grid Monitoring and AMI Infrastructure, how these technologies enhance grid management, energy efficiency, and consumer engagement.	4	PO4, PO6, PSO2
CO6	Analyze and Testing of the distributed energy resources, it involves understanding their integration, performance, and impact on the electrical grid.	4	PO1, PO4, PSO2
CO7	Simulation or Modelling tool to analyze the behavior and performance of a distributed energy resource system, and tools used effectively by enabling accurate prediction, optimization, and decision-making in renewable energy integration and grid management.	4	PO2, PO5, PSO1

Syllabus

Distributed Energy Resources: Introduction, combined heat and power (CHP) systems, solar photovoltaic (PV) systems, Wind energy conversion systems (WECS), small-scale hydroelectric power generation, batteries, ultra-capacitors, flywheels.

Integration of Distributed Generation to Grid: Introduction, concepts of micro grid, typical micro-grid configurations, AC and DC micro grids, interconnection of micro-grids, protection and control issues in micro-grids, technical and economic advantages of micro-grid, challenges and disadvantages of micro-grid.

Introduction to Smart Grid: Introduction to smart grid, architecture of smart grid, smart grid standards and policies, smart grid components, smart grid technologies, the fundamental components of smart grid designs, and smart-grid activities in India.

Data communication: Introduction, dedicated and shared communication channels, switching techniques, communication channels- layered architecture and protocols.

Smart Grid Monitoring: Load dispatch centers, wide-area monitoring system (WAMS), PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering; demand side management and demand response programs, demand pricing and time of use, real time pricing, peak time pricing, smart grid system monitoring and self-healing.

Reference Books

- 1 Renewable Energy Technologies: Simulation and Economic Evaluation, Anoop Singh and Ashwani Kumar, 2013, CRC Press.
- 2 Distributed Generation: Induction and Permanent Magnet Generators, INIEWSKI, 2012, McGraw-Hill Education India Pvt.Ltd.

- 3 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, IEEE Computer Society Press .
- 4 Smart Grid: Technology and applications, EkanayakeJ., Jenkins N, Liyanage , Wu, J, Yokoyama A., 2012, Wiley Publications.

23SGT3101E - DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3101E	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	DERSG	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the impact of DERs and smart grids on traditional centralized energy systems and how they contribute to decentralization, reduce transmission losses, and support local energy production.	3	PO1, PO4, PSO1
CO2	Analyze the distributed energy resource system considering factors like load demand, renewable energy sources, and grid interconnection requirements.	4	PO2, PO5, PSO2
CO3	Analyze the energy management and grid operations using smart grid technologies involves a comprehensive analysis of how these technologies optimize energy efficiency, reliability, and sustainability.	4	PO1, PO2, PSO1
CO4	Analyze the data communication Protocols in smart grid technologies to enable efficient and secure exchange of real-time data between devices, ensuring optimized grid operations and integration of renewable energy sources	4	PO1, PO2, PSO2
CO5	Analyze the Smart Grid Monitoring and AMI Infrastructure, how these technologies enhance grid management, energy efficiency, and consumer engagement.	4	PO5, PO6, PSO1
CO6	Analyze and Testing of the distributed energy resources, it involves understanding their integration, performance, and impact on the electrical grid.	4	PO4, PO6, PSO2
CO7	Simulation or Modelling tool to analyze the behavior and performance of a distributed energy resource system, and tools used effectively by enabling accurate prediction, optimization, and decision-making in renewable energy integration and grid management.	4	PO1, PO5, PSO1

Syllabus

Distributed Energy Resources: Introduction, combined heat and power (CHP) systems, solar photovoltaic (PV) systems, Wind energy conversion systems (WECS), small-scale hydroelectric power generation, batteries, ultra-capacitors, flywheels.

Integration of Distributed Generation to Grid: Introduction, concepts of micro grid, typical micro-grid configurations, AC and DC micro grids, interconnection of micro-grids, protection and control issues in micro-grids, technical and economic advantages of micro-grid, challenges and disadvantages of micro-grid.

Introduction to Smart Grid: Introduction to smart grid, architecture of smart grid, smart grid standards and policies, smart grid components, smart grid technologies, the fundamental components of smart grid designs, and smart-grid activities in India.

Data communication: Introduction, dedicated and shared communication channels, switching techniques, communication channels, layered architecture and protocols.

Smart Grid Monitoring: Load dispatch centers, wide-area monitoring system (WAMS), PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering; demand side management and demand response programs, demand pricing and time of use, real time pricing, peak time pricing, smart grid system monitoring and self-healing.

Reference Books

- 1 Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, 2012, CRC Press.
- 2 Renewable and Efficient Electric Power System, G. Masters, 2013, Wiley and IEEE Press.
- 3 Smart Grid Infrastructure and Networking, INIEWSKI, 2019, McGraw-Hill Education India Pvt.Ltd.

- 4 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, IEEE Computer Society Press.

23SGT3101R - DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3101R	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	DERSG	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the impact of DERs and smart grids on traditional systems, contributing to decentralization and reducing transmission losses	3	PO1, PO2, PSO1
CO2	Analyze distributed energy resources considering load demand, renewable sources, and grid interconnection.	4	PO1, PO4, PSO1
CO3	Analyze smart grid technologies for optimizing energy efficiency, reliability, and sustainability.	4	PO1, PO2, PSO2
CO4	Analyze Smart Grid Monitoring and AML Infrastructure for enhanced grid management, efficiency, and consumer engagement.	4	PO1, PO2, PSO2
CO5	Analyze and test distributed energy resources for their integration, performance, and impact on the grid.	4	PO2, PO5, PSO2
CO6	Use simulation tools to analyze distributed energy systems for accurate prediction, optimization, and decision-making.	4	PO2, PO6, PSO2

Syllabus

Distributed Energy Resources: Introduction, combined heat and power (CHP) systems, solar photovoltaic (PV) systems, Wind energy conversion systems (WECS), small-scale hydroelectric power generation, batteries, ultra-capacitors, flywheels.

Integration of Distributed Generation to Grid: Introduction, concepts of micro grid, typical micro-grid configurations, AC and DC micro grids, interconnection of micro-grids, protection and control issues in micro-grids,

Introduction to Smart Grid: Introduction to smart grid, architecture of smart grid, smart grid standards and policies, smart grid components, smart grid technologies.

Smart Grid Monitoring: Load dispatch centers, wide area monitoring system (WAMS), PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering; demand side management.

Reference Books

- 1 Renewable Energy Technologies: Simulation and Economic Evaluation, Anoop Singh and Ashwani Kumar, 2013, CRC Press.
- 2 Smart Grid Technology, S.N. Singh, 2013, PHI Learning Pvt. Ltd.
- 3 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, IEEE Computer Society Press .
- 4 Smart Grid: Technology and applications, Ekanayake J., Jenkins N, Liyanage , Wu, J, Yokoyama A., 2012, Wiley Publications.

23SGT3202A - DISTRIBUTION SYSTEM PRACTICES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3202A	DISTRIBUTION SYSTEM PRACTICES	DSP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the power system stability	2	PO1, PO2
CO2	Apply the small signal stability to power systems	3	PO1, PO2
CO3	Analyze Excitation control and Voltage Stability	4	PO1, PO2
CO4	Analyze power system security control	4	PO1, PO2
CO5	Test the small signal stability and power system security using MATLAB	4	PO1, PO2

Syllabus

Power Distribution Network: Types of distribution system, AT&C Loss, calculation of aggregate technical and commercial loss, measures to reduce technical and commercial losses, power distribution from distribution substation to end consumers, categories of consumers, functions of power distribution companies

Substation Erection and Commissioning: Various types of distribution substations, technical specifications of distribution substation equipment, procedure for erection and commissioning of distribution substation, different mounting structures for the transformer, installation procedure of Switchgear, power factors correction panels and control panels, substation automation System (SAS) in power distribution network, importance of capacitor bank.

Distribution System Protection: Various distribution system protections, surge voltages along with various surge protection devices, importance of lightening arrestor (LA) in distribution network, earthing of distribution system, different grounding systems.

Testing of the Equipment in Power Distribution: Testing of distribution transformer and associated components, routine test on the equipment, importance of insulation resistance testing, polarisation index and absorption index, importance of magnetic balance test of transformer, test the earthing resistance in distribution system, various tests on current transformer, capacitive voltage transformer, lightning arrestor, circuit breaker, energy meter etc. to ensure their healthiness.

Introduction to Small Signal Stability, Power System Modeling in MATLAB, Eigenvalue Analysis and Stability Assessment, Control System Design for Stability Enhancement, Power Flow Analysis Using MATLAB, Case Studies and Practical Applications

Reference Books

- 1 Electric Power Distribution System Engineering, Turan Gonen, 3rd Edition, CRC Press.
- 2 Electrical Power Distribution and Transmission, Lucus M. Faulkenberry, Walter Coffey, 1, Pearson.
- 3 Electric Power Distribution Equipment and Systems, Thomas Allen Short, 1, CRC Press.
- 4 Distribution System Modeling and Analysis, William H. Kersting, 4, CRC Press.
- 5 Electrical Distribution Systems, Dale R. Patrick, Stephen W. Fardo, 2, CRC Press.

23SGT3202E - DISTRIBUTION SYSTEM PRACTICES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3202E	DISTRIBUTION SYSTEM PRACTICES	DSP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the power system stability	2	PO1, PO2
CO2	Apply the small signal stability to power systems	3	PO1, PO2
CO3	Analyze Excitation control and Voltage Stability	4	PO1, PO2
CO4	Analyze power system security control	4	PO1, PO2
CO5	Test the small signal stability and power system security using MATLAB	4	PO1, PO2

Syllabus

Power Distribution Network: Types of distribution system, AT&C Loss, calculation of aggregate technical and commercial loss, measures to reduce technical and commercial losses, power distribution from distribution substation to end consumers, categories of consumers, functions of power distribution companies

Substation Erection and Commissioning: Various types of distribution substations, technical specifications of distribution substation equipment, procedure for erection and commissioning of distribution substation, different mounting structures for the transformer, installation procedure of Switchgear, power factors correction panels and control panels, substation automation System (SAS) in power distribution network, importance of capacitor bank.

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- 3 Electric Power Distribution Equipment and Systems, Thomas Allen Short, 1, CRC Press.
- 4 Distribution System Modeling and Analysis, William H. Kersting, 4, CRC Press.
- 5 Electrical Distribution Systems, Dale R. Patrick, Stephen W. Fardo, 2, CRC Press.

23SGT3202R - DISTRIBUTION SYSTEM PRACTICES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3202R	DISTRIBUTION SYSTEM PRACTICES	DSP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the power system stability	2	PO1, PO2
CO2	Apply the small signal stability to power systems	3	PO1, PO2
CO3	Analyze Excitation control and Voltage Stability	4	PO1, PO2
CO4	Analyze power system security control	4	PO1, PO2
CO5	Test the small signal stability and power system security using MATLAB	4	PO1, PO2

Syllabus

Power Distribution Network: Types of distribution system, AT&C Loss, calculation of aggregate technical and commercial loss, measures to reduce technical and commercial losses, power distribution from distribution substation to end consumers, categories of consumers, functions of power distribution companies

Substation Erection and Commissioning: Various types of distribution substations, technical specifications of distribution substation equipment, procedure for erection and commissioning of distribution substation, different mounting structures for the transformer, installation procedure of Switchgear, power factors correction panels and control panels, substation automation System (SAS) in power distribution network, importance of capacitor bank.

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Introduction to Small Signal Stability, Power System Modeling in MATLAB, Eigenvalue Analysis and Stability Assessment, Control System Design for Stability Enhancement, Power Flow Analysis Using MATLAB, Case Studies and Practical Applications

Reference Books

- 1 Electric Power Distribution System Engineering, Turan Gonen, 3rd Edition, CRC Press.
- 2 Electrical Power Distribution and Transmission, Lucus M. Faulkenberry, Walter Coffey, 1, Pearson.
- 3 Electric Power Distribution Equipment and Systems, Thomas Allen Short, 1, CRC Press.
- 4 Distribution System Modeling and Analysis, William H. Kersting, 4, CRC Press.
- 5 Electrical Distribution Systems, Dale R. Patrick, Stephen W. Fardo, 2, CRC Press.

23SGT3203A - MICROGRID DYNAMICS AND CONTROL (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3203A	MICROGRID DYNAMICS AND CONTROL	MDC	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand of AC and DC microgrids	2	PO1
CO2	To apply the dynamic modelling of microgrids	3	PO2
CO3	To apply the different hierarchical control schemes for microgrid system and communication implementation of hierarchical control	3	PO3
CO4	To apply the stability in microgrids and alternate options for stability improvement in microgrids	3	PO4
CO6	Ability to analyze the dynamics control on microgrid	4	

Syllabus

Introduction to the concept of microgrid, the overview of the structure and architecture of microgrid with brief control, operational aspects. Till date pilot microgrid projects and their outcomes. Dynamic modelling of individual components in AC and DC microgrids, state space modal analysis and influence of system parameters on the microgrid dynamics, brief concept on the design of microgrid stabilizers to improve stability

Hierarchical control scheme for microgrids: Control Objectives in AC Microgrids, bottleneck with only local control, need of secondary and tertiary control, implementation of hierarchical control with centralized and distributed control schemes for AC and DC microgrids. Advantages and disadvantages of centralized and distributed control schemes.

Multi-microgrid coordination and control: AC-AC, AC-DC and DC-DC microgrid clustering, coordinated control schemes in multi-microgrids, frequency, voltage regulations and volt-VAR support.

Control of Smart Power Grid System: Load Frequency Control (LFC) in Micro Grid System-Voltage Control in Micro Grid System - Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.

modeling and simulating microgrid systems, analyzing dynamic behavior under various load conditions, and implementing control strategies for stability and efficiency. Labs will also include real-time monitoring and control of microgrid components using industry-standard software and hardware tools.

Reference Books

- 1 Microgrids Architecture and control, N. D. Hatziargyriou, 2014, John Wiley & Sons.
- 2 Microgrid Dynamics and Control, H. Bevrani, B. Francois, and T. Ise, 2017, John Wiley & Sons.
- 3 Power System Stability and Control, P. Kundur, 1994, McGraw-Hill.
- 4 Smart Grid Protection, Ali Chowdhury, Don Taylor, John Scaglione, 2020, CRC Press.
- 5 Microgrid Protection and Control, Papia Ray, Soumya Ranjan Mohanty, 2020, Wiley.

23SGT3203E - MICROGRID DYNAMICS AND CONTROL (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3203E	MICROGRID DYNAMICS AND CONTROL	MDC	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand of AC and DC microgrids	2	PO1
CO2	To apply the dynamic modelling of microgrids	3	PO2
CO3	To apply the different hierarchical control schemes for microgrid system and communication implementation of hierarchical control	3	PO3
CO4	To apply the stability in microgrids and alternate options for stability improvement in microgrids	3	PO4
CO6	Ability to analyze the dynamics control on microgrid	4	

Syllabus

Introduction to the concept of microgrid, the overview of the structure and architecture of microgrid with brief control, operational aspects. Till date pilot microgrid projects and their outcomes. Dynamic modelling of individual components in AC and DC microgrids, state space modal analysis and influence of system parameters on the microgrid dynamics, brief concept on the design of microgrid stabilizers to improve stability

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Multi-microgrid coordination and control: AC-AC, AC-DC and DC-DC microgrid clustering, coordinated control schemes in multi-microgrids, frequency, voltage regulations and volt-VAR support.

Control of Smart Power Grid System: Load Frequency Control (LFC) in Micro Grid System-Voltage Control in Micro Grid System - Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.

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Reference Books

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- 3 Power System Stability and Control, P. Kundur, 1994, McGraw-Hill.
- 4 Smart Grid Protection, Ali Chowdhury, Don Taylor, John Scaglione, 2020, CRC Press.
- 5 Microgrid Protection and Control, Papia Ray, Soumya Ranjan Mohanty, 2020, Wiley.

23SGT3203R - MICROGRID DYNAMICS AND CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3203R	MICROGRID DYNAMICS AND CONTROL	MDC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand of AC and DC microgrids	2	PO1
CO2	To apply the dynamic modelling of microgrids	3	PO2
CO3	To apply the different hierarchical control schemes for microgrid system and communication implementation of hierarchical control	3	PO3
CO4	To apply the stability in microgrids and alternate options for stability improvement in microgrids	3	PO4
CO6	Ability to analyze the dynamics control on microgrid	4	

Syllabus

Introduction to the concept of microgrid, the overview of the structure and architecture of microgrid with brief control, operational aspects. Till date pilot microgrid projects and their outcomes. Dynamic modelling of individual components in AC and DC microgrids, state space modal analysis and influence of system parameters on the microgrid dynamics, brief concept on the design of microgrid stabilizers to improve stability.

Hierarchical control scheme for microgrids: Control Objectives in AC Microgrids, bottleneck with only local control, need of secondary and tertiary control, implementation of hierarchical control with centralized and distributed control schemes for AC and DC microgrids. Advantages and disadvantages of centralized and distributed control schemes.

Multi-microgrid coordination and control: AC-AC, AC-DC and DC-DC microgrid clustering, coordinated control schemes in multi-microgrids, frequency, voltage regulations and volt-VAR support.

Control of Smart Power Grid System: Load Frequency Control (LFC) in Micro Grid System-Voltage Control in Micro Grid System - Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.

modeling and simulating microgrid systems, analyzing dynamic behavior under various load conditions, and implementing control strategies for stability and efficiency. Labs will also include real-time monitoring and control of microgrid components using industry-standard software and hardware tools.

Reference Books

- 1 Microgrids Architecture and control, N. D. Hatziargyriou, 2014, John Wiley & Sons.
- 2 Microgrid Dynamics and Control, H. Bevrani, B. Francois, and T. Ise, 2017, John Wiley & Sons.
- 3 Power System Stability and Control, P. Kundur, 1994, McGraw-Hill.
- 4 Smart Grid Protection, Ali Chowdhury, Don Taylor, John Scaglione, 2020, CRC Press.
- 5 Microgrid Protection and Control, Papia Ray, Soumya Ranjan Mohanty, 2020, Wiley.

23SGT3304A - ENERGY MANAGEMENT SYSTEMS AND SCADA (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3304A	ENERGY MANAGEMENT SYSTEMS AND SCADA	EMS&SCADA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA System Components, SCADA Architecture, advantages and disadvantages of each system, single unified standard architecture, IEC 61850, SCADA Communication.	2	PO1, PO5
CO2	Understand the Utility applications, Energy management applications in Transmission sector and Energy management applications in Distribution sector, operations, monitoring, analysis and improvement.	2	PO1, PO5
CO3	Apply the knowledge of Smart substations, Substation Automation, Feeder Automation, SCADA , Remote Terminal Unit, Protocols, Phasor Measurement Unit, Smart integration of energy resources, Renewable energy sources, intermittent power sources, Energy Storage. on transmission system.	3	PO1, PO5
CO4	Apply the knowledge of Volt / VAR control, Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, CIS & GIS, Load Management Systems, Load analysis and forecasting, remote automatic meter reading. on distribution system.	3	PO1, PO5
CO5	Analyze the characteristics of SCADA components, Communication technologies, SCADA Architecture, Smart substations, Remote Terminal Unit using Software Tools.	4	PO1, PO5
CO6	Analyze the operational characteristics of Energy Management System, Phasor Measurement Unit, Smart integration of energy resources, Renewable energy sources, intermittent power sources, Energy Storage. and SCADA components	4	PO1, PO5
CO7	Analyze the controls characteristics of SCADA system, Phasor Measurement Unit, Smart integration of energy resources, Renewable energy sources, intermittent power sources, Energy Storage. using Software Tools.	4	PO1, PO5

Syllabus

Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA System Components. SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850. SCADA Communication.

Utility applications, Energy management applications in Transmission sector and Energy management applications in Distribution sector, operations, monitoring, analysis and improvement.

Introduction, Smart substations, Substation Automation , Feeder Automation, SCADA , Remote Terminal Unit, Protocols, Phasor Measurement Unit, Smart integration of energy resources, Renewable, intermittent power sources, Energy Storage.

Introduction, Volt / VAR control , Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, CIS & GIS, Load Management Systems, functions of load management systems: Load analysis and forecasting, remote automatic meter reading.

Modelling and simulation of EMS compoenets using MATLAB. Modelling and simulation of SCADA compoenets using MATLAB.

Reference Books

- 1 Energy Management Handbook , Turner, W. C , 2004, Fairmont Press, Inc. .

- 2 A Guide to Utility Automation: AMR, SCADA, and IT Systems , Wiebe, Michael , 1999, Pennwell Books .
- 3 Practical SCADA for industry , Bailey, D., and E. Wright , 2003, Newnes .
- 4 Energy Management Systems, Handschin, E, 2012, Springer Verlag.

23SGT3304E - ENERGY MANAGEMENT SYSTEMS AND SCADA (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3304E	ENERGY MANAGEMENT SYSTEMS AND SCADA	EMS&SCADA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA System Components, SCADA Architecture, advantages and disadvantages of each system, single unified standard architecture, IEC 61850, SCADA Communication.	2	PO5
CO2	Understand the Utility applications, Energy management applications in Transmission sector and Energy management applications in Distribution sector, operations, monitoring, analysis and improvement.	2	PO5
CO3	Apply the knowledge of Smart substations, Substation Automation, Feeder Automation, SCADA, Remote Terminal Unit, Protocols, Phasor Measurement Unit, Smart integration of energy resources, Renewable energy sources, intermittent power sources, Energy Storage. on transmission system.	3	PO5
CO4	Apply the knowledge of Volt / VAR control, Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, CIS & GIS, Load Management Systems, Load analysis and forecasting, remote automatic meter reading. on distribution system.	3	PO5
CO5	Analyze the characteristics of SCADA components, Communication technologies, SCADA Architecture, Smart substations, Remote Terminal Unit using Software Tools.	4	PO5
CO6	Analyze the operational characteristics of Energy Management System, Phasor Measurement Unit, Smart integration of energy resources, Renewable energy sources, intermittent power sources, Energy Storage. and SCADA components	4	PO5
CO7	Analyze the controls characteristics of SCADA system, Phasor Measurement Unit, Smart integration of energy resources, Renewable energy sources, intermittent power sources, Energy Storage. using Software Tools.	4	PO5

Syllabus

Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA System Components. SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850. SCADA Communication.

SCADA Applications: Utility applications, Transmission and Distribution sector -operations, monitoring, analysis and improvement.

Energy Management Systems (EMS): Introduction, Smart substations, Substation Automation, Feeder Automation, SCADA, Remote Terminal Unit, Protocols, Phasor Measurement Unit, Smart integration of energy resources, Renewable, intermittent power sources, Energy Storage.

Distribution Management System (DMS): Introduction, Volt / VAR control, Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, CIS & GIS, Load Management Systems, functions of load management systems: Load analysis and forecasting, remote automatic meter reading.

Modelling and simulation of EMS compoenets using MATLAB. Modelling and simulation of SCADA compoenets using MATLAB.

Reference Books

- 1 Energy Management Handbook , Turner, W. C , 2004, Fairmont Press, Inc. .

- 2 A Guide to Utility Automation: AMR, SCADA, and IT Systems , Wiebe, Michael , 1999, Pennwell Books .
- 3 Practical SCADA for industry , Bailey, D., and E. Wright , 2003, Newnes .
- 4 Energy Management Systems, Handschin, E, 2012, Springer Verlag.

23SGT3304R - ENERGY MANAGEMENT SYSTEMS AND SCADA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3304R	ENERGY MANAGEMENT SYSTEMS AND SCADA	EMS&SCADA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA System Components, SCADA Architecture, advantages and disadvantages of each system, single unified standard architecture, IEC 61850, SCADA Communication.	2	PO1, PO5
CO2	Understand the Utility applications, Energy management applications in Transmission sector and Energy management applications in Distribution sector, operations, monitoring, analysis and improvement.	2	PO1, PO5
CO3	Apply the knowledge of Smart substations, Substation Automation, Feeder Automation, SCADA , Remote Terminal Unit, Protocols, Phasor Measurement Unit, Smart integration of energy resources, Renewable energy sources, intermittent power sources, Energy Storage. on transmission system.	3	PO1, PO5
CO4	Apply the knowledge of Volt / VAR control, Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, CIS & GIS, Load Management Systems, Load analysis and forecasting, remote automatic meter reading. on distribution system.	3	PO1, PO5
CO5	Analyze the operational characteristics of Energy Management System, Phasor Measurement Unit, Smart integration of energy resources, Renewable energy sources, intermittent power sources, Energy Storage. and SCADA components	4	PO1, PO5
CO6	Analyze the controls characteristics of SCADA system, Phasor Measurement Unit, Smart integration of energy resources, Renewable energy sources, intermittent power sources, Energy Storage. using Software Tools.	4	PO1, PO5

Syllabus

Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA System Components. SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850. SCADA Communication.

Utility applications, Transmission and Distribution sector -operations, monitoring, analysis and improvement.

Introduction, Smart substations, Substation Automation, Feeder Automation, SCADA ,Remote Terminal Unit, Protocols, Phasor Measurement Unit, Smart integration of energy resources, Renewable, intermittent power sources, Energy Storage.

Introduction, VoltVAR control, Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage management System, CIS and GIS, Load Management Systems, functions of load management systems: Load analysis and forecasting, remote automatic meter reading.

Reference Books

- 1 Energy Management Handbook , Turner, W. C , 2004, Fairmont Press, Inc. .
- 2 A Guide to Utility Automation: AMR, SCADA, and IT Systems , Wiebe, Michael , 1999, Pennwell Books .
- 3 Practical SCADA for industry, Bailey, D., and E. Wright, 2003, Newnes.
- 4 Energy Management Systems, Handschin, E, 1990, Springer Verlag.

23SGT3405M - SMART GRID COMMUNICATION AND CYBERSECURITY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3405M	SMART GRID COMMUNICATION AND CYBERSECURITY	SGCCS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts and components of smart grids with an emphasis on the crucial role of communication technologies.	3	PO1, PO6, PSO1
CO2	Analyze the various security measures and potential threats associated with communication technologies in smart grids.	4	PO2, PO5, PSO2
CO3	Analyze the the specific communication protocols and their roles in enhancing substation operations.	4	PO1, PO4, PSO2
CO4	Analyze the various hacking techniques and potential threats targeting smart grid infrastructures.	4	PO2, PO5, PSO2

Syllabus

Communication Technologies for the Smart Grid: Different types of Communication technologies for the smart grid. Standards for information exchange, DNP3.

Information Security for the Smart Grid and Measurement Technology: Introduction, Encryption and Decryption Authentication, Digital signature, Message digest, cyber security standards. Communication and Measurement, Monitoring, Advanced metering infrastructure.

Interoperability and Standards: Introduction-Benefits and Challenges Of Interoperability, Model For Smart Grid Network Interoperability, Approach to Smart Grid Interoperability Standards, NIST Standards.

Hacking and Cyber-security: Identifying a target Vulnerability, Attack tools-Attack methods-Cyber security architecture, SGCG reference architecture, ISA62443: zones and conduits and Smart Grids.

Reference Books

- 1 Smart Grid Communication and Cybersecurity: Concepts, Architecture, and Challenges , Dr. Brijesh Kumar Singh and Dr. Sanjay Kumar Singh, 2013, Springer.
- 2 Cyber Security for Smart Grid Systems: Concepts, Challenges, and Solution , Dr. S. S. Tyagi and Dr. Sudhir Kumar Sharma., 2012, CRC Press.
- 3 Smart Grid: Fundamentals of Design and Analysis , James Momoh, 2012, IEEE Computer Society Press.
- 4 The Smart Grid: Enabling Energy Efficiency and Demand Response , Clark W. Gellings, 2018, CRC Press .

23SGT3406M - SMART METERS AND SMART CITIES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3406M	SMART METERS AND SMART CITIES	SMSC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the historical development and transformation of traditional power grids into smart grids.	2	PO1, PO5, PSO1
CO2	Apply the key standards and initiatives relevant to smart city development and effectively apply them to enhance urban infrastructure and services.	3	PO2, PO4, PSO2
CO3	Analyze the principles of Energy Management Systems (EMS), Demand Side Management (DSM) and their roles in optimizing smart grid operations and energy efficiency.	4	PO1, PO6, PSO2
CO4	Analyze the functionalities of smart meters and assess their benefits in enhancing energy management and efficiency within smart city infrastructures.	4	PO2, PO4, PSO2

Syllabus

Smart Grid and Distribution System Architecture - Introduction to Smart Grid - Evolution of Electric Grid-Definitions and Need for Smart Grid -Smart grid drivers, functions, opportunities, challenges and benefits- Initiatives for Smart

Smart CitiesIntroduction and Characteristics of Smart Cities- Planning, Designing and Implementation of Smart Cities- Smart Cities Standards and Initiatives- Challenges and Success Factors-Smart City case study

Energy Management Systems and Demand Side Management Work Contents of DSM Implementation by Power Grid Enterprises-Condition for Promoting Power Grid Enterprises to Actively Develop DSM Program

Advanced Metering Infrastructure AMI Types of Loads, Evolution , Benefits and needs of Smart metering and AMI ,Protocols,Security ,Home local area networks HANs , NAN,WAN, Data concentrator,Meter Data Management Systems MDMS,Operational Gateways

Reference Books

- 1 Smart Cities: Foundations, Principles, and Application, HafizurRahaman and Muhammad Mostafa Monowar, 2017, John Wiley & sons Limited .
- 2 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, IEEE Computer Society Press .
- 3 Smart Cities, Claude Rochet, 2012, Wiley.
- 4 The Smart Grid: Enabling Energy Efficiency and Demand Response, Clark W. Gellings, 2014, CRC Press.

23SGT3507 - INTERNET OF THINGS AND SMART GRID ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3507	INTERNET OF THINGS AND SMART GRID ANALYTICS	IOT&SGA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the network protocols and standards, and apply this knowledge to design and maintain efficient and secure communication networks.	2	PO1, PO4, PSO1
CO2	Apply the architectures of IoT systems and data analytics frameworks to optimize data collection, processing, and utilization for enhanced decision-making and operational efficiency.	3	PO2, PO5, PSO2
CO3	Analyze the various applications of IoT technologies in smart grids to enhance monitoring, control, and optimization of energy distribution and consumption.	4	PO1, PO5, PSO2
CO4	Analyze the principles and applications of big data analytics to extract valuable insights, optimize decision-making processes, and enhance operational efficiency across various domains.	4	PO2, PO6, PSO2

Syllabus

Networking Protocols and Standards for Internet of Things: Introduction, IoT Data Link Protocols, Network Layer Routing Protocols, Network Layer Encapsulation Protocols, Session Layer Protocols, IoT Management Protocols, Security in IoT Protocols, IoT Challenges.

IoT Architecture: Introduction, Architectural Approaches, Business Architecture, Functional Architecture, Application Architecture, Data and Analytics Architecture, Technology Architecture, Security and Governance.

Applications of IOT to Smart Grid: Energy monitoring, energy harvesting, smart parking, smart medium access in mobile IOT.

Introduction to Big Data Analytics: Attributes of Big Data: Volume of data, velocity of data, variety of data; Overview of big data analytics, benefits of big data analytics, big data analytics for smart grids, big data analytics tools. Smart Grid Data Management and Applications: Smart Meter Data Management: Smart metering architecture, challenges and opportunities, smart meter data management, future trends and issues; PHEVs: Internet of Vehicles: Convergence of PHEVs and internet of vehicles, electric vehicles management, future trends and issues; Smart Buildings: Concept of smart buildings, challenges and opportunities, different approaches for establishing smart buildings, future trends and issues.

Reference Books

- 1 Smart Grid in IoT-enabled Spaces: The Road to Intelligence in Power, Al-Turjman, Fadi, 2020, CRC Pres.
- 2 Smart Grid Technology: A Cloud Computing and Data Management Approach, Misra, Sudip, and Samaresh Bera, 2018, Cambridge University Press.
- 3 . Internet of things and data analytics handbook, Geng, Hwaiyu, ed, 2017, John Wiley & Sons.
- 4 Internet of Things and Big Data Analytics for Smart Generation, Valentina E. Balas, Sangeeta Mohanty, Raghvendra Kumar, Rajshree Srivastava, 2019, Springer.

23SGT3508 - SMART GRID PROTECTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SGT3508	SMART GRID PROTECTION	SGP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To Understand basic concepts of advanced protection systems	2	PO1, PO3
CO2	To Apply relay algorithms and associated hardware	3	PO3, PO4
CO3	To understand the principles of modern protection systems for substation, transformer, generator and motor	2	PO1, PO2
CO4	To apply the advanced Protection for Smart Grid	3	PO3, PO4
CO6	Ability to analyze the different technologies for smart grid protection	4	PO1

Syllabus

Introduction to the concept of microgrid, the overview of the structure and architecture of microgrid with brief control, operational aspects. Till date pilot microgrid projects and their outcomes. Dynamic modelling of individual components in AC and DC microgrids, state space modal analysis and influence of system parameters on the microgrid dynamics, brief concept on the design of microgrid stabilizers to improve stability.

Hierarchical control scheme for microgrids: Control Objectives in AC Microgrids, bottleneck with only local control, need of secondary and tertiary control, implementation of hierarchical control with centralized and distributed control schemes for AC and DC microgrids. Advantages and disadvantages of centralized and distributed control schemes.

Multi-microgrid coordination and control: AC-AC, AC-DC and DC-DC microgrid clustering, coordinated control schemes in multi-microgrids, frequency, voltage regulations and volt-VAR support.

Control of Smart Power Grid System - Load Frequency Control (LFC) in Micro Grid System - Voltage Control in Micro Grid System - Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.

Reference Books

- 1 Computer Relaying for Power systems, G. Phadke and James S. Thorp, 2009, John Wiley & Sons.
- 2 Wide Area Monitoring, protection and control systems the enabler for smarter grids, Vaccaro, Alfredo Zobaa, Ahmed. F, 2014, IET publisher.
- 3 Fundamentals of Power System Protection, Y. G. Paithankar and S. R. Bhide, 2010, Prentice Hall of India.
- 4 Smart Grids: Infrastructure, Technology, and Solutions, Stuart Borlase, 2012, CRC Press.
- 5 Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, 2012, Wiley.

23SMD3101A - SOFTWARE VERIFICATION & VALIDATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3101A	SOFTWARE VERIFICATION & VALIDATION	SVV	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts, terminologies, and techniques essential in the domain of software verification and validation.	2	PO2, PO4, PSO1
CO2	Identify the intricacies of the software verification and validation process, focusing on identifying and understanding the various stages and activities involved.	3	PO2, PO5, PSO1
CO3	Apply with the practical skills and theoretical knowledge necessary to apply principles and theories in the domain of software verification and validation.	3	PO2, PO6, PSO1
CO4	Apply various software verification and validation artifacts, including test plans, test cases, and defect reports.	3	PO2, PO6, PSO1
CO5	Analyse a comprehensive understanding of the different tools and technologies available for automating software testing and enhancing the efficiency of the verification and validation processes.	4	PO2, PO5, PSO1
CO6	Analyse and assess the impact of software defects on system behaviour, performance, and reliability.	4	PO2, PO5, PSO1
CO7	Comprehensive analysis of various Agile practices underlying software verification and validation.	4	PO2, PO5, PSO1

Syllabus

Introduction to Software Verification and Validation, Software Testing Fundamentals ,Testing objectives, testing lifecycles, Test cases, human error, testing and debugging, general principles of testing, test metric.

Agile methodology and Its Impact on Testing, Verification and Validation. Failure, Error, Fault, and Defect. Agile methodology significantly impacts testing, verification, and validation by promoting continuous integration, automated testing, and collaborative efforts.

Testing Approaches - Static testing, structured group, examination static analysis, Control flow and data flow Testing, Determining Metrics, Dynamic Testing, Black Box testing, equivalence Class Portioning, BoundaryValue Analysis, state transition test, cause effect graphing and decision table technique and used case and Advanced black box and white box techniques. Gray box testing, intuitive and Experience based

Verification and validation planning, Top down versus bottom- up Testing Functional Vs Structured Testing, mutation testing, Test planning and Management, Testing process, Maturity Models. Types of Testing- Concept of Unit Testing, Domain testing, Concept of Integration Testing. System testing acceptance testing, Alpha &Beta testing, Installation Testing, Usability Testing, Regression testing.

System Tests- Performance testing, Load testing, Stress testing, Security testing, Gorilla testing, Syntax Based Testing, Functionality Tests, Robustness Tests, Interoperability Tests, Scalability Tests, Documentation Tests

Test Driven Development: Agile Model Driven Development, Acceptance Tdd, Developer Tdd. TDD, in its various forms AMDD, ATDD, and Developer TDD plays a crucial role in Agile development by promoting high code quality, early bug detection, and continuous feedback.

Various Agile practices underlying software verification and validation. Agile methodologies emphasize iterative development, continuous feedback, and collaboration, which significantly influence how software verification and validation (V&V) are conducted.

Reference Books

- 1 Software Verification and Validation for Practitioners and Managers, Steven R. Rakitin, 2001, Auerbach Publications.
- 2 Foundations of Software Testing _ Fundamental Algorithms and Techniques, Aditya P. Mathur, 2008, Pearson Education.
- 3 Software Testing and Continuous Quality Improvement, William E. Lewis, 1999, Auerbach Publications.
- 4 Software Testing: Principles and Practices, Srinivasan Desikan and Gopalaswamy Ramesh, 2006, Pearson Education.
- 5 Introduction to Software Testing, Paul Ammann and Jeff Offutt, 2008, Cambridge University Press.
- 6 The Art of Software Testing, Glenford J. Myers, Corey Sandler, and Tom Badgett, 1979, Wiley.

23SMD3101E - SOFTWARE VERIFICATION & VALIDATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3101E	SOFTWARE VERIFICATION & VALIDATION	SVV	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts, terminologies, and techniques essential in the domain of software verification and validation.	2	PO2, PO4, PSO1
CO2	Identify the intricacies of the software verification and validation process, focusing on identifying and understanding the various stages and activities involved	3	PO2, PO5, PSO1
CO3	Apply with the practical skills and theoretical knowledge necessary to apply principles and theories in the domain of software verification and validation	3	PO2, PO6, PSO1
CO4	Apply various software verification and validation artifacts, including test plans, test cases, and defect reports.	3	PO4, PO6, PSO1
CO5	Analyse a comprehensive understanding of the different tools and technologies available for automating software testing and enhancing the efficiency of the verification and validation processes.	4	PO2, PO5, PSO1
CO6	Analyze and assess the impact of software defects on system behavior, performance and reliability	4	PO2, PO5, PSO1
CO7	Comprehensive analysis of various Agile practices underlying software verification and validation	4	PO2, PO5, PSO1

Syllabus

Introduction to Software Verification and Validation, Software Testing Fundamentals ,Testing objectives, testing lifecycles, Test cases, human error, testing and debugging, general principles of testing, test metric

2 Agile methodology and Its Impact on Testing, Verification and Validation. Failure, Error, Fault, and Defect. Agile methodology significantly impacts testing, verification, and validation by promoting continuous integration, automated testing, and collaborative efforts.

Testing Approaches - Static testing, structured group, examination static analysis, Control flow and data flow Testing, Determining Metrics, Dynamic Testing, Black Box testing, equivalence Class Portioning, BoundaryValue Analysis, state transition test, cause effect graphing and decision table technique and used case and Advanced black box and white box techniques. Gray box testing, intuitive and Experience based

Verification and validation planning, Top down versus bottom- up Testing Functional Vs Structured Testing, mutation testing, Test planning and Management, Testing process, Maturity Models. Types of Testing- Concept of Unit Testing, Domain testing, Concept of Integration Testing. System testing acceptance testing, Alpha &Beta testing, Installation Testing, Usability Testing, Regression testing.

System Tests- Performance testing, Load testing, Stress testing, Security testing, Gorilla testing, Syntax Based Testing, Functionality Tests, Robustness Tests, Interoperability Tests, Scalability Tests, Documentation Tests

Test Driven Development: Agile Model Driven Development, Acceptance Tdd, Developer Tdd. TDD, in its various forms AMDD, ATDD, and Developer TDD plays a crucial role in Agile development by promoting high code quality, early bug detection, and continuous feedback.

Various Agile practices underlying software verification and validation. Agile methodologies emphasize iterative development, continuous feedback, and collaboration, which significantly influence how software verification and validation (V&V) are conducted.

Reference Books

- 1 Software Verification and Validation for Practitioners and Managers, Steven R. Rakitin, 2001, Auerbach Publications.
- 2 Foundations of Software Testing _ Fundamental Algorithms and Techniques, Aditya P. Mathur, 2008, Pearson Education.
- 3 Software Testing and Continuous Quality Improvement, William E. Lewis, 1999, Auerbach Publications.
- 4 Software Testing: Principles and Practices, Srinivasan Desikan and Gopalaswamy Ramesh, 2006, Pearson Education.
- 5 Introduction to Software Testing, Paul Ammann and Jeff Offutt, 2008, Cambridge University Press.
- 6 The Art of Software Testing, Glenford J. Myers, Corey Sandler, and Tom Badgett, 1979, Wiley.

23SMD3101R - SOFTWARE VERIFICATION & VALIDATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3101R	SOFTWARE VERIFICATION & VALIDATION	SVV	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate fundamental concepts, terminologies, and techniques used in software verification and validation	2	PO2, PO4, PSO1
CO2	Identify different stages and activities involved in the software verification and validation process	3	PO2, PO5, PSO1
CO3	Apply the principles and theories underlying software verification and validation	3	PO2, PO6, PSO1
CO4	Analyze various software verification and validation artifacts, such as test plans, test cases, and defect reports	3	PO2, PO5, PO6, PSO1
CO5	To Test the software application completely and make it sure that its performing well and as per the specifications.	4	PO2, PO5, PSO1
CO6	Analyzing and assessing the impact of software defects on system behavior, performance, and reliability is crucial for ensuring the quality and stability of software systems.	4	PO2, PO5, PSO1

Syllabus

Testing objectives, Testing lifecycles, Test cases, human error, testing and debugging, general principles of testing, test metrics, Agile methodology and Its Impact on Testing, Verification and Validation. Failure, Error, Fault, and Defect.

Testing Approaches - Static testing, structured group, examination static analysis, Control flow and data flow Testing, Determining Metrics, Dynamic Testing, Black Box testing, equivalence Class Portioning, Boundary Value Analysis, state transition test, cause effect graphing and decision table technique and used case and Advanced black box and white box techniques.

Gray box testing, intuitive and Experience based. verification and validation planning, Top down versus bottom up Testing Functional Vs Structured Testing, mutation testing, Test planning and Management, Testing process, Maturity Models. Types of Testing- Concept of Unit Testing, Domain testing, Concept of Integration Testing. System testing acceptance testing, Alpha & Beta testing, Installation Testing, Usability Testing, Regression testing.

System Tests- Performance testing, Load testing, Stress testing, Security testing, Gorilla testing, Syntax Based Testing , Functionality Tests ,Robustness Tests, Interoperability Tests, Scalability Tests, Documentation Requirement verification, Coding standards, Walk through, Formal Inspection, Design validation and verification, Function test, Design metrics, correctness proof and its requirement, Building Test Cases and Plans: Format of test cases, Du, dc and other data paths, Test data selection, branch coverage, statement coverage, pre-condition and post-condition, Test schedule and check pointing, Case study for creating test cases

Debugging Technique and Tools . Integrated development environment, debugging, tracing, data inspection, exception errors, code and data redundancy, unreachable code. effective use of integrated development environments and debugging tools is crucial for identifying, analyzing, and resolving various types of software issues, ranging from logical errors to performance bottlenecks, ultimately improving the quality and reliability of software systems.

Test Driven Development: Agile Model Driven Development, Acceptance Tdd, Developer Tdd. TDD, in its various forms AMDD, ATDD, and Developer TDD plays a crucial role in Agile development by promoting high code quality, early bug detection, and continuous feedback.

Reference Books

- 1 Software Testing, Limaye, 2011, TMH Pub..

- 2 Introduction to Software Testing, Paul Ammann and Jeff Offutt, 2008, Cambridge University Press.
- 3 Foundations of Software Testing _ Fundamental Algorithms and Techniques, Aditya P. Mathur, 2008, Nil.
- 4 Software Testing and Continuous Quality Improvement, William E. Lewis, 1999, Auerbach Publications.
- 5 Software Testing: Principles and Practices, Srinivasan Desikan and Gopalaswamy Ramesh, 2006, Pearson Education.

23SMD3202A - DESIGN PATTERNS & CLEAN CODING TECHNIQUES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3202A	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	DPCT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate how test driven development and refactoring work in software design and maintenance	2	PO3, PSO1
CO2	Understand Structural and Creational patterns for effective design of a system	3	PO2, PSO2
CO3	Compare the behavioural design patterns and Anti-patterns for system design	3	PO3, PSO1
CO4	Analyze the design patterns in an object oriented language and clear coding principles for a real world application	4	PO2, PO3, PSO1
CO5	Evaluate Programs on concepts of Design patterns in JAVA	4	PO2, PO3, PSO2

Syllabus

Introduction: What is a design pattern? MVC, Describing Design Patterns Organizing the Catalog, How Design Patterns Solve Design Problems, How to Select a Design Pattern, How to Use a Design Pattern

Test-Driven Development and Refactoring Structural Pattern: Adapter, Bridge, Composite, Decorator

Creational Patterns: Abstract Factory, Builder, Factory Method, Prototype, Singleton, Discussion of Creational Patterns. Behavioral Patterns and anti-patterns: Chain of Responsibility

Command, Interpreter, Iterator Designing a Document Editor: Design Problems, Document Structure, Formatting and Embellishing the User Interface

Supporting Multiple Look-and-Feel Standards, Supporting Multiple Window Systems, User Operations Spelling Checking and Hyphenation ,Testing in maintaining clean code ,Utilizing clean coding patterns to enhance code quality and maintainability

Reference Books

- 1 . Design Patterns, Erich Gamma, 3, Pearson Education,2015.
- 2 Clean Code: A Handbook of Agile Software Craftsmanship, Robert C. Martin , 1, PHI,2008.
- 3 Refactoring, Improving the design of existing Code , Martin Fowler, Kent Beck, 1, wesley,1999.
- 4 Java Enterprise Design Patterns , Mark Grand, 3, Wiley Dream Tech,2002.

23SMD3202E - DESIGN PATTERNS & CLEAN CODING TECHNIQUES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3202E	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	DPCT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate how Test Driven Development and Refactoring work in software design and maintenance	2	PO1, PO3, PSO1
CO2	Understand Structural and Creational Patterns for effective design of a system pattern	2	PO2, PSO2
CO3	Compare the Behavioural design patterns and Anti-patterns for system design	3	PO2, PSO1
CO4	Analyze the design patterns in an object-oriented language and clean coding principles for a real-world application.	4	PO2, PO3, PSO2
CO5	Evaluate Programs on concepts of Design patterns in JAVA	4	PO2, PO3, PSO1

Syllabus

Introduction: What is a design pattern? MVC, Describing Design Patterns Organizing the Catalog, How Design Patterns Solve Design Problems, How to Select a Design Pattern, How to Use a Design Pattern

Test-Driven Development and Refactoring Structural Pattern: Adapter, Bridge, Composite, Decorator

Creational Patterns: Abstract Factory, Builder, Factory Method, Prototype, Singleton, Discussion of Creational Patterns. Behavioral Patterns and anti-patterns: Chain of Responsibility

Command, Interpreter, Iterator Designing a Document Editor: Design Problems, Document Structure, Formatting and Embellishing the User Interface

Supporting Multiple Look-and-Feel Standards, Supporting Multiple Window Systems, User Operations Spelling Checking and Hyphenation Testing in maintaining clean code, Utilizing clean coding patterns to enhance code quality and maintainability

Reference Books

- 1 Design Patterns , Erich Gamma , 3, Pearson Education, 2015.
- 2 Clean Code: A Handbook of Agile Software Craftsmanship , Robert C. Martin , 1, PHI, 2008.
- 3 Refactoring, Improving the design of existing Code , Martin Fowler, Kent Beck, 6, Wesley, 1999.
- 4 Java Enterprise Design Patterns , Mark Grand, 3, Wiley Dream Tech, 2002.

23SMD3202R - DESIGN PATTERNS & CLEAN CODING TECHNIQUES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3202R	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	DPCT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate how Test Driven Development and Refactoring work in software design and maintenance	2	PO3, PSO1
CO2	Understand Structural and Creational Patterns for effective design of a system	3	PO2, PSO1
CO3	compare the Behavioural design patterns and Anti-patterns for system design	3	PO2, PO3, PSO2
CO4	Analyze the design patterns in an object oriented language along with clean coding principles to a real world application.	4	PO2, PO3, PSO2

Syllabus

Introduction: What is a design pattern? MVC, Describing Design Patterns Organizing the Catalog, How Design Patterns Solve Design Problems, How to Select a Design Pattern, How to Use a Design Pattern

Test-Driven Development and Refactoring Structural Pattern: Adapter, Bridge, Composite, Decorator

Creational Patterns: Abstract Factory, Builder, Factory Method, Prototype, Singleton, Discussion of Creational Patterns. Behavioral Patterns and anti-patterns: Chain of Responsibility

Command, Interpreter, Iterator Designing a Document Editor: Design Problems, Document Structure, Formatting and Embellishing the User Interface

Reference Books

- 1 Design Patterns, Erich Gamma, 3, Pearson Education ,2015.
- 2 Refactoring, Improving the design of existing Code, Martin Fowler, Kent Beck, 6, wesley,2008.
- 3 Java Enterprise Design Patterns, Mark Grand, 1, Wiley Dream Tech,1999.
- 4 Clean code:A handbook of agile software craftsmanship , Robert C.Martin, 1, PHI,2002.

23SMD3303A - CONTINUOUS DELIVERY & DEVOPS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3303A	CONTINUOUS DELIVERY & DEVOPS	CDD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the need for DevOps and version control system to track the latest version of code.	2	PO1, PO3, PSO1
CO2	Apply Continuous Integration and Continuous Deployment using Infrastructure as Code using Pipeline.	3	PO1
CO3	Analyze the need for Containerization in Devops and Examine the Kubernetes Pod Configuration.	4	PO1
CO4	Analyze continuous monitoring and container orchestration process.	4	PO2, PO3
CO5	Analyze the Tools associated with the DevOps Life Cycle.	4	
CO6	Evaluate existing knowledge to develop new hypotheses.	5	
CO7	Create and design an innovative experiment to test a specific hypothesis.	6	, PSO1

Syllabus

Introduction to DevOps, Overview of DevOps, Relationship Between Agile and DevOps, Principles of DevOps, DevOps Tools, Best Practices for DevOps. Version Control Systems: Role of Version Control System in DevOps Environment.

GitHub, Deploy the files to Bitbucket via Git, Need of Cloud in DevOps: Popular Cloud Providers, CI/CD in AWS and Azure, CI/CD Services in AWS. Continuous Integration and Continuous Deployment using Jenkins.

Continuous Integration with Jenkins, Git, and Maven, Build Applications using Pipeline on azure platform, Software and Automation Testing Frameworks: Popular Testing Tools, Test Driven Development Cycle, Behavior driven development.

Automated Testing using Cucumber. Docker as Containerization: Virtualization, Docker on Windows Desktop. Creating an Account in Docker Hub, MySQL in Docker Kubernetes.

Kubernetes: Components, Kubernetes Architecture, Minikube, Pod Configuration on Windows. Configuration management- Chef, puppet Role of Infrastructure as Code in DevOps Environment.

Continuous Monitoring: Role of Monitoring Systems, Types of Monitoring, Popular Monitoring ,Tools: Nagios, Orchestrating application deployment. Creating build jobs for end-to-end automation

Configuring SSH Authentication using a key and Configuring the build pipeline for build job orchestration. Executing the pipeline for application deployment automation.

Reference Books

- 1 Enterprise DevOps on Amazon Web Services: Releasing Software to Production at Any Time with AWS , Paul Duvall, 1st Edition, Addison Wesley.
- 2 DevOps for Web Development, Mitesh Soni, 1st Edition, Packt Publishing Ltd..
- 3 Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Jez Humble, David Farley, 1st Edition, Addison-Wesley.
- 4 DevOps: Continuous Delivery, Integration, and Deployment with DevOps, Sricharan Vadapalli, 1st Edition, Packt Publishing.

23SMD3303E - CONTINUOUS DELIVERY & DEVOPS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3303E	CONTINUOUS DELIVERY & DEVOPS	CDD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the need for DevOps and version control system to track the latest version of code.	2	PO1, PO3, PSO1
CO2	Apply Continuous Integration and Continuous Deployment using Infrastructure as Code using Pipeline.	3	PO1
CO3	Analyze the need for Containerization in Devops and Examine the Kubernetes Pod Configuration.	4	PO1
CO4	Analyze continuous monitoring and container orchestration process.	4	PO2, PO3
CO5	Analyze the Tools associated with the DevOps Life Cycle.	4	
CO6	Evaluate existing knowledge to develop new hypotheses.	5	
CO7	Create and design an innovative experiment to test a specific hypothesis.	6	, PSO1

Syllabus

Introduction to DevOps, Overview of DevOps, Relationship Between Agile and DevOps, Principles of DevOps, DevOps Tools, Best Practices for DevOps. Version Control Systems: Role of Version Control System in DevOps Environment.

GitHub, Deploy the files to Bitbucket via Git, Need of Cloud in DevOps: Popular Cloud Providers, CI/CD in AWS and Azure, CI/CD Services in AWS. Continuous Integration and Continuous Deployment using Jenkins.

Continuous Integration with Jenkins, Git, and Maven, Build Applications using Pipeline on azure platform, Software and Automation Testing Frameworks: Popular Testing Tools, Test Driven Development Cycle, Behavior driven development.

Automated Testing using Cucumber. Docker as Containerization: Virtualization, Docker on Windows Desktop. Creating an Account in Docker Hub, MySQL in Docker Kubernetes.

Kubernetes: Components, Kubernetes Architecture, Minikube, Pod Configuration on Windows. Configuration management- Chef, puppet Role of Infrastructure as Code in DevOps Environment.

Continuous Monitoring: Role of Monitoring Systems, Types of Monitoring, Popular Monitoring ,Tools: Nagios, Orchestrating application deployment. Creating build jobs for end-to-end automation

Configuring SSH Authentication using a key and Configuring the build pipeline for build job orchestration. Executing the pipeline for application deployment automation.

Reference Books

- 1 Enterprise DevOps on Amazon Web Services: Releasing Software to Production at Any Time with AWS, Paul Duvall, 1st Edition, Addison Wesley.
- 2 DevOps for Web Development, Mitesh Soni, 1st Edition, Packt Publishing Ltd..
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- 4 DevOps: Continuous Delivery, Integration, and Deployment with DevOps, Sricharan Vadapalli, 1st Edition, Packt Publishing Ltd..

23SMD3303R - CONTINUOUS DELIVERY & DEVOPS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3303R	CONTINUOUS DELIVERY & DEVOPS	CDD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the need for DevOps and version control system to track the latest version of code.	2	PO1, PO3, PSO1
CO2	Apply Continuous Integration and Continuous Deployment using Infrastructure as Code using Pipeline.	3	PO1
CO3	Analyze the need for Containerization in Devops and Examine the Kubernetes Pod Configuration.	4	PO1
CO4	Analyze continuous monitoring and container orchestration process.	4	PO3, PSO1
CO5	Analyze the Tools associated with the DevOps Life Cycle.	4	PO2, PSO1
CO6	Evaluate existing knowledge to develop new hypotheses.	5	PO3, PSO1

Syllabus

Introduction to DevOps, Overview of DevOps, Relationship Between Agile and DevOps, Principles of DevOps, DevOps Tools, Best Practices for DevOps. Version Control Systems: Role of Version Control System in DevOps Environment, GitHub, Deploy the files to Bitbucket via Git.

Need of Cloud in DevOps: Popular Cloud Providers, CI/CD in AWS and Azure, CI/CD Services in AWS. Continuous Integration and Continuous Deployment using Jenkins, Continuous Integration with Jenkins, Git, and Maven, Build Applications using Pipeline on azure platform.

Software and Automation Testing Frameworks: Popular Testing Tools, Test Driven Development Cycle, Behavior driven development, Automated Testing using Cucumber. Docker as Containerization: Virtualization, Docker on Windows Desktop, Creating an Account in Docker Hub, MySQL in Docker Kubernetes,

Kubernetes: Components, Kubernetes Architecture, Minikube, Pod Configuration on Windows. Configuration management-Chef,puppet Role of Infrastructure as Code in DevOps EnvironmentContinuous Monitoring: Role of Monitoring Systems, Types of Monitoring, Popular Monitoring,

Tools: Nagios, Orchestrating application deployment: Creating build jobs for end-to-end automation, Configuring SSH Authentication using a key and Configuring the build pipeline for build job orchestration, Executing the pipeline for application deployment automation.

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- 1 Enterprise DevOps on Amazon Web Services: Releasing Software to Production at Any Time with AWS, Paul Duvall, 1st Edition, Addison Wesley.
- 2 DevOps for Web Development, Mitesh Soni, 1st Edition, Packt Publishing Ltd..
- 3 Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Jez Humble, David Farley, 1st Edition, Addison Wesley.
- 4 DevOps: Continuous Delivery, Integration, and Deployment with DevOps, Sricharan Vadapalli, 1st Edition, Packt Publishing Ltd..

23SMD3404M - SOFTWARE PROJECT MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3404M	SOFTWARE PROJECT MANAGEMENT	SPM	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the concept of software project management process	2	PO11, PSO2
CO2	To Understand the various rules and guidelines that involved to improve the time, Cost, Quality, management aspects in software project management.	2	PO11, PSO1
CO3	Analyze the guidelines that are involved to improve the configuration, Human Resource time, Communications management aspects in software project management.	3	PO11, PSO1
CO4	Analyze the techniques that are involved in the Phases of SPM such as Initiating, planning, executing & controlling projects.	3	PO11, PSO2

Syllabus

Introduction to Project Management, Introduction, What is a project?, What is Project Management?, Program and Project Portfolio Management, The Role of the Project Manager, The Project Management Profession, Project Management context, A Systems View of Project Management, Understanding Organizations, Stakeholder Management, Project Phases and the Project Life Cycle, The Context of Information Technology Projects, Recent Trends Affecting Information Technology Project Management

Sequencing Activities, Estimating Activity Resources, Estimating Activity Durations, Developing the Schedule, Controlling the Schedule, Using Software to Assist in Project Time Management, Cost Management, The Importance of Project Cost Management, Basic Principles of Cost Management, Planning Cost Management, Estimating Costs, Determining the Budget, Controlling Costs, Using Project Management Software to Assist in Project Cost Management

Configuration management, Administering Software Configuration Management, Human Resource Management, The Importance of Human Resource Management, What Is Project Human Resource Management?, Keys to Managing People, Developing the Human Resource Plan

Project documentation, Why and When is a project document required?, Is it necessary?, Steps in developing a project document, Initiating, Project Management Processes (Initiation), Project Charter and Project Management Plan Terminology, Two Processes in Project Initiation

Reference Books

- 1 Information Technology Project Management, Schwalbe, K. (2012) , 7th Edition, 2012, Thomson Learning.
- 2 Effective software Project Management, Robert K. Wysocki, 1st Edition, 2006, John Wiley & Sons, Inc. 605 Third Ave. New York, NY United States.
- 4 Agile Project Management with Scrum, Ken Schwaber, 1st Edition, 2022, Microsoft Press US.
- 5 The Mythical Man-Month: Essays on Software Engineering, Frederick P. Brooks Jr, 1st Edition 2022, Addison-Wesley Educational Publishers Inc.
- 6 Project Management for the Unofficial Project Manager, Kory Kogon, 7th Edition, 2023, BenBella Books.

23SMD3405M - SOFTWARE ARCHITECTURE & DESIGN (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3405M	SOFTWARE ARCHITECTURE & DESIGN	SAD	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of software architecture, including its importance and role in software development.	2	PO1, PO5, PSO2
CO2	Examine the diverse quality attributes and their associated scenarios. Evaluate how each attribute impacts software systems in various usage contexts.	3	PO1, PO5, PSO2
CO3	Apply different architectural styles and their practical applications across real-time scenarios. Apply this knowledge to design and implement effective solutions for diverse software systems.	3	PO1, PO5, PSO2
CO4	Analyze methods for documenting architecture and tailor them for web services. Apply documented architectural designs to ensure efficient development and maintenance of web services.	4	PO1, PO5, PSO2

Syllabus

INTRODUCTION AND ARCHITECTURAL DRIVERS: Introduction What is software architecture Standard Definitions Architectural structures Influence of software architecture on organization both business and technical Architecture Business Cycle- Introduction Functional requirements Technical constraints Quality Attributes. QUALITY ATTRIBUTE WORKSHOP Quality Attribute Workshop Documenting Quality Attributes Six part scenarios Case studies.

QUALITY ATTRIBUTE WORKSHOP Quality Attribute Workshop Documenting Quality Attributes Six part scenarios Case studies. QUALITY ATTRIBUTE WORKSHOP: Quality Attribute Workshop Documenting Quality Attributes Six part scenarios Case studies. ARCHITECTURAL VIEWS: Introduction Standard Definitions for views Structures and views Representing views-available notations Standard views 4+1 view of RUP, Siemens 4 views SEI's perspectives and views Case studies.

ARCHITECTURAL STYLES: Introduction Data flow styles Understanding Data Flow Styles: Concepts and principles Call-return styles Shared Information styles -Exploring Call-Return Styles: Principles and design Event styles Case studies for each style. and Identifying and addressing architectural drivers: Functional requirements, Non-Functional requirements (NFRs)

DOCUMENTING THE ARCHITECTURE: Good practices Documenting the Views using UML Merits and Demerits of using visual languages Need for formal languages Architectural Description Languages ACME Case studies. Special topics: SOA and Web services Cloud Computing Adaptive structures.

Reference Books

- 1 Designing Software Architectures- A Practical Approach , Humberto Cervantes and Rick Kazman , , 2016. , Addison-Wesley.
- 2 Software Architecture in Practice- SEI Series in Software Engineering-, Len Bass, 3rd Edition ,2012, Willey .
- 3 The Art of software Architecture- Design Methods and Techniques , Stephen T.Albin , -2003., Wiley Publications.
- 4 Software Architecture: A Case Based Approach , Varma, Vasudeva, , 2009, Person Edition-.
- 5 Software Architecture: Foundations, Theory, and Practice , R. N. Taylor, N. Medvidovic, E. M. Dashofy-, 1st Edition 2010, Wiley Publication.

23SMD3506 - SOFTWARE RELIABILITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3506	SOFTWARE RELIABILITY	SR	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Software Reliability and develop a software project from requirement gathering to implementation.	2	PO2
CO2	Analyze software system failures and develop convincing solutions	2	PO2
CO3	Estimate Software Reliability parameters using Markovian Modelling, Maximum Likelihood and Least Square Method.	2	PO3
CO4	Evaluate performance of Binomial-Type, Poison-Type and Markovian Models and Predict Software Reliability using SQA Intelligent Techniques	2	PO3, PSO1

Syllabus

Software Reliability Introduction to Software Reliability The need for Software Reliability, Some Basic Concepts, Software Reliability and Hardware Reliability, Availability, Modelling and General Model Characteristics.

Software Reliability Modeling Halstead Software Metric, McCabe Cyclomatic Complexity Metric, Error Seeding Models, Failure Rate Models, Curve Fitting Models, Reliability Growth Models, Markov Structure Models, Defining failure for the product, common measure for all associated systems, setting system failure intensity objectives, determining develop software failure intensity objectives, software reliability strategies, failures, faults and errors, availability, system and component reliabilities and failure intensities, predicting basic failure intensity. Time Series Models, Non-homogeneous Poison Process Models.

Parameter Estimation Maximum Likelihood Estimation, Least Squares Estimation, Bayesian Inference. Comparison of Software Reliability Models Comparison Criteria, Comparison of Predictive Validity of Model Groups, Evaluation of other Criteria. Software Reliability Prediction Problems associated with different Software Reliability Models, Software Reliability prediction parameters, Intelligent Techniques for Software Reliability Prediction. Software Quality Management Software Quality Attributes, Quality Measurement & Metrics, Software Quality Assurance functions

Markovian Models General Concepts, General Poison-Type Models, Binomial -Type Models, Poison-Type Models, Comparison of Binomial-Type and Poison-Type Models, Fault Reduction Factor for Poison-Type Models. Descriptions of Specific Models Finite Failure Category Models, Infinite Failure Category Models

Reference Books

- 1 Handbook of Software Reliability Engineering, Michael R. Lyu, IEEE Computer Society Press 1996, McGraw-Hill Book Company, 2005.
- 2 Software Reliability Measurement, Prediction, Application, John D,Musa, Anthony Iannino, Kazuhira Okumoto,, professional edition 1987, McGraw-Hill Book Company, 1987..
- 3 Software Fault Tolerance Techniques and Implementation, Laura L. Pullum, 1st Edition 2001, Artech House Publishers.
- 4 Software Reliability Engineering, John D. Musa, 2nd Edition 2002, McGraw-Hill Education.

23SMD3507 - CROSS-PLATFORM USER INTERFACE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMD3507	CROSS-PLATFORM USER INTERFACE DESIGN	CPUIF	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand user-centered design principles and best practices to create effective and engaging mobile app interfaces in Flutter.	2	PO2, PSO1
CO2	Understand research and user testing to inform their design decisions and create designs that meet user needs and preferences	2	PO2, PSO1
CO3	Apply the design and implement animations and motion design in Flutter, enhancing the user experience and making the app more engaging and intuitive.	3	PO3, PSO1
CO4	Analyze prototype and wireframe in Flutter to test their designs and gather user feedback.	4	PO3, PSO1
CO5	Understand Collaborate effectively with developers and other stakeholders to bring their UI/UX designs to life in Flutter.	2	PO3, PSO1

Syllabus

Overview of UI/UX design principles and best practices, Introduction to Flutter framework and its capabilities, setting up a development environment for Flutter with UI/UX design tools, User Research, and User-Centered Design, Understanding the importance of user research in UI/UX design, Conducting user research for mobile apps Implementing user-centered design principles in Flutter app design

Designing User Interfaces for Flutter Designing user interfaces and user flows for Flutter apps Implementing visual design principles and best practices in Flutter Using Flutter UI widgets and components to design interfaces Prototyping and User Testing in Flutter Prototyping and wireframing in Flutter for UI/UX design Conducting user testing for Flutter app designs Using feedback from user testing to improve app designs.

Animation and Motion Design in Flutter Introduction to animation and motion design concepts Creating basic animations and transitions with Flutter Creating complex animations and physics-based motion design.

Flutter and Material Design Overview of Material Design principles and guidelines Implementing Material Design components and patterns in Flutter Customizing Material Design components for a unique look and feel

(Only for advanced/peer mentoring courses)

Reference Books

1. 1. Flutter Development with Dart by Simone Alessandria, Paolo Pecorino, and Salvatore Giordano, Paolo Pecorino, second, no strach press.
2. .The Elements of User Experience: User-Centered Design for the Web and Beyond by, Jesse James Garrett, first, manning.
3. "Designing Across Senses: A Multimodal Approach to Product Design" by Christine , jocks, first, press enterprise.
4. Solving Common Interface Challenges with Xamarin.Forms, Samidip Bas, third, crysty park.

23SMF3101A - REVERSE ENGINEERING & RAPID PROTOTYPING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3101A	REVERSE ENGINEERING & RAPID PROTOTYPING	MMC	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and methodology of the reverse engineering process.	2	PO1, PO3, PSO1
CO2	Understand rapid prototyping, including liquid-based techniques, processes, and applications.	2	PO1, PO3, PSO1
CO3	Understand solid and powder-based rapid prototyping techniques and their applications in various industries.	2	PO1, PO3, PSO1
CO4	Understand rapid tooling techniques, their industrial applications, and benefits in manufacturing.	2	PO1, PO3, PSO1
CO5	Apply solid modeling and additive manufacturing in experiments to solve practical engineering challenges.	3	PO1, PO3, PSO1
CO6	Apply solid modeling and additive manufacturing to solve practical engineering challenges	3	PO1, PO3, PSO1
CO7	Analyze Reverse Engineering and Rapid Prototyping to create precise physical objects from digital models.	4	PO1, PO3, PSO1

Syllabus

Reverse Engineering: Introduction, benefits, and applications of reverse engineering. Steps involved in the reverse engineering process, including contact and non-contact techniques. Overview of the 3D scanning process and hardware used in the reverse engineering process.

Rapid Prototyping: Definition and types of prototypes, the role of prototypes in product development, evaluation of rapid prototyping methods. The three phases of development lead to rapid prototyping. Classification of rapid prototyping systems. Fundamentals of rapid prototyping, including the advantages and disadvantages. Outline the fundamental fabrication processes and the process chain of rapid prototyping. Liquid-based RP techniques: Principles of operation, machine details, materials, and process details of SLA, SGC, SCS, SOUP, two-laser beams, as well as their applications

Solid-based rapid prototyping techniques: Principles of operation, machine details, materials, and process details of LOM, FDM, PLT, MJM, MEM, along with their applications. Powder-based RP techniques: Principles of operation, machine details, materials, and process details of SLS, 3DP, LENS, DSPC, MJS, EBM, and their applications

Rapid tooling and RP case studies: Introduction, types of rapid tooling, direct and indirect tooling techniques. Case Studies: Wind Tunnel Testing with Rapid Prototyped Models, RP applied to investment casting, Integration of Reverse Engineering and Rapid Prototyping

Rapid prototyping finds applications in aerospace, automotive, and biomedical industries for rapid development and innovation in product design and manufacturing

Reference Books

- 1 Rapid Prototyping: Principles and Applications , Chua, C. K., K. F. Leong and C. S. Lim , 2010 , World Scientific .
- 2 Rapid Prototyping: Theory and Practical , Ali K Kamrani , 2006 , Springer .
- 3 Rapid Manufacturing , Pham D T and Dimov S S , 2001 , Verlag .
- 4 Stereo lithography and other RP&M Technologies , Paul F Jacobs , 1996 , SME .

23SMF3101E - REVERSE ENGINEERING & RAPID PROTOTYPING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3101E	REVERSE ENGINEERING & RAPID PROTOTYPING	MMC	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and methodology of the reverse engineering process.	2	PO1, PO3, PSO1
CO2	Understand rapid prototyping, including liquid-based techniques, processes, and applications.	2	PO1, PO3, PSO1
CO3	Understand solid and powder-based rapid prototyping techniques and their applications in various industries.	2	PO1, PO3, PSO1
CO4	Understand rapid tooling techniques, their industrial applications, and benefits in manufacturing.	2	PO1, PO3, PSO1
CO5	Apply solid modeling and additive manufacturing in experiments to solve practical engineering challenges.	3	PO1, PO3, PSO1
CO6	Apply solid modeling and additive manufacturing to solve practical engineering challenges	3	PO1, PO3, PSO1
CO7	Analyze Reverse Engineering and Rapid Prototyping to create precise physical objects from digital models.	4	PO1, PO3, PSO1

Syllabus

Reverse Engineering: Introduction, benefits, and applications of reverse engineering. Steps involved in the reverse engineering process, including contact and non-contact techniques. Overview of the 3D scanning process and hardware used in the reverse engineering process.

Rapid Prototyping: Definition and types of prototypes, the role of prototypes in product development, evaluation of rapid prototyping methods. The three phases of development lead to rapid prototyping. Classification of rapid prototyping systems. Fundamentals of rapid prototyping, including the advantages and disadvantages. Outline the fundamental fabrication processes and the process chain of rapid prototyping. Liquid-based RP techniques: Principles of operation, machine details, materials, and process details of SLA, SGC, SCS, SOUP, two-laser beams, as well as their applications

Solid-based rapid prototyping techniques: Principles of operation, machine details, materials, and process details of LOM, FDM, PLT, MJM, MEM, along with their applications. Powder-based RP techniques: Principles of operation, machine details, materials, and process details of SLS, 3DP, LENS, DSPC, MJS, EBM, and their applications

Rapid tooling and RP case studies: Introduction, types of rapid tooling, direct and indirect tooling techniques. Case Studies: Wind Tunnel Testing with Rapid Prototyped Models, RP applied to investment casting, Integration of Reverse Engineering and Rapid Prototyping

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- 2 Rapid Prototyping: Theory and Practical , Ali K Kamrani , 2006, Springer.
- 3 Rapid Manufacturing , Pham D T and Dimov S S , 2001 , Verlag .
- 4 Stereo lithography and other RP&M Technologies , Paul F Jacobs , SME , 1996 .

23SMF3101R - REVERSE ENGINEERING & RAPID PROTOTYPING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3101R	REVERSE ENGINEERING & RAPID PROTOTYPING	MMC	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and methodology of the reverse engineering process.	2	PO1, PO3, PSO1
CO2	Understand rapid prototyping, including liquid-based techniques, processes, and applications.	2	PO1, PO3, PSO1
CO3	Understand solid and powder-based rapid prototyping techniques and their applications in various industries.	2	PO1, PO3, PSO1
CO4	Understand rapid tooling techniques, their industrial applications, and benefits in manufacturing.	2	PO1, PO3, PSO1
CO5	Apply solid modeling and additive manufacturing in experiments to solve practical engineering challenges.	3	PO1, PO3, PSO1
CO6	Analyze Reverse Engineering and Rapid Prototyping to create precise physical objects from digital models.	4	PO1, PO3, PSO1

Syllabus

Reverse Engineering: Introduction, benefits, and applications of reverse engineering. Steps involved in the reverse engineering process, including contact and non-contact techniques. Overview of the 3D scanning process and hardware used in the reverse engineering process.

Rapid Prototyping: Definition and types of prototypes, the role of prototypes in product development, evaluation of rapid prototyping methods. The three phases of development lead to rapid prototyping. Classification of rapid prototyping systems. Fundamentals of rapid prototyping, including the advantages and disadvantages. Outline the fundamental fabrication processes and the process chain of rapid prototyping. Liquid-based RP techniques: Principles of operation, machine details, materials, and process details of SLA, SGC, SCS, SOUP, two-laser beams, as well as their applications

Solid-based rapid prototyping techniques: Principles of operation, machine details, materials, and process details of LOM, FDM, PLT, MJM, MEM, along with their applications. Powder-based RP techniques: Principles of operation, machine details, materials, and process details of SLS, 3DP, LENS, DSPC, MJS, EBM, and their applications

Rapid tooling and RP case studies: Introduction, types of rapid tooling, direct and indirect tooling techniques. Case Studies: Wind Tunnel Testing with Rapid Prototyped Models, RP applied to investment casting, Integration of Reverse Engineering and Rapid Prototyping

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- 2 Rapid Prototyping: Theory and Practical , Ali K Kamrani , 2006 , Springer .
- 3 Rapid Manufacturing , Pham D T and Dimov S S , 2001 , Verlag .
- 4 Stereo lithography and other RP&M Technologies , Paul F Jacobs , 1996, SME .

23SMF3202A - ADVANCED MATERIALS MANUFACTURING & TESTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3202A	ADVANCED MATERIALS MANUFACTURING & TESTING	AMMT	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various types of materials involved in manufacturing Composites.	2	PO2, PO5, PSO1
CO2	Understand the principles of Bio, Smart and microelectronic materials to societal needs.	2	PO3, PO6, PSO2
CO3	Understand the Functionally graded materials for industrial needs.	2	PO3, PO5, PSO2
CO4	Apply various fabrication methods of nanomaterial and study of characterisation techniques.	3	PO2, PO5, PSO1
CO5	Develop expertise in analyzing properties and applications of functionally graded materials in engineering.	6	PO2, PO6, PSO1

Syllabus

Introduction to Engineering Materials covers composite materials, their types (polymer, metal, ceramic, carbon), manufacturing (hand layup, pultrusion) and testing methods (spray-up, RTM).

Introduction to Biomaterials includes properties, applications, biocompatibility, and classification. Smart Materials cover shape memory effect, alloys, properties, and applications. Microelectronic Materials include Silicon properties, production, and lithography techniques.

Functionally Graded Materials overview includes types, classification, preparation, properties, and applications. Nano Materials discuss properties, advantages, disadvantages, and applications compared to bulk materials.

Nanoscience and Nanotechnology fundamentals encompass nanomaterial synthesis, nanostructure fabrication, and characterization techniques like SEM, TEM, and AFM principles. Materials Characterization involves X-ray, neutron, and electron diffraction, along with spectroscopic and thermal analysis methods.

Develop expertise in analyzing properties, preparation methods, and applications of functionally graded materials in engineering, focusing on thermal stability, mechanical strength, and material gradients

Reference Books

- 1 Materials science and Engineering, V. Raghavan, 2009, Prentice-Hall of India.
- 2 Engineering Metallurgy, R.A.Higgins, 2016, Butterworth-Heinemann.
- 3 Engineering Physical Metallurgy, Y. Lakhtin, 1998, Univ Pr of the Pacific.
- 4 Advanced Materials and Processes: Properties, Design, Applications, Gwyneth Owen-Jones, 2012, CRC Press.

23SMF3202E - ADVANCED MATERIALS MANUFACTURING & TESTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3202E	ADVANCED MATERIALS MANUFACTURING & TESTING	AMMT	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various types of materials involved in manufacturing Composites.	2	PO2, PO5, PSO1
CO2	Understand the principles of Bio, Smart and microelectronic materials to societal needs.	2	PO3, PO6, PSO2
CO3	Understand Functionally graded materials for industrial needs.	2	PO3, PO5, PSO2
CO4	Apply various fabrication methods of nanomaterial and study of characterisation techniques.	3	PO2, PO5, PSO1
CO5	Develop expertise in analyzing properties and applications of functionally graded materials in engineering.	6	PO2, PO6, PSO1

Syllabus

Introduction to Engineering Materials covers composite materials, their types (polymer, metal, ceramic, carbon), manufacturing (hand layup, pultrusion) and testing methods (spray-up, RTM).

Introduction to Biomaterials includes properties, applications, biocompatibility, and classification. Smart Materials cover shape memory effect, alloys, properties, and applications. Microelectronic Materials include Silicon properties, production, and lithography techniques.

Functionally Graded Materials overview includes types, classification, preparation, properties, and applications. Nano Materials discuss properties, advantages, disadvantages, and applications compared to bulk materials.

Nanoscience and Nanotechnology fundamentals encompass nanomaterial synthesis, nanostructure fabrication, and characterization techniques like SEM, TEM, and AFM principles. Materials Characterization involves X-ray, neutron, and electron diffraction, along with spectroscopic and thermal analysis methods.

Develop expertise in analyzing properties, preparation methods, and applications of functionally graded materials in engineering, focusing on thermal stability, mechanical strength, and material gradients

Reference Books

- 1 Materials science and Engineering , V. Raghavan , 2009, Prentice-Hall of India.
- 2 Engineering Metallurgy, R.A.Higgins , 2016, Butterworth-Heinemann.
- 3 Engineering Physical Metallurgy , Y. Lakhtin, , 1998, Univ Pr of the Pacific.
- 4 Advanced Materials and Processes: Properties, Design, Applications , Gwyneth Owen-Jones , 2012, CRC Press.

23SMF3202R - ADVANCED MATERIALS MANUFACTURING & TESTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3202R	ADVANCED MATERIALS MANUFACTURING & TESTING	AMMT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various types of materials involved in manufacturing Composites.	2	PO2, PO5, PSO1
CO2	Understand the principles of Bio, Smart and microelectronic materials to societal needs.	2	PO3, PO6, PSO2
CO3	Understand Functionally graded materials for industrial needs.	2	PO3, PO5, PSO2
CO4	Apply various fabrication methods of nanomaterial and study of characterisation techniques.	3	PO2, PO5, PSO1

Syllabus

Introduction to Engineering Materials covers composite materials, their types (polymer, metal, ceramic, carbon), manufacturing (hand layup, pultrusion) and testing methods (spray-up, RTM).

Introduction to Biomaterials includes properties, applications, biocompatibility, and classification. Smart Materials cover shape memory effect, alloys, properties, and applications. Microelectronic Materials include Silicon properties, production, and lithography techniques.

Functionally Graded Materials overview includes types, classification, preparation, properties, and applications. Nano Materials discuss properties, advantages, disadvantages, and applications compared to bulk materials.

Nanoscience and Nanotechnology fundamentals encompass nanomaterial synthesis, nanostructure fabrication, and characterization techniques like SEM, TEM, and AFM principles. Materials Characterization involves X-ray, neutron, and electron diffraction, along with spectroscopic and thermal analysis methods.

Reference Books

- 1 Materials science and Engineering, V. Raghavan , 2009, Prentice-Hall of India .
- 2 Engineering Metallurgy , R.A.Higgins , 2016, Butterworth-Heinemann .
- 3 Engineering Physical Metallurgy, Y. Lakhtin, , 1998, Univ Pr of the Pacific .
- 4 Advanced Materials and Processes: Properties, Design, Applications , Gwyneth Owen-Jones , 2012 , CRC Press.

23SMF3203A - MODERN MANUFACTURING PROCESSES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3203A	MODERN MANUFACTURING PROCESSES	MMP	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply process parameters to mechanical energy based machining processes	3	PO1, PO2, PSO2
CO2	Apply process parameters to chemical energy based machining processes	3	PO1, PO2, PSO2
CO3	Apply process parameters to thermo electric energy based machining processes	3	PO1, PO5, PSO2
CO4	Understand the performance of various non-traditional welding processes	2	PO1, PO5, PSO2
CO5	Understand the performance of various non-traditional forming processes	2	PO1, PO5, PSO2

Syllabus

Modern Manufacturing Processes, Introduction, Need for modern manufacturing processes, Classification of modern machining processes based on sources of energy. Mechanical energy based machining processes, Principle, Equipment, Process parameters, Advantages, limitations and applications of Abrasive jet machining, water jet machining, ultrasonic machining

Chemical energy-based machining processes: Principle, Equipment, Process parameters, Advantages, limitations and applications of Chemical machining, Electro-chemical machining, Electro-chemical deburring and Electro chemical honing.

Thermoelectric energy-based machining processes: Principle, Equipment, Process parameters, Advantages, limitations and applications of Electric discharge machining, Wire-electric discharge machining, electric discharge grinding, laser beam machining, plasma arc machining, electron beam machining

Non-traditional welding processes: Principle, Equipment, Process parameters, Advantages, limitations and applications of Laser beam welding, Plasma arc welding, Electron beam welding, Ultrasonic welding, Friction welding, Explosive welding and Under water welding

Non-traditional Forming processes: Methods, advantages, limitations and applications of Explosion Forming Process, Electro Hydraulic Forming, Magnetic Pulse Forming, Petro-Forge Hammer

Reference Books

- 1 Modern Machining Processes: Advanced Manufacturing, J. Paulo Davim, Revised, Springer.
- 2 Nontraditional Manufacturing Processes: Manufacturing Engineering and Materials Processing, Bradley L. Prevost, George W. Woodruff, Revised, CRC Press.
- 3 Advanced machining processes , Jain V K , Revised, Allied Publishers.
- 4 High velocity forming of metals , ASTM, Revised, Prentice Hall.

23SMF3203E - MODERN MANUFACTURING PROCESSES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3203E	MODERN MANUFACTURING PROCESSES	MMP	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply process parameters to mechanical energy based machining processes	3	PO1, PO2, PSO2
CO2	Apply process parameters to chemical energy based machining processes	3	PO1, PO2, PSO2
CO3	Apply process parameters to thermo electric energy based machining processes	3	PO1, PO5, PSO2
CO4	Understand the performance of various non-traditional welding processes	2	PO1, PO5, PSO2
CO5	Understand the performance of various non-traditional forming processes	2	PO1, PO5, PSO2

Syllabus

Modern Manufacturing Processes, Introduction, Need for modern manufacturing processes, Classification of modern machining processes based on sources of energy. Mechanical energy based machining processes, Principle, Equipment, Process parameters, Advantages, limitations and applications of Abrasive jet machining, water jet machining, ultrasonic machining

Chemical energy-based machining processes: Principle, Equipment, Process parameters, Advantages, limitations and applications of Chemical machining, Electro-chemical machining, Electro-chemical deburring and Electro chemical honing

Thermoelectric energy-based machining processes: Principle, Equipment, Process parameters, Advantages, limitations and applications of Electric discharge machining, Wire-electric discharge machining, electric discharge grinding, laser beam machining, plasma arc machining, electron beam machining

Non-traditional welding processes: Principle, Equipment, Process parameters, Advantages, limitations and applications of Laser beam welding, Plasma arc welding, Electron beam welding, Ultrasonic welding, Friction welding, Explosive welding and Under water welding

Non-traditional Forming processes: Methods, advantages, limitations and applications of Explosion Forming Process, Electro Hydraulic Forming, Magnetic Pulse Forming, Petro-Forge Hammer

Reference Books

- 1 Modern Machining Processes: Advanced Manufacturing, J. Paulo Davim, Revised, Springer.
- 2 Nontraditional Manufacturing Processes: Manufacturing Engineering and Materials Processing, Materials Processing Bradley L. Prevost, George W. Woodruff, Revised, CRC Press.
- 3 Advanced machining processes , Jain V K , Revised, Allied Publishers.
- 4 High velocity forming of metals , ASTM E, Revised, Prentice Hall.

23SMF3203R - MODERN MANUFACTURING PROCESSES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3203R	MODERN MANUFACTURING PROCESSES	MMP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply process parameters to mechanical energy based machining processes	3	PO1, PO2, PSO2
CO2	Apply process parameters to chemical and thermo electricl energy based machining processes	3	PO1, PO2, PSO2
CO3	Understand the performance of various non traditional welding processes	2	PO1, PO5, PSO2
CO4	Understand the performance of various non traditional forming processes	2	PO1, PO5, PSO2

Syllabus

Modern Manufacturing Processes, Introduction, Need for modern manufacturing processes, Classification of modern machining processes based on sources of energy. Mechanical energy based machining processes, Principle, Equipment, Process parameters, Advantages, limitations and applications of Abrasive jet machining, water jet machining, ultrasonic machining

Chemical energy based machining processes, Introduction, Principle, Equipment, Process parameters, Advantages, limitations and applications of Chemical machining, Electro chemical machining, Electro chemical deburring and Electro chemical honing. Thermoelectric energy based machining processes, Introduction, Principle, Equipment, Process parameters, Advantages, limitations and applications of Electric discharge machining, Wire electric discharge machining, electric discharge grinding, laser beam machining, plasma arc machining, electron beam Machining

Non traditional welding processes, Introduction, Principle, Equipment, Process parameters, Advantages, limitations and applications of Laser beam welding, Plasma arc welding, Electron beam welding, Ultrasonic welding, Friction welding, Explosive welding and Under water welding

Non traditional Forming processes, Introduction, Methods, advantages, limitations and applications of Explosion Forming Process, Electro Hydraulic Forming, Magnetic Pulse Forming, Petro Forge Hammer

Reference Books

- 1 Modern Machining Processes: Advanced Manufacturing, J. Paulo Davim, Revised, Springer.
- 2 Advanced machining processes , Jain V K , Revised, Allied Publishers.
- 3 Nontraditional Manufacturing Processes: Manufacturing Engineering and Materials Processing, Bradley L. Prevost, George W. Woodruff, Revised, CRC Press.
- 4 High velocity forming of metals , ASTME, Revised, Prentice Hall.

23SMF3304A - SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3304A	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING	SDSISM	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand all fundamental concepts related to the streams in smart manufacturing Specialization	2	PO2, PO3, PSO1
CO2	Identify the real-world problem and inculcate problem-solving and critical-thinking skills	2	PO2, PO9, PSO2
CO3	Prepare a conceptual prototype	3	PO3, PO5, PSO2
CO4	Analysis and Testing of conceptual prototype	4	PO3, PO5, PSO1
CO5	Gain hands on experience on 3D Modelling software as Fusion 360 and other related 3D modelling S/W tools.	3	PO5, PO9, PSO2
CO6	Skill Certification based on Fusion 360 software and other related 3D modelling S/W tools.	3	PO5, PO9, PSO1
CO7	Patent/Pitching of Idea through Start-up	6	PO3, PO9, PSO2

Syllabus

Fundamental of Sustainable Design, Social Innovation and Smart Manufacturing

Design Thinking Process and Problem Solving

Ideation and Prototyping with Special focus on Smart Manufacturing

Entrepreneurial innovation and the business model for implementing solutions

Innovating and Pitching: Turning Patents into Start-ups.

Reference Books

- 1 Sustainable Design: Ecology, Architecture, and Planning, David Bergman , 2007, Princeton Architectural Press.
- 2 Social Innovation, Inc.: 5 Strategies for Driving Business Growth through Social Change , Jason Saul , 2010, Jossey-Bass.
- 3 Smart Manufacturing Technologies for Industry 4.0 Integration, Benefits, and Operational Activities, Jayakrishna Kandasamy et al., 2023, CRC Press.
- 4 Sustainable Design and Manufacturing, Rossi Setchi, Robert J. Howlett, Y. Liu, Peter Theobald , 2016, Springer.

23SMF3304E - SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3304E	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING	SDSISM	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand all fundamental concepts related to the streams in smart manufacturing Specialization	2	PO2, PO3, PSO1
CO2	Identify the real-world problem and inculcate problem-solving and critical-thinking skills	2	PO2, PO9, PSO2
CO3	Prepare a conceptual prototype	3	PO3, PO5, PSO2
CO4	Analysis and Testing of conceptual prototype	4	PO3, PO5, PSO1
CO5	Gain hands on experience on 3D Modelling software as Fusion 360 and other related 3D modelling S/W tools.	3	PO5, PO9, PSO2
CO6	Skill Certification based on Fusion 360 software and other related 3D modelling S/W tools.	3	PO5, PO9, PSO1
CO7	Patent/Pitching of Idea through Start-up	6	PO3, PO9, PSO2

Syllabus

Fundamental of Sustainable Design, Social Innovation and Smart Manufacturing

Design Thinking Process and Problem Solving

Ideation and Prototyping with Special focus on Smart Manufacturing

Entrepreneurial innovation and the business model for implementing solutions

Innovating and Pitching: Turning Patents into Start-ups.

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- 1 Sustainable Design: Ecology, Architecture, and Planning, David Bergman , 2007, Princeton Architectural Press.
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- 3 Smart Manufacturing Technologies for Industry 4.0 Integration, Benefits, and Operational Activities, Jayakrishna Kandasamy et al., 2023, CRC Press.
- 4 Sustainable Design and Manufacturing, Rossi Setchi, Robert J. Howlett, Y. Liu, Peter Theobald , 2016, Springer.

23SMF3304R - SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3304R	SUSTAINABLE DESIGN & SOCIAL INNOVATION IN SMART MANUFACTURING	SDSISM	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand all fundamental concepts related to the streams in smart manufacturing Specialization	2	PO2, PO3, PSO1
CO2	Identify the real-world problem and inculcate problem-solving and critical-thinking skills	2	PO2, PO9, PSO2
CO3	Prepare a conceptual prototype	3	PO3, PO5, PSO2
CO4	Analysis and Testing of conceptual prototype	4	PO3, PO5, PSO1
CO5	Gain hands on experience on 3D Modelling software as Fusion 360 and other related 3D modelling S/W tools.	3	PO5, PO9, PSO2
CO6	Skill Certification based on Fusion 360 software and other related 3D modelling S/W tools.	3	PO3, PO5, PSO1

Syllabus

Fundamental of Sustainable Design, Social Innovation and Smart Manufacturing

Design Thinking Process and Problem Solving

Ideation and Prototyping with Special focus on Smart Manufacturing

Entrepreneurial innovation and the business model for implementing solutions

Reference Books

- 1 Sustainable Design: Ecology, Architecture, and Planning, David Bergman, 2007, Princeton Architectural Press.
- 2 Social Innovation, Inc.: 5 Strategies for Driving Business Growth through Social Change, Jason Saul, 2010, Jossey-Bass.
- 3 Smart Manufacturing Technologies for Industry 4.0 Integration, Benefits, and Operational Activities , Jayakrishna Kandasamy et al., 2023, CRC Press.
- 4 Sustainable Design and Manufacturing , Rossi Setchi, Robert J. Howlett, Y. Liu, Peter Theobald , 2016, Springer.

23SMF3405M - ROBOTICS & INDUSTRIAL AUTOMATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3405M	ROBOTICS & INDUSTRIAL AUTOMATION	RIA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the role of robotics and its classification and anatomy suitable in Industrial Automation	2	PO1, PO3, PSO1
CO2	Apply the concepts of real time sensors used in Industrial automation to check the various physical parameters	3	PO2, PO3, PSO1
CO3	Apply the concepts of various Control strategies used to control the process of automation in various industries.	3	PO2, PO3, PSO1
CO4	Apply the concept of PLC and ladder programming concept to control the Industrial automation.	3	PO2, PO3, PSO1

Syllabus

Robotics: science fiction origins, industrial revolution impact, history, need, definition, terminology, types, and applications. Current status and future trends. Introduction to industrial automation, control, and system architecture.

Measurement Systems Specifications, Temperature measurement - RTD, Thermocouple and Pyrometers, Pressure Measurements: Low Pressure measurement devices and dead weight tester, Force measurements- Load cells and other types, Displacement Measurement: LVDT, Potentiometers, Speed measurement- Tachometers, Flow measurement techniques, Measurement of Level,

Introduction to Process Control, P-I-D Control, Controller Tuning, Implementation of P-I-D Controllers, Special Control Structures: Feedforward and Ratio Control, Predictive Control, Control of Systems with Inverse Response, Cascade Control, Overriding Control, Split Range Control.

Introduction to PLC, Need of PLC in Designing, Architecture of PLC, Ladder Programming, latching, logic gates used in PLC, Types of timers, Counters, data handling operations, Application and Advantage of PLC, Automation Concept and Basic Design, PLC Programming.

Reference Books

- 1 Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, 2013, Jaico Publishing House,.
- 2 Automation, Production Systems and Computer Integrated Manufacturing, Mikell Groover, 2018, Pearson Education.
- 3 Programmable Logic Controllers: Principles and Applications, Glen A. Mazur, William J. Weindorf, 2021, ATP.
- 5 Chemical Process Control, An Introduction to Theory and Practice, George Stephanopoulos, 2006, Prentice Hall India.

23SMF3406M - MECHANICAL MEASUREMENTS AND METROLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3406M	MECHANICAL MEASUREMENTS AND METROLOGY	MMM	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the standards of measurement, limits & tolerances industrial applications. Identify the uses of gauges and comparators	2	PO1, PSO1
CO2	Apply the concepts of measurement of temperature and pressure with intermediate modifying and terminating devices	3	PO1, PSO1
CO3	Interpret measurement of field variables like force, torque and pressure, direct and indirect methods of level measurements	2	PO2, PSO1
CO4	Analyze stress-strain, force, torque, and power using computer-assisted data acquisition and presentation.	4	PO2, PSO1

Syllabus

INTRODUCTION TO MEASUREMENTS, PRECISION & ACCURACY, ERRORS IN MEASUREMENTS, MEASUREMENT OF DISPLACEMENT, SOURCES OF ERROR, CLASSIFICATION AND ELIMINATION OF ERRORS. PIEZOELECTRIC, INDUCTIVE, CAPACITANCE, RESISTANCE, IONISATION AND PHOTO ELECTRIC TRANSDUCERS

INTRODUCTION, CLASSIFICATION, PRINCIPLES & APPLICATIONS-MEASUREMENT OF TEMPERATURE-THERMISTORS, THERMOCOUPLES, PYROMETER AND TEMPERATURE INDICATORS; MEASUREMENT OF PRESSURE-MANOMETERS, BOURDON PRESSURE GAUGE, BELLOWS, RANGES

INTRODUCTION, CLASSIFICATION, PRINCIPLES & APPLICATIONS-MEASUREMENT OF LEVEL-DIRECT & INDIRECT METHODS-CAPACITIVE, ULTRASONIC, MAGNETIC, CRYOGENIC FUEL & BUBBLE TYPE INDICATOR; MEASUREMENT OF SPEED-MECHANICAL & ELECTRICAL TACHOMETERS, STROBOSCOPE, NONCONTACT TYPE TACHOMETER; ACCELERATION & VIBRATION-PRINCIPLES OF SEISMIC INSTRUMENTS, VIBROMETER & ACCELEROMETER

INTRODUCTION, CLASSIFICATION, PRINCIPLES & APPLICATIONS-MEASUREMENT OF STRESS STRAIN-ELECTRIC STRAIN GAUGE AND GAUGE FACTOR, METHOD OF USAGE OF RESISTANCE STRAIN GAUGE FOR BENDING AND TENSILE STRAIN; FORCE, TORQUE & POWER; STRAIN GAUGE ROSSETTES, LOAD CELLS, TORSION METERS, DYNAMOMETERS; COMPUTER ASSISTED DATA ACQUISITION, DATA MANIPULATION, DATA PRESENTATION

Reference Books

- 1 Measurement systems: Application and design , Ernest O Doebelin, Dhanesh N Manik , 2;2004, Tata McGraw Hill Education .
- 2 Instrumentation and Control systems , S.BHASKAR, 5,2018, Anuradha Agencies .
- 3 Mechanical and Industrial Measurements , R K JAIN, 6,2021, Khanna Publishers .
- 4 Instrumentation & mech. Measurements , A K TAYAL, 3,2011, GALGOTIA.
- 5 Instrumentation, measurement & analysis , B.C.Nakra & K.K.Choudhary , 4,2020, Tata McGraw Hill Education .

23SMF3507 - MACHINE TO MACHINE COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3507	MACHINE TO MACHINE COMMUNICATION	MMC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify the main challenges associated with M2M and sensors	3	PO1, PO2, PSO2
CO2	Understand main standards, protocols, algorithms, and research activities for machine to machine communication with sensors	3	PO1, PO2, PSO2
CO3	Apply protocols to develop machine to machine communication and to understand Hardware interfaces in a sensor network	3	PO1, PO5, PSO2
CO4	Analyze and evaluate different protocols and technologies utilized in machine-to-machine communication systems	4	PO1, PO2, PSO2

Syllabus

Introduction to M2M: Overview, current landscape, early implementations, architecture, protocols, requirements, and high-level architectural principles of M2M communications.

High-Level Architecture Principles for M2M Communications: Service architectures, ETSI TC M2M Service Capabilities Framework, service capabilities, resource-based communication, and procedures.

M2M Terminals and Modules: Hardware interfaces include Power, USB, UART, Antenna, UICC, GPIO, SPI, I2C, ADC, PCM, and PWM.

Analyze and evaluate protocols and technologies in M2M communication systems: architecture, protocols, technologies, standards, implementation, and performance assessment.

Reference Books

- 1 M2M Communications - A System Approach , D. Boswarthick, O. Elloumi, and O. Hersent , 1st, Wiley .
- 2 Machine-to-Machine (M2M) Communications- Architecture, Performance and Applications , C. Anton-Haro, M. Dohler , 3rd, Woodhead Publishing ISBN 978-1-78242-102-3 .
- 3 Building the Internet of Things with IPv6 and MIPv6 The Evolving World of M2M Communications , D. Minoliauth , 2nd, Wiley .
- 4 Machine-to-Machine Communications Architectures, Technology, Standards, and Applications , Vojislav B. Mistic, Jelena Mistic , 2nd, CRC Press .

23SMF3508 - FLEXIBLE MANUFACTURING SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SMF3508	FLEXIBLE MANUFACTURING SYSTEMS	FMS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Schedule machines using hollier methods in various plant layouts	3	PO1, PO2, PSO2
CO2	Apply the concept of group technology to the development of FMS	3	PO1, PO2, PSO2
CO3	Assess performance of Flexible Manufacturing Systems	3	PO1, PO2, PSO2
CO4	Illustrate Manufacturing cells and hardware components of FMS	3	PO2, PO9, PSO2

Syllabus

Production systems: Types of production- Job Shop production, Batch production and Mass production - Functions in manufacturing - Organization and information processing in manufacturing - Plant layouts: Inline Layout, Loop Layout, Rectangular Layout, Ladder Layout and Open Field Layout, - Work in progress inventory - Scheduling using Hollier Method-1 and Hollier method-2, problems

Group technology: Formation of part families - Part classification and Coding system - Opitz system, Multi Class system, Production flow analysis - Machine cell design - Clustering methods, Rank order clustering methods: problems - Modern algorithms - Benefits - System planning - Objective, guide line, system definition and sizing - Human resources - Objective, staffing, supervisor role

Flexible manufacturing systems: Flexible manufacturing systems - Introduction - Types of flexibility - Evolution - Definition - Need - Economic Justification, Application - Machine tool Selection and Layout - Computer control system - Data files - Reports - Planning the Flexible manufacturing systems - Analysis Methods for Flexible manufacturing systems - Benefits and limitations of Flexible manufacturing systems

Flexible manufacturing cells: Introduction , Cell description and classifications , Unattended machining concept, benefits of Unattended machining, Component handling and storage system, Cellular versus Flexible Manufacturing systems, Hardware configuration, Controllers, Communication networks: Local Area Networks, Wide Area Networks, Metropolitan Area Networks, Lean production and agile manufacturing

Reference Books

- 1 Flexible Manufacturing Cells and Systems , William W. Luggen , 2: 1991, Prentice Hall, New Jersey .
- 2 Automation Production Systems & Computer Integrated manufacturing , Mikell P. Groover , 4: 2016, Pearson India.
- 3 Flexible Manufacturing , David J. Parrish , 2:1993, Elsevier Science & Technology Books.
- 4 Flexible Manufacturing Systems: Recent Developments , Raouf.A and Ben-Daya.M , 3: 1995, Elsevier.

23STE3101A - ADVANCED CONCRETE TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3101A	ADVANCED CONCRETE TECHNOLOGY	ACT	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding about Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design.	2	PO1, PO2, PSO2
CO2	Understanding about Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers	2	PO1, PO2, PSO2
CO3	Understanding about Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting	2	PO1, PO2, PSO2
CO4	Understanding about Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.	2	PO1, PO2, PSO2
CO5	Apply the knowledge of mix design for preparation of high strength concrete	3	PO1, PO2, PSO2
CO6	To apply the knowledge on concrete to live situations	3	PO1, PO2, PSO2
CO7	To investigate the use of innovative materials and methods in concrete technology	3	PO1, PO2, PSO2

Syllabus

Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design

Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers

Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting

Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.

ACI Method of Mix Design, DOE Method of Mix Design

Reference Books

- 1 Concrete Technology, Santhakumar.A.R, 2, Oxford University press, New Delhi.
- 2 Concrete Technology, Gambhir.M.L, 2, Tata McGraw Hill Book Co. Ltd.,Delhi.
- 3 Concrete Technology, M.S. Shetty, 6, S. Chand & Company Ltd..
- 4 Properties of Concrete, A.M. Neville, 5, Pearson Education.

23STE3101E - ADVANCED CONCRETE TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3101E	ADVANCED CONCRETE TECHNOLOGY	ACT	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding about Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design.	2	PO1, PO2, PSO2
CO2	Understanding about Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers	2	PO1, PO2, PSO2
CO3	Understanding about Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting	2	PO1, PO2, PSO2
CO4	Understanding about Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.	2	PO1, PO2, PSO2
CO5	Apply the knowledge of mix design for preparation of high strength concrete	3	PO1, PO2, PSO2
CO6	To apply the knowledge on concrete to live situations	3	PO1, PO2, PSO2
CO7	Apply the knowledge on concrete to perform the mix design preparation	3	PO1, PO2, PSO2

Syllabus

Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design

Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers

Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting

Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.

ACI Method of Mix Design, DOE Method of Mix Design

Reference Books

- 1 Concrete Technology, Santhakumar.A.R, 2, Oxford University press, New Delhi.
- 2 Concrete Technology, Gambhir.M.L, 2, Tata McGraw Hill Book Co. Ltd.,Delhi.
- 3 Concrete Technology, M.S. Shetty, 6, S. Chand & Company Ltd..
- 4 Properties of Concrete, A.M. Neville, 5, Pearson Education.

23STE3101R - ADVANCED CONCRETE TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3101R	ADVANCED CONCRETE TECHNOLOGY	ACT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding about Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design.	2	PO1, PO3, PSO2
CO2	Understanding about Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers	2	PO1, PO3, PSO2
CO3	Understanding about Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting	2	PO1, PO3, PSO2
CO4	Understanding about Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.	2	PO1, PO3, PSO2
CO5	To apply the knowledge on concrete to live situations	3	PO1, PO3, PSO2
CO6	Apply the knowledge of mix design for preparation of high strength concrete	3	PO1, PO3, PSO2

Syllabus

Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design.

Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers

Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting

Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.

ACI Method of Mix Design, DOE Method of Mix Design

Reference Books

- 1 Concrete Technology, Santhakumar.A.R, 2, Oxford University press, New Delhi.
- 2 Concrete Technology, Gambhir.M.L, 2, Tata McGraw Hill Book Co. Ltd., Delhi, .
- 3 Concrete Technology, M.S. Shetty, 6, S. Chand & Company Ltd..
- 4 Properties of Concrete, A.M. Neville, 5, Pearson Education.

23STE3202A - ADVANCED STRUCTURAL ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3202A	ADVANCED STRUCTURAL ANALYSIS	ASA	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Review of Statically Indeterminate Structures Analysis of continuous beams and frames using the force method and displacement method Slope-deflection method and moment distribution method for indeterminate structures Analysis of three-dimensional frames and spatial structures	3	PO1, PO5, PSO1
CO2	Matrix Structural Analysis Formulation of the stiffness matrix for trusses, beams, and frames Assembly of the global stiffness matrix and application of boundary conditions Solution techniques for solving systems of linear equations arising from structural analysis	3	PO1, PO5, PSO1
CO3	Finite Element Analysis (FEA) Introduction to the finite element method for structural analysis Discretization of structures into finite elements and assembly of the global stiffness matrix Application of FEA software for analyzing structural behavior and obtaining numerical solutions	3	PO1, PO5, PSO1
CO4	Advanced Topics in Structural Dynamics Modal analysis and mode shapes of structures Response spectrum analysis for seismic loading Time-history analysis of structures subjected to dynamic loads Introduction to dynamic stability and buckling analysis	3	PO1, PO5, PSO1
CO5	Design and optimize structural systems considering various constraints and performance criteria.	4	PO1, PO5, PSO1
CO6	Use modern computational tools and software for structural analysis and design. Conduct critical reviews of research literature in structural analysis and apply findings to practical problems.	5	PO1, PO5, PSO1
CO7	Develop a comprehensive understanding of the stability and reliability of structures under different loading conditions.	4	PO1, PO5, PSO1

Syllabus

Advanced Analysis of Statically Indeterminate Structures Review of force method and displacement method for indeterminate structures Slope-deflection method and moment distribution method for continuous beams and frames Analysis of three-dimensional frames and spatial structures Introduction to energy methods for structural analysis

Matrix Structural Analysis Formulation of the stiffness matrix for trusses, beams, and frames Assembly of the global stiffness matrix and application of boundary conditions Solution techniques for solving systems of linear equations arising from structural analysis Introduction to computer-based matrix analysis software

Finite Element Analysis (FEA) Introduction to the finite element method for structural analysis Discretization of structures into finite elements and assembly of the global stiffness matrix Application of FEA software for analyzing structural behavior and obtaining numerical solutions Advanced topics in FEA, such as nonlinear analysis and dynamic analysis

Advanced Topics in Structural Dynamics Modal analysis and mode shapes of structures Response spectrum analysis for seismic loading Time-history analysis of structures subjected to dynamic loads Dynamic stability and buckling analysis for structures

Influence Lines and Moving Loads Construction and use of influence lines for determinate and indeterminate structures, Analysis of structures subjected to moving loads using influence lines Applications of influence lines in bridge and transportation engineering

Plastic Analysis of Structures , Plastic behavior of materials and structural elements

Dynamic Analysis of Structures , Fundamentals of structural dynamics Free and forced vibration analysis of single and multi-degree-of-freedom systems

Special Topics in Advanced Structural Analysis , Nonlinear analysis of structures Stability analysis of structures

Reference Books

- 1 Advanced Structural Analysis, Devdas Menon, 3rd Edition, Oxford University Press.
- 2 Matrix Analysis of Structures, Aslam Kassimali, 2nd Edition, Cengage Learning.
- 3 Finite Element Analysis: Theory and Application with ANSYS, Saeed Moaveni, 4th Edition, Pearson.
- 4 Advanced Structural Analysis, S.S. Bhavikatti, 2nd Edition, Vikas Publishing House.

23STE3202E - ADVANCED STRUCTURAL ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3202E	ADVANCED STRUCTURAL ANALYSIS	ASA	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Review of Statically Indeterminate Structures Analysis of continuous beams and frames using the force method and displacement method Slope-deflection method and moment distribution method for indeterminate structures Analysis of three-dimensional frames and spatial structures	1	PO1, PO5, PSO1
CO2	Matrix Structural Analysis Formulation of the stiffness matrix for trusses, beams, and frames Assembly of the global stiffness matrix and application of boundary conditions Solution techniques for solving systems of linear equations arising from structural analysis	1	PO1, PO5, PSO1
CO3	Finite Element Analysis (FEA) Introduction to the finite element method for structural analysis Discretization of structures into finite elements and assembly of the global stiffness matrix Application of FEA software for analyzing structural behavior and obtaining numerical solutions	3	PO1, PO5, PSO1
CO4	Advanced Topics in Structural Dynamics Modal analysis and mode shapes of structures Response spectrum analysis for seismic loading Time-history analysis of structures subjected to dynamic loads Introduction to dynamic stability and buckling analysis	3	PO1, PO5, PSO1
CO5	Design and optimize structural systems considering various constraints and performance criteria.	4	PO1, PO5, PSO1
CO6	Conduct critical reviews of research literature in structural analysis and apply findings to practical problems.	5	PO1, PO5, PSO1
CO7	Develop a comprehensive understanding of the stability and reliability of structures under different loading conditions.	4	PO1, PO5, PSO1

Syllabus

Advanced Analysis of Statically Indeterminate Structures Review of force method and displacement method for indeterminate structures Slope-deflection method and moment distribution method for continuous beams and frames Analysis of three-dimensional frames and spatial structures Introduction to energy methods for structural analysis

Matrix Structural Analysis Formulation of the stiffness matrix for trusses, beams, and frames Assembly of the global stiffness matrix and application of boundary conditions Solution techniques for solving systems of linear equations arising from structural analysis Introduction to computer-based matrix analysis software

Finite Element Analysis (FEA) Introduction to the finite element method for structural analysis Discretization of structures into finite elements and assembly of the global stiffness matrix Application of FEA software for analyzing structural behavior and obtaining numerical solutions Advanced topics in FEA, such as nonlinear analysis and dynamic analysis

Finite Element Methods ,Finite element formulation and discretization Analysis of trusses, beams, and frames using finite element method

Structural Stability, Introduction to structural stability and buckling

Analysis of stability of beams, columns, and frames Design considerations for stability

Dynamics of Structures, Free and forced vibration analysis of single and multi-degree-of-freedom systems

Advanced Topics in Structural Analysis, Nonlinear structural analysis

Reference Books

- 1 Advanced Structural Analysis, Devdas Menon, 3rd Edition, Oxford University Press.
- 2 Matrix Analysis of Structures, Aslam Kassimali, 2nd Edition, Cengage Learning.
- 3 Finite Element Analysis: Theory and Application with ANSY, Saeed Moaveni, 4th Edition, Pearson.
- 4 Advanced Structural Analysis, Ashok K. Jain, 1st, Nem Chand & Bros.

23STE3202R - ADVANCED STRUCTURAL ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3202R	ADVANCED STRUCTURAL ANALYSIS	ASA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Review of Statically Indeterminate Structures Analysis of continuous beams and frames using the force method and displacement method Slope-deflection method and moment distribution method for indeterminate structures Analysis of three-dimensional frames and spatial structures	3	PO1, PO5, PSO1
CO2	Matrix Structural Analysis Formulation of the stiffness matrix for trusses, beams, and frames Assembly of the global stiffness matrix and application of boundary conditions Solution techniques for solving systems of linear equations arising from structural analysis	3	PO1, PO5, PSO1
CO3	Finite Element Analysis (FEA) Introduction to the finite element method for structural analysis Discretization of structures into finite elements and assembly of the global stiffness matrix Application of FEA software for analyzing structural behavior and obtaining numerical solutions	3	PO1, PO5, PSO1
CO4	Advanced Topics in Structural Dynamics Modal analysis and mode shapes of structures Response spectrum analysis for seismic loading Time-history analysis of structures subjected to dynamic loads Introduction to dynamic stability and buckling analysis	3	PO1, PO5, PSO1
CO5	Utilize advanced structural analysis software and computational tools to model, analyze, and optimize structural systems.	3	PO1, PO5, PSO1
CO6	Design and optimize structural systems considering advanced criteria such as sustainability and life-cycle cost.	5	PO1, PO5, PSO1
CO7	Critically evaluate research literature in advanced structural analysis and apply findings to practical engineering problems.	5	PO1, PO5, PSO1

Syllabus

Advanced Analysis of Statically Indeterminate Structures Review of force method and displacement method for indeterminate structures Slope-deflection method and moment distribution method for continuous beams and frames Analysis of three-dimensional frames and spatial structures Introduction to energy methods for structural analysis

Matrix Structural Analysis Formulation of the stiffness matrix for trusses, beams, and frames Assembly of the global stiffness matrix and application of boundary conditions Solution techniques for solving systems of linear equations arising from structural analysis Introduction to computer-based matrix analysis software

Finite Element Analysis (FEA) Introduction to the finite element method for structural analysis Discretization of structures into finite elements and assembly of the global stiffness matrix Application of FEA software for analyzing structural behavior and obtaining numerical solutions Advanced topics in FEA, such as nonlinear analysis and dynamic analysis

Advanced Topics in Structural Dynamics Modal analysis and mode shapes of structures Response spectrum analysis for seismic loading Time-history analysis of structures subjected to dynamic loads Dynamic stability and buckling analysis for structures

Finite Element Methods m, Finite element formulation and discretization

Structural Stability, Introduction to structural stability and buckling Analysis of stability of beams, columns, and frames

Dynamics of Structures, Free and forced vibration analysis of single and multi-degree-of-freedom systems

Advanced Topics in Structural Analysis, Nonlinear structural analysis

Reference Books

- 1 Advanced Structural Analysis, Devdas Menon, 3rd Edition, Oxford University Press.
- 2 Matrix Analysis of Structures, Aslam Kassimali, 2nd Edition, Cengage Learning.
- 3 Finite Element Analysis: Theory and Application with ANSYS, Saeed Moaveni, 4th Edition, Pearson.
- 4 Advanced Structural Analysis, Ashok K. Jain, 1st , Nem Chand & Bros.

23STE3203A - ADVANCED DESIGN OF STEEL STRUCTURE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3203A	ADVANCED DESIGN OF STEEL STRUCTURE	ADSS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Advanced Structural Analysis Techniques: Explore advanced methods for structural analysis of steel frames, including nonlinear analysis, dynamic analysis, and finite element analysis (FEA).	4	PO1, PO5, PSO1
CO2	Design Optimization: Learn strategies for optimizing the design of steel structures, including the use of advanced software tools and optimization algorithms to achieve optimal performance and efficiency.	4	PO1, PO5, PSO1
CO3	Composite Steel-Concrete Structures: Understand the principles and design considerations for composite steel-concrete structures, including composite beams, columns, and slabs.	4	PO1, PO5, PSO1
CO4	Connections and Joints: Study advanced connection design principles for steel structures, including moment-resisting connections, braced connections, and bolted and welded connections.	4	PO1, PO5, PSO1
CO5	Seismic Design of Steel Structures: Gain insights into seismic design principles for steel structures, including performance-based design, base isolation, and energy dissipation devices.	4	PO1, PO5, PSO1
CO6	Buckling and Stability Analysis: Learn about buckling and stability analysis of steel structures, including global and local buckling phenomena and their implications for design.	4	PO1, PO5, PSO1
CO7	Fatigue and Fracture Mechanics: Explore the effects of fatigue and fracture on the performance and safety of steel structures, and learn strategies for mitigating these effects through design.	4	PO1, PO5, PSO1

Syllabus

Introduction to Advanced Steel Design Overview of advanced topics in steel design Review of fundamental concepts

Advanced Analysis Techniques Nonlinear analysis of steel structures Finite element analysis (FEA) for steel design

Plastic Design of Steel Structures Plastic analysis and design methods Plastic hinge theory

Structural Stability Buckling analysis of steel members Design for structural stability Week 5: Seismic Design of Steel Structures

Seismic Design of Steel Structures Seismic design principles and regulations Performance-based seismic design

Advanced Connection Design Moment-resisting connections Braced connections Bolted and welded connections

Reference Books

- 1 Advanced Design of Steel Structures, Dr. Michael Johnson, Dr. Emily Thompson, 2nd Edition, Wiley.
- 2 Design of Steel Structures, Duggal S K , 4th Edition, McGraw Hill Education.
- 3 Steel Structures: Design and Behavior, Charles G. Salmon, John E. Johnson, Faris A. Malhas , 5th Edition, Pearson.
- 4 Limit States Design of Structural Steelwork, N.S. Trahair, M.A. Bradford, David Nethercot, Leroy Gardner, 3rd Edition, Publisher: CRC Press.

23STE3203E - ADVANCED DESIGN OF STEEL STRUCTURE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3203E	ADVANCED DESIGN OF STEEL STRUCTURE	ADSS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Advanced Structural Analysis Techniques: Explore advanced methods for structural analysis of steel frames, including nonlinear analysis, dynamic analysis, and finite element analysis (FEA).	4	PO1, PO5, PSO1
CO2	Design Optimization: Learn strategies for optimizing the design of steel structures, including the use of advanced software tools and optimization algorithms to achieve optimal performance and efficiency.	4	PO1, PO5, PSO1
CO3	Composite Steel-Concrete Structures: Understand the principles and design considerations for composite steel-concrete structures, including composite beams, columns, and slabs.	4	PO1, PO5, PSO1
CO4	Connections and Joints: Study advanced connection design principles for steel structures, including moment-resisting connections, braced connections, and bolted and welded connections.	4	PO1, PO5, PSO1
CO5	Seismic Design of Steel Structures: Gain insights into seismic design principles for steel structures, including performance-based design, base isolation, and energy dissipation devices.	4	PO1, PO5, PSO1
CO6	Buckling and Stability Analysis: Learn about buckling and stability analysis of steel structures, including global and local buckling phenomena and their implications for design.	4	PO1, PO5, PSO1

Syllabus

Introduction to Advanced Steel Design Overview of advanced topics in steel design Review of fundamental concepts

Advanced Analysis Techniques Nonlinear analysis of steel structures Finite element analysis (FEA) for steel design

Plastic Design of Steel Structures Plastic analysis and design methods Plastic hinge theory

Structural Stability Buckling analysis of steel members Design for structural stability

Seismic Design of Steel Structures Seismic design principles and regulations Performance-based seismic design

Advanced Connection Design Moment-resisting connections Braced connections Bolted and welded connections

Reference Books

- 1 Advanced Design of Steel Structures, Dr. Michael Johnson, Dr. Emily Thompson, 2nd Edition, Wiley.
- 2 Design of Steel Structures, N. Subramanian , 2nd Edition, Oxford University Press.
- 3 Limit States Design of Structural Steelwork, N.S. Trahair, M.A. Bradford, David Nethercot, Leroy Gardner , 3rd Edition, Publisher: CRC Press.
- 4 Steel Structures: Design and Behavior, Charles G. Salmon, John E. Johnson, Faris A. Malhas, 5th Edition, Pearson.

23STE3203R - ADVANCED DESIGN OF STEEL STRUCTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3203R	ADVANCED DESIGN OF STEEL STRUCTURE	ADSS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Advanced Structural Analysis Techniques: Explore advanced methods for structural analysis of steel frames, including nonlinear analysis, dynamic analysis, and finite element analysis (FEA).	3	PO1, PO5, PSO1
CO2	Design Optimization: Learn strategies for optimizing the design of steel structures, including the use of advanced software tools and optimization algorithms to achieve optimal performance and efficiency.	3	PO1, PO5, PSO1
CO3	Composite Steel-Concrete Structures: Understand the principles and design considerations for composite steel-concrete structures, including composite beams, columns, and slabs.	3	PO1, PO5, PSO1
CO4	Connections and Joints: Study advanced connection design principles for steel structures, including moment-resisting connections, braced connections, and bolted and welded connections.	3	PO1, PO5, PSO1
CO5	Seismic Design of Steel Structures: Gain insights into seismic design principles for steel structures, including performance-based design, base isolation, and energy dissipation devices.	3	PO1, PO5, PSO1

Syllabus

Introduction to Advanced Steel Design Overview of advanced topics in steel design Review of fundamental concepts

Advanced Analysis Techniques Nonlinear analysis of steel structures Finite element analysis (FEA) for steel design

Plastic Design of Steel Structures Plastic analysis and design methods Plastic hinge theory

Structural Stability Buckling analysis of steel members Design for structural stability

Seismic Design of Steel Structures Seismic design principles and regulations Performance-based seismic design

Reference Books

- 1 Advanced Design of Steel Structures, Dr. Michael Johnson, Dr. Emily Thompson, 2nd Edition, Wiley.
- 2 Design of Steel Structures, Duggal S K , 4th Edition, McGraw Hill Education.
- 3 Design of Steel Structures, N. Subramanian , 2nd Edition, Oxford University Press.
- 4 Advanced Steel Design of Structure, Srinivasan Chandrasekaran, 1st Edition, CRC Press.

23STE3304A - BRIDGE ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3304A	BRIDGE ENGINEERING	BE	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the various types of bridges and their structural components.	3	PO1
CO2	Apply the principles of statics and dynamics to the analysis of bridge structures.	4	PO2
CO3	Analyze bridges to withstand the forces of gravity, wind, and traffic.	4	PO3
CO4	Evaluate bridges to withstand the forces of gravity, wind, and traffic.	4	
CO5	Design bridges to withstand the forces of gravity, wind, and traffic.	4	PO3, PSO1
CO6	Develop the model bridges to withstand the forces of gravity, wind, and traffic.	4	
CO7	Understand the construction methods and project management in bridge engineering	2	

Syllabus

Concrete Bridge: Various types of bridges, I.R.C. specifications for road bridges. Culverts: Design of R.C. slab culvert. T Beam Bridge: Pigeaud method for computation of slab moments, courbon method for computation of moments in girders, Design of simply supported T beam bridge.

Sub Structure for Bridges: Pier and abutment caps, Materials for piers and abutments, Design of pier, Design of abutment, Backfill behind abutment, approach slab. Bearings for Bridges: Importance of bearings, bearings for slab bridge, bearings for girder bridges, Expansion bearings, Fixed bearings.

Design of elastomeric pad bearing. Foundations For Bridges: scour at abutments and piers, Grip length, Types of foundations, Design of well foundation.

Cable Supported Bridge: Different types of cable supported bridge, difference between suspension bridge and cable stayed bridge. Different components and factors considered for design of a) suspension bridge, b) cable stayed bridge.

Steel Bridges and Composite Bridges Steel Bridges: Types of Steel Bridges: Plate Girder Bridges Truss Bridges Arch Bridges Box Girder Bridges Design Considerations: Load and Resistance Factor Design (LRFD) and Allowable Stress Design (ASD) Fatigue and Fracture Considerations Corrosion Protection and Maintenance Connection Design (Bolted and Welded Connections) IRC Specifications: IRC codes relevant to the design and construction of steel bridges Standard loading specifications and design requirements Design Examples: Design of a simple plate girder bridge Design of a truss bridge for highway loading

Composite Bridges: Concept and Advantages: Definition of composite bridges Benefits over traditional concrete or steel bridges, including material efficiency and structural performance Types of Composite Bridges: Composite Plate Girder Bridges Composite Box Girder Bridges Design Principles: Shear connectors and their role in composite action Design methodologies for composite sections under bending and shear Differential shrinkage and creep considerations in composite design IRC and International Specifications: Relevant IRC codes for composite bridge design Comparison with AASHTO LRFD specifications and Eurocode standards Design Examples: Design of a composite plate girder bridge for highway application Detailing of shear connectors and composite action evaluation

Design Principles: Shear connectors and their role in composite action Design methodologies for composite sections under bending and shear Differential shrinkage and creep considerations in composite design IRC and International Specifications: Relevant IRC codes for composite bridge design Comparison with AASHTO LRFD specifications and Eurocode standards Design Examples: Design of a composite plate girder bridge for highway application Detailing of shear connectors and composite action evaluation

Construction Methods and Project Management: Bridge Construction Techniques, Equipment and Machinery for Bridge Construction, Equipment and Machinery for Bridge Construction

Reference Books

- 1 Bridge Engineering Handbook, Wai-Fah Chen, Lian Duan (Editors), 2nd, CRC Press.
- 2 Bridge Engineering: Substructure Design, Wai-Fah Chen, Lian Duan, 3rd, CRC Press.
- 3 Essentials of Bridge Engineering, D. Johnson Victor, 6th, Oxford University Press, 2007.
- 4 Bridge Engineering, Demetrios E. Tonnias and Jim J. Zhao, 3rd, McGraw-Hill Education, 2012.

23STE3304E - BRIDGE ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3304E	BRIDGE ENGINEERING	BE	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the various types of bridges and their structural components.	3	PO1
CO2	Apply the principles of statics and dynamics to the analysis of bridge structures.	4	PO2
CO3	Analyze bridges to withstand the forces of gravity, wind, and traffic.	4	PO3
CO4	Evaluate bridges to withstand the forces of gravity, wind, and traffic.	4	
CO5	Design bridges to withstand the forces of gravity, wind, and traffic.	4	PO3, PSO1
CO6	Develop the model bridges to withstand the forces of gravity, wind, and traffic.	4	
CO7	Understand the construction methods and project management in bridge engineering	2	

Syllabus

Concrete Bridge: Various types of bridges, I.R.C. specifications for road bridges. Culverts: Design of R.C. slab culvert. T Beam Bridge: Pigeaud method for computation of slab moments, courbon method for computation of moments in girders, Design of simply supported T beam bridge.

Sub Structure for Bridges: Pier and abutment caps, Materials for piers and abutments, Design of pier, Design of abutment, Backfill behind abutment, approach slab. Bearings for Bridges: Importance of bearings, bearings for slab bridge, bearings for girder bridges, Expansion bearings, Fixed bearings.

Design of elastomeric pad bearing. Foundations For Bridges: scour at abutments and piers, Grip length, Types of foundations, Design of well foundation.

Cable Supported Bridge: Different types of cable supported bridge, difference between suspension bridge and cable stayed bridge. Different components and factors considered for design of a) suspension bridge, b) cable stayed bridge.

Hybrid Bridges: Introduction to Hybrid Bridges: Definition and examples of hybrid bridges combining different materials and structural systems Advantages and applications of hybrid bridges in modern infrastructure Design Considerations: Structural behavior under combined material usage Load distribution and interaction between different materials Case Studies: Analysis of notable hybrid bridge projects Lessons learned and best practices in hybrid bridge design

Construction Techniques: Erection Methods for Steel and Composite Bridges: Incremental launching Cantilever construction Use of temporary supports and cranes Welding and Bolting Practices: Standards and procedures for welding in steel bridge construction Bolting techniques and quality control measures Inspection and Quality Control: Techniques for the inspection of steel and composite bridges during and after construction Non-destructive testing methods for ensuring structural integrity

Steel Bridges: Types of Steel Bridges: Plate Girder Bridges Truss Bridges Arch Bridges Box Girder Bridges Design Considerations: Load and Resistance Factor Design (LRFD) and Allowable Stress Design (ASD) Fatigue and Fracture Considerations Corrosion Protection and Maintenance Connection Design (Bolted and Welded Connections) IRC Specifications: IRC codes relevant to the design and construction of steel bridges Standard loading specifications and design requirements

Construction Methods and Project Management: Bridge Construction Techniques, Equipment and Machinery for Bridge Construction, Equipment and Machinery for Bridge Construction

Reference Books

- 1 Bridge Engineering Handbook, Wai-Fah Chen, Lian Duan (Editors), 2nd, CRC Press.

- 2 Bridge Engineering: Substructure Design, Wai-Fah Chen, Lian Duan, 3rd, CRC Press.
- 3 Essentials of Bridge Engineering, D. Johnson Victor, 6, Oxford University Press, 2007.
- 4 Bridge Engineering, Demetrios E. Tonnias and Jim J. Zhao, 3, McGraw-Hill Education, 2012.

23STE3304R - BRIDGE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3304R	BRIDGE ENGINEERING	BE	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the various types of bridges and their structural components.	3	PO1
CO2	Apply the principles of statics and dynamics to the analysis of bridge structures.	4	PO2
CO3	Analyze bridges to withstand the forces of gravity, wind, and traffic.	4	PO3
CO4	Evaluate bridges to withstand the forces of gravity, wind, and traffic.	4	, PSO1
CO5	Design bridges to withstand the forces of gravity, wind, and traffic.	4	PO3
CO6	Develop the model bridges to withstand the forces of gravity, wind, and traffic.	3	
CO7	Understand the construction methods and project management in bridge engineering	2	

Syllabus

Concrete Bridge: Various types of bridges, I.R.C. specifications for road bridges. Culverts: Design of R.C. slab culvert. T Beam Bridge: Pigeaud method for computation of slab moments, courbon method for computation of moments in girders, Design of simply supported T beam bridge.

Sub Structure for Bridges: Pier and abutment caps, Materials for piers and abutments, Design of pier, Design of abutment, Backfill behind abutment, approach slab. Bearings for Bridges: Importance of bearings, bearings for slab bridge, bearings for girder bridges, Expansion bearings, Fixed bearings.

Design of elastomeric pad bearing. Foundations For Bridges: scour at abutments and piers, Grip length, Types of foundations, Design of well foundation.

Cable Supported Bridge: Different types of cable supported bridge, difference between suspension bridge and cable stayed bridge. Different components and factors considered for design of a) suspension bridge, b) cable stayed bridge.

Composite Bridges: Concept and Advantages: Definition of composite bridges Benefits over traditional concrete or steel bridges, including material efficiency and structural performance Types of Composite Bridges: Composite Plate Girder Bridges Composite Box Girder Bridges Design Principles: Shear connectors and their role in composite action Design methodologies for composite sections under bending and shear Differential shrinkage and creep considerations in composite design IRC and International Specifications: Relevant IRC codes for composite bridge design Comparison with AASHTO LRFD specifications and Eurocode standards Design Examples: Design of a composite plate girder bridge for highway application Detailing of shear connectors and composite action evaluation

Hybrid Bridges: Introduction to Hybrid Bridges: Definition and examples of hybrid bridges combining different materials and structural systems Advantages and applications of hybrid bridges in modern infrastructure Design Considerations: Structural behavior under combined material usage Load distribution and interaction between different materials Case Studies: Analysis of notable hybrid bridge projects Lessons learned and best practices in hybrid bridge design

Steel Bridges: Types of Steel Bridges: Plate Girder Bridges Truss Bridges Arch Bridges Box Girder Bridges Design Considerations: Load and Resistance Factor Design (LRFD) and Allowable Stress Design (ASD) Fatigue and Fracture Considerations Corrosion Protection and Maintenance Connection Design (Bolted and Welded Connections) IRC Specifications: IRC codes relevant to the design and construction of steel bridges Standard loading specifications and design requirements Design Examples: Design of a simple plate girder bridge Design of a truss bridge for highway loading

Construction Methods and Project Management: Bridge Construction Techniques, Equipment and Machinery for Bridge Construction, Equipment and Machinery for Bridge Construction

Reference Books

- 1 Bridge Engineering Handbook, Wai-Fah Chen, Lian Duan (Editors), 2nd, CRC Press.
- 2 Bridge Engineering: Substructure Design, Wai-Fah Chen, Lian Duan, 3rd, CRC Press.
- 3 Essentials of Bridge Engineering, D. Johnson Victor, 6, Oxford University Press, 2007.
- 4 Bridge Engineering, Demetrios E. Tonnias and Jim J. Zhao, 3, McGraw-Hill Education, 2012.

23STE3405M - PRESTRESSED CONCRETE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3405M	PRESTRESSED CONCRETE	PC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Fundamentals of Prestressed Concrete: Understand the principles and advantages of prestressed concrete, including its behavior, material properties, and applications.	3	PO1, PO5, PSO1
CO2	Prestressing Techniques: Learn about different methods of prestressing, including pre-tensioning and post-tensioning, and their advantages and limitations.	3	PO1, PO5, PSO1
CO3	Analysis of Prestressed Structures: Explore methods for analyzing the behavior of prestressed concrete structures under various loading conditions, including flexure, shear, and torsion.	3	PO1, PO5, PSO1
CO4	Design of Prestressed Members: Gain proficiency in designing prestressed concrete members such as beams, slabs, and bridges according to relevant design codes and standards.	3	PO1, PO5, PSO1
CO5	Construction Techniques: Understand the construction techniques involved in prestressed concrete, including formwork, tendon installation, grouting, and quality control measures.	3	PO1, PO5, PSO1
CO6	Prestressed Concrete Bridges: Study the design and construction of prestressed concrete bridges, including bridge superstructures, substructures, and deck systems.	3	PO1, PO5, PSO1
CO7	Prestressed Concrete Buildings: Explore the design considerations and construction techniques for prestressed concrete buildings, including floor systems, columns, and connections.	3	PO1, PO5, PSO1

Syllabus

Introduction to Prestressed Concrete Definition and advantages of prestressed concrete Historical development and applications Basic concepts and terminology

Materials for Prestressed Concrete Properties of concrete and steel materials Types of prestressing tendons and anchorages Selection criteria for prestressing materials

: Pre-Tensioning Techniques Pre-tensioning process and equipment Analysis and design considerations Examples of pre-tensioned members

Post-Tensioning Techniques Post-tensioning process and equipment Analysis and design considerations Examples of post-tensioned members

Flexural Behavior of Prestressed Members Behavior of prestressed members under flexure Stress analysis and deflection calculations Design of prestressed beams and slabs

Shear and Torsion in Prestressed Members Shear and torsional behavior of prestressed members Design considerations and reinforcement detailing Examples and applications

Reference Books

- 1 Prestressed Concrete, N. Krishna Raju, 6th Edition, Pearson Education.
- 2 Prestressed Concrete: A Fundamental Approach, Edward G. Nawy, 5th Edition, Pearson.
- 3 Prestressed Concrete Design, M.K. Hurst, Roger J. Plank, 2nd Edition, Taylor & Francis.
- 4 Prestressed Concrete Structures, Krishan K. Kaushik, George C. Lee, 2nd Edition, Wiley.

23STE3406M - PRECAST AND PREFABRICATED STRUCTURES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3406M	PRECAST AND PREFABRICATED STRUCTURES	PPS	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Residential Buildings: Prefabricated panels and modules are increasingly popular for residential construction, offering quick and cost-effective housing solutions.	3	PO1, PO5, PSO1
CO2	Commercial Structures: From office buildings to retail spaces, precast elements enable rapid construction without compromising design flexibility or quality.	3	PO1, PO5, PSO1
CO3	Infrastructure Projects: Bridges, tunnels, and other civil engineering projects benefit from precast concrete components, which enhance durability and reduce construction time.	3	PO1, PO5, PSO1
CO4	Industrial Facilities: Factories, warehouses, and manufacturing plants often utilize prefabricated structures for their speed of construction and adaptability to specific operational needs.	3	PO1, PO5, PSO1
CO5	Modular Construction: Entire buildings can be fabricated off-site as modular units, then transported and assembled on location, providing an efficient solution for temporary or permanent structures.	3	PO1, PO5, PSO1

Syllabus

Introduction to Precast and Prefabricated Construction Design Principles and Engineering Considerations Manufacturing Processes and Quality Control Case Studies in Precast and Prefabricated Structures Sustainability and Environmental Impact Design Software and Modeling Techniques Transportation and Logistics Emerging Trends and Future Directions

Lectures: Presenting theoretical concepts and foundational knowledge. Case Studies: Analyzing real-world examples to illustrate key principles and challenges. Demonstrations: Showcasing manufacturing processes and construction techniques. Hands-on Exercises: Engaging students in design projects and software simulations. Guest Lectures: Inviting industry experts to share insights and experiences. Site Visits (Optional): Organizing field trips to precast facilities or construction sites.

Quizzes and Exams: Assessing understanding of theoretical concepts and practical applications. Design Projects: Evaluating students' ability to apply design principles and engineering calculations. Presentations: Communicating findings from case studies or research projects. Class Participation: Engaging in discussions, asking questions, and contributing to group activities.

Basic knowledge of structural engineering principles. Familiarity with construction materials and methods. Proficiency in computer-aided design (CAD) software is advantageous but not mandatory. Textbooks:

Reference Books

- 1 Precast and Prefabricated Structures: Innovations in Modern Construction, John Smith, Emily Johnson, 2nd Edition, Construction Publications Ltd..
- 2 Design of Prestressed Concrete Structures, T.Y. Lin, Ned H. Burns, 3rd Edition, Wiley.
- 3 Prestressed Concrete: A Fundamental Approach, Edward G. Nawy, 5th Edition, Pearson.
- 4 Prestressed Concrete Design, M.K. Hurst, Roger J. Plank, 2nd Edition, Taylor & Francis.

23STE3507 - PRE ENGINEERING STRUCTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3507	PRE ENGINEERING STRUCTURES	PES	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Industrial Buildings: Warehouses, factories, and manufacturing plants often utilize pre-engineered steel structures for their strength, durability, and cost-effectiveness.	3	PO1, PO5, PSO1
CO2	Commercial Buildings: Retail outlets, offices, and recreational facilities benefit from the versatility and flexibility of pre-engineering structures, which can be customized to suit specific design requirements.	3	PO1, PO5, PSO1
CO3	Agricultural Facilities: Barns, storage sheds, and livestock shelters are commonly constructed using pre-engineered metal buildings, providing efficient and durable solutions for agricultural operations.	3	PO1, PO5, PSO1
CO4	Agricultural Facilities: Barns, storage sheds, and livestock shelters are commonly constructed using pre-engineered metal buildings, providing efficient and durable solutions for agricultural operations.	3	PO1, PO5, PSO1
CO5	Infrastructure Projects: Pre-engineered components such as bridges, culverts, and pedestrian walkways contribute to the efficient and timely completion of infrastructure projects, minimizing traffic disruptions and enhancing safety.	3	PO1, PO5, PSO1

Syllabus

Introduction to Pre-Engineering Structures Structural Analysis and Design Principles Materials for Pre-Engineering Structures Types of Pre-Engineered Components Design Considerations and Standards

Case Studies in Pre-Engineering Projects Sustainability and Environmental Impact Safety and Regulatory Compliance Fabrication Techniques and Quality Control Installation and Site Consideration

Lectures: Presenting theoretical concepts and fundamental principles. Workshops: Conducting hands-on exercises and design projects. Case Studies: Analyzing real-world examples to illustrate key concepts and challenges.

Lectures: Presenting theoretical concepts and fundamental principles. Workshops: Conducting hands-on exercises and design projects. Case Studies: Analyzing real-world examples to illustrate key concepts and challenges.

Software Demonstrations: Utilizing structural analysis and design software tools. Guest Lectures: Inviting industry experts to share insights and experiences. Field Visits (Optional): Organizing visits to pre-engineering fabrication facilities or construction sites.

Reference Books

- 1 Pre-Engineering Structures: Principles and Applications, David R. Jones, Emily K. Patel, 3rd Edition, CivilTech Publishers.
- 2 Pre-Engineered Metal Buildings, Jeffrey A. Wincel, 1st Edition, CreateSpace Independent Publishing Platform.
- 3 Pre-Engineered Building Design, M. K. Gupta, 1st Edition, CBS Publishers & Distributors.
- 4 PE Structural Reference Manual, Alan Williams, 10th Edition, PPI, a Kaplan Company.

23STE3508 - ADVANCED DESIGN OF REINFORCED CONCRETE STRUCTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23STE3508	ADVANCED DESIGN OF REINFORCED CONCRETE STRUCTURES	ADRCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Advanced Design of Slender and High-Rise Structures Design considerations for slender columns and walls Analysis and design of high-rise buildings Performance-based design approaches for tall structures	3	PO1, PO5, PSO1
CO2	Design of Long-Span and Special-Purpose Structures Design of long-span floor systems and roof structures Design of bridges, stadiums, and other special-purpose structures Structural optimization techniques for efficient design	3	PO1, PO5, PSO1
CO3	Innovative Materials and Construction Technologies Use of advanced materials such as high-strength concrete and fiber-reinforced polymers (FRP) Innovative construction techniques, including prefabrication and modular construction Design considerations for sustainable and resilient structures	3	PO1, PO5, PSO1
CO4	Seismic Design and Retrofitting of Reinforced Concrete Structures Seismic design principles for reinforced concrete buildings Performance-based seismic design and assessment Retrofitting techniques for enhancing the seismic resilience of existing structure	3	PO1, PO5, PSO1
CO5	Incorporate advanced design considerations, such as sustainability, life-cycle cost analysis, and constructability, into reinforced concrete design projects.	5	PO1, PO5, PSO1
CO6	Utilize advanced structural analysis software and computational tools to perform design calculations and simulations for reinforced concrete structures.	3	PO1, PO5, PSO1
CO7	Critically review and analyze research literature and industry standards related to advanced design practices in reinforced concrete structures.	4	PO1, PO5, PSO1

Syllabus

Design of High-Rise and Slender Structures Analysis and design considerations for tall buildings and slender structures Effects of slenderness ratio on design requirements and performance Application of advanced analysis techniques for tall building design, such as second-order effects and wind-induced vibrations Case studies of iconic high-rise structures and their design challenges

Innovative Materials and Construction Techniques Introduction to advanced materials for reinforced concrete construction, such as high-strength concrete, fiber-reinforced polymers (FRP), and ultra-high-performance concrete (UHPC) Design considerations and applications of advanced materials in structural elements, including beams, columns, and slabs Innovative construction techniques and technologies, including prefabrication, modular construction, and 3D printing Case studies of projects showcasing the use of innovative materials and construction methods

Seismic Design and Retrofitting of Reinforced Concrete Structures Principles of seismic design for reinforced concrete structures, including performance-based design approaches Seismic design provisions and detailing requirements according to relevant building codes and standards Retrofitting techniques for enhancing the seismic performance of existing reinforced concrete buildings Seismic assessment and strengthening of critical infrastructure, such as bridges and lifeline structures

Seismic Design of Reinforced Concrete Structures, Seismic behavior of reinforced concrete buildings Seismic design principles and performance-based design

Advanced Topics in Reinforced Concrete Design, Design of special structural elements (e.g., transfer structures, folded plates)

Sustainable design principles in reinforced concrete construction Innovative materials and construction techniques

Design of Deep Beams and Shear Walls, Analysis and design of deep beams

Case Studies and Project Work, Analysis and design of real-world reinforced concrete structures

Reference Books

- 1 Advanced Reinforced Concrete Design, P.C. Varghese, 2nd Edition, Prentice Hall.
- 2 Design of Prestressed Concrete Structure, T.Y. Lin, Ned H. Burns, 3rd Edition, Wiley.
- 3 High-Rise Concrete Buildings in Seismic Zones: Structural Analysis and Design, Mohamed A. El-Reedy, 1st Edition, Butterworth-Heinemann.
- 4 Design of Reinforced Concrete Structures, M. L. Gambhir, 4th, PHI Learning Pvt. Ltd..

23VLS3101A - ANALOG VLSI DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3101A	ANALOG VLSI DESIGN	AVD	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of MOS transistors for the design of single stage amplifiers.	3	PO1, PSO1
CO2	Realize the active & passive current Mirrors and analyze the differential amplifiers with qualitative and quantitative approaches.	4	PO2, PSO1
CO3	Analyze the CMOS Op Amps, and various types of Op Amps with qualitative and quantitative approaches.	4	PO1, PO3, PO5, PSO1
CO4	Analyze the high frequency response of CS, CG and CD amplifiers and noise analysis of various amplifiers and mixers.	4	PO2, PSO1
CO5	Analysis of real time circuits like switched capacitor circuits, voltage controlled oscillators, and phase locked loops	4	PO2, PO3, PO5, PSO1
CO6	Design and analysis of various MOS analog circuits using Cadence/ LT-Spice/ Qsim environment for real time applications	4	PO2, PSO1
CO7	Design and analysis of various MOS analog circuits using Cadence environment for real time applications	4	PO2, PSO1

Syllabus

Basics of Mosfet operation, drain equation, Mosfet large and small signal models Second order effects CS with different loads CS with Source degeneration and CD CG and Cascode stage

Simple current mirror, multi current mirror, cascode current mirror, Voltage references - Supply independent, PTAT current generation- Constant-Gm Biasing. Basic differential pair - Quantative and qualitative analysis Degenerative differential pair Differential pair with MOS loads Differential amplifier with active current mirror

OP-amp performance parameters, One stage Op-amp Two stage Op-amp cascode Op-amp I/O limitations and Gain boosting, Slew rate, power supply rejection, noise in OP-amps Stability and Frequency Compensation

Miller effect, Association of poles with nodes frequency response of common source stage Statistical characteristics of noise, noise in single stage amplifiers noise in differential amplifiers, Introduction to mixers and Single balanced mixer Double balanced mixer

Switched Capacitor Circuits: Sampling switches; switched capacitor amplifiers; switched capacitor integrator, Phase locked loops: Simple PLL; charge pump PLLs; non ideality effects

Reference Books

- 1 Design of Analog CMOS Integrated Circuits, Behzad Razavi, 2, McGraw Hill.
- 2 Analysis & Design of Analog Integrated Circuits, Gray and Mayer, 5, Wiley.
- 3 CMOS Mixed Signal Circuit Design, Jacob Baker, 2, Wiley.
- 4 Bipolar and MOS Analog Integrated circuit design, Grebene, 2, John Wiley & sons.

23VLS3101E - ANALOG VLSI DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3101E	ANALOG VLSI DESIGN	AVD	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of MOS transistors for the design of single stage amplifiers.	3	PO1, PO3, PSO1
CO2	Realize the active & passive current Mirrors and analyze the differential amplifiers with qualitative and quantitative approaches.	4	PO2, PSO1
CO3	Analyze the CMOS Op Amps, and various types of Op Amps with qualitative and quantitative approaches.	4	PO2, PSO1
CO4	Analyze the high frequency response of CS, CG and CD amplifiers and noise analysis of various amplifiers and mixers.	4	PO2, PSO1
CO5	Analysis of real time circuits like switched capacitor circuits, voltage controlled oscillators, and phase locked loops	4	PO2, PSO1
CO6	Design and analysis of various MOS analog circuits using Cadence/ LT-Spice/ Qsim environment for real time applications	4	PO2, PO3, PO5, PSO1
CO7	Design and analysis of various MOS analog circuits using Cadence environment for real time applications	4	PO2, PO3, PO5

Syllabus

Basics of Mosfet operation, drain equation, Mosfet large and small signal models Second order effects CS with different loads CS with Source degeneration and CD CG and Cascode stage

Simple current mirror, multi current mirror, cascode current mirror, Voltage references - Supply independent, PTAT current generation- Constant-Gm Biasing. Basic differential pair - Quantative and qualitative analysis Degenerative differential pair Differential pair with MOS loads Differential amplifier with active current mirror

OP-amp performance parameters, One stage Op-amp Two stage Op-amp cascode Op-amp I/O limitations and Gain boosting, Slew rate, power supply rejection, noise in OP-amps Stability and Frequency Compensation

Miller effect, Association of poles with nodes frequency response of common source stage Statistical characteristics of noise, noise in single stage amplifiers noise in differential amplifiers, Introduction to mixers and Single balanced mixer Double balanced mixer

Switched Capacitor Circuits: Sampling switches; switched capacitor amplifiers; switched capacitor integrator, Phase locked loops: Simple PLL; charge pump PLLs; non ideality effects

Reference Books

- 1 Design of Analog CMOS Integrated Circuits, Behzad Razavi, 2, McGraw Hill.
- 2 Analysis & Design of Analog Integrated Circuits, Gray and Mayer, 5, Wiley.
- 3 CMOS Mixed Signal Circuit Design, Jacob Baker, 2, Wiley.
- 4 Bipolar and MOS Analog Integrated circuit design, Grebene, 2, John Wiley & sons.

23VLS3101R - ANALOG VLSI DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3101R	ANALOG VLSI DESIGN	AVD	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of MOS transistors for the design of single stage amplifiers.	3	PO1, PO2, PSO1
CO2	Realize the active & passive current Mirrors and analyze the differential amplifiers with qualitative and quantitative approaches.	4	PO2, PSO1
CO3	Analyze the CMOS Op Amps, and various types of Op Amps with qualitative and quantitative approaches.	4	PO2, PO3, PSO1
CO4	Analyze the high frequency response of CS, CG and CD amplifiers and noise analysis of various amplifiers and mixers.	4	PO2, PO3, PSO1
CO5	Analysis of various MOS analog circuits using Cadence/ LT-Spice/ Qsim environment for real time applications	4	PO3, PO5, PSO2
CO6	Design and analysis of various MOS analog circuits using Cadence/ LT-Spice/ Qsim environment for real time applications	4	PO2, PO3, PO5, PSO2

Syllabus

Basics of Mosfet operation, drain equation, Mosfet large and small signal models Second order effects CS with different loads Cs with Source degeneration and CD CG and Cascode stage

Simple current mirror, multi current mirror, cascode current mirror, Voltage references - Supply independent, PTAT current generation- Constant-Gm Biasing. Basic differential pair - Quantative and qualitative analysis Degenerative differential pair, Differential pair with MOS loads, Differential amplifier with active current mirror

OP-amp performance parameters, One stage Op-amp Two stage Op-amp cascode Op-amp I/O limitations and Gain boosting, Slew rate, power supply rejection, noise in OP-amps Stability and Frequency Compensation

Miller effect, Association of poles with nodes frequency response of common source stage Statistical characteristics of noise, noise in single stage amplifiers noise in differential amplifiers, Introduction to mixers and Single balanced mixer Double balanced mixer

Reference Books

- 1 Design of Analog CMOS Integrated Circuits, Behzad Razavi, 2, McGraw Hill.
- 2 CMOS Analog Circuit Design, Phillip Allen and Douglas Holmberg, 2, Oxford University Press.
- 3 Analysis and Design of Analog Integrated Circuits, Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, 3, Wiley.
- 4 Bipolar and MOS Analog Integrated circuit design, Grebene, 2, John Wiley & sons.

23VLS3202A - TESTING AND VERIFICATION OF VLSI CIRCUITS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3202A	TESTING AND VERIFICATION OF VLSI CIRCUITS	TVVC	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Realize the test generation for combinational and sequential circuits	3	PO1, PO3, PO6, PO9, PSO1
CO2	Apply the set of fault modeling approaches to realize the various algorithms for fault simulation	3	PO1, PO3, PO6, PO9, PSO1
CO3	Analyze the concepts of functional coverage	3	PO1, PO3, PO6, PO9, PSO1
CO4	Demonstrate the randomization in System Verilog.	3	PO1, PO3, PO6, PO9, PSO1
CO5	Analyze the Advance BIST Architectures	4	PO1, PO3, PO6, PO9, PSO1

Syllabus

Testing and Test Approaches: Introduction, Test challenges, Fault models - Defects, errors, and faults, Functional Vs structural testing, Stages of fault models, Stuck-at faults, Logic, and fault Simulation: design verification and test evaluation, Modeling circuits for evaluation, Algorithms for fault simulation, Statistical approach for fault simulation

TG Algorithms and illustrations, Redundancy identification, Combinational ATPG algorithms, Test generation systems. Test generation algorithms for sequential circuits, and BIST

Design for Testability -Ad-hoc design - Generic scan-based design - Classical scan-based design- System level DFT approaches. Self-Test and Test AlgorithmsTest generation for Embedded RAMs.

Verification with System Verilog: The concept of Device under test (DUT), Complexity of verification, SV verification environment - Basics of SV testbench, concurrency in SV, encapsulation, and randomization. Inter-thread communications, mailbox, code coverage, functional coverage, and building efficient SV test benches. System Verilog UVM.

Verification of Advanced BIST Architectures

Reference Books

- 1 Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits, Michael L. Bushnell & Vishwani D. Agrawal, 4, Pearson.
- 2 Digital Systems Testing and Testable Design, Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, 2, PHI Learning.
- 3 System Verilog for Verification, Chris Spears, 2, Springer.
- 4 Logic Design Theory, NN Biswas, 2, PHI.

23VLS3202E - TESTING AND VERIFICATION OF VLSI CIRCUITS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3202E	TESTING AND VERIFICATION OF VLSI CIRCUITS	TVVC	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Realize the test generation for combinational and sequential circuits	3	PO1, PO3, PO6, PO9, PSO1
CO2	Apply the set of fault modeling approaches to realize the various algorithms for fault simulation	3	PO1, PO3, PO6, PO9, PSO1
CO3	Analyze the concepts of functional coverage	3	PO1, PO3, PO6, PO9, PSO1
CO4	Demonstrate the randomization in System Verilog.	3	PO1, PO3, PO6, PO9, PSO1
CO5	Analyze the Advance BIST Architectures	4	PO1, PO3, PO6, PO9, PSO1

Syllabus

Testing and Test Approaches: Introduction, Test challenges, Fault models - Defects, errors, and faults, Functional Vs structural testing, Stages of fault models, Stuck-at faults, Logic, and fault Simulation: design verification and test evaluation, Modeling circuits for evaluation, Algorithms for fault simulation, Statistical approach for fault simulation

TG Algorithms and illustrations, Redundancy identification, Combinational ATPG algorithms, Test generation systems. Test generation algorithms for sequential circuits, and BIST

Design for Testability -Ad-hoc design - Generic scan-based design - Classical scan-based design- System level DFT approaches. Self-Test and Test AlgorithmsTest generation for Embedded RAMs.

Verification with System Verilog: The concept of Device under test (DUT), Complexity of verification, SV verification environment - Basics of SV testbench, concurrency in SV, encapsulation, and randomization. Inter-thread communications, mailbox, code coverage, functional coverage, and building efficient SV test benches. System Verilog UVM.

Verification of Advanced BIST Architectures

Reference Books

- 1 Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits, Michael L. Bushnell & Vishwani D. Agrawal, 4, Pearson.
- 2 Digital Systems Testing and Testable Design, Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, 2, PHI Learning.
- 3 System Verilog for Verification, Chris Spears, 2, Springer.
- 4 Logic Design Theory, NN Biswash, 2, PHI Learning.

23VLS3202R - TESTING AND VERIFICATION OF VLSI CIRCUITS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3202R	TESTING AND VERIFICATION OF VLSI CIRCUITS	TVVC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Realize the test generation for combinational and sequential circuits	3	PO1, PO3, PO6, PO9, PSO1
CO2	Apply the set of fault modeling approaches to realize the various algorithms for fault simulation	3	PO1, PO3, PO6, PO9, PSO1
CO3	Analyze the concepts of functional coverage	3	PO1, PO3, PO6, PO9, PSO1
CO4	Demonstrate the randomization in System Verilog.	3	PO1, PO3, PO6, PO9, PSO1

Syllabus

Testing and Test Approaches: Introduction, Test challenges, Fault models - Defects, errors, and faults, Functional Vs structural testing, Stages of fault models, Stuck-at faults, Logic, and fault Simulation: design verification and test evaluation, Modeling circuits for evaluation, Algorithms for fault simulation, Statistical approach for fault simulation

TG Algorithms and illustrations, Redundancy identification, Combinational ATPG algorithms, Test generation systems. Test generation algorithms for sequential circuits, and BIST

Design for Testability -Ad-hoc design - Generic scan-based design - Classical scan-based design- System level DFT approaches. Self-Test and Test Algorithms Test generation for Embedded RAMs.

Verification with System Verilog: The concept of Device under test (DUT), Complexity of verification, SV verification environment - Basics of SV testbench, concurrency in SV, encapsulation, and randomization. Inter-thread communications, mailbox, code coverage, functional coverage, and building efficient SV test benches. System Verilog UVM.

Reference Books

- 1 Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits, Michael L. Bushnell & Vishwani D. Agrawal, 4, Pearson.
- 2 Digital Systems Testing and Testable Design, Miron Abramovici, Melvin A. Breuer, Arthur D. Friedman, 2, PHI Learning.
- 3 System Verilog for Verification, . Chris Spears, 2, Springer.
- 4 Logic Design Theory, NN Biswas, 2, PHI.

23VLS3303A - VLSI PHYSICAL DESIGN AUTOMATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3303A	VLSI PHYSICAL DESIGN AUTOMATION	VPDA	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Formulate the graphs for the physical design problems and estimate the complexity of physical design algorithms	3	PO1, PSO1
CO2	Apply the group migration algorithm for the successive circuit partitioning	3	PO1, PSO1
CO3	Modify the floorplans in an abstract manner and apply computer algorithms to make large and optimized floorplans	3	PO2, PSO1
CO4	Apply quadratic and Euclidean distance approaches for the wire length estimation of the full-custom / semi-custom placement problem	3	PO1, PSO1
CO5	Apply the CAD design problems using algorithmic methods	3	PO2, PSO1
CO6	To analyze circuits using both analytical and CAD tools	4	PO3, PSO1
CO7	Design of problems accumulated to FPGA boards	4	PO3, PSO1

Syllabus

Physical Design and Graph Theory: Introduction to the physical design cycle, Types of graph: complete graph, connected graph, subgraph, isomorphism, bipartite graph tree, Shortest path and spanning tree algorithms: Dijkstras Algorithm, Kruskals Algorithm, Prims Algorithm, DFS, and BFS Big O notation Class P class NP NP hard NP complete.

Partitioning: Introduction and Terminology, Objective, and goals Types of partitioning algorithms Group migration algorithms: Kernighan Lin Algorithm, Extensions of Kernighan Lin Algorithm Simulated annealing Multilevel Partitioning

Floorplanning: Introduction and optimization goals Floorplan Representations: Floorplan to a Constraint Graph Pair, Floorplan to a Sequence Pair, Sequence Pair to a Floorplan Floorplanning Algorithms: Floorplan Sizing, Cluster Growth, Integrated Floorplanning Algorithms Pin Assignment.

Placement: Wire length estimation models for placement Quadratic placement Sequence pair technique Routing: Grid routing- Maze routing Line Probe algorithms, Weighted Steiner tree approach Global and Detailed Routing: Rectilinear routing, Left Edge algorithm, Dogleg router Introduction to switch box routing.

Simulation and logic synthesis- gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis. High-level synthesis- hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

High-level synthesis- hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

FPGA technologies: Physical Design cycle for FPGAs partitioning and routing for segmented and staggered models. MCM technologies, MCM physical design cycle, Partitioning, Placement Chip array based and full custom approaches, Routing Maze routing, Multiple stage routing, Topologic routing, Integrated Pin Distribution and routing, routing and programmable MCMs.

Reference Books

- 1 VLSI Physical Design Automation Theory and Practice, H. Yosuff and S.M. Sait, 2010, Cambridge.
- 2 Practical Problems in VLSI Physical Design Automation, Sung Kyu Lim, 2011, Springer.

- 3 Algorithms for VLSI Physical Design Automation, Naveed A. Sherwani, 1999, Kluwer Academic Publishers.
- 4 VLSI Physical Design: From Graph Partitioning to Timing Closure, Andrew B. Kahng, Jens Lienig, Igor L. Markov, JinHu, 2011, Springer.

23VLS3303E - VLSI PHYSICAL DESIGN AUTOMATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3303E	VLSI PHYSICAL DESIGN AUTOMATION	VPDA	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Formulate the graphs for the physical design problems and estimate the complexity of physical design algorithms	3	PO1, PSO1
CO2	Apply the group migration algorithm for the successive circuit partitioning	3	PO1, PSO1
CO3	Modify the floorplans in an abstract manner and apply computer algorithms to make large and optimized floorplans	3	PO2, PSO1
CO4	Apply quadratic and Euclidean distance approaches for the wire length estimation of the full custom semi-custom placement problem	3	PO1, PSO1
CO5	Apply CAD design problems using algorithmic methods	3	PO1, PSO1
CO6	To analyze circuits using both analytical and CAD tools	4	
CO7	Design of problems accumulated to FPGA boards	4	

Syllabus

Physical Design and Graph Theory: Introduction to the physical design Types of graph: complete graph, connected graph, subgraph, isomorphism, bipartite graph tree Shortest path and spanning tree algorithms, Dijkstras Algorithm, Kruskals Algorithm, Prim's Algorithm, DFS, and BFS Big O notation Class P class NP NP hard NP complete

Partitioning, Introduction and Terminology, Objective, and goals, Types of partitioning algorithms, Group migration algorithms, Kernighan Lin Algorithm, Extensions of Kernighan Lin Algorithm, Simulated annealing, Multilevel Partitioning

Floorplanning: Introduction and optimization goals Floorplan Representations: Floorplan to a Constraint Graph Pair, Floorplan to a Sequence Pair, Sequence Pair to a Floorplan, Floorplanning Algorithms, Floorplan Sizing, Cluster Growth, Integrated Floorplanning Algorithms , Pin Assignment

Placement: Wire length estimation models for placement Quadratic placement Sequence pair technique, Routing: Grid routing, Maze routing, Line Probe algorithms, Weighted Steiner tree approach, Global and Detailed Routing: Rectilinear routing, Left Edge algorithm, Dogleg router Introduction to switch box routing.

Simulation and logic synthesis- gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis. High-level synthesis- hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

High-level synthesis- hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

FPGA technologies: Physical Design cycle for FPGAs partitioning and routing for segmented and staggered models. MCM technologies, MCM physical design cycle, Partitioning, Placement Chip array based and full custom approaches, Routing Maze routing, Multiple stage routing, Topologic routing, Integrated Pin Distribution and routing, routing and programmable MCMs.

Reference Books

- 1 VLSI Physical Design Automation Theory and Practice, H. Yosuff and S.M. Sait, 2010, Cambridge.
- 2 Practical Problems in VLSI Physical Design Automation, Sung Kyu Lim, 2011, Springer.

- 3 Algorithms for VLSI Physical Design Automation, Naveed A. Sherwani, 1999, Kluwer Academic Publishers.
- 4 VLSI Physical Design: From Graph Partitioning to Timing Closure, Andrew B. Kahng, Jens Lienig, Igor L. Markov, JinHu, 2011, Springer.

23VLS3303R - VLSI PHYSICAL DESIGN AUTOMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3303R	VLSI PHYSICAL DESIGN AUTOMATION	VPDA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Formulate the graphs for the physical design problems and estimate the complexity of physical design algorithms	3	PO1, PSO1
CO2	Apply the group migration algorithm for the successive circuit partitioning	3	PO1, PSO1
CO3	Modify the floorplans in an abstract manner and apply computer algorithms to make large and optimized floorplans	3	PO2, PSO1
CO4	Apply quadratic and Euclidean distance approaches for the wire length estimation of the full-custom / semi-custom placement problem	3	PO1, PSO1
CO5	Apply the CAD design problems using algorithmic methods	3	PO3, PSO1
CO6	To analyze circuits using both analytical and CAD tools	4	PO3, PSO1

Syllabus

Physical Design and Graph Theory, Introduction to the physical design cycle Types of graph: complete graph, connected graph, subgraph, isomorphism, bipartite graph tree Shortest path and spanning tree algorithms Dijkstra Algorithm, Kruskal Algorithm, Prims Algorithm, DFS, and BFS Big O notation Class P class NP NP hard NP complete.

Partitioning, Introduction and Terminology, Objective, and goals Types of partitioning algorithms Group migration algorithms Kernighan Lin Algorithm, Extensions of Kernighan-Lin Algorithm Simulated annealing Multilevel Partitioning.

Floorplanning, Introduction and optimization goals Floorplan Representations, Floorplan to a Constraint Graph Pair, Floorplan to a Sequence Pair, Sequence Pair to a Floorplan , Floorplanning Algorithms, Floorplan Sizing, Cluster Growth, Integrated Floorplanning Algorithms, Pin Assignment.

Placement, Wire length estimation models for placement, Quadratic placement, Sequence pair technique, Routing: Grid routing Maze routing Line Probe algorithms, Weighted Steiner tree approach, Global and Detailed Routing, Rectilinear routing, Left Edge algorithm, Dogleg router, Introduction to switch box routing.

Simulation and logic synthesis- gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis. High-level synthesis- hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

High-level synthesis- hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.

Reference Books

- 1 VLSI Physical Design Automation Theory and Practice, H. Yosuff and S.M. Sait, 2010, Cambridge.
- 2 Practical Problems in VLSI Physical Design Automation, Sung Kyu Lim, 2011, Springer.
- 3 Algorithms for VLSI Physical Design Automation, Naveed A. Sherwani, 1999, Kluwer Academic Publishers.
- 4 VLSI Physical Design From Graph Partitioning to Timing Closure, Andrew B. Kahng, Jens Lienig, Igor L. Markov, JinHu, 2011, Springer.

23VLS3404M - SYSTEM-ON-CHIP (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3404M	SYSTEM-ON-CHIP	SOC	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the transition of System-on-Chip	2	, PSO1
CO2	Apply system-level design and analyze MPSoC concepts.	4	PO1, PSO1
CO3	Analyze the on-chip communication with performance and process execution modeling.	4	PO1, PO2, PSO1
CO4	Realize the functional difference between various bus standards in SoC.	3	PO1, PO2, PSO1

Syllabus

SoC and H/W-S/W Co-Design: Introduction to SoC design, SoC design flow, System level design issues in SoC, Transition of SoC design methodology, Classic Hardware-Software co-design, System level H/W-S/W co-design process, Design flow of co-design process

System-level design: Platform-based SoC design, Types of platforms-based SoC, Concepts of bus-based on-chip communication architecture: Bus topologies, Bus physical structure, Arbitration schemes, Bus data transfer modes, Bus clocking, On-chip standard bus architecture: AMBA 2.0 and AMBA 3.0 bus standards.

Multi-Processor SoC (MPSoC): Introduction to MPSoC, Types of MPSoC, Design methodologies, Design issues of MPSoC, Designing of energy aware MPSoC: Processor design, Memory Design, On-Chip Communication Design, MPSoC performance modeling: Architecture component performance modeling and analysis, Process execution modeling, Modeling of shared resources, Global performance analysis.

Network-on-Chip (NoC): ASIC to System and NOC, Comparison of bus-based and NoC-based system design, NoC for SoC design, Network topologies, Switching strategies, Routing algorithms, Flow control, and clocking schemes, Quality of service (QoS) in NoC.

Reference Books

- 1 On-Chip Communication Architectures: System-on-Chip Interconnect, Sudeep Pasricha, Nikil Dutt, 2, Morgan Kaufmann, Elsevier.
- 2 Low Power NoC for High-Performance SoC Design, Hoi-Jun Yoo, Kangmin Lee, and Kyong Kim, 2, CRC Press.
- 3 Multiprocessor Systems-on-Chip, Ahmed Amine Jerraya, Wayne Wolf, 1, Morgan Kaufmann, Elsevier.
- 4 A Practical Approach to VLSI System on Chip (SoC) Design, Veena S. Chakravarthi, 1, Springer.

23VLS3505 - MIXED SIGNAL IC DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23VLS3505	MIXED SIGNAL IC DESIGN	MSID	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the performance analysis of MOSFET circuits.	2	, PSO1
CO2	Apply the small signal model concepts to realize the analog-based IC circuits.	3	PO1, PSO1
CO3	Apply the small signal model concepts to realize the analog-based IC circuits.	4	PO1, PO2, PSO1, PSO2
CO4	Apply the sampling and aliasing to convert an analog signal into a digital representation	3	PO1, PSO1, PSO2

Syllabus

Submicron CMOS: Overview and Models, CMOS process flow, Capacitors, and Resistors. Digital circuit design: The MOSFET Switch, Delay Elements, and An Adder. Analog Circuit Design: Biasing, Op-Amp Design, Circuit Noise.

Integrator Building Blocks- low pass filter, Active RC integrators, MOSFET-C Integrators, gm- C integrators, Discrete-time integrators. Filtering Topologies: The Bilinear transfer function, The Biquadratic transfer function, Filter using Noise shaping.

DAC Architectures- Resistor string, R-2R ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, and Pipeline DAC. ADC Architectures- Flash, Two-step Flash ADC, Pipeline ADC, Integrating ADCs, Successive Approximation ADC.

Sampling and Aliasing: A modeling approach, Impulse sampling, The sample and Hold, Quantization noise. Data converter SNR: An overview, Clock Jitter, Improving SNR using Averaging, Decimating filter for ADCs, Interpolating filter for DACs, Band pass and High pass filters - Using feedback to improve SNR. OSCILLATORS AND PLL: LC oscillators, Voltage Controlled Oscillators. Simple PLL, Charge pumps PLLs, Non-ideal effects in PLLs, Delay Locked Loops.

Reference Books

- 1 CMOS Mixed Signal Circuit Design, R. Jacob Baker, 2008, Wiley .
- 2 Design of Analog CMOS Integrated Circuits, Behzad Razavi, 2016, McGraw Hill.
- 3 Analysis and Design of Analog Integrated Circuits, Gray, Hurst, Lewis, and Meyer, 2006, Wiley.
- 4 The Design of CMOS Radio-Frequency Integrated Circuits, Lee, 2005, cambridge.

23WRE3101A - RIVER ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3101A	RIVER ENGINEERING	RE	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Computation of incipient motion and flow regime	3	PO1, PO2, PO7, PSO1
CO2	Estimation of river meandering and causes	3	PO1, PO2, PO7, PSO1
CO3	Concept of river training and training works	3	PO1, PO2, PO7, PSO1
CO4	Analysis of flow discharge and sediment transport using similitude	3	PO1, PO2, PO7, PSO1
CO5	Flow and discharge analysis	4	PO1, PO2, PO7, PSO1
CO6	Illustrate the experimental procedure and interpretation of results obtained using different experiment for Turbulence: Turbulence theory, Turbulence Intensity, Bed Shear Stress, Turbulent Kinetic Energy, Concept of Burst, Velocity distribution, ADV.	4	PO1, PO2, PO7, PSO1
CO7	Flow analysis in open channel flow	4	PO1, PO2, PO7, PSO1

Syllabus

Incipient motion and flow regime Types of sediment, its characteristics and alluvial channel, Concept of Incipient motion and Shields diagram, Methods for incipient motion, Description of regime of flow, Ripple, dune, and antidune regime, Importance of regime of flow, Resistance to flow in alluvial channel; Velocity distribution in alluvial channel, Concept of bed load, suspended load, wash load, and total load, Methods for the computation of bed load and suspended load.

River meandering: River plan form variations; River channel pattern; River confluences and branches; Meandering characteristics of river; Braided stream characteristics; Lateral river migration; River equilibrium; River dynamics; River aggradation and degradation; Stream power.

River training: Introduction to river training works; Objective of river training and bank protection; River training for flood control; River training for navigation; River training for guiding the flow; Causes of sedimentation in channel; Importance of sediment control; Silt excluder; Silt extractor; River dredging.

River similitude model: Types of river models; Mathematical river models; Sediment transport equations; Dimensionless numbers; Hydraulic similitude; Dimensional analysis; Distorted and undistorted models; Rigid-bed model; Mobile-bed river models.

Mathematical models for the flow and discharge analysis and hydrological model

Reference Books

- 1 Mechanics of Sediment Transportation and Alluvial Stream Problems, R. J. Garde and K. G. Ranga Raju, Third Edition, New Age International.
- 2 Hydraulics of Sediment Transport, Walter Hans Graf, Fourth Edition, Water Resources Publication, LLC.
- 3 Mechanics of Sediment Transport, A. Mueller and B. Mutlu Sumer, First Edition, CRC Press.
- 4 River Engineering, Santosh Kumar, First Edition, Khanna Publishing House.

23WRE3101E - RIVER ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3101E	RIVER ENGINEERING	RE	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Computation of incipient motion and flow regime	3	PO1, PO2, PO7, PSO1
CO2	Estimation of river meandering and causes	3	PO1, PO2, PO7, PSO1
CO3	Concept of river training and training works	3	PO1, PO2, PO7, PSO1
CO4	Analysis of flow discharge and sediment transport using similitude	3	PO1, PO2, PO7, PSO1
CO5	Flow and discharge analysis	4	PO1, PO2, PO7, PSO1
CO6	Illustrate the experimental procedure and interpretation of results obtained using different experiment for Turbulence: Turbulence theory, Turbulence Intensity, Bed Shear Stress, Turbulent Kinetic Energy, Concept of Burst, Velocity distribution, ADV.	4	PO1, PO2, PO7, PSO1
CO7	Flow analysis in open channel flow	4	PO1, PO2, PO7, PSO1

Syllabus

Incipient motion and flow regime Types of sediment, its characteristics and alluvial channel, Concept of Incipient motion and Shields diagram, Methods for incipient motion, Description of regime of flow, Ripple, dune, and antidune regime, Importance of regime of flow, Resistance to flow in alluvial channel; Velocity distribution in alluvial channel, Concept of bed load, suspended load, wash load, and total load, Methods for the computation of bed load and suspended load.

River meandering: River plan form variations; River channel pattern; River confluences and branches; Meandering characteristics of river; Braided stream characteristics; Lateral river migration; River equilibrium; River dynamics; River aggradation and degradation; Stream power.

River training: Introduction to river training works; Objective of river training and bank protection; River training for flood control; River training for navigation; River training for guiding the flow; Causes of sedimentation in channel; Importance of sediment control; Silt excluder; Silt extractor; River dredging.

River similitude model: Types of river models; Mathematical river models; Sediment transport equations; Dimensionless numbers; Hydraulic similitude; Dimensional analysis; Distorted and undistorted models; Rigid-bed model; Mobile-bed river models.

Mathematical models for the flow and discharge analysis and hydrological model

Reference Books

- 1 Mechanics of Sediment Transportation and Alluvial Stream Problems, R. J. Garde and K. G. Ranga Raju, Third Edition, New Age International.
- 2 Hydraulics of Sediment Transport, Walter Hans Graf, Fourth Edition, Water Resources Publication, LLC.
- 3 Mechanics of Sediment Transport, A. Mueller and B. Mutlu Sumer, First Edition, CRC Press.
- 4 River Engineering, Santosh Kumar, First Edition, Khanna Publishing House.

23WRE3101R - RIVER ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3101R	RIVER ENGINEERING	RE	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Computation of incipient motion and flow regime	3	PO1, PO2, PO7, PSO1
CO2	Understanding of river meandering and causes	3	PO1, PO2, PO7, PSO1
CO3	Concept of river training and training works	3	PO1, PO2, PO7, PSO1
CO4	Analysis of flow discharge and sediment transport using similitude	4	PO1, PO2, PO7, PSO1
CO5	Illustrate the experimental procedure and interpretation of results obtained using different experiment for Turbulence: Turbulence theory, Turbulence Intensity, Bed Shear Stress, Turbulent Kinetic Energy, Concept of Burst, Velocity distribution, ADV.	4	PO1, PO2, PO7, PSO1
CO6	Analysis geology and geologic processes, knowledge of hydrology in the basin	4	PO1, PO2, PO7, PSO1

Syllabus

Incipient motion and flow regime Types of sediment, its characteristics and alluvial channel, Concept of Incipient motion and Shields diagram, Methods for incipient motion, Description of regime of flow, Ripple, dune, and antidune regime, Importance of regime of flow, Resistance to flow in alluvial channel; Velocity distribution in alluvial channel, Concept of bed load, suspended load, wash load, and total load, Methods for the computation of bed load and suspended load.

River meandering: River plan form variations; River channel pattern; River confluences and branches; Meandering characteristics of river; Braided stream characteristics; Lateral river migration; River equilibrium; River dynamics; River aggradation and degradation; Stream power.

River training: Introduction to river training works; Objective of river training and bank protection; River training for flood control; River training for navigation; River training for guiding the flow; Causes of sedimentation in channel; Importance of sediment control; Silt excluder; Silt extractor; River dredging.

River similitude model: Types of river models; Mathematical river models; Sediment transport equations; Dimensionless numbers; Hydraulic similitude; Dimensional analysis; Distorted and undistorted models; Rigid-bed model; Mobile-bed river models.

Reference Books

- 1 Mechanics of Sediment Transportation and Alluvial Stream Problems, R. J. Garde and K. G. Ranga Raju, Third Edition, New Age International.
- 2 Hydraulics of Sediment Transport, Walter Hans Graf, Fourth Edition, Water Resources Publication, LLC.
- 3 Mechanics of Sediment Transport, A. Mueller and B. Mutlu Sumer, First Edition, CRC Press.
- 4 River Engineering, Santosh Kumar, First Edition, Khanna Publishing House.

23WRE3202A - SOLID WASTE MANAGEMENT AND LANDFILLS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3202A	SOLID WASTE MANAGEMENT AND LANDFILLS	SWML	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basics of solid waste and management and options available for disposal	2	PO1, PO6, PO7, PSO2
CO2	Understand the engineered systems for solid waste management and conversion and recovery of materials and energy	2	PO1, PO6, PO7, PSO2
CO3	Understand Familiarize with landfills , site selection design and operation, collection of gas and lechate , treatment of lechate and CPCB and MOEF guidelines. Design of Land filling	2	PO1, PO6, PO7, PSO2
CO4	Understand Familiarize with clay and geo synthetic lining systems and their designing	2	PO1, PO6, PO7, PSO2
CO5	Understand the hazardous waste and treatment.	2	PO1, PO6, PO7, PSO2

Syllabus

Classification of solid wastes (source and type based), solid waste management (SWM), elements of SWM, ESSWM (environmentally sound solid waste management) and EST (environmentally sound technologies), factors affecting SWM, Indian scenario, progress in MSW (municipal solid waste) management in India. Indian and global scenario of e-waste

Introduction to Solid Waste Management, Definition and classification of solid waste, Sources and characteristics of solid waste, Waste Collection and Transport, Collection methods and equipment,

Introduction to Landfills, Role and importance of landfills in waste management, Site Selection for Landfills, Criteria for site selection, Design of Landfills, Operation of Landfills, Collection and Management of Landfill Gas, Leachate Collection and Treatment

Introduction to Lining Systems, Importance of lining systems in waste management and groundwater protection, Clay Liners, Geosynthetic Liners, Composite Lining Systems, Design criteria for lining systems, Hydraulic conductivity and leak detection in liners

Introduction to Hazardous Waste, Environmental and Health Impacts, Overview of hazardous waste regulations, Hazardous Waste Characterization, Physical Treatment Methods, Chemical Treatment Methods, Biological Treatment Methods, Thermal Treatment Methods

Reference Books

- 1 Solid Waste Management: Principles and Practice, Ramesha Chandrappa, 2000, Springer.
- 2 hazardous waste management, Michael D. LaGrega, 2005, Waveland press.
- 3 Nanoparticle Technology Handbook, Masuo Hosokawa, 2018, Elsevier.
- 4 Design of Landfills and Integrated Solid Waste Management, Amalendu Bagchi, 1999, Wiley.
- 5 Solid Waste Engineering: A Global Perspective, William A. Worrell and P. Aarne Vesilind, 2017, Cengage Learning.
- 6 Municipal Solid Waste Management in Developing Countries: Perspectives and Challenges, Sunil Kumar and Ajay S. Kalamdhad, 2005, CRC Press.

23WRE3202E - SOLID WASTE MANAGEMENT AND LANDFILLS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3202E	SOLID WASTE MANAGEMENT AND LANDFILLS	SWML	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	MUNICIPAL SOLID WASTES- Types of solid wastes, Sources of Municipal and Hazardous wastes, Properties of solid wastes-Physical and Chemical composition.	2	PO1, PO6, PO7, PSO2
CO2	Understand the engineered systems for solid waste management and conversion and recovery of materials and energy	2	PO1, PO6, PO7, PSO2
CO3	Understand Familiarize with landfills , site selection design and operation, collection of gas and lechate , treatment of lechate and CPCB and MOEF guidelines. Design of Land filling	2	PO1, PO6, PO7, PSO2
CO4	Understand Familiarize with clay and geo synthetic lining systems and their designing	2	PO1, PO6, PO7, PSO2
CO5	Understand the Solid and hazardous waste disposal	2	PO1, PO6, PO7, PSO2

Syllabus

MUNICIPAL SOLID WASTES- Types of solid wastes, Sources of Municipal and Hazardous wastes, Properties of solid wastes-Physical and Chemical composition

Introduction to Solid Waste Management, Definition and classification of solid waste, Sources and characteristics of solid waste, Waste Collection and Transport, Collection methods and equipment,

Introduction to Landfills, Role and importance of landfills in waste management, Site Selection for Landfills, Criteria for site selection, Design of Landfills, Operation of Landfills, Collection and Management of Landfill Gas, Leachate Collection and Treatment

Introduction to Lining Systems, Importance of lining systems in waste management and groundwater protection, Clay Liners, Geosynthetic Liners, Composite Lining Systems, Design criteria for lining systems, Hydraulic conductivity and leak detection in liners

Guidelines and Landfill Procedure for Disposing Hazardous Waste, Location and Site Selection Criteria for Hazardous Waste Landfill, Site Investigation, Planning and Design of Hazardous Waste Landfill, Waste Acceptance Criteria at Hazardous Waste Landfil

Reference Books

- 1 Solid waste Engineering, Solid waste Engineering, 2010, Cengage Learning India Private Limited, New Delhi.
- 2 Environmental Science and Engineering, J.Glynn Henry, 2019, Pearson Education Inc, Singapore.
- 3 Environmental Engineering, Howard S, 2018, Mc Graw-Hill International Editions.
- 4 Industrial Water Pollution Control, Eckenfelder W.W, 2000, McGraw Hill Book Company.

23WRE3202R - SOLID WASTE MANAGEMENT AND LANDFILLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3202R	SOLID WASTE MANAGEMENT AND LANDFILLS	SWML	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basics of solid waste and management and options available for disposal	2	PO1, PO6, PO7, PSO2
CO2	Understand the engineered systems for solid waste management and conversion and recovery of materials and energy	2	PO1, PO6, PO7, PSO2
CO3	Understand Familiarize with landfills , site selection design and operation, collection of gas and lechate , treatment of lechate and CPCB and MOEF guidelines. Design of Land filling	2	PO1, PO6, PO7, PSO2
CO4	Understand Familiarize with clay and geo synthetic lining systems and their designing	2	PO1, PO6, PO7, PSO2

Syllabus

MUNICIPAL SOLID WASTES- Types of solid wastes, Sources of Municipal and Hazardous wastes, Properties of solid wastes- Physical and Chemical composition.

Introduction to Solid Waste Management, Definition and classification of solid waste, Sources and characteristics of solid waste, Waste Collection and Transport, Collection methods and equipment,

Introduction to Landfills, Role and importance of landfills in waste management, Site Selection for Landfills, Criteria for site selection, Design of Landfills, Operation of Landfills, Collection and Management of Landfill Gas, Leachate Collection and Treatment

Introduction to Lining Systems, Importance of lining systems in waste management and groundwater protection, Clay Liners, Geosynthetic Liners, Composite Lining Systems, Design criteria for lining systems, Hydraulic conductivity and leak detection in liners

Reference Books

- 1 Solid waste Engineering, 1. P.Aarne Vesilind, William Worrell and Debra Reinhart, 2010, Cengage Learning India Private Limited, New Delhi.
- 2 Environmental Science and Engineering, 2. J.Glynn Henry, Gary W.Heinke, 2019, Pearson Education Inc, Singapore.
- 3 Environmental Engineering, 1. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous , 2018, Mc Graw-Hill International Editions, NewYork.
- 4 Solid Waste Engineering: A Global Perspective, William A. Worrell, P. Aarne Vesilind, Christian Ludwig, 2006, Cengage Learning.

23WRE3203A - DESIGN OF HYDRAULIC STRUCTURES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3203A	DESIGN OF HYDRAULIC STRUCTURES	DHS	A	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyses different parameter of lined and unlined channels	4	PO1, PO5, PO7, PSO1
CO2	Analyses different parameter of cross regulators on channel, Barrages and surplus weirs	4	PO1, PO5, PO7, PSO1
CO3	Analyses different parameter of Transitions and cross drainage works.	4	PO1, PO5, PO7, PSO1
CO4	Analyses different parameter of Spillway, Design principle of gravity and earthen dam.	4	PO1, PO5, PO7, PSO1
CO5	Design of different hydraulic structure for a river valley project	4	PO1, PO5, PO7, PSO1

Syllabus

Canal Introduction to design of lined and unlined channels (Triangular and Trapezoidal shape), Analysis for surface and sub-surface flow at hydraulic structures.

Regulation works Design of head regulator, cross regulator and falls (Trapezoidal notch type falls) on canal.

Cross Drainage works Design transitions and cross drainage works (Aqueducts; Super passage; Syphon Aqueducts.) on canal, Design of barrages and weirs on river.

Dam and spillways, Design principles for gravity and earthen dams, Design of spillway (ogee and chute spillway).

Different hydraulic structure for a river valley project.

Reference Books

- 1 Irrigation and Water Power Engineering, P. N. Modi, 6th Edition, Standard Book House, New Delhi.
- 2 Irrigation and Water Resources Engineering, G. L. Asawa, 1st Edition, New Age International Publishers Ltd.
- 3 Irrigation Engineering and Hydraulic structures, S. K. Garg, 2nd Edition, Standard Book House, New Delhi.
- 4 Urban Hydrology, Hydraulics, and Stormwater Quality, A. Osman Akan, Robert J. Houghtalen, 1st Edition, John Wiley & Sons.

23WRE3203E - DESIGN OF HYDRAULIC STRUCTURES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3203E	DESIGN OF HYDRAULIC STRUCTURES	DHS	E	5	0	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyses different parameter of lined and unlined channels	4	PO1, PO5, PO7, PSO1
CO2	Analyses different parameter of cross regulators on channel, Barrages and surplus weirs	4	PO1, PO5, PO7, PSO1
CO3	Analyses different parameter of Transitions and cross drainage works.	4	PO1, PO5, PO7, PSO1
CO4	Analyses different parameter of Spillway, Design principle of gravity and earthen dam.	4	PO1, PO5, PO7, PSO1
CO5	Design of different hydraulic structure for a river valley project	4	PO1, PO5, PO7, PSO1

Syllabus

Canal Introduction to design of lined and unlined channels (Triangular and Trapezoidal shape), Analysis for surface and sub-surface flow at hydraulic structures.

Regulation works Design of head regulator, cross regulator and falls (Trapezoidal notch type falls) on canal.

Cross Drainage works Design transitions and cross drainage works (Aqueducts; Super passage; Syphon Aqueducts.) on canal, Design of barrages and weirs on river.

Dam and spillways, Design principles for gravity and earthen dams, Design of spillway (ogee and chute spillway).

Different hydraulic structure for a river valley project.

Reference Books

- 1 Irrigation and Water Power Engineering, P. N. Modi, 6th Edition, Standard Book House, New Delhi .
- 2 Irrigation and Water Resources Engineering, G. L. Asawa, 1st Edition, New Age International Publishers Ltd .
- 3 Irrigation Engineering and Hydraulic structures, S. K. Garg, 2nd Edition, Standard Book House, New Delhi.
- 4 Urban Hydrology, Hydraulics, and Stormwater Quality, A. Osman Akan, Robert J. Houghtalen, 1st Edition, John Wiley & Sons.

23WRE3203R - DESIGN OF HYDRAULIC STRUCTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3203R	DESIGN OF HYDRAULIC STRUCTURES	DHS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyses different parameter of lined and unlined channels	4	PO1, PO5, PO7, PSO1
CO2	Analyses different parameter of cross regulators on channel, Barrages and surplus weirs	4	PO1, PO5, PO7, PSO1
CO3	Analyses different parameter of Transitions and cross drainage works.	4	PO1, PO5, PO7, PSO1
CO4	Analyses different parameter of Spillway, Design principle of gravity and earthen dam.	4	PO1, PO5, PO7, PSO1

Syllabus

Canal Introduction to design of lined and unlined channels (Triangular and Trapezoidal shape), Analysis for surface and sub-surface flow at hydraulic structures.

Regulation works Design of head regulator, cross regulator and falls (Trapezoidal notch type falls) on canal.

Cross Drainage works Design transitions and cross drainage works (Aqueducts; Super passage; Syphon Aqueducts.) on canal, Design of barrages and weirs on river.

Dam and spillways, Design principles for gravity and earthen dams, Design of spillway (ogee and chute spillway).

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- 1 Irrigation and Water Power Engineering, P. N. Modi, 6th Edition, Standard Book House, New Delhi.
- 2 Irrigation and Water Resources Engineering, G. L. Asawa, 1st Edition, New Age International Publishers Ltd.
- 3 Irrigation Engineering and Hydraulic Structures, S. K. Garg, 2nd, Standard Book House, New Delhi.
- 4 Urban Hydrology, Hydraulics, and Stormwater Quality, A. Osman Akan, Robert J. Houghtalen, 1st Edition, John Wiley & Sons.

23WRE3304A - WATER RESOURCES FIELD METHODS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3304A	WATER RESOURCES FIELD METHODS	WRFM	A	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Measure and Estimate of different losses during rainfall event.	3	PO1, PO3, PO7, PSO1
CO2	Surface-Water Measurements and Methods	3	PO1, PO3, PO7, PSO1
CO3	Surface Water-Quality Measurements and Methods	3	PO1, PO3, PO7, PSO1
CO4	Groundwater Measurements and Methods	3	PO1, PO3, PO7, PSO1
CO5	To estimate the water resources of watershed for the allocation to different sector based on demand	3	PO1, PO3, PO7, PSO1
CO6	Illustrate the experimental procedure and interpretation of results obtained using different experiment for surface hydrology and groundwater hydrology	3	PO1, PO3, PO7, PSO1
CO7	Illustrate the skill procedure and interpretation for the water resources management of an area.	3	PO1, PO3, PO7, PSO1

Syllabus

Abstractions Water losses, Initial losses, Interception and depression storage, Evaporation, Evaporimeters, Estimation of Evaporation, Evapotranspiration, Field Measurement, Empirical Equations, Infiltration, Infiltrimeters, Infiltration Equation, Infiltration Indices.

Surface-Water Measurements and Methods, Stage and Velocity Measurement, Gauges, Current meter and Doppler flow velocity meter, Discharge measurement, Area Velocity method, Area Slope method, Discharge Measuring Structures, Dilution Technique, Stage Discharge relationship, Selection of a Stream Gauging Site.

Water Quality Measurements and Methods Water-quality principles, Measurement principles, chemical compatibility, quality assurance, Sample Collection flowing and nonflowing water sites, Sample preparation, Field Measurements

Groundwater Measurements and Methods: Groundwater Hydraulics and Principles, Well Construction, Hydraulic Tests and Measurements, determining aquifer parameters, steady and transient conditions, Slug test, Locating hydro geological boundaries, Image well theory, Determination of well characteristics and specific capacity of wells, Well characteristics of large diameter wells

Water resources of watershed estimation for the allocation water to different sector based on demand.

Reference Books

- 1 Elementary Hydrology, V. P. Singh, 1st Edition, PHI Publishers, New Delhi, India.
- 2 Hydrologic Analysis and Design, Hydrologic Analysis and Design, 1st Edition, Printice Hall..
- 3 Hand Book of Applied Hydrology, Chow, V.T., 3rd Edition, Mc Graw Hill, New York.
- 4 Ground Water Hydrology, Todd, D.K., 3rd Edition, John Wiley & Sons, New York.

23WRE3304E - WATER RESOURCES FIELD METHODS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3304E	WATER RESOURCES FIELD METHODS	WRFM	E	4	0	4	4	7

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Measure and Estimate of different losses during rainfall event.	3	PO1, PO3, PO7, PSO1
CO2	Surface-Water Measurements and Methods	3	PO1, PO3, PO7, PSO1
CO3	Surface Water-Quality Measurements and Methods	3	PO1, PO3, PO7, PSO1
CO4	Groundwater Measurements and Methods	3	PO1, PO3, PO7, PSO1
CO5	To estimate the water resources of watershed for the allocation to different sector based on demand	3	PO1, PO3, PO7, PSO1
CO6	Illustrate the experimental procedure and interpretation of results obtained using different experiment for surface hydrology and groundwater hydrology	3	PO1, PO3, PO7, PSO1
CO7	Illustrate the skill procedure and interpretation for the water resources management of an area.	3	PO1, PO3, PO7, PSO1

Syllabus

Abstractions Water losses, Initial losses, Interception and depression storage, Evaporation, Evaporimeters, Estimation of Evaporation, Evapotranspiration, Field Measurement, Empirical Equations, Infiltration, Infiltrometers, Infiltration Equation, Infiltration Indices.

Surface-Water Measurements and Methods, Stage and Velocity Measurement, Gauges, Current meter and Doppler flow velocity meter, Discharge measurement, Area Velocity method, Area Slope method, Discharge Measuring Structures, Dilution Technique, Stage Discharge relationship, Selection of a Stream Gauging Site.

Water Quality Measurements and Methods Water-quality principles, Measurement principles, chemical compatibility, quality assurance, Sample Collection flowing and nonflowing water sites, Sample preparation, Field Measurements

Groundwater Measurements and Methods: Groundwater Hydraulics and Principles, Well Construction, Hydraulic Tests and Measurements, determining aquifer parameters, steady and transient conditions, Slug test, Locating hydro geological boundaries, Image well theory, Determination of well characteristics and specific capacity of wells, Well characteristics of large diameter wells

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- 2 Hydrologic Analysis and Design, Hydrologic Analysis and Design, 1st Edition, Printice Hall..
- 3 Hand Book of Applied Hydrology, Chow, V.T., 3rd Edition, Mc Graw Hill, New York.
- 4 Ground Water Hydrology, Todd, D.K., 3rd Edition, John Wiley & Sons, New York.

23WRE3304R - WATER RESOURCES FIELD METHODS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3304R	WATER RESOURCES FIELD METHODS	WRFM	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Measure and Estimate of different losses during rainfall event.	3	PO1, PO3, PO7, PSO1
CO2	Surface-Water Measurements and Methods	3	PO1, PO3, PO7, PSO1
CO3	Surface Water-Quality Measurements and Methods	3	PO1, PO3, PO7, PSO1
CO4	Groundwater Measurements and Methods	3	PO1, PO3, PO7, PSO1
CO5	Illustrate the experimental procedure and interpretation of results obtained using different experiment for surface hydrology and groundwater hydrology	4	PO1, PO3, PO7, PSO1
CO6	Illustrate the skill procedure and interpretation for the water resources management of an area.	4	PO1, PO3, PO7, PSO1

Syllabus

Abstractions Water losses, Initial losses, Interception and depression storage, Evaporation, Evaporimeters, Estimation of Evaporation, Evapotranspiration, Field Measurement, Empirical Equations, Infiltration, Infiltrometers, Infiltration Equation, Infiltration Indices.

Surface-Water Measurements and Methods, Stage and Velocity Measurement, Gauges, Current meter and Doppler flow velocity meter, Discharge measurement, Area Velocity method, Area Slope method, Discharge Measuring Structures, Dilution Technique, Stage Discharge relationship, Selection of a Stream Gauging Site.

Water Quality Measurements and Methods Water-quality principles, Measurement principles, chemical compatibility, quality assurance, Sample Collection flowing and nonflowing water sites, Sample preparation, Field Measurements

Groundwater Measurements and Methods: Groundwater Hydraulics and Principles, Well Construction, Hydraulic Tests and Measurements, determining aquifer parameters, steady and transient conditions, Slug test, Locating hydro geological boundaries, Image well theory, Determination of well characteristics and specific capacity of wells, Well characteristics of large diameter wells

Reference Books

- 1 Elementary Hydrology, V. P. Singh, 1st Edition, PHI Publishers, New Delhi, India.
- 2 Hydrologic Analysis and Design, McCuen, R. H., 1st Edition, Printice Hall..
- 3 Hand Book of Applied Hydrology, Chow, V.T., 3rd Edition, Mc Graw Hill, New York .
- 4 Ground Water Hydrology, Todd, D.K. , 3rd Edition, John Wiley & Sons, New York .

23WRE3405M - URBAN WATER HYDROLOGY AND HYDRAULICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3405M	URBAN WATER HYDROLOGY AND HYDRAULICS	UWHH	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the urban hydrological cycle & hydraulic process	2	PO1, PO3, PO7, PSO1
CO2	Estimate the components of urban hydrological processes	3	PO1, PO3, PO7, PSO1
CO3	Estimate runoff from highways, airports and urban areas	3	PO1, PO3, PO7, PSO1
CO4	Analysis of storm water management system	3	PO1, PO3, PO7, PSO1

Syllabus

Urban hydrological cycle and components, Impact of urbanization on hydrological cycle, Anomalies and characterization of rainfall, Time and scale effects, Urban hydrological data requirements and analysis, Storm water runoff generation, return period, hydrologic risk, frequency analysis-IDF relationships.

Open channel flow in urban watersheds; interception storage, infiltration, depression storage; estimation of runoff rates from urban watersheds; flow routing; storm water drainage structures; storm water detention; structural and non-structural control measures; urban watershed modelling.

Overland and drainage channel flows; hydraulics of storm-drain systems and culverts; determination of design flow; runoff for highways, airports, and urban areas.

Planning and design aspects of storm water/drainage infrastructure; design of drainage gutters, channels, sewer networks, and culverts and storm water management.

Reference Books

- 1 Urban Hydrology , M. J. Hall , Ist. Edition, Elsevier Applied Science, London.
- 2 Urban Hydrology, Timothy R. Lazaro, Ist. Edition, CRC Press.
- 3 Urban Hydrology and Hydraulics Design , J. C. Y. Guo, Ist Edition, Water Resources Pubns .
- 4 Urban Hydrology, Hydraulics, and Stormwater Quality , A. Osman Akan, Robert J. Houghtalen, Ist. Edition, John Wiley & Sons .

23WRE3406M - ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3406M	ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSES	EIALCA	M	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Concepts of EIA methodologies, Sustainable development	2	PO1, PO6, PO7, PSO2
CO2	Understand the General Framework for Environmental Impact Assessment, Characterization and site assessment	2	PO1, PO6, PO7, PSO2
CO3	Understand the Prediction and Assessment of EIA	2	PO1, PO6, PO7, PSO2
CO4	Understand the Environmental Legislation, Life Cycle Assessment	2	PO1, PO6, PO7, PSO2

Syllabus

Introduction to Environmental Impact Assessment (EIA), Definition and purpose of EIA , Historical background and evolution, Methodology of EIA , Screening and scoping, Impact assessment, Mitigation and enhancement

Screening Process, Definition and significance of screening Methods for screening potential projects , Tools used for screening, such as checklists and matrices, Importance of scoping in EIAs Techniques for scoping, including stakeholder engagement and consultation Tools for scoping, such as scoping matrices and flowcharts

Introduction to Life Cycle Analysis (LCA), Definition and significance of LCA in sustainability, Historical development and evolution of LCA, Principles and Stages of LCA, The life cycle concept: cradle-to-grave, cradle-to-gate, and cradle-to-cradle. Stages of LCA: goal and scope definition, inventory analysis, impact assessment, and interpretation.

Introduction to quantitative assessment methods, Environmental modeling techniques, Statistical analysis for impact assessment Life Cycle Assessment (LCA) and its application in EIA, Integrating Environmental and Social Impact Assessment

Reference Books

- 1 . Environmental Impact Assessment, Larry Canter, 2000, Mc Graw Hill Publishers .
- 2 Handbook of Environmental Impact Assessment Vol. I & II, Judith Petts, 2010, Blackwell Science.
- 3 .Environmental Science and Engineering, Suresh K. Dhaneja, 2015, S.K.Katania& SonsPublication., New Delhi.
- 4 Environmental Pollution and Control,, Dr H.S. Bhatia, 2019, Galgotia Publication (P) Ltd,Delhi .

23WRE3507 - PHYSICO-CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3507	PHYSICO-CHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT	PCPWWT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the inter-relationship between water quality parameters and plant sizing, hydraulics and layout. Able to design intake structures.	2	PO1, PO6, PO7, PSO2
CO2	Learn aeration, sedimentation, coagulation and flocculation processes. Able to explain settling equations. Tube settlers and pulsators.	2	PO1, PO6, PO7, PSO2
CO3	Design filter units alongwith filter backwash system. Analyze chemistry of disinfection and to know the kinetics of disinfection. Understand adsorption process and apply the knowledge of isotherms.	3	PO1, PO6, PO7, PSO2
CO4	design various miscellaneous treatment processes such as softening, fluoridation/defluoridation. Able to know the importance and removal of trace organics.	2	PO1, PO6, PO7, PSO2

Syllabus

Design considerations - Plant Sizing and Layout, Hydraulic Flow Diagram, IntakeStructures - Design types. Water Quality Characteristics and Parameters Interlinks. Inorganic and Organic constituents.

Aeration - principles and design of aeration systems - two film theory. Sedimentation - types of setting and settling equations (Stokes, Newtons and Transition), design of setting tanks; Operational problems. Tube and pulsators Coagulation and Flocculation - types of Coagulants, Coagulation theory, optimum dosage of coagulant, design criteria and design

Filtration - theory, types, hydraulics of filter bed, design of filter units, filter backwash, operational problems and trouble shooting. Disinfection - disinfections, influencing factors, methods, byproducts and kinetics. Adsorption - types. equilibrium kinematics and Isotherms and applications.

Miscellaneous treatment: water softening - process operation and design. Fluoridation/defluoridation - design. removal of specific/trace organic contaminations - Arsenic (As), natural organic matter (NOM), dissolved organic matter (DOM), taste and order, volatile organic compounds (VOCs), synthetic organic chemicals.

Reference Books

- 1 Physicochemical Processes for Water Quality Control, J. Weber, W.J. Control,, 2000, John Wiley and Sons..
- 2 Environmental Engineering, Peavy, H.s, Rowe, D.R, Tchobanoglous, G. , 2011, Mc-Graw -Hill.
- 3 Wastewater Engineering, Treatment, Disposal and Reuse, . MetCalf and Eddy., 2016, Tata McGraw-Hill.
- 4 MWH (2012) Water Treatment: Principles and Design, J. Weber, W.J. Control,, 2005, John Wiley & Sons.

23WRE3508 - SUSTAINABLE ENGINEERING AND TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23WRE3508	SUSTAINABLE ENGINEERING AND TECHNOLOGY	SET	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of sustainability, Challenges for Sustainable Development and Clean Development Mechanism	2	PO1, PO7, PO9, PSO1
CO2	Understand the sources, impacts of solid waste, Global environmental issues and Water Act, Air Act.	2	PO1, PO7, PO9, PSO1
CO3	Understand the Life Cycle Analysis, Procedures of EIA, green materials for building construction and Methods for increasing energy efficiency of buildings Sustainable cities	2	PO1, PO7, PO9, PSO1
CO4	Understand the Conventional and non-conventional of Energy sources and Sustainable Urbanization, industrialization and poverty reduction	2	PO1, PO7, PO9, PSO1

Syllabus

Sustainability Introduction, Need and concept of sustainability, Social environmental and economic sustainability concepts. Sustainable development, Nexus between Technology and Sustainable development, Challenges for Sustainable Development. Multilateral environmental agreements and Protocols Clean Development Mechanism (CDM), Environmental legislations in India Water Act, Air Act. A

Air Pollution, Effects of Air Pollution, Water pollution sources, Sustainable wastewater treatment, Solid waste sources, impacts of solid waste, Zero waste concept, 3 R concept. Global environmental issues Resource degradation, Climate change, Global warming, Ozone layer depletion, Regional and Local Environmental Issues.

Carbon credits and carbon trading, carbon foot print. Environmental management standards, ISO 14000 series, Life Cycle Analysis (LCA) Scope and Goal, Bio mimicking, Environment Impact Assessment (EIA) Procedures of EIA in India. Basic concepts of sustainable habitat, Green buildings, green materials for building construction, material selection for sustainable design, green building certification, Methods for increasing energy efficiency of buildings. Sustainable cities, Sustainable transport.

Energy sources: Basic Concepts-Conventional and non-conventional, solar energy, Fuel cells, Wind energy, Small hydro plants, bio fuels, Energy derived from oceans, Geothermal energy. Green Engineering, Sustainable Urbanization, industrialization, and poverty reduction, Social and technological change, Industrial Processes Material selection, Pollution Prevention, Industrial Ecology, Industrial symbiosis.

Reference Books

- 1 Introduction to Sustainable Engineering, K Shibu, 4th Edition, PKC Books.
- 2 Sustainability Engineering: Concepts, Design and Case Studies, D.T Allen, and D.R. Shonnard, 1st Edition, Prentice Hall.
- 3 Engineering applications in sustainable design and development, A.S Bradley, A. O Adebayo , P. Maria, 1st Edition, Cengage learning.
- 4 Systems Analysis for Sustainable Engineering: Theory and Applications, Ni Bin Chang, 3rd Edition, McGraw-Hill Professional.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Project Research And Internship (PRI)

23IE2040 - SOCIAL INTERNSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE2040	SOCIAL INTERNSHIP	SIP	R	0	0	0	4	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Remember the fundamentals of the science of water cycle along with powerful tools that students can use to diagnose the health of the local water cycle as well as develop targeted action plans to restore the local natural water cycle and bring water prosperity	2	PO3, PSO1
CO2	Remember the water sustainability and water resilience of village, city, residential facilities and households using multi-level water scorecards	2	PO4, PSO1
CO3	Apply the design thinking positive action plan for a village, campus, residential facility and community neighbourhood.	3	PO5, PSO1
CO4	Apply the water positive solutions within an urban watershed, a rural watershed, residential institutional and corporate community	3	PO6, PSO1

Syllabus

The module will cover the following 1) Science of Natural Water Cycle 2) Watershed death spiral that is the cause of climate change 3) Water Literacy - Know how water flows in your city, in your residential community and inside your own home.

4) Design Thinking Process 5) Water Accounting - Water Scorecard Tools to rapidly assess and account for water sustainability security & resilience of your own household, your residential community & your city 6) Basic Hydrology 7) Groundwater Fundamentals

8) Water Cycle and Biodiversity 9) Nature Based Solutions to Restore & Repair the Local Natural Water Cycle

10) Model prototype

Reference Books

- 1 The Social Work Skills Workbook, Barry R. Cournoyer, 1, CWP Press.
- 2 Social Work Practice: A Generalist Approach, Louise C. Johnson and Stephen J. Yanca, 1, Springer.
- 3 The Social Work Internship: A Guide for Students, Pamela Myers Kiser, 1, Springer.
- 4 Community Organizing and Community Building for Health and Welfare, Meredith Minkler, 1, Springer.

23IE3041 - TECHNICAL INTERNSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE3041	TECHNICAL INTERNSHIP	TIP	R	0	0	0	4	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Ability to demonstrate the impact of academic skills and logical thinking	3	PO3, PSO1
CO2	Ability to integrate existing and new technical knowledge for industrial application	3	PO4, PSO1
CO3	Ability to demonstrate the impact of the internship on their learning and professional development	3	PO5, PSO1
CO4	Demonstrate the ability to harness resources by analyzing challenges	4	PO6, PSO1

Syllabus

students will explore key academic skills such as effective study strategies, time management, and critical reading techniques. They will also dive into research methodologies, including how to conduct literature reviews and properly reference sources in academic writing. The module will focus on developing logical thinking abilities, emphasizing structured approaches to solving complex problems. Students will engage in exercises and case studies that challenge their logical reasoning, enhancing their capacity for critical analysis and decision-making.

Students will learn how to apply advanced technical tools and methodologies to solve real-world industrial problems. Key topics will include adapting to evolving technologies, analyzing industry trends, and understanding the impact of innovations on process optimization. Through case studies and practical examples, students will gain insights into how technical knowledge is applied in industries like manufacturing, product design, and automation.

Students will reflect on their experiences in the workplace, examining how internships enhance their understanding of technical concepts, teamwork, and communication skills. The module will include discussions on the application of academic knowledge in practical scenarios, as well as the importance of soft skills such as leadership and adaptability. Through reflective assignments and discussions, students will assess the long-term impact of their internships on their career development.

students will learn about effective resource management and its role in solving industrial challenges. The focus will be on identifying available resources, such as human capital, materials, and technology, and learning how to allocate them efficiently. Students will explore techniques for analyzing challenges and developing strategic solutions that maximize resource utilization. Through case studies from various industries, students will examine real-world examples of successful resource management, and they will engage in group projects to simulate problem-solving in complex, resource-constrained environments.

Reference Books

- 1 Research Methodology, Ranjit Kumar, 3rd, SAGE.
- 2 Engineering Project Management for the Global High Technology Industry, Sammy G. Shina, 3rd, McGraw-Hill Education.
- 3 Engineering Project Management, Nigel J. Smith, 3rd, Wiley-Blackwell.
- 4 Project Management for Engineering, Business and Technology, John M. Nicholas, Herman Steyn, 6th, Pearson..

23IE4048 - ENGINEERING PROJECT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE4048	ENGINEERING PROJECT	EPJ	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Literature search equips students with the ability to efficiently locate, evaluate, and synthesize academic and scholarly sources relevant to their field of study. Students will develop skills to conduct comprehensive searches, critically assess the credibility of sources, and apply research findings to support their academic or professional work.	2	PO1
CO2	Problem identification enables students to accurately recognize and define complex issues or challenges within a given context. Students will learn to analyze situations critically, identify underlying causes, and articulate clear problem statements that guide effective problem-solving strategies.	3	PO2
CO3	Analysis of research work prepares students to critically evaluate and interpret research studies, assessing the methodology, data, and conclusions. Students will develop the ability to dissect research findings, identify strengths and weaknesses, and draw informed conclusions that contribute to their own academic or professional endeavors.	2	PO6, PSO1
CO4	Evaluation of research work trains students to systematically assess the quality and relevance of research studies by examining their design, methodology, and overall contributions to the field. Students will gain the skills to judge the validity, reliability, and impact of research, enabling them to make informed decisions and provide constructive feedback in academic or professional contexts.	3	PO9, PSO2

Syllabus

A literature survey involves a comprehensive review of existing scholarly works, such as books, academic papers, and articles, on a specific topic or research question. The purpose is to gather, summarize, and critically analyze the current state of knowledge, identifying key theories, methodologies, and gaps in the research. This process helps researchers contextualize their work within the broader academic landscape, ensuring that their study builds on existing knowledge and addresses unresolved issues.

Acquiring knowledge and practicing on the tools required to execute a project involves gaining proficiency in the specific software, technologies, or methodologies essential for the project's successful completion. This process includes hands-on training, experimentation, and application of these tools to develop the skills needed to handle real-world project challenges effectively. By mastering these tools, individuals can enhance their efficiency, accuracy, and overall ability to deliver high-quality results within the project's scope and objectives.

"Problems identification and implementing the existing work" involves recognizing and clearly defining challenges or gaps in a particular area of study or practice. This process requires a thorough understanding of existing solutions and methodologies, allowing for the application or adaptation of these approaches to address the identified issues. By leveraging established work, individuals can efficiently implement proven strategies, ensuring that solutions are both effective and aligned with current best practices while also identifying areas where further innovation is needed.

"Designing and developing solutions for the problems identified and publishing the work in reputed journals" involves creating innovative and practical responses to the challenges uncovered during research or analysis. This process requires a deep understanding of the problem, creative problem-solving skills, and the ability to develop solutions that are both effective and feasible. Once the solutions are validated, publishing the work in reputed journals ensures that the research is peer-reviewed, widely disseminated, and recognized within the academic or professional community, contributing to the advancement of knowledge in the field.

Reference Books

- 1 Research Methodology , Ranjit Kumar, 2011, SAGE.
- 2 Engineering Project Management for the Global High Technology Industry, Sammy G. Shina, 2014, McGraw-Hill Education.
- 3 Engineering Project Management, Nigel J. Smith, 2007, Wiley-Blackwell.
- 4 Project Management for Engineering, Business and Technology, John M. Nicholas, Herman Steyn, 2008, Pearson.

23IE4053 R - CAPSTONE PROJECT - 1 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE4053 R	CAPSTONE PROJECT - 1	CP-1	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Exercise to acquire knowledge within the chosen area of technology for project development.	2	PO1
CO2	Identify, discuss and justify the technical aspects of the chosen area for problem analysis	3	PO2
CO3	Reproduce, improve and refine technical aspects for chosen problem	2	PO6, PSO1
CO4	Communicate and report effectively project related activities and findings.	3	PO9, PSO2

Syllabus

Literature Survey

Literature Survey

Problems identification

Problems identification

Reference Books

- 1 Research Methodology, RAnjith Kumar, 3rd, SAGE.
- 2 Engineering Project Management for the Global High Technology Industry, Sammy G. Shina, 3rd, McGraw-Hill Education.
- 3 Engineering Project Management, Nigel J. Smith, 3rd, Wiley-Blackwell.
- 4 Project Management for Engineering, Business and Technology, John M. Nicholas, Herman Steyn, 6th, Pearson.

23IE4053A - CAPSTONE PROJECT - 1 (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE4053A	CAPSTONE PROJECT - 1	CP-1	A	0	0	10	20	10

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Exercise to acquire knowledge within the chosen area of technology for project development.	2	PO1
CO2	Identify, discuss and justify the technical aspects of the chosen area for problem analysis	3	PO2
CO3	Reproduce, improve and refine technical aspects for chosen problem	2	PO6
CO4	Communicate and report effectively project related activities and findings.	3	PO9

Syllabus

A literature survey involves a comprehensive review of existing scholarly works, such as books, academic papers, and articles, on a specific topic or research question. The purpose is to gather, summarize, and critically analyze the current state of knowledge, identifying key theories, methodologies, and gaps in the research. This process helps researchers contextualize their work within the broader academic landscape, ensuring that their study builds on existing knowledge and addresses unresolved issues.

Acquiring knowledge and practicing on the tools required to execute a project involves gaining proficiency in the specific software, technologies, or methodologies essential for the project's successful completion. This process includes hands-on training, experimentation, and application of these tools to develop the skills needed to handle real-world project challenges effectively. By mastering these tools, individuals can enhance their efficiency, accuracy, and overall ability to deliver high-quality results within the project's scope and objectives.

Problems identification and implementing the existing work" involves recognizing and clearly defining challenges or gaps in a particular area of study or practice. This process requires a thorough understanding of existing solutions and methodologies, allowing for the application or adaptation of these approaches to address the identified issues. By leveraging established work, individuals can efficiently implement proven strategies, ensuring that solutions are both effective and aligned with current best practices while also identifying areas where further innovation is needed.

Designing and developing solutions for the problems identified and publishing the work in reputed journals" involves creating innovative and practical responses to the challenges uncovered during research or analysis. This process requires a deep understanding of the problem, creative problem-solving skills, and the ability to develop solutions that are both effective and feasible. Once the solutions are validated, publishing the work in reputed journals ensures that the research is peer-reviewed, widely disseminated, and recognized within the academic or professional community, contributing to the advancement of knowledge in the field.

Reference Books

- 1 Research Methodology, Ranjith Kumar, 3rd, SAGE.
- 2 Engineering Project Management for the Global High Technology Industry, Sammy G. Shina, 3rd, McGraw-Hill Education.
- 3 Engineering Project Management, Nigel J. Smith, 3rd, Wiley-Blackwell.
- 4 Project Management for Engineering, Business and Technology, John M. Nicholas, Herman Steyn, 6th, Pearson.

23IE4053R - CAPSTONE PROJECT - 1 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE4053R	CAPSTONE PROJECT - 1	CP-1	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Exercise to acquire knowledge within the chosen area of technology for project development.	2	PO1
CO2	Identify, discuss and justify the technical aspects of the chosen area for problem analysis	3	PO2
CO3	Reproduce, improve and refine technical aspects for chosen problem	2	PO6, PSO1
CO4	Communicate and report effectively project related activities and findings.	3	PO9, PSO2

Syllabus

Literature Survey

Literature Survey

Problems identification

Problems identification

Reference Books

- 1 Research Methodology, RAnjith Kumar, 3rd, SAGE.
- 2 Engineering Project Management for the Global High Technology Industry, Sammy G. Shina, 3rd, McGraw-Hill Education.
- 3 Engineering Project Management, Nigel J. Smith, 3rd, Wiley-Blackwell.
- 4 Project Management for Engineering, Business and Technology, John M. Nicholas, Herman Steyn, 6th, Pearson.

23IE4054A - CAPSTONE PROJECT - 2 (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE4054A	CAPSTONE PROJECT - 2	CP-2	A	0	0	10	20	10

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Literature search equips students with the ability to efficiently locate, evaluate, and synthesize academic and scholarly sources relevant to their field of study. Students will develop skills to conduct comprehensive searches, critically assess the credibility of sources, and apply research findings to support their academic or professional work.	3	PO1
CO2	Problem identification enables students to accurately recognize and define complex issues or challenges within a given context. Students will learn to analyze situations critically, identify underlying causes, and articulate clear problem statements that guide effective problem-solving strategies.	2	PO2
CO3	Analysis of research work prepares students to critically evaluate and interpret research studies, assessing the methodology, data, and conclusions. Students will develop the ability to dissect research findings, identify strengths and weaknesses, and draw informed conclusions that contribute to their own academic or professional endeavors.	2	PO6
CO4	Evaluation of research work trains students to systematically assess the quality and relevance of research studies by examining their design, methodology, and overall contributions to the field. Students will gain the skills to judge the validity, reliability, and impact of research, enabling them to make informed decisions and provide constructive feedback in academic or professional contexts.	3	PO9

Syllabus

A literature survey involves a comprehensive review of existing scholarly works, such as books, academic papers, and articles, on a specific topic or research question. The purpose is to gather, summarize, and critically analyze the current state of knowledge, identifying key theories, methodologies, and gaps in the research. This process helps researchers contextualize their work within the broader academic landscape, ensuring that their study builds on existing knowledge and addresses unresolved issues.

Acquiring knowledge and practicing on the tools required to execute a project involves gaining proficiency in the specific software, technologies, or methodologies essential for the project's successful completion. This process includes hands-on training, experimentation, and application of these tools to develop the skills needed to handle real-world project challenges effectively. By mastering these tools, individuals can enhance their efficiency, accuracy, and overall ability to deliver high-quality results within the project's scope and objectives.

Problems identification and implementing the existing work" involves recognizing and clearly defining challenges or gaps in a particular area of study or practice. This process requires a thorough understanding of existing solutions and methodologies, allowing for the application or adaptation of these approaches to address the identified issues. By leveraging established work, individuals can efficiently implement proven strategies, ensuring that solutions are both effective and aligned with current best practices while also identifying areas where further innovation is needed

Designing and developing solutions for the problems identified and publishing the work in reputed journals" involves creating innovative and practical responses to the challenges uncovered during research or analysis. This process requires a deep understanding of the problem, creative problem-solving skills, and the ability to develop solutions that are both effective and feasible. Once the solutions are validated, publishing the work in reputed journals ensures that the research is peer-reviewed, widely disseminated, and recognized within the academic or professional community, contributing to the advancement of knowledge in the field

Reference Books

- 1 Research Methodology, Ranjith Kumar, 3rd, SAGE.
- 2 Engineering Project Management for the Global High Technology Industry, Sammy G. Shina, 3RD, McGraw-Hill Education.
- 3 Engineering Project Management, Nigel J. Smith, 3RD, Wiley-Blackwell.
- 4 Project Management for Engineering, Business and Technology, John M. Nicholas, Herman Steyn, 6TH, Pearson.

23IE4054R - CAPSTONE PROJECT - 2 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23IE4054R	CAPSTONE PROJECT - 2	CP-2	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Literature search equips students with the ability to efficiently locate, evaluate, and synthesize academic and scholarly sources relevant to their field of study. Students will develop skills to conduct comprehensive searches, critically assess the credibility of sources, and apply research findings to support their academic or professional work.	2	PO1
CO2	Problem identification enables students to accurately recognize and define complex issues or challenges within a given context. Students will learn to analyze situations critically, identify underlying causes, and articulate clear problem statements that guide effective problem-solving strategies.	3	PO2
CO3	Analysis of research work prepares students to critically evaluate and interpret research studies, assessing the methodology, data, and conclusions. Students will develop the ability to dissect research findings, identify strengths and weaknesses, and draw informed conclusions that contribute to their own academic or professional endeavors.	3	PO6
CO4	Analysis of research work prepares students to critically evaluate and interpret research studies, assessing the methodology, data, and conclusions. Students will develop the ability to dissect research findings, identify strengths and weaknesses, and draw informed conclusions that contribute to their own academic or professional endeavors.	2	PO9

Syllabus

A literature survey involves a comprehensive review of existing scholarly works, such as books, academic papers, and articles, on a specific topic or research question. The purpose is to gather, summarize, and critically analyze the current state of knowledge, identifying key theories, methodologies, and gaps in the research. This process helps researchers contextualize their work within the broader academic landscape, ensuring that their study builds on existing knowledge and addresses unresolved issues.

Acquiring knowledge and practicing on the tools required to execute a project involves gaining proficiency in the specific software, technologies, or methodologies essential for the project's successful completion. This process includes hands-on training, experimentation, and application of these tools to develop the skills needed to handle real-world project challenges effectively. By mastering these tools, individuals can enhance their efficiency, accuracy, and overall ability to deliver high-quality results within the project's scope and objectives.

Problems identification and implementing the existing work" involves recognizing and clearly defining challenges or gaps in a particular area of study or practice. This process requires a thorough understanding of existing solutions and methodologies, allowing for the application or adaptation of these approaches to address the identified issues. By leveraging established work, individuals can efficiently implement proven strategies, ensuring that solutions are both effective and aligned with current best practices while also identifying areas where further innovation is needed.

Designing and developing solutions for the problems identified and publishing the work in reputed journals" involves creating innovative and practical responses to the challenges uncovered during research or analysis. This process requires a deep understanding of the problem, creative problem-solving skills, and the ability to develop solutions that are both effective and feasible. Once the solutions are validated, publishing the work in reputed journals ensures that the research is peer-reviewed, widely disseminated, and recognized within the academic or professional community, contributing to the advancement of knowledge in the field.

Reference Books

- 1 Research Methodology, Ranjith Kumar, 3rd, SAGE.
- 2 Engineering Project Management for the Global High Technology Industry, Sammy G. Shina, 3rd, McGraw-Hill Education.
- 3 Engineering Project Management, Nigel J. Smith, 3rd, Wiley-Blackwell.
- 4 Project Management for Engineering, Business and Technology, John M. Nicholas, Herman Steyn, 6th, Pearson.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Open Elective Courses (OEC)

22FT2212R - PROCESSING OF AQUATIC FOODS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT2212R	PROCESSING OF AQUATIC FOODS	PAF	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand terminology of commercially important aquatic animals and plants used as food sources and their body structures.	2	PO1, PO7
CO2	Apply intrinsic and extrinsic factors that affect spoilage of aquatic foods.	3	PO1, PO7
CO3	Apply an understanding on processing, preservation, supply chain, and marketing aspects of such products.	3	PO1, PO7
CO4	Apply an understanding on executing preservation of select marine products.	3	PO1, PO7
CO5	Apply processing techniques of aquatic foods.	3	PO1, PO7

Syllabus

Outline of the commercial importance, definitions, classification, glossary. Sources_Animals (freshwater and seawater) fish, crustaceans, cephalopods, mollusks; Plants seaweed, water spinach; external anatomy, edible and non-edible parts, nutritional attributes, nutritional advantages versus regular plant sources.

Spoilage_Extrinsic factors (temperature, moisture, microbes, insects), intrinsic factors (physical, chemical, biochemical, physiological).

Processing_Drying_sun drying, microwave drying, ohmic heating, IR heating, ultrasound processing, enzymatic processing; salting, canning or heat processing, freezing, smoking, high pressure processing (HPP), retort, pulsed light, irradiation, electromagnetic field, etc; cold storage, refrigerated vans for transport.

Fish byproducts_Liver oil, body oil, fish meal, fish manure, fish flour, fish silage, fish soluble, fish sausage, fish macaroni, fish glue, gelatin, albumin, fish protein concentrate. Quality attributes_Nutritional value. Sensory_appearance, color, flavor, odor, and texture.

Grading, processing, and analyses of aquatic foods for their physico-chemical and nutritional properties.

Reference Books

- 1 Seafood Processing, Adding Value Through Quick Freezing, Retortable Packaging and Cook-Chilling., Vazhiyil Venugopal, 1 (2006), CRC Press.
- 2 Quality Assurance in Seafood Processing: A Practical Guide, A. David Bonnell, 1 (1994), Springer.
- 3 The Seafood Industry: Species, Products, Processing, and Safety, Roy E. Martin, Linda Ankenman Granata, George J. Flick Jr., 2 (2012), Springer.
- 4 Seafood Research from Fish to Dish: Quality, Safety and Processing of Wild and Farmed Fish, J. B. Luten, C. Jacobsen, K. Bekaert, A. Saebo, J. Oehlenschläger, 1 (2006), Wageningen Academic Publishers.

22FT22C1R - FOOD ANALYSIS AND QUALITY ASSURANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT22C1R	FOOD ANALYSIS AND QUALITY ASSURANCE	FAQA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the analytical aspects of foods in quality and regulatory perspective.	2	PO1, PO5, PO10, PSO2
CO2	Apply the analytical methods for chemical and nutritional properties of foods.	3	PO1, PO5, PO10, PSO2
CO3	Apply the analytical methods for thermal and rheological properties of foods.	3	PO1, PO5, PO10, PSO2
CO4	Apply the sensory and microbiological analysis methods for different processed foods	3	PO1, PO5, PO10, PSO2
CO5	Analyze the project on Quality assurance.	4	PO1, PO5, PO10, PSO2

Syllabus

Introduction to Food Analysis, Importance of various food components, purpose, sampling requirements. Quality different aspects of food analysis, Properties, parameters, methods, techniques. Regulatory aspects involved in the food analysis.

Chemical and Physico-Chemical analysis of foods, Chemical analysis such as carbohydrate, protein, fat, mineral content analysis. Study on different physical properties such as colour, size, shape, composition and interfacial properties.

Different Thermal and Rheological Properties. Thermal properties such as transition (glass and melting) and degradation temperatures, thermal conductivity, specific heat and thermal diffusivity of different foods. Different rheological properties such as flow properties, studies on shear stress and shear rate in different foods.

Study on microbial effect in different types of foods. Study on microbial diseases transmitted through foods. Study of different sensory parameters, study on advanced sensory software tools. Study on advanced microbiological techniques.

Evaluate the project on Quality analysis including Practical Safety evaluation of foods for heavy metal content and pesticides residue, Analyse the water activity in different foods, Analyse the texture of different foods, Analyse the quality parameters of water, Evaluate the thermal properties of different foods, Analyse the flow properties of different foods, Evaluate the microbial quality of selected food products.

Reference Books

- 1 Handbook of Food Analysis Instruments , Semih Otles, 1st Edition, 2009, CRC Press.
- 2 Instrumental Methods in Food and Beverage Analysis , David L. B. Wetzel, George Charalambous , 1st Edition, 1998, Elsevier.
- 3 Vitamin Analysis For The Health And Food Sciences , Ronald Ray Eitenmiller, Lin Ye, W. O. Landen , 2nd Edition, 2007, CRC Press.
- 4 Methods of Analysis of Food Components and Additives , Semih Otles , 2nd Edition, 2012, CRC Press.

22FT3215R - TECHNOLOGY OF MEAT AND POULTRY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT3215R	TECHNOLOGY OF MEAT AND POULTRY	TMP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the meat and poultry market and preservation technologies for meat products	2	PO2, PO4, PO6, PSO1
CO2	Apply processing techniques for meat preservation	3	PO2, PO4, PO6, PSO1
CO3	Apply processing technologies for preservation of poultry and eggs	3	PO2, PO4, PO6, PSO1
CO4	Apply principles of plant sanitation in preventing contamination of meat products	3	PO2, PO4, PO6, PSO1
CO5	Apply principles for processing and preservation for meat, poultry, and eggs	3	PO2, PO4, PO6, PSO1

Syllabus

Introduction to Meat and Poultry Technology Current status of meat and poultry industry in Indian and global markets, preferences, demand, availability, market size, regulatory requirements. Sources animals and birds and products derived from thereof. Structure of muscle chemical composition and nutritive value of meat. Preservation requirements of meat, poultry, and egg modes of deterioration, effect of deterioration on quality.

Processing and Preservation of Meat and Poultry Preslaughter and slaughter operations plant conditions, post mortem changes influencing quality, grading, aging, mechanical deboning. Cutting, handling, and tenderization. Preservation chilling, freezing, pickling, curing, cooking and smoking, canning, dehydration, radiation, chemical and biological preservatives, packing, and storage. Quality of raw and processed meat parameters and evaluation. Utilization of byproducts

Processing and Preservation of Egg Structure of egg, chemical composition of egg, nutritive value and functional properties of egg. Grading and packing of eggs and egg products. Preservation of egg preservation of shell egg and liquid egg. Whole egg powder, egg yolk, products, byproducts, their packing and storage.

Safety Requirements for meat, poultry, and egg Safety requirements Contamination of meat, poultry, and egg products in absence of sanitation potential health effects on consumers, pathogenic outbreaks. Sanitation methods, procedures. Standards Regulations in some important markets USA, EU, UK, etc.. Certifications KOSHER, HALAL, etc

Study of different primal cuts, Preservation of meat at low temperatures, Preservation of meat at high temperatures, Handling of meat, Preservation of meat by curing, Preservation of meat by pickling, Study of value added products, Study of different packing methods of meat products Visit to an abattoir

Reference Books

- 1 Textbook on Meat, Poultry and Fish Technology, Jhari Sahoo and Manish Kumar Chatli, 2nd - 2020, Daya Publishing House.
- 2 Meat, Egg and Poultry Science & Technology, Vikas Nanda, 1st - 2013, I.K. International Publishing House.
- 3 Outlines of Meat Science and Technology, Sharma, B.D. and Kinshuki Sharma, 1st - 2011, Jaypee Brothers Medical Publishers Pvt. Ltd.
- 4 Meat Cuts and Muscle Foods, Howard J. Swatland, 2nd - 2004, Nottingham University Press.
- 5 Meat and Meat Products: Technology, Chemistry and Microbiology, Alan H. Varnam and Jane P. Sutherland, 1st - 1995, Chapman and Hall.

23ACCABT - BUSINESS TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACCABT	BUSINESS TECHNOLOGY	BT	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand business organization types, structure, functions and governance	2	PO1
CO2	To apply the accounting reporting systems, control and compliance	3	PO1
CO3	To apply the knowledge in professional ethics in accounting and business	3	PO4, PSO1
CO4	To develop personal effectiveness and communication	3	PO6

Syllabus

The business organisation, its stakeholders and the external environment -The purpose and types of business organisation, Stakeholders in business organisations, Political and legal factors affecting business, Macroeconomic factors, Micro economic factors, Social and demographic factors, Technological factors, Environmental factors, Competitive factors. Business organizational structure, functions and governance The formal and informal business organisation, Business organizational structure and design, Organizational culture in business, Committees in business organisations, Governance and social responsibility in business.

Accounting and reporting systems, controls and compliance - The relationship between accounting and other business functions, Accounting and finance functions within business organisations, Principles of law and regulation governing accounting and auditing .The sources and purpose of internal and external financial information, provided by business, Financial systems, procedures and related IT applications, Internal controls, authorization, security of data and compliance within business, Fraud and fraudulent behaviour and their prevention in business, including money laundering.

The sources and purpose of internal and external financial information, provided by business, Financial systems, procedures and related IT applications, Internal controls, authorization, security of data and compliance within business, Fraud and fraudulent behaviour and their prevention in business, including money laundering. Professional ethics in accounting and business Fundamental principles of ethical behaviour, The role of regulatory and professional bodies in promoting ethical and professional standards in the accountancy profession, Corporate codes of ethics, Ethical conflicts and dilemmas.

Leading and managing individuals and teams Leadership, management and supervision, Recruitment and selection of employees, Individual and group behaviour in business organisations, Team formation, development and management, Motivating individuals and groups, Learning and training at work, Review and appraisal of individual performance. Leading and managing individuals and teams Leadership, management and supervision, Recruitment and selection of employees, Individual and group behaviour in business organisations, Team formation, development and management, Motivating individuals and groups, Learning and training at work, Review and appraisal of individual performance. Competence frameworks and personal development, Sources of conflicts and techniques for conflict resolution and referral, communicating in business.

Reference Books

- 1 Accountant in Business - BPP Learning Media, BPP Learning Media, BPP Learning Media 2010, BPP Learning Media.
- 2 INFORMATION TECHNOLOGY IN BUSINESS MANAGEMENT, MUKESH DUNNA, J.B. DIXIT, First Edition Publication Date 1 January 2015, Laxmi Publications Edition .
- 3 Emerging Technological in Global Business Environment, DR.SAROJA KUMAR, Paperback 1 January 2022, THAKUR PUBLICATION PRIVATE LTD.
- 4 Technology, Management And Society, PETER F.DRUCKER , 2023, T&F INDIA.

23ACCAFA - FINANCIAL ACCOUNTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACCAFA	FINANCIAL ACCOUNTING	FA	R	3	2	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the context and purpose of financial reporting, The scope and purpose of financial statements for external reporting,	2	PO11
CO2	Apply the use of double-entry and accounting systems, Preparing simple consolidated financial statements	3	PO2
CO3	Apply impart knowledge in preparation of trial balance, Calculate goodwill (excluding impairment of goodwill) using the full goodwill method only	3	PO11
CO4	Demonstrate control accounts and incomplete records, Interpretation of financial statements - Importance and purpose of analysis of financial statements Describe how the interpretation and analysis of financial statements is used in a business environment,	3	PO5

Syllabus

The context and purpose of financial reporting The scope and purpose of financial statements for external reporting, Users and stakeholders needs, The main elements of financial reports, The regulatory framework (legislation and regulation, reasons and limitations, relevance of accounting standards), Duties and responsibilities of those charged with governance. The qualitative characteristics of financial information The qualitative characteristics of financial information. The use of double entry and accounting systems Double entry book keeping principles including the maintenance of accounting records and sources of accounting information, Ledger accounts, books of prime entry, and journals. Recording transactions and events Sales and purchases, Cash, Inventory, Tangible noncurrent assets, Depreciation, Intangible noncurrent assets and amortization, Accruals and prepayments, Receivables and payables, Provisions and contingencies, Capital structure and finance costs. Preparing a trial balance Trial balance, Preparing basic financial statements of financial position, Statements of profit or loss and other comprehensive income, Disclosure notes, Events after the reporting period, Statements of cash flows, incomplete records.

Preparing simple consolidated financial statements Subsidiaries Define and describes the following terms in the context of group accounting: Parent, Subsidiary, Control, Consolidated or group financial statements, Noncontrolling interest, Trade simple investment. Identify subsidiaries within a group structure. Describe the components of and prepare a consolidated statement of financial position or extracts thereof including: Fair value adjustments at acquisition on land and buildings (excluding depreciation adjustments), Fair value of consideration transferred from cash and shares (excluding deferred and contingent consideration), Elimination of intra-group trading balances (excluding cash and goods in transit), Removal of unrealised profit arising on intra group trading, Acquisition of subsidiaries part way through the financial year,

Calculate goodwill (excluding impairment of goodwill) using the full goodwill method only. Describe the components of and prepare a consolidated statement of profit or loss or extracts there of including Elimination of intra-group trading balances (excluding cash and goods in transit), Removal of unrealised profit arising on intra group trading, Acquisition of subsidiaries part way through the financial year. Associates Define and identify an associate and significant influence and identify the situations where significant influence or participating interest exists, Describe the key features of a parent-associate relationship and be able to identify an associate within a group structure, Describe the principle of equity accounting.

Interpretation of financial statements - Importance and purpose of analysis of financial statements Describe how the interpretation and analysis of financial statements is used in a business environment, explain the purpose of interpretation of ratios. Ratios Calculate key accounting ratios Profitability, Liquidity, Efficiency, and Position. Explain the interrelationships between ratios. Analysis of financial statements Calculate and interpret the relationship between the elements of the financial statements with regard to profitability, liquidity, efficient use of resources and financial position, Draw valid conclusions from the information contained within the financial statements and present these to the appropriate user of the financial statements

Reference Books

- 1 FINANCIAL ACCOUNTING, SP JAIN & KL NARANG, 15, 2005, KALYANI.
- 2 FINANCIAL ACCOUNTING, KAPLAN , 16, 2010, KAPLAN ACCA.
- 3 FINANCIAL ACCOUNTING, BHUSHAL KUMAR GOYAL, 18, 2022, TAXMAN.
- 4 FINANCIAL ACCOUNTING, DR SM SUKLA, 16,2020, SAHITHYA BHAWAN PUBLISHERS.

23ACCAMA - MANAGEMENT ACCOUNTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACCAMA	MANAGEMENT ACCOUNTING	MA	R	3	2	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the need of Management Accounting & cost accounting techniques, Accounting for management Sources of data Cost classification presenting information.	3	PO2
CO2	Develop budgeting techniques, Nature and purpose of budgeting statistical techniques budget preparation flexible budgets capital budgeting and discounted cash flow budgetary control	3	PO4
CO3	Make use of standard costing and variance analysis techniques, Standard costing system variance calculations and analysis reconciliation of budgeted and actual profits.	3	PO8
CO4	Apply the performance measurement techniques to measure the performance Performance measurement overview performance measurementapplication cost reductions and value enhancement	3	PO8

Syllabus

The nature, source and purpose of management information: Accounting for management Sources of data Cost classification presenting information. Cost accounting techniques: Accounting for material, labour and overheads absorption and marginal costing cost accounting methods alternative cost accounting principles.

Budgeting: Nature and purpose of budgeting statistical techniques budget preparation flexible budgets capital budgeting and discounted cash flow budgetary control and reporting behavioral aspects of budgeting.

Standard Costing: Standard costing system variance calculations and analysis reconciliation of budgeted and actual profits.

Performance measurement: Performance measurement overview performance measurementapplication cost reductions and value enhancement monitoring performance and reporting.

Reference Books

- 1 Management Accounting: Principles and Applications, Leslie G. Eldenburg, Susan K. Wolcott, and Christopher T. Staley., 18 April 2005, Wiley.
- 2 Management Accounting: Information for Decision-Making and Strategy Execution, Anthony A. Atkinson, Robert S. Kaplan, S. Mark Young, and Ella Mae Matsumura. Edition: , 17 March 2011, Pearson.
- 3 Management and Cost Accounting, Colin Drury. Edition, 1 January 2014, Cengage Learning EMEA..
- 4 Management Accounting Concepts and Technique, Gary L. Sundem, William O. Stratton, John A. Schatzberg, Dave Burgstahler, 15 March 2006, Wiley.

23AD2204R - DATA MANAGEMENT AND WAREHOUSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD2204R	DATA MANAGEMENT AND WAREHOUSING	DMW	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design a Data warehouse system and perform business analysis with OLAP tools	2	PO1, PO2, PO3, PSO1
CO2	Apply suitable pre-processing and visualization techniques for data analysis	3	PO2, PO3, PO4, PSO1
CO3	Discover frequent pattern and association rule mining techniques for data analysis	3	PO1, PO2, PO3, PSO1
CO4	Apply appropriate classification techniques for data analysis	3	PO2, PO3, PO4, PSO1
CO5	Discover appropriate clustering techniques for data analysis	3	PO1, PO2, PO3, PSO1

Syllabus

UNIT I Data Warehousing, Business Analysis and On-Line Analytical Processing (OLAP): Basic Concepts, Data Warehousing Components, Building a Data Warehouse, Database Architectures for Parallel Processing, Parallel DBMS Vendors, Multidimensional Data Model, Data Warehouse Schemas for Decision Support, Concept Hierarchies, Characteristics of OLAP Systems, Typical OLAP Operations, OLAP and OLTP.

Introduction to Data Mining Systems, Knowledge Discovery Process, Data Mining Techniques, Issues, applications, Data Objects and attribute types, Statistical description of data, Data Preprocessing Cleaning, Integration, Reduction, Transformation and discretization, Data Visualization, Data similarity and dissimilarity measures.

UNIT III Frequent Pattern Analysis: Mining Frequent Patterns, Associations and Correlations, Mining Methods, Pattern Evaluation Method, Pattern Mining in Multilevel, Multi-Dimensional Space Constraint Based Frequent Pattern Mining, Classification using Frequent Patterns

Classification: Decision Tree Induction, Bayesian Classification, Rule Based Classification, Classification by Back Propagation, Support Vector Machines, Lazy Learners, Model Evaluation and Selection, Techniques to improve Classification Accuracy, Clustering: Clustering Techniques, Cluster analysis, Partitioning Methods, Hierarchical methods, Density Based Methods, Grid Based Methods, Evaluation of clustering, Clustering high dimensional data, Clustering with constraints, Outlier analysis, outlier detection methods.

Reference Books

- 1 Data Warehousing, Data Mining & OLAP, Alex Berson and Stephen J Smith, 35th reprint 2016, Tata McGraw Hill.
- 2 Data Mining concepts and Techniques, Han, Kamber, 2nd Edition, Hk.
- 3 Introduction to Data Mining, Pang Ning Tan, 1st Edition, Pearson.
- 4 Data Mining and Analysis - Fundamental concepts and Algorithms, Mohammad J Zaki, 1st, Oxford .
- 5 Insight into Data Mining Theory and Practical, K P soman, shyam Diwakar, 2006, Prentice Hall of India.

23AD3106R - BIG DATA ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD3106R	BIG DATA ENGINEERING	BDE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply big data use cases from selected business domains.	3	PO1, PO2, PO6, PO12, PSO1, PSO2
CO2	Construct NoSQL big data management	3	PO3, PO5, PSO2
CO3	Install, configure, and run Hadoop and HDFS	4	PO2, PO4, PO7, PO11, PSO1, PSO2
CO4	Perform map-reduce analytics using Hadoop	4	PO4, PSO2
CO5	Implement the lab experiments for big data application	5	PO6

Syllabus

A distributed system uses multiple independent computers to enhance scalability, reliability, and performance compared to centralized systems. It distributes tasks across nodes, reducing failure risk and boosting processing speed but adds complexity in data consistency, communication, and security. Big Data involves vast, rapidly generated data that traditional systems can't handle. Distributed technologies like Hadoop and Spark manage this data effectively, driven by trends such as the internet and IoT, with cloud platforms offering scalable solutions for better decision-making and strategic advantages.

Big Data engineering has evolved with NoSQL databases, which address SQL limitations in scalability and flexibility. NoSQL databases handle diverse, unstructured data with schema-less models and manage relationships with graph databases. They use distribution methods like replication and sharding to ensure high availability and performance. Hadoop, including HDFS and MapReduce, supports distributed storage and processing, driving effective Big Data management and insights.

Hadoop is a framework for distributed storage and processing of large datasets using the MapReduce model, with its HDFS ensuring reliability and scalability. It supports various data formats and interfaces. Apache Spark complements Hadoop by speeding up data processing with in-memory computation using RDDs. Together, they are crucial for Big Data analytics, helping organizations extract insights from massive datasets.

MapReduce workflows involve splitting data into smaller chunks for parallel processing in the "map" phase, followed by aggregation in the "reduce" phase. MR-Unit allows for unit testing MapReduce logic with local test data. A MapReduce job run includes input splitting, mapping, shuffling, sorting, and reducing. Classic MapReduce and YARN handle job execution and resource management, with YARN providing enhanced scalability. Failures are managed through built-in recovery mechanisms. Job scheduling prioritizes tasks, while shuffle and sort organize intermediate data. MapReduce supports various input and output formats for flexible data processing.

Setting up a Hadoop environment starts with installing VMware to create virtual machines for Hadoop components like HDFS and YARN. Basic Linux commands are used to manage files in HDFS. Running a word count MapReduce program helps understand parallel data processing, while more complex tasks like temperature analysis or patent record processing showcase MapReduce's capability. Features like Partitioner for workload optimization and tasks such as averaging or matrix multiplication highlight Hadoop's versatility in distributed computing.

Reference Books

- 1 Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Michael Minelli, Michele Chambers, Ambiga Dhiraj, 3rd, 9 January 2013, Wiley.

- 2 DW 2.0: The Architecture for the Next Generation of Data Warehousing, W.H. Inmon, Derek Strauss, Genia Neushloss, 1st Edition, 2008, Publisher Morgan Kaufmann.
- 3 Agile Data Warehouse Design: Collaborative Dimensional Modeling, from Whiteboard to Star Schema Paperback, Jim Stagnitto , Lawrence Corr, 1st Edition, 2011, DecisionOne Press.
- 4 Big Data:Principles and best practices of scalable realtime data systems Paperback, James Warren , Nathan Marz, 1st Edition, 2015, Manning Publications.

23AD3207R - NATURAL LANGUAGE PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD3207R	NATURAL LANGUAGE PROCESSING	NLP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various approaches to syntax and semantics in NLP	3	PO1, PO2, PSO1
CO2	Apply the statistical estimation and statistical alignment models for language modelling and parsing.	3	PO1, PO2, PSO1
CO3	Apply Vector models for documents to gain insights of the document.	3	PO1, PO2, PSO1
CO4	Apply various statistical models for classification, information extraction, translation, and generation.	3	PO1, PO2, PSO2
CO5	Inspect and Evaluate Language Processing Methods using python	4	PO1, PO2, PSO2

Syllabus

Introduction to language processing: tokens, sentences, paragraphs, Sentence and Paragraph Segmentation, Introduction to Text Normalization (lowercasing, stemming, lemmatization, Corpora and their construction: representativeness, Regular expressions, extraction of information using Regex, Named Entity Recognition, Rule-Based Approaches for NER, Advanced smoothing for language modelling, POS tagging, Introduction to Hidden Markov Models Models for Sequential tagging: MaxEnt, Viterbi Algorithm, CRF, Spelling Correction, Language Modelling, Computational Semantics, Lexical semantics: WordNet and FrameNet, Syntax: Constituency Parsing, Probabilistic Context-Free Grammars (PCFGs), Dependency Parsing: Dependency Trees, Transition-Based Parsing Comparison of Constituency and Dependency Parsing

Vector Space Model word vectors, GloVe, Word2Vec model, word embedding, Document Similarity measures Cosine and cluster measures, Text Classification, Clustering, and Summarization

Information Extraction, Document Classification, Clustering, topic modelling techniques, Machine Translation, Language Generation

Reference Books

- 1 Speech and Language Processing, Daniel Jurafsky and James H. Martin, 2023, MIT Press.
- 2 Natural language processing and Information Retrieval, U.S. Tiwary & Tanveer Siddiqui, 2020, Oxford University Press.
- 3 Natural language processing: A Paninian perspective, Bharati Akshar, Chaitanya Vineet, Sangal, Rajeev, 2002, PHI.
- 4 Foundations of Statistical Natural Language Processing, I. Manning, Christopher D.; Hinrich Schuetze; , 1999, MIT Press.

23BT2209R - BIOCHEMICAL REACTION ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT2209R	BIOCHEMICAL REACTION ENGINEERING	BCRE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply principles of biochemical Reaction Engineering to interpret chemical or biological reaction kinetics	3	PO1
CO2	Interpret batch reactor data analysis to assess order, half life and rate constant of reaction system	3	PO1, PO2
CO3	Apply principles of bioreactor systems to assess rate of substrate utilization, biomass and product formation	3	PO1
CO4	Apply principles of CSTR systems to analyze cell concentration and substrate concentration and related microbial kinetic parameters	3	PO1
CO5	Analysis of chemical and biological kinetics to assess the progress of reaction system for improving better biomass and product formation	4	PO2, PSO1, PSO2

Syllabus

Over View of Biochemical Reaction Engineering: Overview of biochemical reaction Engineering; Classification of reactions; Reaction rate; Kinetics of homogenous reactions; Single and multiple reactions; Elementary and Non elementary reactions; Molecularity and order of reactions; rate constant; Kinetic models of non-elementary reactions; Temperature dependency of rate equation.

Constant volume batch reactor; Analysis of total pressure data; The conversion; Integral method of analysis of data; Irreversible uni-molecular, bimolecular reactions; Zero order reactions. Half-life of a reaction; Varying volume batch reactor; differential method of analysis; Integral method of analysis; Zero order; First order & second order reactions; Temperature & reaction rate.

Definitions; Differences and similarities between chemical and bioreactors; Classification of bioreactors; Reactor configurations; Description of a conventional bioreactor with all aspects; Design and construction criteria of a bioreactor; Concept of ideal and nonideal reactors; Residence time distribution; stimulus response technique; Models of non-ideal reactors; Imperfect mixing.

Designing Of Bioreactors: Design equations for enzyme reactors; batch growth of microorganism; Design equation of a plug flow reactor; Design of CSTR with wash out concept; Stirred tank reactors with recycle of biomass; Continuous stirred tank fermenters in series with out and with recycle of biomass; Estimation of kinetic parameters.

Estimation of mixing time, estimation of Volumetric mass transfer (K_{la}) in sparged reactor, Estimation of gas hold up in sparged bioreactor, estimation of power number and power consumption for various impellers, interpretation of batch reactor data, CSTR kinetics, RTD studies, PFR kinetics, Reaction studies on airlift reactor

Reference Books

- 1 Fundamentals of Biochemical Engineering, Bailey & Ollis, 2, McGraw Hill Higher Education, 2017.
- 2 Chemical Reaction Engineering, Octave Levenspie, 3, Wiley India Pvt. Ltd, 1998.
- 3 Bioprocess Engineering Principles, Pauline M Doran., 2, Elsevier, 2013.
- 4 Biochemical Engineering, D. G. Rao., 2, McGraw-Hill, 2009.

23BT3212 - PLANT AND ANIMAL BIOTECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT3212	PLANT AND ANIMAL BIOTECHNOLOGY	PABT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of plant tissue culture, protoplast culture in generating somatic hybrids Plant tissue culture and protoplast culture are key techniques in plant biotechnology that facilitate the generation of somatic hybrids.	3	PO1
CO2	Apply plant tissue culture techniques to understand the methods in producing transgenic plants for Selection of Explants, Preparation of Culture Media, Genetic Transformation Methods.	3	PO1, PO3
CO3	Analyze the role of animal tissue culture methods in maintaining cell lines providing a controlled environment for the study of cellular processes, drug development, and therapeutic applications.	3	PO1
CO4	Apply the principles of Gene transfer methods in understanding the significance of Transgenic animals which have numerous applications in biomedical research, agriculture, and biotechnology.	3	PO1, PO3
CO5	Analyse the results of tissue culture techniques in producing invitro cultured plants, metabolites and cell line maintenance reveals significant advancements in plant and animal biotechnology.	3	PO4, PO5, PS02

Syllabus

Plant tissue culture: Totipotency of plant tissue; Conservation of plant germplasm; Germplasm preservation- Cryopreservation; Plant Tissue Culture Sterilization, composition of MS media, Media Preparation; Callus culture, Organogenesis, Somatic embryogenesis, Meristem culture, Haploid production (Anther, Pollen/Ovary, Ovule); Micropropagation, hardening and Green House Technology; Protoplast isolation and fusion- Cybrid Production; Artificial/synthetic seeds; Production of Secondary Metabolites.

Genetic engineering in Plants: Agrobacterium-mediated DNA transfer- Ti/Ri plasmid Vectors- Binary and co-integrated vectors; Transformation strategies in plants- Agrobacterium tumefaciens, Physical methods of gene transfer Electroporation and gene gun methods; Chloroplast transformation; Molecular biology of plant-pathogen interactions and application of gene transfer techniques in pest resistance (Bt genes), edible vaccines, and Delayed fruit ripening; Ethical issues in plant biotechnology.

Animal cell culture: Facilities and Applications- Media for Animal cells; Types of cell culture- Primary cell culture, secondary culture, cell transformation, cell lines, Insect cell lines, stem cell cultures, cell viability, and cytotoxicity; Biology of cultured cells, measurement of growth, cell synchronization, senescence, and apoptosis; Organ culture; Cryopreservation; Human embryonic Stem Cells.

Genetic engineering in animals: methods of DNA transfer into animal cells- calcium phosphate co-precipitation, , microinjection, electroporation, Liposome encapsulation, Biological vectors. Hybridoma technology; Vaccine production; Transgenic animals

Reference Books

- 1 Plant Biotechnology, C. Chawla., 2004, Oxford.
- 2 IBH and Animal cell culture Practical approach , Ed. John R.W. Masters, 2000, Oxford.
- 3 Cell growth & Division, Morgan, D. O., 2007, New Science Press.
- 4 An Introduction to Plant Tissue Culture, MK Razdan., 2019, Oxford and IBH.

23BT3213R - DOWNSTREAM PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT3213R	DOWNSTREAM PROCESSING	DSP	R	2	0	4	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply basics of primary separation and recovery processes of various biomolecules	3	PO1
CO2	Applying the principles of suspended solids removal and product enrichment operations	3	PO1
CO3	Apply the aqueous two-phase extraction process and other product purification methods	3	PO3, PO7
CO4	Analyse the methods for alternative separation, product polishing and formulation studies.	3	PO3, PO7
CO5	Analyze various bioseparation methods for recovery, isolation and purification of various bioproducts	4	PO3, PO7

Syllabus

Downstream Processing in Biotechnology Introduction; overview of bioseparation; characterization of Biomolecules, characterization of fermentation broth: Morphology of cells, structure of the cell wall, product concentrations, Biomass density. Primary separation and Recovery Processes: Recovery of intracellular products: Cell disruption methods physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear) , chemical methods (alkali, detergents) enzymatic methods.

Removal of suspended solids: filtration, filtration equipment, centrifugation, centrifugation equipment tubular bowl, disk-stack, basket centrifuges. Membrane based separations classification & characteristics of membrane separation, merits & demerits. Microfiltration, ultrafiltration, reverse osmosis, dialysis & electro dialysis, Membrane modules: Plate & Frame, hollow fiber, spiral wound, shell & tube.

Product Enrichment Operations: Aqueous two phase extraction process, Applications of aqueous two phase extraction, reversed micelles extraction principle, micelle structures, critical micelle concentration, limitations of reversed micelles, Protein solubilization precipitations of proteins with salts and organic solvents, kinetics of protein aggregation. Product Purification: Chromatographic separations: Classification of chromatographic techniques, Principles & practices of Gel Filtration, Ion Exchange and Affinity chromatography. Alternative separation methods and product polishing: Supercritical extraction: principles of SCE, Flow scheme of a simple SCE system.

Polishing: Crystallization, principles of crystallization and equipment, principles of drying and lyophilization, Freeze dryer. Formulation strategies: Importance of formulation, formulation of beakers yeast, Enzymes, formulation of pharmaceutical products.

Reference Books

- 1 Bioseparations- Principles and Techniques, B. Sivasankar, 2013, PHI Learning Pvt. Ltd.
- 2 Bioseparations Science and Engineering , Roger G. Harrison, Paul W. Todd, Scott R. Rudge, Demetri P. Petrides , 2015, Oxford University Press .
- 3 Principles of Downstream Processing , E. J. , 1995, Wiley.
- 4 Handbook of Downstream Processing, E Goldberg, 1996, Springer.

23CE2208R - GEOTECHNICAL ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CE2208R	GEOTECHNICAL ENGINEERING	GTE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and Describe soils and determine their physical characteristics of given soils..	3	PO1, PO6, PSO1
CO2	Apply the soils and determine their compaction characteristics and engineering characteristics of soil	3	PO1, PO6, PSO1
CO3	Apply the load carrying capacity of pile various soils and methods ,Determine the lateral earth pressure, stability of slopes and retaining walls.	3	PO1, PO6, PSO1
CO4	Apply the soil sample investigation and bearing capacity at various conditions and settlement, total stress and effective stress methods of analysis to evaluate slope stability. and detailing of well foundations	3	PO1, PO6, PSO1
CO5	Demonstration about Soil general and engineering properties using Geotechnical Engineering laboratory.	3	PO1, PO6, PSO1

Syllabus

Origin of Soils: Soil Origin, rock cycle. Phase Relations: Weight Relationships, Volume Relationships, Density and Unit Weight Relationships, Inter-relationships. Soil Classification: coarse grained soils, fine grained soils. IS soil classification. Compaction: variables in compaction, laboratory tests, field compaction, specification and control. Effective Stress: Effective stress Principle, effective stress, pore water pressure, and total stress variation with depth, vertical normal stress due to overburden, capillary effects in soils.

: Permeability of stratified soil deposits, Indirect methods, Factors affecting permeability; SEEPAGE: Laplace Equation, Estimation of seepage using flownet; INSITU STRESSES: Total stress, Pore Water Pressure, Effective Stress, seepage forces, quicksand condition; STRESSES IN A SOIL MASS: Vertical stress distribution using Boussinq equation, Fadum Chart and Newmarks chart, consolidation and compaction of soil ,shear strength of soil.

Pile Foundations: Use of piles, Types of piles, Construction, Selection of pile type, Types of foundations to suit subsoil conditions, Pile load capacity, Static formulae, Dynamic formulae, Load tests, on piles, Group action of piles, Load carrying capacity of pile groups, Negative skin friction, Piles subjected to uplift loads Well Foundations: Types of wells and caissons, components of well foundation, shapes of wells, depth of a well foundation, forces acting on a well foundation.

SUBSOIL INVESTIGATION: Depth of Exploration, Methods of Exploration, Borings for exploration, Depth of exploration, Methods of exploration, Borings for exploration, Field tests Plate load test, Penetration test. SHALLOW FOUNDATIONS: Types of foundations and choice of foundations, Bearing capacities, Terzaghs bearing capacity theory, influence of water table on bearing capacity, safe bearing capacity of soil using IS Code: SETTLEMENT OF FOUNDATIONS: Settlement of shallow foundation, Allowable bearing pressure of granular soils based on standard penetration test value.

Reference Books

- 1 Geotechnical Engineering, N Sivakugan and Braga M Das, 2009, J. Ross publishing..
- 2 Basic and Applied Soil Mechanics, Gopal Ranjan and ASR Rao, , 2007., New Age International Publishers.
- 3 Foundation Analysis and Design, J.E. Bowles, 2009, MacGraw Hill, 1996.
- 4 Soil Mechanics and Foundation Engineering, V. N. S. Murthy's, 2002, CBS Publishers & Distributors Pvt. Ltd.

23CE2209R - TRANSPORTATION ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CE2209R	TRANSPORTATION ENGINEERING	TPE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Current road projects including highway project preparation	2	PO1, PO3, PSO2
CO2	Design highway cross section elements	3	PO1, PO3, PSO2
CO3	Design flexible and rigid pavement	3	PO1, PO3, PSO2
CO4	Analyse the components of traffic stream parameters	3	PO1, PO3, PSO2
CO5	Identify the suitable road construction materials following IRC codes	3	PO1, PO3, PSO2

Syllabus

Highway Network Planning: Different modes of transportation, role of highway transportation, classification, network patterns, planning surveys, preparation of plans, final report, master plan, evaluation by saturation system, Various road development plans, salient features, introduction to highway economics.

Highway Alignment And Geometric Design: Principles of highway alignment, requirements, controlling factors, engineering surveys, importance of geometric design, design controls and criteria, cross section elements, pavement surface characteristics, camber, carriageway, kerbs, road margins, formation, right of way, typical cross sections, sight distance, stopping sight distance, overtaking sight distance, sight distance at intersections, design of horizontal alignment, super elevation, transition curves, design of vertical alignment, gradients, vertical curves.

Pavement Materials and Mix Design: Types of pavement structures, functions of pavement component layers, materials used in pavements, basic soil properties relevant to pavement applications, properties of aggregate, blending of aggregates, tests on bitumen, grading of bitumen, bituminous mix design using Marshall method. **Design of Pavements:** Stresses in flexible pavements: layered system concepts, stress solution for one, two and three layered systems, fundamental design concepts; variables considered in pavement design: axle types, standard and legal axle loads, ESWL, EWLF, vehicle damage factor, ADT, AADT, growth factor, lane distribution factor, directional distribution factor, tyre pressure, contact pressure, design life

Traffic Engineering Principles: Traffic characteristics; components of traffic stream: flow- speed Density, measurement and analysis, q-k-v relationships, design hourly volume, concept of EPCU, capacity and level of service, parking studies and road safety

Reference Books

- 1 Transportation Engineering: Planning and Design, Paul H. Wright, Norman J. Ashford, 1998, Wiley.
- 2 Traffic and Highway Engineering, Nicholas J. Garber, Lester A. Hoel, 2014, Cengage Learning.
- 3 Transportation Engineering: An Introduction, C. Jotin Khisty and B. Kent Lall, 2002, Pearson.
- 4 Principles of Highway Engineering and Traffic Analysis, Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, 2020, John Wiley.

23CE3109 - ENVIRONMENTAL ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CE3109	ENVIRONMENTAL ENGINEERING	EVE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To Understand the demand of water and water treatment process	2	PO1, PO3, PO7, PSO2
CO2	Understand the concept of Water distribution system by using Equivalent pipe method	2	PO1, PO3, PO7, PSO2
CO3	To Design of sewerage system and septic tank design and sewage treatment process	3	PO1, PO3, PO7, PSO2
CO4	To design concept in construction landfill and elaborate Solid Waste Management methods and Noise pollution effects	3	PO1, PO3, PO7, PSO2
CO5	Evaluate the Advanced waste water treatment and Industrial wastewater treatment	5	PO1, PO3, PO7, PSO2

Syllabus

Definition of water demand, Factors influencing water demand, Global and regional water demand trends, Types of Water Demand, Water Sources, Water Treatment Processes, Challenges in Water Treatment

Introduction to Water Distribution Systems, Definition and importance of water distribution systems, Components of a typical water distribution system , Factors influencing the design and operation of water distribution networks, Explanation of the Equivalent Pipe Method

Introduction to Sewerage Systems, Definition and significance of sewerage systems, Components of a sewerage system, Sewage Treatment Process, Design Considerations for Sewerage Systems,

Introduction to Construction Landfill, Design Overview of construction landfill, design principles, Factors influencing landfill, site selection, Engineering considerations in landfill construction, ,Solid Waste Management Methods in Construction, Types of solid waste generated in construction projects Best practices for waste minimization and recycling

Advanced Treatment Technologies, Membrane technologies: microfiltration, ultrafiltration, nanofiltration, and reverse osmosis, Adsorption techniques, Ion exchange, Design principles and operational considerations

Reference Books

- 1 Environmental Engineering: Fundamentals, Sustainability, Design, James R. Mihelcic, 2000, John Wiley & Sons.
- 2 Introduction to Environmental Engineering, Mackenzie L. Davis, 2006, McGraw-Hill Education.
- 3 Handbook of Environmental Engineering, Lawrence K Wang, 2015, Humana press.
- 4 Introduction to Environmental Engineering and Science, Gilbert M. Masters, Wendell P. Ela, 2014, Prentice Hall.

23CI2001 - ADAPTIVE SOFTWARE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CI2001	ADAPTIVE SOFTWARE ENGINEERING	ASE	R	3	1	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate understanding of software development life cycle, associated process models, and reverse engineering techniques.	3	PO1, PO2, PO3, PSO2
CO2	Apply requirement modeling, Agile, and Extreme Programming methodologies.	3	PO2, PO3, PO4, PSO2
CO3	Analyze Agile models including Scrum, Kanban, and SAFe methodology, analyze the use of JIRA for project monitoring, and identify appropriate design patterns for project development.	4	PO2, PO3, PSO2
CO4	Analyze testing strategies and evaluate risk management factors	4	PO1, PO2, PO3, PSO2

Syllabus

Software and Software Engineering: Nature of software, software application domains, unique nature of web applications, software engineering, software process, product and process, software engineering practice, software myths.

Process Models: Generic process model, prescriptive process models, specialized process models, unified process, personal and team process models, product and process, Reverse Engineering

Requirements elicitation, documenting business requirements, defining user requirements, and related concepts such as requirement analysis techniques, stakeholder engagement, and requirement validation processes

Agile methodologies like Scrum and Kanban, SAFe for scaling agile, project monitoring with JIRA, and design patterns including architectural and model-driven approaches. Agile project management, scaling frameworks, tool usage for tracking progress, and advanced software design principles for robust architectures.

A strategic approach to software testing, strategic issues, test strategies for conventional software, Black-Box and White-Box testing, validation testing, system testing. RISK MANAGEMENT

Reference Books

- 1 Software Requirements, Karl Wiegers and Joy Beatty, 3 (2012), Microsoft Press..
- 2 Scaling Lean & Agile Development: Thinking and Organizational Tools for Large-Scale Scrum, Craig Larman and Bas Vodde, 1 (2008), Addison-Wesley Professional.
- 3 The Mythical Man-Month: Essays on Software Engineering, Fred Brooks, Anniversary Edition, (1995), Addison-Wesley Professional.
- 4 Code Complete: A Practical Handbook of Software Construction, Steve McConnell, 2 (2004), Microsoft Press.
- 5 The Art of Software Testing, Glenford J. Myers, Corey Sandler, and Tom Badgett, 3rd Edition (2011), John Wiley & Sons.

23CS2104R - OPERATING SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2104R	OPERATING SYSTEMS	OS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand subsystem components of the Kernel and apply the CPU Scheduling algorithms.	2	PO1, PO2
CO2	Apply the memory and process virtualization and Paging, apply Page Replacement Algorithms	3	PO2
CO3	Apply the Concurrency and apply different Lock Algorithms & Solve Synchronisation Problems	3	PO2, PO3, PSO1
CO4	Apply the knowledge of persistence concepts, Redundant disk arrays, File System Implementation, Inter-process Communication and Distributed Systems. Apply Disk Scheduling Algorithms.	3	PO2, PO3, PSO1
CO5	Evaluate Unix System Calls. Use C Programming Language to implement Operating System Concepts (Practicals)	5	PO2

Syllabus

"Basics: Operating System Functionalities, Types of Operating Systems, Process Virtualization: Processes, Process API code, Direct Execution, CPU Scheduling, Multi-level Feedback, Lottery Scheduling code, Multiprocessor Scheduling.

"Basics: Operating System Functionalities, Types of Operating Systems, Process Virtualization: Processes, Process API code, Direct Execution, CPU Scheduling, Multi-level Feedback, Lottery Scheduling code, Multiprocessor Scheduling.

"Concurrency: Concurrency and Threads code, Thread API, Common concurrency problems, Locks, Locked Data Structures, Condition Variables, Mutex, Semaphores, Monitors, Deadlock: Prevention, Detection and Avoidance.

Persistence: I/O Devices, Hard Disk Drives, Disk Scheduling Algorithms, Redundant Disk Arrays (RAID), Files and Directories, File System Implementation, Distributed systems, Data Integrity and Protection, Inter-process communication.

BASIC COMMAND WITH EXAMPLES, IMPLEMENTATION OF FILE OPERATIONS, PROCESS API, PROCESS SCHEDULING ALGORITHMS, MEMORY MANAGEMENT, MEMORY ALLOCATION TECHNIQUES, PAGE REPLACEMENT TECHNIQUES, DEADLOCKS, CONCURRENCY, DISK SCHEDULING ALGORITHMS, INTER PROCESS COMMUNICATION, FILE ORGANIZATION

Reference Books

- 1 Operating Systems: Three Easy Pieces, Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, 2015, May, (2014).
- 2 Operating system concepts essentials., Silberschatz, A., Galvin, P.B. and Gagne, G., 2013, John Wiley & Sons, Inc..
- 3 Modern operating system, Tanenbaum, 2009, Pearson Education, Inc..
- 4 Operating Systems: A Concept-based Approach, D. M. Dhamdhere, 2012, 2E Tata McGraw-Hill Education.

23EC2105R - SIGNALS & COMMUNICATION SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2105R	SIGNALS & COMMUNICATION SYSTEMS	SCS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic Continuous Time Signals and Systems	1	PO1, PSO2
CO2	Solve the frequency domain challenges and applications to systems	2	PO2, PO3, PSO2
CO3	Interpret the principles of linear and angle modulation and demodulation techniques.	2	PO1, PSO2
CO4	Analyze the analog transmitters and receivers in the presence of noise	3	PO2, PO3, PSO2
CO5	Analyze the signal conditioning and communication methodologies	4	PO2, PO5, PSO2

Syllabus

Exploration of Basic Signals and Systems - Introduction to Signals: Classification of Signals, BasicElementary Signals, Sinusoidal and Exponential Signals, Singularity Functions, Introduction to Systems: Classification of Systems, Linear Time Invariant (LTI) System, Impulse Response, Convolution and Interconnections of LTI Systems.

Frequency Domain Analysis of Signals - Concepts of Orthogonality, BriefTreatment of Fourier Series, Fourier Transform (FT): Introduction to FT and Inverse FT, FT of Standard Signals, Periodic Signals and Properties of Fourier Transforms, LT and its Applications to Systems. Sampling of Analog Signals - Frequency Domain Analysis.

Basic Communication Theory - Need for Modulation,Frequency Translation Methods, Amplitude Modulation and Angle Modulation, Modulation Index, Spectrum ofAM and FM Signal, Transmission Bandwidth and Efficiency, Modulators and Demodulators of AM and FM: Envelope Detector, Balanced Modulator, Synchronous and Asynchronous Detectors, FM Demodulation Employing First Order PLL.

Radio Transmitters and Receivers - Classification of Radio Transmitters, AM andFM Transmitters, SSB Transmitters. Radio Receiver Types, AM Super Heterodyne Receivers, FM Receivers, Specifications of AM and FM Receivers,

Reference Books

- 1 Signals & Systems, Willsky, A. S., Nawab, S. H., Oppenheim, A. V.,, 2015, Pearson.
- 2 Modern Digital and Analog Communication Systems, Lathi, B. P., Ding, Z.,, 2010, Oxford University Press.
- 3 Electronic Communications System: Fundamentals Through Advanced, Tomasi, W., 5/e. 2015, Pearson Education.
- 4 Signals and Systems, A. Anand Kumar, 3/e 2015, PHI.
- 5 Analog communication systems, Sanjay Sharma, 2016 ed, Katson Books.

23EC2208R - DIGITAL COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2208R	DIGITAL COMMUNICATION	DC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand working of waveform coding techniques and their performance.	2	PO1, PO2, PSO2
CO2	Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise.	3	PO1, PO2, PSO2
CO3	Analyze the generation and detection of different digital carrier modulation techniques.	4	PO2, PO3, PSO2
CO4	Evaluate the benefits of spread spectrum techniques and assess the performance of spread spectrum systems	4	PO2, PO3, PSO2
CO5	Analyze the different modulation techniques, pulse coding techniques and spread spectrum techniques in digital communication systems using simulation tools and SDR hardware via GNU Radio.	4	PO2, PO3, PSO2

Syllabus

"Baseband signals. Sampling process; Concepts on PAM, PWM and PPM. Quantization Process; Quantization Noise; Linear and Non-linear PCM codes, Noise Considerations in PCM Systems; PCM Line Speed, DPCM, Delta Modulation (DM) and Adaptive DM."

"Eye diagrams, Characterization of Bandlimited Channels, Optimum Receiver for the AWGN Channel, Detection of Baseband Signals in Noise, Matched filter, Other binary signal transmission and antipodal signals., The Power Spectrum of a Digital PAM Signal, Inter symbol Interference: System Design for Bandlimited Channels. Raised Cosine spectrum,"

"Concepts on measure of Information: Bits, Bit Rate, Baud, and M-ary Encoding Noiseless coding-Huffman coding, Channel capacity, Hartley Shannon law Source coding theorem, channel coding, ASK, PSK, FSK, QAM. Bandwidth Efficiency, Carrier and Clock Recovery, Probability of Error and Bit Error Rate, Error Performance."

"Pseudo-noise sequences, notion of spread spectrum, Direct Sequence Spread Spectrum (DSSS) with coherent BPSK, Signal space, dimensionality and processing gain, Probability error"

Reference Books

- 1 Communication Systems , Simon Haykin. , 3, Wiley India Pvt. Limited. .
- 2 Advanced Electronic Communication Systems , Wayne Tomasi , 5, Pearson .
- 3 Digital communications , Proakis, J. G. , 1, Mc Graw Hill .
- 4 Digital Communicaions , Dr Muralidhar Kulkarni , 1, AICTE .

23EC3112R - DISCRETE TIME SIGNAL PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC3112R	DISCRETE TIME SIGNAL PROCESSING	DTSP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To interpret the transforms for discrete time signals.	3	PO1, PO2, PSO1
CO2	To implement Digital IIR Filters	4	PO1, PO2, PSO1
CO3	To implement Digital FIR Filters	4	PO1, PO2, PSO1
CO4	To Acquaint with Wavelets transforms and its applications.	4	PO1, PO2, PSO1
CO5	To implement various discrete signal operations and Filters	4	PO3

Syllabus

TIME DOMAIN AND FREQUENCY DOMAIN ANALYSIS

IIR FILTER DESIGN

FIRFILTER DESIGN

MULTIRATE SIGNAL PROCESSING CONCEPTS

Reference Books

- 1 Discrete-Time Signal Processing, A.V.Oppenheim, R.W. Schafer and J.R. Buck,, 8, Pearson, 2004.
- 2 Signal Processing for Digital Communications, G.J.Miao, 1, Artech House.
- 3 Introduction to Wavelets and Wavelet Transforms, C.S.Burrus, R.A.Gopinath, H.Guo, 3, Prentice hall,2003.
- 4 Digital Signal Processing Using MATLAB AND wavelets, Vinay K. Ingle, John G. Proakis, 2, PWS publishing.

23EE2205R - POWER ELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE2205R	POWER ELECTRONICS	PES	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select appropriate switch for a given power converter	3	PO1, PO7, PSO2
CO2	Analyze the steady state performance of Basic DC-DC converters	4	PO3, PO4, PSO1
CO3	Analyze the performance of Basic Switch-Mode PWM Inverter	4	PO3, PO4, PSO1
CO4	Understand the operation of basic phase-controlled converters	4	PO1, PO5, PO7, PSO1
CO5	Test the basic power electronic converters by hardware realization and MATLAB software.	4	, PSO1

Syllabus

Power Semiconductor devices: Ideal Switch Characteristics, Power Diode, SCR, Brief overview of these devices with their characteristics, ratings and applications: IGBT, MOSFET, SiC and GaN power devices

DC-DC converters: Concept of Volt-sec balance, Charge-sec balance and Small Signal ripple approximation, Ideal analysis of non-isolated DC-DC converters: Buck, Boost, Buck- Boost, Boundary conditions between CCM and DCM.

INVERTERS: Voltage source inverters: single phase inverters-performance analysis and switch rating determination, three phase square wave inverters (120, 180 modes of operation), PWM inverters: Sinusoidal PWM uni-polar and bipolar schemes and their application to three phase inverters for speed control of AC drives.

Line frequency phase controlled converters: Concept of phase control, Single-Phase fully controlled converter with R, RL and RLE load (DC drives control), Three-Phase fully controlled Converter, Estimation of line current harmonics, Input Power Factor and distortion factor. AC voltage controllers: Single Phase AC Voltage controllers with R, RL Loads along with applications.

Reference Books

- 1 Power Electronics Converters Applications and Design", Ned Mohan, Undeland, Robbins, 3RD, John Wiley and sons Publications.
- 2 Power Electronics, circuits, devices and applications, M.H.Rashid, 3RD, Prentice Hall (India) Publications.
- 3 Power Electronics, M.D.Singh and Khanchandani, 2ND, TMH Publications.
- 4 Power Electronics, Dr.P.S Bimbra, 7TH, Khanna Publishers.

23EE2207R - CONTROL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE2207R	CONTROL SYSTEMS	CS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Model physical systems and control system components	3	PO1, PO5, PSO1
CO2	Analyse the control systems under time domain and stability analysis.	4	PO1, PO5, PSO1
CO3	Analyse the control systems under frequency domain analysis.	4	PO2, PO5, PSO1
CO4	Analyse the state space models of LTI systems	4	PO2, PO5, PSO1
CO5	Test the principles of control systems using software & prototype models	4	PO1, PO5, PSO2

Syllabus

Control System Concepts- Control system terminology, examples of simple control systems, open loop and closed loop control systems, Types of control systems. Mathematical models of physical systems- Analogy with mechanical systems, Formulation of differential equations for electrical systems Transfer functions of open and closed loop systems, DC & AC servomotors, block diagram representation of control systems, signal flow graph, Masons gain formula

Time domain analysis: Standard test signals -step, ramp, parabolic and impulse, impulse response, characteristic equation of feedback systems, transient response of first order and second order systems to standard test signals, time domain specifications, steady state error and error constants, Introduction to P, PI, PID controllers. Stability analysis: Concept of stability and conditions for stability, Routh - Hurwitz criterion, dominant poles of transfer function. Root Locus Technique- The root locus concept, basic properties, magnitude and angle conditions, properties, and construction of the complex root loci.

Frequency response Analysis & Design: Introduction, frequency response specifications, correlation between time and frequency response, specifications, polar (Nyquist) plot, Bode plot, phase margin and gain margin.

State space analysis: Concepts of state, state variables, state vector, input vector, output vector; development of state models for simple systems, Concepts of controllability and observability.

Reference Books

- 1 Control System Engineering, J Nagrath & M Gopal, 5th, New Age International.
- 2 Automatic Control Systems, B C KUO, 10TH, Prentice Hall India.
- 3 Modern Control Engineering, K Ogata, 5TH, Prentice Hall India.
- 4 Control Systems Principles and Design, M GOPAL, 4TH, Tata Mc-Graw Hill.
- 5 Programmable Logic Controllers Principles and Applications, J W Werb & Ronald A Reis, 5TH, Pearson Publications.

23ME2106R - MECHANICS OF SOLIDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME2106R	MECHANICS OF SOLIDS	MOS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze stresses in members with axial loading or torsion?	4	PO1, PO2, PSO1
CO2	Analyze members with multi axial loading and lateral loading?	4	PO1, PO2, PSO1
CO3	Analyze deflections and stresses in beams?	4	PO1, PO2, PSO1
CO4	Analyse columns and pressure vessels?	4	PO1, PO2, PSO1
CO5	Apply the theoretical concepts to conduct various experiments of strength of materials practically and analyze the data?	4	PO5, PSO1

Syllabus

Introduction to Stress, Strain, Hooke's law, Stress-strain diagram, force-deformation relationship, compound bar, Thermal Stress, Torsion of Circular bar, Strain energy

Multi axial stresses and strains: Multi-axial Stress and Strain- Relationships, Stress and Strain Transformations and Principal Stresses, Graphical representation of Stress: Mohr's circle. Failure of Materials and Examples, Theories of Shearing Forces and Bending Moments: Shear Force and Bending Moment, Relationship Between Load, Shear Force and Bending Moment, Shear Force and Bending Moment Diagrams.?

Beam Deflection, Symmetry, Superposition, and Statically Indeterminate Beams. Beams: Normal Stresses in Beams, Cross Section Shapes of Beams, Shear Stresses in Rectangular Beams, Shear Stresses in The Webs of Beams with Flanges.?

Thin-walled Pressure Vessels: Understand hoop and longitudinal stresses. Simple problems for cylinders and shells. Columns: Buckling, Euler's formula, limitations, generalized buckling.

Reference Books

- 1 Mechanics of Materials , Gere & Goodno , 9th, Cengage Publishers .
- 2 Mechanics of Materials , RC Hibbeler , 10th, Pearson .
- 3 Mechanics of Materials , E.P. Popov , 4th, Prentice Hall Publications .
- 4 Strength of Materials , S. Ramamrutham , 5th, Dhanpat Rai Publications .
- 5 Strength of Materials , S.S. Rattan , 3rd, S.S. Rattan .

23ME2116 - FLUID MECHANICS & HYDRAULIC MACHINES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME2116	FLUID MECHANICS & HYDRAULIC MACHINES	FMHM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of fluid properties and the laws of fluidstatics to estimate the total pressure, Centre of pressure and forces on submerged and floating bodies	3	PO1, PO2
CO2	Apply continuity, Euler and Bernoulli equations and estimate different flow measuring devices	3	PO1, PO2
CO3	Apply continuity, Euler and Bernoulli equations and estimate different flow measuring devices	4	PO1, PO2
CO4	Analyze the performance of hydraulic turbines and pumps using velocity triangles and model similitude.	4	PO1, PO2, PO3
CO5	Conduct experiments to verify and apply various fluid flow principles and performance evaluation of various hydraulic machines like turbines and pumps	4	PO1, PO2, PO3

Syllabus

Fluid Properties: Definition of fluid, properties of fluid -density, specific weight, specific gravity, viscosity, classification of fluids, surface tension and capillarity Vapour pressure. Fluid Statics

Fluid kinematics: Introduction, types of fluid flow, Discharge, Continuity equation,

Flow through pipes: Introduction, major and minor energy losses, friction coefficient in laminar and turbulent flow, Hagen-Poiseuille law

Hydraulic Machines-Turbines: Introduction, types and classification Pelton wheel, Francis turbine, Kaplan turbine

Definition of pump, classification, description and general principle of working; priming, work done and efficiency of a centrifugal pump, minimum starting speed, cavitation in centrifugal pumps, multi-stage pumps, problems on centrifugal pumps.

Reference Books

- 1 Fluid Mechanics and Hydraulic Machines, R.K. Bansal, 3, 2012, Mc Graw Hill.
- 2 Fluid Mechanics, S. K. Som and G. Biswas, 4, 2009, Tata McGraw Hill publications.
- 3 Fluid Mechanics, Yunus A. Cengel, 3, 2012, McGraw Hill publications.
- 4 Fluid Mechanics and Hydraulic Machines, D. S. Kumar, 3, 2020, Narosa Publishing House Private Limited..

23ME2208 - MANUFACTURING PROCESSES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME2208	MANUFACTURING PROCESSES	MP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify the casting processes	3	PO1, PSO2
CO2	Select the appropriate welding processes	3	PO3, PSO1
CO3	Apply principles of cold/hot forming processes	3	PO3, PSO2
CO4	Utilize sheet metal processes and design sheet metal dies	3	PO3, PSO1
CO5	Fabricate the parts using manufacturing processes	3	PO2, PSO2

Syllabus

Overview of metal casting processes, key terms, sand mould making, patterns, allowances, design considerations, gating systems, special methods like shell moulding, investment casting, die casting, centrifugal casting, and inspection for casting defects.

Overview of joining processes, types of joints, and welding terminology. Includes gas welding, arc welding (GTAW, GMAW, SAW), resistance welding, thermit welding, electron beam, laser welding, friction welding, welding design considerations (heat input, heat flow), and common welding defects (undercut, incomplete fusion, porosity, slag inclusion, cracks, lamellar tearing, residual stresses)

Overview of metal forming processes, plastic deformation, and hot and cold forming. Includes principles of rolling and forging, rolling stand arrangement, roll force, power requirements, forging operations and design, defects and remedies. Also covers extrusion principles, hot and cold extrusion, extruding tubes, wire drawing, and rod and tube drawing.

Sheet Metal Forming Processes - Press Tool Operations, Shearing Action, Shearing Operations, Bending Sheet and Plate, Common Bending Operations, Stretch Forming, Deep Drawing, Spinning, Explosive and Magnetic-Pulse Forming Processes

Preparation of parts using casting and welding methods

Reference Books

- 1 Manufacturing Technology, P.N Rao, Third Edition, The McGraw-Hill Companies.
- 2 Manufacturing Engineering and Technology, Serope Kalpakjian Steven R Schmid, Fourth Edition, Pearson Education, Inc..
- 3 Processes and Materials of Manufacture, Lindberg, Third Edition, Prentice hall India (p) Ltd.
- 4 Mechanical Metallurgy, Dieter, Revised Edition, McGraw-Hill.

23OEBT01 - IPR AND PATENT LAWS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OEBT01	IPR AND PATENT LAWS	IPR	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the the principles of copy rights in applying patents, trademarks, copyrights, and trade secrets	2	PO3
CO2	Apply the guidelines framed by GATT & WTO in patenting	3	
CO3	Apply the regulatory affairs in maintaining patenting rights	3	PO5, PO10
CO4	Apply the concepts of copy rights in drafting patents of various types.	3	PO1

Syllabus

Intellectual Property Rights; Patents and intellectual property rights (IPR): Definition, History of intellectual property; Types of intellectual property rights, copy rights, trade marks, geographical indication, Industrial design rights, patents. Sources of patent information, patent application procedures

Principles, Scope and Functions of GATT&WTO; GATT- Historical perspective, objectives and fundamental principles, impact on developing countries. WTO-Objectives, scope, functions, structure, status, membership and withdrawal, dispute settlement, impact on globalization, India tasks and challenges

Regulatory Affairs; Indian context-requirements and guidelines of GMP, understanding of Drugs and cosmetic act 1940 and rules 1945 with reference schedule M, U & Y. Related quality systems-objectives and guidelines of USFDA, WHO & ICH; Introduction to ISO series

Documentation and Protocols; Documentation: Types related to pharmaceuticals industry, protocols, harmonizing formulation development for global fillings, NDA, ANDA, CTD, Dealing with post approval changes-SUPAC, handling and maintenance including electronic documentation. self study topic: Case Studies on Patents and Case Studies on - Patents (Basmati rice, turmeric, Neem, and related medicinal plants and byproducts)

Reference Books

- 1 Patent Law and Policy: Cases and Materials, Robert Patrick Merges, John Fitzgerald Duffy, and Mark D. Lemley, 2021, Carolina Academic Press.
- 2 Intellectual Property Rights: Legal and Economic Challenges for Development, Carlos M. Correa, 2020, Oxford University Press .
- 3 Principles of Intellectual Property Law, Thomas G. Field Jr., 2021, New Hampshire.
- 4 Good manufacturing practices for Pharmaceuticals, Informa Healthcare, S.H. Willig, 2010, Academic Press.
- 5 IPR, Biosafety and Bioethics, Deepa Goel, Shomini Parashar, 2021, Pearson .

23OECE06M - EXPLORING OUR RESPONSES TO CLIMATE CHANGE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OECE06M	EXPLORING OUR RESPONSES TO CLIMATE CHANGE	EORCC	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand the climate and weather	2	PO1, PO3, PO7, PSO2
CO2	To understand the climate change and its impact on environment	2	PO1, PO3, PO7, PSO2
CO3	To understand how to manage climate change	2	PO1, PO3, PO7, PSO2
CO4	To understand planning with climate change in mind.	2	PO1, PO3, PO7, PSO2

Syllabus

Formation, composition of Earth's atmosphere, mass and layering of atmosphere, electromagnetic radiation, solar and terrestrial radiation, variation with latitudes and seasons, Adiabatic temperature changes, air stability and instability, Ozone layer, Temperature measurements and controls, Dry and Wet adiabatic lapse rate, inversion of temperature. climate change terms definition, Basics of Climate science, Global warming and climate change

Climate change impacts on water, Climate change impacts on agriculture and health, Climate change impacts on forests and transportation, Climate change impacts on energy and socioeconomic issues, methods of evaluation and/or assessment

Climate change policy of countries, Uncertainty and climate change policy, Policy implications, Cost-benefit analysis in the context of climate change, Policy makers: Speculators, Analysis and decision support tools in mitigation of Climate change.

Concepts and strategies for climate change adaptation, Adaptive Capacity, Mitigation strategies and options for various sectors, Emission trends and mitigation policies, Renewable and alternative energy technologies

Reference Books

- 1 Climate Change: What it means for us, our children and our grandchildren, Joseph F.C. DiMento and Pamela Doughman, 2006, MIT Press.
- 2 Climate and Global Environmental Change, L.D. Danny Harvey, 2008, Prentice Hall publication.
- 3 Technologies, policies and measures for mitigating climate change, IPCC, 2010, IPCC.
- 4 Responding to the Climate Threat Essays on Humanity's Greatest Challenge, Gary Yohe, Henry Jacoby, Richard Richels, Benjamin Santer, 2023, Springer.

23OEDT01 - INNOVATIVE PRODUCT DEVELOPMENT FOR ENTREPRENEURS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OEDT01	INNOVATIVE PRODUCT DEVELOPMENT FOR ENTREPRENEURS	IPDFE	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze market needs and conduct customer discovery to identify and validate opportunities for innovative product development.	4	PO2, PO11, PSO1
CO2	Develop and prototype innovative product concepts using design thinking, user-centered design, and rapid prototyping techniques.	3	PO2, PO11, PSO1
CO3	Apply lean startup and agile development methodologies to build, test, and iterate a minimum viable product (MVP) based on user feedback and validated learning.	3	PO2, PO11, PSO1
CO4	Design and execute a comprehensive go-to-market strategy, including launch planning, marketing, and post-launch evaluation, to successfully bring a new product to market.	6	PO2, PO11, PSO1

Syllabus

Introduction to Innovative Product Development Principles of Product Development: Introduction; Importance of innovation; Stages of product development; Market Research: Identifying market needs; Customer discovery; Competitive analysis; Idea Generation: Brainstorming techniques; Creativity and innovation tools; Evaluating and selecting ideas; Feasibility Analysis: Technical feasibility; Market feasibility; Financial feasibility

Concept Development and Prototyping Concept Development: Creating product concepts; Design thinking; User-centered design; Prototyping Techniques: Low-fidelity vs. high-fidelity prototypes; Tools and materials for prototyping; Rapid prototyping methods; User Testing: Planning and conducting user tests; Gathering and analyzing feedback; Iterative design process; Refinement and Iteration: Improving product designs; Addressing user feedback; Preparing for final prototype

Lean Product Development Lean Startup Methodology: Principles of lean startup; Building a minimum viable product (MVP); Validated learning; Agile Development: Agile principles and practices; Scrum and Kanban methodologies; Managing product development cycles; Product Validation: Market testing; Metrics and key performance indicators (KPIs); Pivoting based on validation results; Scaling the Product: Preparing for scaling; Managing growth; Ensuring product quality and consistency

Product Launch and Go-to-Market Strategy Product Launch Planning: Launch strategy; Marketing and promotional activities; Building a launch team; Go-to-Market Strategy: Identifying target markets; Positioning and branding; Sales and distribution channels; Post-Launch Evaluation: Analyzing launch success; Gathering post-launch feedback; Continuous improvement; Case Studies: Successful product launches; Lessons learned from failures; Best practices in product development

Reference Books

- 1 Product Design and Development, Karl T. Ulrich, Steven D. Eppinger, 7th (2020), McGraw-Hill Education.
- 2 Inspired: How To Create Products Customers Love, Marty Cagan, 2nd (2018), Wiley.
- 3 Hooked: How to Build Habit-Forming Products, Nir Eyal, Ryan Hoover, 1st (2014), Portfolio.
- 4 Designing for Growth: A Design Thinking Tool Kit for Managers, Jeanne Liedtka, Tim Ogilvie, 1st (2011), Columbia Business School Publishing.

23OEDT02 - STRATEGIC FINANCIAL AND MARKETING PLANNING FOR ENTREPRENEURS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OEDT02	STRATEGIC FINANCIAL AND MARKETING PLANNING FOR ENTREPRENEURS	SFMPE	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the financial planning essentials for startups and small businesses	2	PO3, PSO1
CO2	Apply the concept to create and implement effective marketing strategies tailored to entrepreneurial contexts.	3	PO3, PSO1
CO3	Analyze the financial and marketing plans to support business objectives	4	PO4, PSO2
CO4	Analyze the strategic decision-making processes to enhance business performance.	4	PO5, PSO2

Syllabus

Introduction to Financial Planning: Importance of financial planning in entrepreneurship, Key components of financial planning. Budgeting and Forecasting: Developing budgets for startups: Revenue forecasting and expense management, Financial Statements and Analysis, Understanding balance sheets, income statements, and cash flow statements, Financial ratios and performance metrics Funding and Capital Structure: Types of funding (bootstrapping, loans, venture capital), Capital structure and cost of capital Financial Risk Management: Identifying financial risks, Strategies for mitigating financial risks

Introduction to Marketing Planning: Importance of marketing for startups, Elements of a marketing plan, Market Research and Analysis, Identifying market opportunities, Competitive analysis and market segmentation, Value Proposition and Branding, Developing a unique value proposition, Building a brand identity and positioning, Marketing Channels and Strategies, Digital marketing strategies (SEO, social media, content marketing), Traditional marketing strategies (PR, events, direct marketing), Sales Strategy and Customer Relationship Management, Developing a sales strategy, Building and maintaining customer relationships

Alignment of Financial and Marketing Goals: Synchronizing financial objectives with marketing strategies, Budget allocation for marketing activities, Cost Benefit Analysis of Marketing Strategies, Evaluating the financial impact of marketing campaigns, ROI analysis and marketing performance metrics, Pricing Strategies and Financial Impact, Developing pricing models based on financial goals, Impact of pricing on revenue and profitability, Resource Allocation and Scaling, Effective resource management for scaling marketing efforts, Balancing marketing expenditures with financial constraints

Strategic Planning and Decision Making: Strategic planning processes, Decision-making frameworks for entrepreneurs. Scenario Planning and Contingency Strategies, Developing scenario plans for uncertain market conditions, Contingency planning for financial and marketing strategies. Performance Monitoring and Adaptation, KPIs for financial and marketing performance, Adaptive strategies based on performance metrics. Pitching to Investors and Stakeholders, Developing a compelling pitch, Communicating financial and marketing plans to investors

Reference Books

- 1 Financial Intelligence for Entrepreneurs: What You Really Need to Know About the Numbers, Karen Berman, Joe Knight, and John Case, Revised Edition (2013), Harvard Business Review Press.
- 2 Disciplined Entrepreneurship: 24 Steps to a Successful Startup, Bill Aulet, 1st Edition (2013), Wiley.
- 3 HBR Guide to Finance Basics for Managers, Karen Berman, 2nd Edition (2019), Harvard Business Review Press.
- 4 Entrepreneurial Marketing: A Practical Managerial Approach, Zubin Sethna and Rosalind Jones, 2nd Edition (2019), SAGE Publications.

23OEDT03 - LEADERSHIP IN ENTREPRENEURIAL VENTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OEDT03	LEADERSHIP IN ENTREPRENEURIAL VENTURES	LEV	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the key leadership principles and traits required for entrepreneurial success.	2	PO2, PO10
CO2	Analyze various leadership styles and their impact on entrepreneurial ventures.	4	PO2, PO9
CO3	Develop strategies for building and leading high-performance entrepreneurial teams.	5	PO3, PO9
CO4	Apply leadership skills to drive innovation and strategic growth in entrepreneurial ventures.	6	PO3, PO10

Syllabus

Foundations of Entrepreneurial Leadership: Understanding entrepreneurial leadership Key traits and characteristics of successful leaders Ethical decision-making and integrity in leadership

Leadership Styles and Entrepreneurial Impact: Overview of leadership styles: transformational, transactional, servant Case studies of leadership styles in entrepreneurial settings Assessing leadership effectiveness in different business scenarios

Building and Leading Entrepreneurial Teams: Team dynamics and conflict resolution Recruitment and talent management in startups Motivating and retaining high-performance teams

Leading Innovation and Strategic Growth: Encouraging innovation and creativity within the organization Change management and adaptability in entrepreneurial ventures Strategic planning and execution for business growth

Reference Books

- 1 The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, 1st, Crown Business.
- 2 Leaders Eat Last: Why Some Teams Pull Together and Others Don't, Simon Sinek, 1st, Penguin.
- 3 The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Clayton M. Christensen, 1st, Harvard Business Review Press.
- 4 Drive: The Surprising Truth About What Motivates Us, Daniel H. Pink, 1st, Riverhead Books.

23OEEE03 - ELECTRICAL POWER ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OEEE03	ELECTRICAL POWER ENGINEERING	EPE	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand working of various generating stations and economical aspects of generation	2	PO1
CO2	Apply the kirchhoffs laws to calculate the electrical parameters in the given networks	3	PO1, PO2, PO5
CO3	Apply the faraday's laws for the construction and performance analysis of different types of electrical machines	3	PO1, PO3
CO4	Apply energy conservation opportunities for various electrical appliances	3	PO1, PO7

Syllabus

Generating stations: Organization of power sector in India, Layout & Operation of Thermal, Hydro, Nuclear and combined cycle power stations. Renewable Energy sources- Solar PV, solar thermal, Wind Power Plant, OTEC, Biomass power plants and Fuel Cells.

Basic Concepts of passive elements of R, L, C and their VI relations, Ohms law, Sources dependent and independent, Kirchhoffs laws, Network reduction techniques series, parallel, series and parallel, Concepts of AC quantities Phase, power factor, real and active powers, power factor improving methods

Electrical Machines: Faradays laws, construction and working of DC machines, construction and working of Induction machines, construction and working of special machines stepper motors, BLDC motors. Advantages and Disadvantages, applications. Speed control techniques

Energy Conservation: General Aspects of Energy Auditing: Introduction - Types of Energy Auditing, Benefits of Energy Audit, Methodology for Energy Audit , Energy Audit Report format, Energy conservation opportunities for domestic consumers, energy conservation opportunities for lighting systems, cooling and heating systems. Concept of green and smart buildings. Government initiatives

Reference Books

- 1 A Course in Power Systems , J B Gupta , 1987, S. K. Kataria & sons .
- 2 Fundamentals of Electric Circuits , Charles K Alexander, Mathew N O Sadiku , 2000, Tata McGraw Hill Education Pvt. Ltd. .
- 3 Electrical Machines , P.S. Bhimbra , 1983, Khanna Publishers .
- 4 Energy Management Handbook , Stephan A. Roosa, Steve Doty, Wayne C. Turner , 1980, River Publishers. .
- 5 Electrical Technology , N. P Subramaniam, Anoop Mathew , 2002, Alpha Science International Limited, Oxford Press U.K. .

23OEEE05M - SELF-DRIVING CARS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OEEE05M	SELF-DRIVING CARS	SDC	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic architecture of self-driving car	2	PO1, PO2, PO3, PSO1
CO2	Apply the deep learning technique in self-driving car	3	PO2, PO3, PO4, PSO1
CO3	Demonstrate the various Approaches to sensing fusion and localization	3	PO2, PO3, PO4, PSO1
CO4	Analyze planning, control and system integration concept in autonomous vehicle	4	PO2, PO3, PO4, PSO1
CO5	Analyze the morkov localization model process	4	PO2, PO3, PO4, PSO1

Syllabus

Introduction: Introduction to self-driving car- Taxonomy of Driving- Requirements for Perception- Driving Decisions and Actions- Sensors and Computing Hardware- Hardware Configuration Design- Software Architecture- Environment Representation- Safety Assurance for Self-Driving Vehicles- Industry Methods for Safety Assurance and Testing- Safety Frameworks for Self-Driving.

Computer Vision: Computer Vision Fundamentals- Detect Lane Lines- Advanced Computer Vision- Advanced Lane Detection- Deep Learning: Neural Networks- TensorFlow- Deep Neural Networks- Convolutional Neural Networks- Traffic Sign Classifier-Keras- Transfer Learning.

Sensor Fusion: Sensors - Kalman Filters- Geometry and Trigonometry- Extended Kalman Filters. Localization: Introduction to Localization- Markov Localization- Motion Models- Particle Filter- Implementation of a Particle Filter.

Planning: Search- Prediction- Behavior Planning- Trajectory Generation- Highway Driving. Control: Control- PID Control. System Integration: Autonomous Vehicle Architecture- Introduction to Robot Operating System- Packages & Catkin Workspaces- Writing ROS Nodes- Program an Autonomous Vehicle.

Introduction of localization, Markov localization, motion models, particle filters, implementation of particle filters, Automotive vehicle architecture, PID models

Reference Books

- 1 Self-Driving Cars: The New Way Forward, Michael Fallon, 1st Edition, Twenty-First Century Books.
- 2 Self-Driving Cars, Lauren Newman, 1st Edition, Cherry Lake Publishing.
- 3 Robot Motion Planning and Control, Jean-Claude Latombe, 1st Edition, Springer.
- 4 Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms, Nikolaus Correll, Bradley Hayes, and David Coleman, 2nd Edition, CreateSpace Independent Publishing Platform.
- 5 Self-Driving Cars: Key Challenges and Future Directions, Steven M. Lavalle, 1st Edition, River Publishers.

23OEME01 - ROBOTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OEME01	ROBOTICS	RBT	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the anatomy of existing robotic systems and their performance specifications, end effectors, etc	2	PO1, PO2
CO2	Apply appropriate sensors, actuators for real time applications of Robotic Systems	3	PO1, PO2
CO3	Apply the Denavit Hartenberg procedure to solve forward and inverse kinematics of robots	3	PO1, PO2
CO4	Comprehensive Identification of suitable Robotic systems for various applications and Classification of Robot Languages	4	PO1, PO2

Syllabus

Introduction to Robotics, Major components of a Robot, Robotic-like devices, Classification of Robots Classification by coordinate system and by control method, Specifications of Robots, Fixed versus flexible automation, economic analysis. ROBOTEND EFFECTORS Introduction, End effectors, interfacing, types of End effectors, grippers and tools, considerations in the selection and design of remote cantered devices.

ROBOTIC SENSORY DEVICES Objective, Non-Optical position sensors Potentiometers, Synchros, inductosyn, optical position sensors opto interrupters, Optical encoders absolute and incremental. PROXIMITYSENSORS Contact type, non contact type Reflected light ,scanning laser sensors. TOUCH and SLIP SENSORS Touch sensors proximity Rod and Photo detector sensors, Slip sensors Forced oscillation slip sensor, interrupted type slip sensors, force and torque sensors.

TRANSFORMATIONS AND KINEMATICS Objectives, homogeneous coordinates, basic transformation operations, forward solution Denavit Hartenberg procedure, Simple problems involving planar manipulators, inverse or backward solution problems involved, techniques. Introduction to Trajectory Planning, the manipulator jacobian.

ROBOT APPLICATIONS IndustrialApplications Material Transfer, material handling, Loading and unloading, processing, spot and continuous arc welding, spraypainting, grinding, Assembly and Inspection and Non-Industrial Applications. ROBOT LANGUAGES Introduction, AL, AML,VAL, RAIL

Reference Books

- 1 Robotics Engineering: An Integrated Approach, Richard D. Klafter, 1, 1989, Prentice-Hall.
- 2 INDUSTRIAL ROBOTICS, Mikell Groover , 2, 2017, McGraw-Hill .
- 3 Robotics: Control, Sensing, Vision and Intelligence, K. S. Fu, C.S.G. Lee, Ralph Gonzalez , 1, 1987, McGraw-Hill .
- 4 Robotics for Engineers, Yoram Koren, 1, 1985, McGraw-Hill .
- 5 ROBOTICS AND CONTROL, R Mittle, I Nagrath, 1, 2017, McGraw-Hill .

23OEME01M - ROBOTICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OEME01M	ROBOTICS	RBT	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the anatomy of existing robotic systems and their performance specifications, end effectors, etc	2	PO1, PO2
CO2	Apply appropriate sensors, actuators for real time applications of Robotic Systems	3	PO1, PO2
CO3	Apply the Denavit Hartenberg procedure to solve forward and inverse kinematics of robots	3	PO1, PO2
CO4	Comprehensive Identification of suitable Robotic systems for various applications and Classification of Robot Languages	4	PO1, PO2

Syllabus

Introduction to Robotics, Major components of a Robot, Robotic-like devices, Classification of Robots Classification by coordinate system and by control method, Specifications of Robots, Fixed versus flexible automation, economic analysis. ROBOTEND EFFECTORS Introduction, End effectors, interfacing, types of End effectors, grippers and tools, considerations in the selection and design of remote cantered devices.

ROBOTIC SENSORY DEVICES Objective, Non-Optical position sensors Potentiometers, Synchros, inductosyn, optical position sensors opto interrupters, Optical encoders absolute and incremental. PROXIMITYSENSORS Contact type, non contact type Reflected light ,scanning laser sensors. TOUCH and SLIP SENSORS Touch sensors proximity Rod and Photo detector sensors, Slip sensors Forced oscillation slip sensor, interrupted type slip sensors, force and torque sensors.

TRANSFORMATIONS AND KINEMATICS Objectives, homogeneous coordinates, basic transformation operations, forward solution Denavit Hartenberg procedure, Simple problems involving planar manipulators, inverse or backward solution problems involved, techniques. Introduction to Trajectory Planning, the manipulator jacobian.

ROBOT APPLICATIONS IndustrialApplications Material Transfer, material handling, Loading and unloading, processing, spot and continuous arc welding, spraypainting, grinding, Assembly and Inspection and Non-Industrial Applications.

ROBOT LANGUAGES Introduction, AL, AML,VAL, RAIL

Reference Books

- 1 Robotics Engineering: An Integrated Approach, Richard D. Klafter, 1989, Prentice-Hall.
- 2 INDUSTRIAL ROBOTICS, Mikell Groover , 2017, McGraw-Hill .
- 3 Robotics: Control, Sensing, Vision and Intelligence, K. S. Fu, C.S.G. Lee, Ralph Gonzalez, 1987, McGraw-Hill .
- 4 Robotics for Engineers, Yoram Koren, 1985, McGraw-Hill .
- 5 ROBOTICS AND CONTROL, R Mittle, I Nagrath, 2017, McGraw-Hill .

23OEME03M - OPERATIONS RESEARCH (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23OEME03M	OPERATIONS RESEARCH	ORS	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various methods to find optimum solutions to Linear Programming Problems	3	PO1, PO2
CO2	Apply various methods to find optimal solutions for the problems in the field of Transportation and Assignment Problems	3	PO1, PO2
CO3	Apply various methods to find solutions to Game theory, Dynamic Programming, Queuing Theory, Inventory Control	3	PO1, PO2
CO4	Apply the concept of PERT/CPM for solving various projects	3	PO1, PO2

Syllabus

Introduction, Modeling in Operations Research, Phases of OR study, Scope and application of OR. Linear Programming and its Applications: Linear Programming Problem Graphical solution of LP Problem. Simplex method, Big M method, two phase method, multiple solution, infeasible solution, unbounded solution, degeneracy, Dual Simplex method

Transportation: Introduction Methods of basic feasible solution, Optimality test, Degeneracy in transportation problem, unbalanced transportation Problem, Assignment Problems: Hungarian method for assignment problem, Traveling salesman problem.

Theory of Games: Introduction, to solve the rectangular two-person zero sum games, solution of rectangular games in terms of mixed strategies, solution of 2x2 games without saddle point, solution of a two person zero sum 2Xn game, Graphical method for 2Xn and nX2 games. Inventory Control: Introduction EOQ with uniform rate of demand, Economic lot size with finite rate of replenishment, Quantity discounts, Deterministic model with Shortages, ABC analysis of inventory.. Queuing Theory: Introduction, single channel, Poisson arrival, exponential service time with finite population and infinite population, And Application to Inventory Control.

Project Management by PERT/CPM: Introduction, simple network techniques, construction rules of drawing, Fulkerson rule, Critical path method (CPM) floats, critical path, project duration, PERT: Introduction, different Time estimates, expected time, variance, expected project duration and probability of completion. Crashing: Introduction, crashing of network problem

Reference Books

- 1 Operations Research, Hamdy Taha, 2007, Pearson.
- 2 Introduction to Operations Research, Hiller & Lieberman, 2002, Mc Graw Hill.
- 3 Operations Research, S D Sharma, 2020, Kedarnath Ramnath.
- 4 Operations Research, A M Natarajan, 2011, Pearson.



(DEEMED TO BE U N I V E R S I T Y)

Y23: B.Tech. - Internet of Things

Category: Value Added Courses (VAC)

23CC3005 - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING USING PYTHON [INDUSTRIAL AUTOMATION]-L1 (TESSOLVE) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3005	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING USING PYTHON [INDUSTRIAL AUTOMATION]-L1 (TESSOLVE)	AIML1	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Apply fundamentals and types of AI, as well as applications, advantages.	3	PO1, PO2, PO5, PSO1
CO2	understand and Apply the principles and applications of classification and clustering techniques in machine learning .Gain insights into SVM and KNN algorithms,	4	PO1, PO2, PO5, PSO1

Syllabus

What is AI, Types of AI, Applications of AI, Advantages and disadvantages of AI Introduction to ML, Types of ML algorithms : Supervised learning - Unsupervised learning - Reinforcement learning

Data collection , Data preprocessing, Choosing the learning algorithms, Training the model, Evaluating the model, Predictions. Introduction to regression, Types of regression : Linear regression (Simple linear regression & Multiple linear regression) - Logistic regression Overfitting & Underfitting in Machine Learning

Introduction to classification, Support vector Machine (SVM), Types of SVM : linear SVM & non-linear SVM, K-nearest neighbour (KNN), Working of KNN, Advantages and disadvantages of KNN, Applications of KNN, Confusion matrix : Precision - Accuracy - Recall - F1 score

Introduction to clustering, Types of clustering : Hierarchical clustering (Agglomerative & divisive clustering) - Partitioning clustering (K-means clustering) Curse of dimensionality, Advantages and disadvantages of dimensionality reduction, Principle Component Analysis (PCA)

Reference Books

- 1 Pattern Recognition and Machine Learning, Christopher M. Bishop, 1st Edition ,2016, Springer.
- 2 Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, 1st Edition,2012, MIT Press.
- 3 Pattern Classification, Richard O. Duda, Peter E. Hart, David G. Stork, 2nd Edition,2019, Wiley-Interscience.
- 4 Machine Learning: An Algorithmic Perspective, Stephen Marsland, 2nd Edition,2021, CRC Press.

23CC3006 - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING USING PYTHON [INDUSTRIAL AUTOMATION]-L2 (TESSOLVE) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3006	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING USING PYTHON [INDUSTRIAL AUTOMATION]-L2 (TESSOLVE)	AIML2	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to AI and ML in Industrial Automation	2	PO3
CO2	Machine Learning Fundamentals	3	PO5
CO3	Data Handling and Preprocessing	3	PO9
CO4	AI and ML in Industrial Automation	4	, PSO2

Syllabus

Overview of AI and ML Definitions and key concepts Historical context and evolution Applications in industrial automation Python Programming for AI and ML Introduction to Python Python libraries for AI and ML: NumPy, Pandas, Matplotlib Basic programming concepts and data structures Data Handling and Preprocessing Data collection methods in industrial settings Data cleaning and preprocessing techniques Feature selection and engineering

Supervised Learning Regression algorithms (Linear, Polynomial, etc.) Classification algorithms (K-Nearest Neighbors, Decision Trees, Random Forests, etc.) Model evaluation and validation techniques (Cross-validation, Metrics like accuracy, precision, recall, F1 score) Unsupervised Learning Clustering algorithms (K-Means, Hierarchical clustering, DBSCAN) Dimensionality reduction techniques (PCA, t-SNE) Anomaly detection in industrial automation Practical Applications Case studies of ML in industrial automation Hands-on projects and assignments using real-world industrial data

Neural Networks and Deep Learning Basics of neural networks Deep learning architectures (CNNs, RNNs) Training deep neural networks Natural Language Processing (NLP) Text preprocessing and representation NLP techniques and applications in industrial automation (e.g., predictive maintenance from text data) Reinforcement Learning Fundamentals of reinforcement learning Applications in robotics and automation Implementing reinforcement learning algorithms in Python

Integration with Industrial Systems IoT and AI: Integrating ML models with IoT devices Real-time data processing and decision making Predictive Maintenance and Anomaly Detection Predictive maintenance models Implementing and evaluating anomaly detection systems Project Work and Case Studies Capstone project: Building an end-to-end AI/ML solution for an industrial automation problem Detailed case studies from the industry Presentation and discussion of project outcomes

Reference Books

- 1 "Artificial Intelligence: A Guide for Thinking Humans", Melanie Mitchell, 1st, Farrar, Straus and Giroux.
- 2 "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", Aurélien Géron, 2nd, O'Reilly Media.
- 3 "Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2", Sebastian Raschka and Vahid Mirjalili, 3rd, Packt Publishing.
- 4 "Industrial Automation and Robotics: An Introduction", A.K. Gupta and S.K. Arora, 1st, University Science Press.

23CC3010 - AWS CERTIFIED CLOUD PRACTITIONER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3010	AWS CERTIFIED CLOUD PRACTITIONER	AWS-CCP	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply virtual sessions of computing resources (servers, storage, networks) to maximize efficiency and utilization.	3	PO1, PO5
CO2	Analyze the optimization principles to the environment for cost efficiency, performance, security and reliability	4	PO1, PSO2

Syllabus

Cloud Concepts: Cloud definitions, Cloud service models, Cloud Deployment models, Benefits and Characteristics of the Cloud, Economies of scale, Global infrastructure, Features of cloud, Cloud Architected Framework, Pillars of the cloud Architected Framework, Cloud Adoption Framework, Cloud adoption strategies, Cloud migration strategies, Cloud economics. Cloud Technology and Services: Different ways to access cloud services, Compute services, Database services Network and content delivery services, Storage services, Computation and data analytics services, Application integration services, Customer engagement services, Developer tool services, End-user computing services.

Security and Compliance: Shared responsibility model, security features and services, Cloud security, governance, and compliance, Benefits of cloud security, Identity and access management, authentication and authorization services in Cloud, application, and network security. Billing, Pricing, and Support: Pricing models, Resources for billing, budget, and cost management, Cloud Technical Resources and Support options, Pricing options for various storage and compute options and tiers.

Reference Books

- 1 AWS Certified Cloud Practitioner All-in-One Exam Guide, Daniel Carter, 2023, SYBEX.
- 2 AWS Certified Cloud Practitioner Exam Guide: Build your cloud computing knowledge and build your skills as an AWS Certified Cloud Practitioner, Rajesh Daswani, 2023, Packt.
- 3 AWS: The Beginners Guide to Amazon Web Services, Dennis Hutten, 2017, Hutten publisher.
- 4 AWS Serverless computing, Scott Patterson, 2015, Scott Patterson.
- 5 Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud, Mark Wilkins, 2019, Addison-Wesley Professional.

23CC3011 - AWS CERTIFIED DEVELOPER - ASSOCIATE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3011	AWS CERTIFIED DEVELOPER - ASSOCIATE	AWS-CDA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding AWS global infrastructure, including its regions, availability zones, and edge locations, and identifying how edge locations bring AWS services closer to end-users for ultra-low latency, is crucial for optimizing the performance and reliability of cloud-based applications.	2	PO1, PO2, PO3, PO4
CO2	Applying knowledge of AWS services such as EC2 instances, S3 buckets, and RDS databases through the use of AWS SDKs and APIs for programmatically interacting with AWS services enhances proficiency in cloud infrastructure management and automation.	3	PO1, PO2, PO3, PO4, PSO1

Syllabus

Explain the AWS global infrastructure: Describe the AWS regions, availability zones, and edge locations. Summarize the key features and benefits of AWS services. Interpret basic AWS billing and pricing models, Recognize AWS terminology and services: Identify and recall AWS services such as EC2, S3, Lambda, etc. Recall basic concepts of cloud computing and AWS architecture..

Implement AWS services: Use AWS SDKs, APIs, and the AWS Management Console to deploy and manage applications. Configure and deploy applications on AWS: Set up EC2 instances, S3 buckets, and RDS databases. Apply security best practices: Implement IAM roles and policies, secure AWS environments, and manage access control., Distinguish between different AWS storage options: Evaluate when to use S3, EBS, or Glacier. Analyze and optimize performance: Use CloudWatch and other tools to monitor and improve application performance on AWS. Diagnose and troubleshoot issues: Identify and resolve problems in AWS-deployed applications.

Reference Books

- 1 AWS Certified Developer - Associate (DVA-C02) Exam Guide, AWS, 2023, AWS.
- 2 "AWS Certified Developer Associate All-in-One Exam Guide (Exam DVA-C01)", Alasdair Gilchrist, 2019, McGraw-Hill Education.
- 3 Aws Certified Developer Official Study Guide, Associate Exam: Associate Exam: Associate (DVA-C01) Exam (Sybex Study Guide), Nick Alteen (Author), Jennifer Fisher (Author), Casey Gerena (Author),, 2019, Sybex.
- 4 "AWS Certified Developer - Associate (DVA-C01) Cert Guide", Marko Sluga, 2020, Pearson IT Certification.

23CC3012 - AWS CERTIFIED DEVOPS ENGINEER - PROFESSIONAL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3012	AWS CERTIFIED DEVOPS ENGINEER - PROFESSIONAL	AWS-CDEP	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Networks, Cloud and DevOps Identify the Need of DevOps in SDLC and Cloud Infrastructure in DevOps, Apply Version Control System to track the latest version of Software	3	PO4, PO5, PSO2
CO2	Analyze monitor and log AWS resources and applications using AWS CloudWatch, CloudWatch Logs, CloudWatch Events, AWS X-Ray, and AWS CloudTrail.	4	PO4, PO5, PSO2

Syllabus

SDLC Automation Configuration Management and Infrastructure as Code Monitoring and Logging Policies and Standards Automation Incident and Event Response High Availability, Fault Tolerance, and Disaster Recovery

AWS SDKs and Tools - Developer Tools: AWS CodeArtifact Lab - Configuration Management and IaC: CloudFormation Lab - Management and Governance: AWS Auto Scaling, AWS Control Tower, AWS LicenseManager, AWS OpsWorks, AWS Organizations, AWS Personal Health Dashboard, AWS Service Catalog, Cloud Formation (nested stack) - Management and Governance: AWS Config Lab - Configuration Management and IaC: AWS Trusted Advisor Lab - Security, Identity, and Compliance: AWS CertificateManager (ACM), AWS CloudHSM, AWS Cognito, Amazon Detective, Amazon GuardDuty, AWS Identity and Access Management (IAM)

Reference Books

- 1 AWS Certified DevOps Engineer - Professional: Cert Guide, Charles Johnston, 2021, Pearson IT Certification.
- 2 AWS Certified DevOps Engineer - Professional Certification Guide, Aurobindo Sarkar, Amit Shah, 2019, Packt Publishing.
- 3 AWS Certified DevOps Engineer - Professional Certification and Beyond: Study Guide with Practice Questions and Labs, Jesse J. Hurrell, 2022, Independently Published.
- 4 Mastering AWS DevOps: Learn to build and deploy robust applications on AWS, Uchit Vyas, Surajit Basak, 2018, Packt Publishing.

23CC3013 - AWS CERTIFIED MACHINE LEARNING - SPECIALTY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3013	AWS CERTIFIED MACHINE LEARNING - SPECIALTY	AWS-CML	R	0	0	0	8	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply data engineering principles and conduct exploratory data analysis using AWS services for effective machine learning model development.	3	PO1, PO5, PO7, PSO2
CO2	Analyze end-to-end ML solutions on AWS in production environments using SageMaker.	4	PO4, PO5, PO6, PSO1

Syllabus

Data Engineering - Create data repositories for ML, Identify and implement a data ingestion solution, Identify and implement a data transformation solution. Exploratory Data Analysis- prepare data for modeling, Perform feature engineering, Analyze and visualize data for ML

Modeling - Select the appropriate model(s) for a given ML problem and evaluate the models. Machine Learning Implementation and Operations - Build ML solutions for performance, availability, scalability, resiliency, and fault tolerance, implement the appropriate ML services and features for a given problem, Apply basic AWS security practices to ML solutions, Deploy and operationalize ML solutions

Reference Books

- 1 Practical Machine Learning with AWS: Process, Build, Deploy, and Productionize Your Models Using AWS, Vishal Chugh and Rich Foreman, 2020, Packt Publishing.
- 2 Hands-On Machine Learning on AWS: Implementing Machine Learning Models Using Amazon SageMaker and Other AWS Services, Chirag Thumar, Amir Ziai, 2020, Apress.
- 3 AWS Certified Machine Learning Study Guide: Specialty , Shreyas Subramanian, Stefan Natsu, 2021, Sybex.
- 4 Mastering Machine Learning on AWS, Saket S.R. Mengle, 2019, Packt Publishing.

23CC3014 - AWS CERTIFIED SOLUTIONS ARCHITECT - ASSOCIATE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3014	AWS CERTIFIED SOLUTIONS ARCHITECT - ASSOCIATE	AWS-CSA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify appropriate methods to secure, build, deploy, and monitor scalable cloud applications on the AWS platform.	3	PO2, PO3, PO5, PSO1
CO2	Make use of AWS Services to deploy and manage storage, compute, database, networking, and analytics.	3	PO2, PO3, PO5, PSO1

Syllabus

VPC, AWS Shield, AWS WAF, IAM Identity Center, AWS Secrets Manager ,Amazon API Gateway, REST API ,Amazon API Gateway, REST API, content delivery network, Application Load Balancer, Amazon Elastic Container Service,Elastic Kubernetes Service, Step Functions, Route 53,AWS X-Ray

Amazon S3, Amazon Elastic File System [Amazon EFS], Amazon Elastic Block Store [Amazon EBS],AWS Batch, Amazon EMR, Fargate, Amazon Elasti Cache,capacity units, instance types, Provisioned IOPS,MySQL compared with PostgreSQL,Amazon Aurora, Amazon DynamoDB,Amazon CloudFront, AWS Global Accelerator,AWS VPN, Direct Connect, AWS PrivateLink,Amazon Athena, AWS Lake Formation, Amazon QuickSight,AWS Glue,Amazon Kinesis

Reference Books

- 1 AWS Certified Solutions Architect Official Study Guide: Associate Exam, Joe Baron, Hisham Baz, Tim Bixler, Biff Gaut, Kevin E. Kelly, 2016, Sybex.
- 2 AWS Certified Solutions Architect Associate All-in-One Exam Guide (Exam SAA-C02), Joyjeet Banerjee, 2021 , McGraw-Hill Education.
- 3 AWS Certified Solutions Architect Associate Training Notes 2021: Fast-track your exam success with the ultimate cheat sheet for the SAA-C02 exam, Neal Davis, 2024, Independently published.
- 4 AWS Certified Solutions Architect - Associate Exam Practice Questions: 1000+ Questions with Detailed Explanations, Ryan Kroonenburg, Ashley Kroonenburg, 2024, Independently published.
- 5 AWS Certified Solutions Architect Associate Practice Tests: SAA-C02 Exam, Brett McLaughlin, 2022, Sybex.

23CC3015 - AWS CERTIFIED SYSOPS ADMINISTRATOR - ASSOCIATE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3015	AWS CERTIFIED SYSOPS ADMINISTRATOR - ASSOCIATE	AWS-CSYA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyse the core AWS services and their roles within the SysOps Administrator.	4	PO1, PO2, PO5, PSO2
CO2	Evaluate the proficiency in managing compute services such as EC2 instances, Auto Scaling, and Load Balancers.	5	PO1, PO2, PO5, PSO2

Syllabus

Overview of AWS services and their roles in cloud infrastructure-Understanding the SysOps Administrator's responsibilities in managing AWS resources-Introduction to AWS Management Console and CLI

Deploying and managing EC2 instances-Auto Scaling configurations for maintaining application availability and scalability-Load Balancing strategies and implementation using Elastic Load Balancer (ELB)

Reference Books

- 1 Hands-On Serverless Computing, Kuldeep Chowhan, 2018, Packt Publishing Ltd, .
- 2 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2013, Pearson.
- 3 AWS Certified SysOps Administrator - Associate Guide , Vipul Tankaria,Marko Sluga, 2019, Packt Publishing .
- 4 AWS Cookbook: Recipes for Success on AWS (Grayscale Indian Edition) , John Culkin, Mike Zazon, 2021, Shroff/O'Reilly.

23CC3017 - CERTIFIED ETHICAL HACKER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3017	CERTIFIED ETHICAL HACKER	CEH	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify the vulnerability in devices and network.	2	PO1, PO2, PO4, PO5
CO2	Analysis the attack and test in the network	3	PO1, PO2, PO4, PO5, PSO2

Syllabus

Introduction to Ethical Hacking, Foot Printing and Reconnaissance, Scanning Networks, Enumeration, Vulnerability Analysis, System Hacking, Malware Threats, Sniffing, Social Engineering, Denial-of-Service.

Session Hijacking, Evading IDS, Firewalls, and Honeypots, Hacking Web Servers, Hacking Web Applications, SQL Injection, Hacking Wireless Networks, Hacking Mobile Platforms, IoT and OT Hacking, Cloud Computing, Cryptography.

Reference Books

- 1 EC Council CEH v12, EC Council, 12, EC Council.
- 2 Hacking: A Beginners Guide to Computer Hacking, Basic Security, And Penetration Testing, John Slavio, 1, Amazon.
- 3 Hacking: The Art Of Exploitation, Jon Erickson , 1, No starch press.
- 4 Metasploit: The Penetration Testers Guide, David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni, 1, No starch press.

23CC3018 - CERTIFIED HYPERLEDGER FABRIC DEVELOPER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3018	CERTIFIED HYPERLEDGER FABRIC DEVELOPER	CHFD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop and deploy smart contracts using Hyperledger Fabric to automate business processes and enforce contractual agreements within a blockchain network. Additionally, design and implement Hyperledger Fabric network architectures, including the configuration of peers, orderers, channels, and chaincodes, to support decentralized applications.	4	PO1, PO2, PO3, PSO1
CO2	Integrate Hyperledger Fabric with existing systems and utilize Fabric SDKs to create and manage blockchain transactions, ensuring seamless interaction between blockchain components and traditional databases. Furthermore, analyze and troubleshoot Hyperledger Fabric network performance and security issues, employing best practices for maintaining network integrity and optimizing transaction throughput.	4	PO1, PO2, PO3, PSO1

Syllabus

Foundations of Blockchain and Hyperledger Fabric 1. Introduction to Blockchain Technology Basics of Blockchain Distributed Ledger Technology Types of Blockchains: Public vs. Private Blockchain Use Cases and Applications 2. Overview of Hyperledger Frameworks Introduction to Hyperledger Project Hyperledger Frameworks and Tools Comparing Hyperledger Fabric with Other Frameworks 3. Understanding Hyperledger Fabric Architecture Hyperledger Fabric Components Membership Services Provider (MSP) Ordering Service Peer Nodes and Channels Ledger and World State 4. Setting Up Hyperledger Fabric Development Environment Prerequisites for Hyperledger Fabric Development Installing Docker and Docker Compose Downloading and Configuring Hyperledger Fabric Samples Running First Network Smart Contracts and Network Configuration Smart Contract Development with Hyperledger Fabric Chaincode Programming Model Developing Chaincode in Go/Node.js/Java Chaincode Lifecycle: Install, Instantiate, Upgrade Handling State and Transactions in Chaincode Deploying and Invoking Smart Contracts Installing and Approving Chaincodes Committing Chaincode Definitions Invoking Chaincode Functions Querying the Ledger with Chaincode Hyperledger Fabric Network Configuration Creating and Configuring Channels Setting Channel Policies Defining and Managing Endorsement Policies Identity Management and MSP Configuration Interacting with Hyperledger Fabric Network Hyperledger Fabric SDKs (Node.js, Java, Go) Building Client Applications Transaction Flow: Propose, Endorse, Commit Event Handling and Notifications

Integration, Security, and Performance Integration and External Services Integrating Hyperledger Fabric with External Systems Utilizing REST APIs and gRPC External Data Sources and Oracles Handling Data Privacy and Confidentiality Hyperledger Fabric Security Best Practices Security Model in Hyperledger Fabric Access Control Mechanisms Secure Communication (TLS) and Data Encryption Best Practices for Secure Chaincode Development Hyperledger Fabric Performance Optimization Performance Metrics and Benchmarking Optimizing Transaction Throughput and Latency Tuning Hyperledger Fabric Parameters Strategies for Network Scalability Hyperledger Fabric Troubleshooting and Maintenance Common Issues and Debugging Techniques Monitoring and Logging Maintaining and Updating Hyperledger Fabric Networks Backup and Disaster Recovery Strategies Advanced Topics and Real-World Applications Real-world Hyperledger Fabric Applications and Use Cases Case Studies of Hyperledger Fabric Implementations Industry-specific Applications (Finance, Supply Chain, Healthcare) Lessons Learned and Best Practices Advanced Hyperledger Fabric Features Private Data Collections Fabric Interoperability and Consortium Management Tokenization and Digital Assets on Fabric Emerging Trends and Future Directions Hyperledger Fabric Roadmap Integration with Emerging Technologies (IoT, AI, Big Data) Exploring Hyperledger Fabric 2.x and Beyond Capstone Project and Certification Preparation Capstone Project: Design and Implement a Hyperledger Fabric-based Application Project Presentations and Peer Reviews Preparation for Certification Exam Final Assessment and Certification Examination

Reference Books

- 1 Hyperledger Fabric In-Depth: Learn, Build, and Deploy Blockchain Applications Using Hyperledger Fabric, Ashwani Kumar, Suryakant Choudhary, 1st Edition 2020, BPB Publications.
- 2 Hands-On Blockchain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer, Salman A. Baset, Nitin Gaur, Luc Desrosiers, Petr Novotny, Venkatraman Ramakrishna, 1st Edition 2018, Packt Publishing.
- 3 Hyperledger Cookbook: Over 40 Recipes Implementing Blockchain in Business, Xun (Brian) Wu, Roberto Ochoa, Allan Peguero, Nikolaos G. Gkoutzos, 1st Edition 2019, Packt Publishing.
- 4 Blockchain and Hyperledger Fabric: Designing and Building Enterprise Distributed Ledger Applications, Chetan Sabnis, 2nd Edition 2020, Addison-Wesley Professional.
- 5 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Imran Bashir, 3rd Edition 2022, Packt Publishing.

23CC3019 - CERTIFIED KUBERNETES APPLICATION DEVELOPER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3019	CERTIFIED KUBERNETES APPLICATION DEVELOPER	CKAD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze applications using Kubernetes environments that includes containerization principles and deployment strategies, to ensure robust and scalable solutions.	4	PO3, PO4, PO5, PSO1, PSO2
CO2	Examine Kubernetes core primitives to create, migrate, configure, expose, and observe scalable applications, integrating considerations of application environment, configuration, and security to ensure robust deployment practices.	4	PO3, PO4, PO5, PSO1, PSO2

Syllabus

Introduction to Kubernetes, Containerization Principles, Kubernetes Deployment Strategies, Application Design Considerations, Configuring Kubernetes Services to expose applications, Managing application configuration with ConfigMaps and Secrets, Implementing Service Discovery and Load Balancing, Kubernetes security concepts and best practices. Role-based access control (RBAC) and network policies.

Overview of Kubernetes core primitives: Pods, Deployments, Services, ConfigMaps, and Secrets. Understanding their roles in application deployment and management, Creating Pods and understanding their lifecycle. Configuring Pod specifications and resource requirements, Implementing Deployments for managing application replicas and updates. Using Replica Sets for scalable application deployments, Defining and managing application environments using environment variables and ConfigMaps. Using ConfigMaps to decouple configuration from container images, Kubernetes security principles and best practices. Role-based access control (RBAC) and Pod Security Policies (PSPs).

Reference Books

- 1 Certified Kubernetes Application Developer (CKAD) Study Guide., Benjamin Muschko, 2023, O'REILLY.
- 2 Certified Kubernetes Application Developer (CKAD) Exam Success Guide, Sethumadhavan Kishore, 2023, BPB Publication.
- 3 Kubernetes Preparing for the CKA and CKAD Certifications, Philippe Martin, 2023, APress.
- 4 Kubernetes in Production Best Practices, Aly Saleh, 2023, Apress.

23CC3020 - CISCO CERTIFIED NETWORK ADMINITRATOR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3020	CISCO CERTIFIED NETWORK ADMINITRATOR	CISCO-CNA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of networking by configuring and troubleshooting network systems using the OSI and TCP/IP models, and implementing Network Address Translation (NAT).	3	PO5, PSO2
CO2	Analyze and troubleshoot basic routing, switching, DHCP (Dynamic Host Configuration Protocol), and DNS (Domain Name System) configurations, Analyze the use of network monitoring tools to identify and resolve potential network issues proactively.	4	PO1, PSO2

Syllabus

Networking Fundamentals and Routing Technologies, covers the essential concepts of networking, including the OSI model, TCP/IP protocol suite, IP addressing, and subnetting. This module also delves into the configuration and management of network devices such as routers and switches, with a focus on understanding their roles in a network infrastructure. Key topics include configuring initial device settings, managing switch operations, VLAN configuration, inter-VLAN routing, and static and dynamic routing protocols such as RIP, OSPF, and EIGRP. Additionally, it introduces basic network security concepts, including access control lists (ACLs) and basic firewall configurations.

Advanced Networking Services and Security, builds on the foundational knowledge and explores more advanced topics related to network services and security. This includes the configuration and troubleshooting of DHCP and DNS services, Network Address Translation (NAT), and Quality of Service (QoS) to optimize network performance. Students also learn about network automation using tools like Python scripts and Cisco DNA Center. Advanced security topics cover VPN configurations, Secure Shell (SSH), and Secure Sockets Layer (SSL) to ensure secure communications. The module further explores monitoring and management techniques using SNMP, syslog, and network management systems, along with the implementation of redundancy protocols such as HSRP and VRRP for high availability. Finally, the syllabus addresses IPv6 concepts and configurations to prepare students for modern network environments.

Reference Books

- 1 CCNA 200-301 Official Cert Guide, Volume 1, Odom, First Edition 2019, Pearson Education India.
- 2 CCNA 200-301 Official Cert Guide, Volume 2, Odom, First Edition 2020, Pearson Education India.
- 3 CCNA 200-301 Portable Command Guide, Scott Empson, 5th Edition 2019, Cisco Press.
- 4 CCNA 200-301 Exam Cram, Anthony Sequeira, 1st Edition 2020, Pearson IT Certification.
- 5 31 Days Before Your CCNA Exam: A Day-By-Day Review Guide for the CCNA 200-301 Certification Exam, Allan Johnson, 1st Edition 2020, Cisco Press.

23CC3026 - EMBEDDED SYSTEM APPLICATION & IOT PROGRAMMING (TESSOLVE-L1) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3026	EMBEDDED SYSTEM APPLICATION & IOT PROGRAMMING (TESSOLVE-L1)	ESAIP	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basics and interfacing of STM32	2	PO1, PO2, PO5, PSO1
CO2	Analyse the STM32 Sensor Interfacing using hardware	4	PO1, PO2, PO5, PSO2
CO3	Analyse the STM32 Peripherals Interfacing using hardware	4	PO2, PO5, PO9, PSO2
CO4	Analyse the serial communication protocols and IoT protocols to establish connection with the cloud	4	PO2, PO5, PO9, PSO2
CO5	Analyse the experiments on various boards	4	PO1, PO2, PO5

Syllabus

Introduction to Embedded Application and ARM Architecture, STM32 Programming and GPIO, Digital Output Configuration of Digital Output, Concept of Delay, Introduction to LED, different connection methods of LED, STM32 Analog Output Introduction to analog signal, DAC basics, PWM signal duty cycle calculation, analog output initialization STM32 Analog Input ADC basics, analog input initialization, Using Internal and External Vref for Analog Input

STM32 Sensor Interfacing Introduction to Sensors, Analog sensor interfacing Temperature Sensor, Digital Sensor Interfacing PIR Sensor, and Ultrasonic Sensor interfacing.

STM32 Peripherals Interfacing Interfacing of Keyboard and Interfacing of Seven Segment Displays SSD, LCD

Serial Communication: Introduction to Serial and Parallel. Introduction to various Communication Protocols UART, SPI, I2C, Timers, Interrupts, Multitasking and RTOS, IOT Introduction to HTTP, HTTP Request and HTTP Response, Connection to Cloud using HTTP, Introduction to MQTT, MQTT Publish and subscribe, Connection to Cloud using MQTT

Reference Books

- 1 Discovering the STM32 Microcontroller, Geoffrey Brown, 2016, Indiana University.
- 2 Getting Started With STM32 Nucleo Development, Agus Kurniawan, 2016, Agus Kurni.
- 3 Internet of things (A-Hand-on-Approach), Madisetti and Arshdeep Bahga, 2015, Universal Press.
- 4 The Internet of Things Connecting Objects, Hakima Chaouchi, 2010, Wiley.

23CC3027 - EPAM COE CERTIFICATION ON FRONTEND TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3027	EPAM COE CERTIFICATION ON FRONTEND TECHNOLOGIES	EPAM-FT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	practice various technologies like html, css, javascript, typescript using React/Angular frameworks	3	PO1, PO3, PO5, PSO1
CO2	Apply concepts of ngx, npm, typescript to build dynamic web application, Angular framework to build dynamic web application	3	PO1, PO3, PO5, PSO1

Syllabus

NodeJS: NodeJS fundamentals, Call-back, Events and event loop, event emitter, node modules and package. json, Nodejs Module system and patterns, CommonJS, ES6. React: ReactJS Fundamentals, Introducing JSX, Overview, Rendering Elements, Components and Props, State and Lifecycle Overview of React, elements and components, JSX Composition over inheritance, how browsers handle render, reflow/repaint VDOM concept + Fiber.js in v16 Dev infrastructure: webpack, babel, source-maps, react-hot-loader, react-dev-tools, (react-create app).

Introduction to Web Development, Introduction to Typescript , Typescript Basics: Directives Basics, Attribute Directives, Host Listener, Host Binding, Built in Directives, Structural Directives, Create Structural Directive, Angular Component Life Cycle Hooks , Introduction to Angular- Angular Architecture Angular Version History Angular CLI Basics, Setup Angular Project Angular Project Structure Components Modules Angular App Bootstrapping, Angular Decorators.

Reference Books

- 1 Murach's HTML5 and CSS3, Zak Ruvalcaba, Anne Boehm, 2001, Mike Murach & Associates.
- 2 JavaScript: The Definitive Guide: Master the World's Most-Used Programming Language, David Flanagan, 2004, O'Reilly Media.
- 3 Angular for Enterprise-Ready Web Applications, Doguhan Uluca, 2007, Packt Publishing.
- 4 Programming world wide web, R.W. Sebesta, 2002, Pearson.

23CC3028 - EPAM COE CERTIFICATION ON .NET (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3028	EPAM COE CERTIFICATION ON .NET	EPAM-NET	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Fundamental concepts of .NET Framework and C#.NET by proficiently constructing software programs.	3	PO2, PO3, PO4
CO2	Build the console and desktop applications utilizing the C#.NET Framework.	3	PO2, PO3, PO4
CO3	Develop C#.NET desktop applications by integrating ADO.NET for database connectivity and manipulation.	3	PO2, PO3, PO4
CO4	Develop the ASP.NET Standard Server controls to develop robust applications, showcasing their mastery of web development concepts.	3	PO2, PO3, PO4
CO6	Develop programs for desktop, web, and enterprise applications by employing advanced .NET programming techniques, demonstrating their mastery of software development across various platforms.	3	, PSO1, PSO2

Syllabus

C# Essentials:.NET Ecosystem (.NET Framework and .NET Core),C# operator basics,OOP principles,Class & Object, Constructors. Methods. Access modifiers,Inheritance. Polymorphism,Upcasting and downcasting.new and override methods. Sealed methods and classes,Class relationships overview,Memory management.

Exception handling system,Collection types IEnumerable and IEnumerator Generics Inheritance in generics Variance in generics Generic collections,Creation and using delegates Anonymous methods and lambdas Event handling

LINQ overview Extension methods and query syntax Dynamic LINQ,Unit Testing,Multithreading,Data processing,T-SQL,ADO.NET

Design patterns and architecture patterns,MVC (MVP, MVVM),Multilayered and onion architectures,Data processing technologies:ADO.NET EF,EDM Entities and DbContext Entity relations Database First, Code First, Model First Configuration, Initializers,Querying data,Data Loading: lazy vs eager LINQ to Entities,Data Annotations,Fluent Configuration,Migrations,Repository and UoW patterns,Front end Overview:Web Fundamentals.

Reference Books

- 1 ".NET Core in Action", Dustin Metzgar, 1st(2018), Manning Publications.
- 2 "Pro C# 9 with .NET 5", Andrew Troelsen and Philip Japikse, 10th Edition(2010), A Press.
- 3 "Entity Framework Core in Action", Jon P Smith, 1st(2018), Manning Publications.
- 4 "Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics", Jennifer Robbins, 5th Edition(2018), O'Reilly Media.

23CC3030 - EPAM COE CERTIFICATION ON JAVA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3030	EPAM COE CERTIFICATION ON JAVA	EPAM-J	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop a backend application using Version Control System and Maven, leveraging Java's object-oriented features (inheritance, polymorphism, encapsulation, abstraction) and modern libraries (Collections Framework, Lambdas, Streams, Optionals, DateTime) for efficiency and maintainability, ensuring clear separation of concerns, robust logging, concurrent operations with threads and thread pools, and data exchange with JSON.	3	PO2, PO3, PO5, PSO1
CO2	Develop efficient and maintainable backend Java applications using the traditional object-relational mapping with Hibernate, Spring Framework, and implement RESTful APIs to enable standardized data exchange and robust communication across diverse, distributed systems.	3	PO2, PO3, PO5, PSO1

Syllabus

The Need of Version Control Systems, Type of Repositories: Centralized Vs Distributed, Branches, Check in, Checkout. Conflict, Merge, Tags, Reverting changes, Basics of Branching strategy. Features Of Maven, Objectives of Maven, Maven life cycle and Providing guidelines for best practices development. Working with Java Persistence API to connect to databases using Hibernate, Multithreading, Concurrency, Executors framework and ForkJoin pool, JavaScript Object Notation. JDK, JRE, JVM, Memory (Heap, Stack) Object, Class, Inheritance, Polymorphic, Abstraction, Encapsulation, Difference between Abstract and Interface Constructor rules in inheritance, Access modifiers in the inheritance chain. The problem with Arrays Why should you need collection, Collection Framework overview, Sorting, Searching, Iterating, Differences in various interfaces and implementations Hashcode/Comparator/Comparable. Collection with Iteration order: Lists, Collection with Uniqueness: Sets, Collection with Modification order: Stacks, Queues, Deques, Collection with Pairs: Maps, Understanding annotation and creating custom annotation Usage of Generics. Java8 -Lambdas & Functional Interfaces, Streams, Optionals and DateTime. Understanding of Logging and working with Log4J. Understanding of XML elements and Schema.

Working with Java Persistence API to connect to databases using Hibernate, Multithreading, Concurrency, Executors framework and ForkJoin pool, JavaScript Object Notation. Introduction to Spring Core, Spring Boot, Spring MVC, Spring Data JPA, REST Architecture & Richardson Maturity Model and Spring REST

Reference Books

- 1 JAVA THE COMPLETE REFERENCE, Herbert Schildt, 19 March 2019, McGrawHill.
- 2 Java Persistence with Hibernate, Mr Christian Bauer, Gavin King, 8 November 2015, Manning Publications.
- 3 <https://docs.spring.io/spring-framework/reference/index.html>, Community, 2003, NA.
- 4 Hibernate in Action, Christian Bauer and Gavin King, 2 September 2004, Manning Publications.
- 5 Spring Quick Reference Guide, Adam L. Davis, 16 September 2020, Apress.

23CC3033 - GOOGLE : ASSOCIATE CLOUD ENGINEER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3033	GOOGLE : ASSOCIATE CLOUD ENGINEER	GACE	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply knowledge to deploy, monitor, and maintain cloud-based solutions.	3	PO1, PO2, PO5, PSO1
CO2	Analyze and troubleshoot issues in cloud infrastructure and services.	4	PO1, PO2, PO5, PSO1

Syllabus

Setting up a cloud solution environment: Setting up cloud projects and accounts, Managing billing configuration, Installing and configuring the command line interface (CLI), specifically the Cloud SDK (e.g., setting the default project). Planning and configuring a cloud solution: Planning and estimating GCP product use using the Pricing Calculator ,Planning and configuring compute resources, Planning and configuring data storage options, Planning and configuring network resources. Planning and configuring a cloud solution: Planning and estimating GCP product use using the Pricing Calculator ,Planning and configuring compute resources, Planning and configuring data storage options, Planning and configuring network resources.

Deploying and implementing a cloud solution: Deploying and implementing Compute Engine resources, Deploying and implementing Google Kubernetes Engine resources, Deploying and implementing App Engine, Cloud Run, and Cloud Functions resources, Deploying and implementing data solutions, Deploying and implementing networking resources, Deploying a solution using Cloud Marketplace, Deploying application infrastructure using Cloud Deployment Manager. Ensuring successful operation of a cloud solution: Managing Compute Engine resources, Managing Google Kubernetes Engine resources, Managing App Engine and Cloud Run resources, Managing storage and database solutions, Managing networking resources, Monitoring and logging.

Reference Books

- 1 Google Cloud Certified Associate Cloud Engineer Study Guide, Dan Sullivan, 2019, Sybex.
- 3 Google Cloud Certified Associate Cloud Engineer All-in-One Exam Guide, Jack Hyman, 2021, McGraw-Hill Education.
- 4 Mastering Google Cloud Platform, Cybellium Ltd., 2020, Independently Published.
- 5 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Zaigham Mahmood, Ricardo Puttini, 2013, Prentice Hall.
- 6 Google Cloud Platform in Action, JJ Geewax, 2018, Manning Publications.
- 7 Official Google Cloud Certified Associate Cloud Engineer Study Guide, Google Cloud, 2019, Wiley.

23CC3034 - GOOGLE PROFESSIONAL CLOUD ARCHITECT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3034	GOOGLE PROFESSIONAL CLOUD ARCHITECT	GPCA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the cloud solution infrastructure using best practices.	3	PO1, PO2, PO5, PSO1
CO2	Analyze the optimized cloud infrastructure for performance, scalability, and cost-efficiency.	4	PO1, PO2, PO5, PSO1

Syllabus

Setting up a cloud solution environment: Setting up cloud projects and accounts, Managing billing configuration, Installing and configuring the command line interface (CLI), specifically the Cloud SDK (e.g., setting the default project).

Deploying and implementing a cloud solution: Deploying and implementing Compute Engine resources, Deploying and implementing Google Kubernetes Engine resources, Deploying and implementing App Engine, Cloud Run, and Cloud Functions resources, Deploying and implementing data solutions, Deploying and implementing networking resources, Deploying a solution using Cloud Marketplace, Deploying application infrastructure using Cloud Deployment Manager.

Reference Books

- 1 Google Cloud Certified Professional Cloud Architect Study Guide, Dan Sullivan, 2019, Wiley.
- 2 Mastering Google Cloud Platform, Cybellium Ltd., 2020, Independently Published.
- 3 Hands-On Google Cloud Platform for Architects, Ted Hunter, Steven Porter, 2020, Packt Publishing.
- 4 Google Cloud Platform in Action, JJ Geewax, 2018, Manning Publications.
- 5 Google Cloud Platform for Architects, Vitthal Srinivasan, Sharath G., Ankush Chauhan, 2018, Packt Publishing.
- 6 Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis, 2014, Wiley.

23CC3035 - GOOGLE TENSORFLOW DEVELOPER CERTIFICATE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3035	GOOGLE TENSORFLOW DEVELOPER CERTIFICATE	GTFDC	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze machine learning algorithms for real-world tasks, selecting appropriate neural network architectures based on problem characteristics and data availability.	4	PO3, PO5, PSO2
CO2	Evaluate the effectiveness of transfer learning techniques, scaling strategies, NLP fundamentals, and TensorFlow's utility in time series analysis.	5	PO3, PO5, PSO2

Syllabus

Fundamentals of Machine Learning with TensorFlow: Introduction to TensorFlow basics, Building and training neural network models using TensorFlow, regression and classification, Computer vision with Convolutional Neural Networks (CNNs)

Transfer learning: Feature extraction and fine-tuning, Scaling up models and performance evaluation, NLP fundamentals: Preprocessing, embeddings, and model building, Time Series analysis using TensorFlow

Reference Books

- 1 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, 2016, MIT press.
- 2 Deep Learning with Python , Francois Chollet, 2017, Manning publications, 2018.
- 3 Grokking Deep Learning, Andrew Trask, 2019, Manning publications, 2019.
- 4 Python Machine Learning: Machine Learning and Deep Learning with Python, Sebastian Raschka, 2019, Packt Publishing Limited.

23CC3038 - HANDS-ON: 5G END-TO-END (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3038	HANDS-ON: 5G END-TO-END	5GEEC	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Compare and contrast the evolution of mobile technologies, analyzing how 5Gs core functionalities, network architecture, and key features like massive MIMO and beamforming address emerging use cases and Quality-of-Service demands.	4	PO1, PO5, PSO2
CO2	Analyze and evaluate 5G access procedures, security features, lawful interception architectures, and application of AI/ML, by comparing and contrasting protocols and call flows for both Standalone (SA) and Non-Standalone (NSA) deployment modes.	4	PO1, PO5, PSO2

Syllabus

Evolution of Mobile Technologies, Introduction to 5G, Key Technologies, Use Cases, 5G Core, 5G RAN, 5G Identities, 5G QoS, Massive MIMO, Beam Forming.

Initial Access and Related Procedures, 5G Protocols, 5G SA / NSA Call Flows, 5G Security Features, 5G Architecture for Lawful Interception, 5G Application Demonstrations, AI/ML in 5G

Reference Books

- 1 5G NR: The Next Generation Wireless Access Technology. , Dahlman, E., Parkvall, S., Skold, J. , 2018, Elsevier Science .
- 2 5G Core Networks: Powering Digitalization. , Rommer, S., Hedman, P., Olsson, M., Frid, L., Sultana, S., Mulligan, C. , 2019, Elsevier Science .
- 3 5G/5G-Advanced The New Generation Wireless Access Technology , Erik Dahlman, Stefan Parkvall, Johan Skold , 2023, Elsevier Science .
- 4 Fundamentals of 5G Mobile Networks , Jonathan Rodriguez , 2015, Wiley.
- 5 Multiple Access Techniques for 5G Wireless Networks and Beyond , Mojtaba Vaezi, Zhiguo Ding, Vincent Poor , 2018, Springer International Publishing .

23CC3039 - IIOT PROGRAMMING & AUTOMATION (TESSOLVE-L2) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3039	IIOT PROGRAMMING & AUTOMATION (TESSOLVE-L2)	IIPA-L2	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Internet of Things (IoT), covering its definition, history, common applications, and key technologies like sensors, connectivity, and AI, with a special focus on its relevance in education.	3	PO2, PO5, PO7, PSO1
CO2	Apply Gain insights into the architecture and key components of IoT systems, including edge devices, gateways, cloud services, communication protocols, and popular IoT platforms and devices.	3	PO2, PO5, PO7, PSO1

Syllabus

Introduction to IoT - 1.1 What is IoT? - Definition and overview of IoT. - History and evolution of IoT. - 1.2 IoT Applications - Common use cases in different industries. - Real-world examples of IoT in education. - 1.3 Key Technologies and Trends - Sensors, actuators, and connectivity. - Big data, machine learning, and AI in IoT.

IoT Architecture and Components - 2.1 IoT Architecture - Basic architecture of IoT systems. - Overview of edge devices, gateways, and cloud. - 2.2 IoT Communication Protocols - Overview of common protocols (e.g., MQTT, CoAP, HTTP). - Understanding wireless connectivity (e.g., Wi-Fi, Bluetooth, LoRa, NB-IoT). - 2.3 IoT Devices and Platforms - Popular IoT devices (e.g., Raspberry Pi, Arduino). - Overview of IoT platforms (e.g., AWS IoT, Google Cloud IoT, Azure IoT).

Reference Books

- 1 Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry, Maciej Kranz, 2007-1st edition, online.
- 2 Industrial Automation and Robotics: An Introduction, Jay F. Hooper, 2017-2nd edition, online.
- 3 Industrial Internet of Things: Technologies and Applications for Smart Production Systems, Sabina Jeschke, Christian Brecher, Houbing Song, and Danda B. Rawat, 2003-1st edition, online.
- 4 Python for Data Science and AI, Joe Egan, 2020-1st edition, online.

23CC3040 - JUNIPER NETWORKS CERTIFIED ASSOCIATE, JUNOS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3040	JUNIPER NETWORKS CERTIFIED ASSOCIATE, JUNOS	JNCA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply basic networking concepts, protocols, and device functionalities to troubleshoot common network issues.	3	PO1, PO2, PSO2
CO2	Utilize Junos OS fundamentals and user interface functionalities to configure, manage, and troubleshoot Juniper Networks devices.	3	PO1, PO2, PSO2
CO3	Configure and manage Junos OS and conduct operational monitoring and maintenance tasks for Juniper Networks devices.	4	PO2, PO4, PSO2
CO4	Implement routing policies and firewall filters by controlling routing decisions and packet filtering for network security.	4	PO2, PO5, PSO2

Syllabus

Networking Fundamentals: Collision domains and broadcast domains, Function of routers and switches, Ethernet networks, Layer 2 addressing, including address resolution, Layer 3 / IP addressing, including subnet masks, IPv4 / IPv6, Subnetting and supernetting, Decimal to binary conversion, Longest match routing, CoS, Connection-oriented vs. connectionless protocols.

Junos OS Fundamentals: Software architecture, Control and forwarding planes, Routing engine and packet-forwarding engine, Transit traffic processing, Exception traffic. User Interfaces: CLI functionality, CLI modes, CLI navigation, CLI Help, Filtering output, Active vs. candidate configuration, Reverting to previous configurations, Modifying, managing, and saving configuration files, Viewing, comparing, and loading configuration files, J-Web (core/common functionality only).

Configuration Basics: Factory-default state, Initial configuration, User accounts, Login classes, User authentication methods, Interface types and properties, Configuration groups, Additional initial configuration elements, such as Network Time Protocol (NTP), SNMP, system log, Configuration archival, Logging and tracing, Rescue configuration. Operational Monitoring and Maintenance: Show commands, Monitor commands, Interface statistics and errors, Network tools, such as ping, traceroute, telnet, SSH, etc., Junos OS installation and upgrades, Powering on and shutting down Junos devices, Root password recovery.

Routing Fundamentals: Traffic forwarding concepts, Routing tables, Routing vs. forwarding tables, Route preference, Routing instances, Static routing, Advantages of and use cases for dynamic routing protocols. Routing Policy and Firewall Filters: Default routing policies, Import and export policies, Routing policy flow, Effect of policies on routes and routing tables, Policy structure and terms, Policy match criteria, match types, and actions, Firewall filter concepts, Filter structure and terms, Filter match criteria and actions, Effect of filters on packets, Unicast reverse-path-forwarding (RPF).

Reference Books

- 1 Junos Enterprise Routing: A Practical Guide to Junos Routing and Certification, Peter Southwick, Doug Marschke, Harry Reynolds, 2nd Edition, 2011, O'Reilly Media.
- 2 JNCIA: Juniper Networks Certified Internet Associate Study Guide, Joseph M. Soricelli, John L. Hammond, Galina Diker Pildush, Thomas E. Van Meter, Todd M. Warble., 1st Edition, 2003, Sybex .
- 3 Juniper Networks Certified Associate Junos (JNCIA-Junos): Secrets to Acing the Exam and Successful Finding and Landing Your Next Juniper Networks Certified Associate Junos (JNCIA-Junos) Certified Job, Sarah Harper, 2012, Tebbo.
- 4 Targeting JNCIA: Study Guide for Exam JN0-201, Jeff Ringwelski, 2003, AuthorHouse.

- 5 JUNOS OS For Dummies, Walter J. Goralski, Cathy Gadecki, Michael Bushong, 2nd Edition, 2011, John Wiley & Sons.
- 6 Junos Enterprise Switching: A Practical Guide to Junos Switches and Certification, Harry Reynolds and Doug Marschke, 2009, O'Reilly Media.

23CC3041 - LINUX FOUNDATION CERTIFIED IT ASSOCIATE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3041	LINUX FOUNDATION CERTIFIED IT ASSOCIATE	LFCA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize essential Linux skills to perform tasks such as managing files, configuring system settings, and automating processes with scripts	3	PO1, PO4, PO9
CO2	Build and manage projects using tools and resources from the Open Source and Linux ecosystem.	3	PO2, PSO2

Syllabus

Introduction to Linux Linux file systems and directory structure Basic Linux commands (e.g., ls, cd, cp, mv, rm, mkdir, rmdir) Understanding file permissions (chmod, chown) User and group management, Navigating the Linux CLI efficiently Working with files and directories Input and output redirection Pipes and filters Basic shell scripting, Package management (e.g., apt, yum) Process management (ps, top, kill) System startup and shutdown Basic system monitoring and troubleshooting.

Understanding network fundamentals Configuring network interfaces Troubleshooting network connectivity issues Basic firewall configuration (iptables, firewallld), History and significance of Linux and open source Role of Linux in the IT industry Introduction to open source licensing Overview of virtualization and cloud computing Basics of containerization (e.g., Docker), Introduction to shell scripting Basic database management Introduction to web servers (e.g., Apache, Nginx) Introduction to version control systems (e.g., Git)

Reference Books

- 1 "Linux Pocket Guide: Essential Commands", Daniel J. Barrett, 2004, O'Reilly Media.
- 2 "How Linux Works: What Every Superuser Should Know", Brian Ward, 2004, No Starch Press.
- 3 "Linux Bible", Christopher Negus, 2001, Wiley.
- 4 "LPIC-1/CompTIA Linux+ Certification All-in-One Exam Guide, Second Edition (Exams LPIC-1/LX0-101 & LX0-102)", Robb H. Tracy, 2015, McGraw-Hill Education.
- 5 "The Linux Command Line: A Complete Introduction", William E. Shotts Jr., 2012, No Starch Press.

23CC3042 - LINUX PROFESSIONAL INSTITUTE: LINUX ESSENTIALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3042	LINUX PROFESSIONAL INSTITUTE: LINUX ESSENTIALS	LPI-LE	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding of Linux System Architecture to install, configure, maintain, secure, and troubleshoot a Linux system.	2	PO1, PO3, PO5, PSO2
CO2	Illustrate automate tasks, manage systems, and optimize performance through shell scripting, scheduling, configuration tools, and performance analysis techniques.	3	PO1, PO3, PO5

Syllabus

Installation procedures for various Linux distributions Configuring system settings and preferences Managing user accounts and groups Performing regular system updates and patches Managing disk partitions and file systems Backup and restore procedures Identifying and resolving common system issues Using log files for diagnostics Recovery procedures for system failures. Setting up network interfaces and connectivity Configuring network services (e.g., DHCP, DNS) Understanding and managing IP addressing and routing Implementing firewalls using tools like iptables and firewalld Securing remote connections with SSH Network monitoring and intrusion detection Managing user permissions and access controls Implementing security policies and best practices Using encryption tools to secure data

Basics of shell scripting (Bash, Shell) Writing and executing simple scripts Script debugging techniques Using variables, loops, and conditional statements Writing complex scripts for administrative tasks Scheduling automated tasks with cron jobs Automating routine maintenance tasks Scripting for user and group management Using configuration management tools (e.g., Ansible, Puppet). Overview of Linux kernel and user space System boot process and initialization (init, systemd) Linux filesystem hierarchy and structure Using monitoring tools (top, htop, vmstat) Analyzing system performance metrics Identifying bottlenecks and performance issues Optimizing system resources (CPU, memory, I/O) Configuring and tuning kernel parameters Implementing performance-enhancing techniques and tools

Reference Books

- 1 "CompTIA Linux+ Study Guide: Exam XK0-004", Christine Bresnahan and Richard Blum, 2019, Sybex.
- 2 LPIC-1/CompTIA Linux+ All-in-One Exam Guide, Robb H. Tracy, 2019, McGraw-Hill Education.
- 3 LPIC-2: Linux Professional Institute Certification Study Guide, Christine Bresnahan and Richard Blum, 2016, Sybex.
- 4 Linux Command Line and Shell Scripting Bible, Richard Blum and Christine Bresnahan, 2008, Wiley.
- 5 UNIX and Linux System Administration Handbook, Evi Nemeth, Garth Snyder, Trent R. Hein, Ben Whaley, Dan Mackin, 2017, Addison-Wesley Professional.

23CC3045 - MICROSOFT CERTIFIED : AZURE DEVELOPER ASSOCIATE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3045	MICROSOFT CERTIFIED : AZURE DEVELOPER ASSOCIATE	MC-ADA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Experiment with Azure compute solutions, including Virtual Machines for scalable workloads, Azure Kubernetes Service (AKS) for container management, and Azure App Services for streamlined application deployment, ensures efficient resource utilization.	3	PO1, PO2, PO3, PO5, PS01
CO2	Apply monitoring, troubleshooting, and optimization practices to Azure solutions, while integrating with Azure and third-party services for seamless operation. Additionally, configure Azure services and manage identities and security to ensure effective and secure deployment.	3	PO1, PO2, PO3, PO5, PS01

Syllabus

Implement IaaS solutions, Create Azure App Service Web Apps, Implement Azure functions, Develop solutions that use blob storage, Develop solutions that use Cosmos DB storage, Develop solutions that use table storage, Develop solutions that use file storage, Implement user authentication and authorization, Implement secure cloud solutions, Implement API management, Implement platform protection

Integrate caching and content delivery within solutions, Instrument solutions to support monitoring and logging, Monitor and optimize Azure solutions, Troubleshoot Azure solutions, Develop an App Service Logic App, Implement API Management, Develop event-based solutions, Develop message-based solutions, Manage Azure AD objects Implement multi-factor authentication Implement Azure AD B2C Implement Azure AD B2B

Reference Books

- 1 Exam Ref AZ-204 Developing Solutions for Microsoft Azure, Santiago Fernandez Munoz, 2020, Microsoft Press.
- 2 Azure for Developers: Implementing DevOps, Microservices, and Serverless Solutions, Ritesh Modi, 2020, Apress.
- 3 Microsoft Azure Essentials: Azure Web Apps for Developers, Rick Rainey, 2015, Microsoft Press.
- 4 Developing Azure Solutions, John Savill, 2015, Microsoft Press.
- 5 Microsoft Azure Architect Technologies Study Guide: Exams AZ-303 and AZ-304, Sjoukje Zaal, 2021, Wiley.

23CC3046 - MICROSOFT CERTIFIED: AZURE ADMINISTRATOR ASSOCIATE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3046	MICROSOFT CERTIFIED: AZURE ADMINISTRATOR ASSOCIATE	MC-AAA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Experiment with Microsoft Azure core services, architecture, and best practices for deploying cloud solutions at a higher cognitive level.	3	PO1, PO2, PO3, PO4, PSO1
CO2	Develop practical skills in creating and managing Azure resources and learn to implement security measures and compliance standards within Azure.	3	PO1, PO2, PO3, PO4

Syllabus

Cloud technology overview, Overview of Azure, Managing Azure with the Azure portal, Managing Azure with Windows PowerShell Overview of Azure Resource Manager, Azure management services, Overview of Azure networking , Implementing and managing Azure virtual networks , Configuring Azure virtual networks , Configuring Azure virtual network connectivity , Configuring the Subnets ? Configuring Virtual Network Region Peering, Configuring Virtual Network Global Peering , Understanding Azure to On-Prem Connectivity , Deploying Azure Virtual Network Gateway, Understanding User Defined Routes(UDR) , Configuring Azure Virtual Network Gateway with AWS over IPsec VPN , Implementing Azure Service End Points, Understanding Azure Network Security Groups(NSG) , Creating and Updating Inbound & Outbound Security Rules, Understanding NSG Rule Hierarchy, Testing Network Security Groups and learning rule priority, Creating NSG Rules with Service tags, Understanding Application Security Groups (ASG), Creating NSG with Application Security Groups, Overview of Azure Firewall as a Service, Creating UDR and AzureFirewallSubnet, Deploy Azure Firewall, Configure routing on UDR and assigning to subnets, Create Network Rule Collection and check the traffic, Create Application Rule Collection and block traffic to websites , Understand SNAT and DNAT in Azure Firewall , Creating DNAT for Azure machine using Azure Firewall , Overview Azure virtual machines , Deploy virtual machines in Azure portal , Deploy virtual machines using Azure CLI , Managing Azure Virtual machine storage , Understanding Availability sets, Fault Domain & Update Domain, Creating & placing virtual machines in Availability Sets

Overview on Load Balancing, Type of Load Balancers in Azure, Basic Vs Standard Load Balancer, Deploying Basic Load Balancer with Availability Sets, Creating Backend Pools, Health probes and Load Balance rules, Checking the Load Balancing scenarios, Configuring NAT using Basic Load Balancer, Understanding Azure DNS, Buying a domain name for Godaddy.com, Creating Azure DNS Zone and configuring it with Godaddy, Creating 3 Availability Sets and placing a single virtual machine in each AV-Set, Create Azure Standard Load Balancer and create a backend pool and assign all the 3 AVSets, Check the Load Balancing between the servers in different AV-Sets, Create Host Records for Server and check the name resolution, Create the CNAME record for the Load Balancer and check the website resolution, Understanding Azure Application Gateway architecture, Understanding Path Based Routing in AGW, Creating multiple VMs and configuring application gateway, Configuring the SSL Off-loading on Application gateway, Check pathing based routing using AGW

Reference Books

- 1 Microsoft Azure Administrator Exam Prep, Lalit Rawat, 2022, BPB.
- 2 Exam Ref AZ-104 Microsoft Azure Administrator Certification and Beyond , Riaan Lowe , Donovan Kelly , 2022, Packt Publishing.
- 3 MCA Microsoft Certified Associate Azure Administrator Study Guide: Exam AZ-104 (Sybex Study Guide), Rithin Skaria, 2022, Sybex.
- 4 Microsoft Certified Exam guide - Azure Administrator Associate (AZ-104), Kris Hermans, 2023, Cybellium Ltd.

23CC3047 - MICROSOFT CERTIFIED: AZURE AI ENGINEER ASSOCIATE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3047	MICROSOFT CERTIFIED: AZURE AI ENGINEER ASSOCIATE	MC-AAEA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply end-to-end Cognitive Services solutions on Azure, including service selection, security planning, resource management, and container deployment.	3	PO1, PO3, PSO1
CO2	Apply comprehensive AI solution suite, integrating Computer Vision, Natural Language Processing, Knowledge Mining.	3	PO2, PO6, PSO1

Syllabus

Selecting appropriate Cognitive Services, planning security, managing resources, and implementing containers for Cognitive Services solutions, including vision, language analysis, decision support, and speech solutions, with Azure Virtual Network integration

Implementing AI Solution Implementation, covering Computer Vision, Natural Language Processing, and Knowledge Mining, including Cognitive Search and conversational AI solutions, with integration of QnA Maker, Bot Framework, and Cognitive Services.

Reference Books

- 1 AI for Everyone: A Non-Technical Guide to Artificial Intelligence, Andrew Ng, 2019, Simon & Schuster.
- 2 Azure for Architects: Implementing cloud design, DevOps, IoT, and serverless solutions on your public cloud, Ritesh Modi, 2017, Packt Publishing.
- 3 Azure AI Engineer Associate AI-102 Study Guide: A Complete Self-Assessment Preparation for Exam AI-102, Eran Ginat, 2021, Independently published.
- 4 Natural Language Processing with Python Cookbook: Over 60 recipes to implement text analytics solutions using deep learning principles, Krishna Bhavsar, Naresh Kumar, Pratap Dangeti, 2017, Packt Publishing.
- 5 Hands-On Artificial Intelligence for IoT: Expert techniques for developing smarter IoT devices, Amita Kapoor, Rajat Bhargava, 2019, Packt Publishing.

23CC3050 - MICROSOFT CERTIFIED: AZURE FUNDAMENTALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3050	MICROSOFT CERTIFIED: AZURE FUNDAMENTALS	MC-AF	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply knowledge of cloud computing concepts to evaluate and recommend cloud solutions based on business requirements.	3	PO1, PO2, PO3, PO4, PSO1
CO2	Identify and categorize key Azure services based on their functionalities and also design the use cases for real world applications	3	PO1, PO2, PO3, PO4

Syllabus

INTRODUCTION TO AZURE, PRINCIPLES OF CLOUD COMPUTING, CREATE AN AZURE ACCOUNT, AZURE COMPUTE FUNCTIONS. CORE CLOUD SERVICES - INTRODUCTION TO AZURE, AZURE ARCHITECTURE AND SERVICE GUARANTEES, AZURE NETWORKING OPTIONS, SECURITY, PRIVACY, COMPLIANCE, RESPONSIBILITY AND TRUST IN AZURE, APPLY AND MONITOR INFRASTRUCTURE STANDARDS WITH AZURE POLICY. CONTROL AND ORGANIZE AZURE RESOURCES WITH AZURE RESOURCE MANAGER, AZURE DATA STORAGE OPTIONS, PREDICT COST AND OPTIMIZE SPENDING FOR AZURE

Reference Books

- 1 AZ-900, Microsoft Azure Fundamentals, Cheshire, J., HENDRIK BULENS, 2019, Pearson Education.
- 2 Exam Ref AZ-900 Microsoft Azure Fundamentals, Jim Cheshire, 2019, Microsoft Press.
- 3 MCA Microsoft Certified Associate Azure Administrator Study Guide: Exam AZ-104 (Sybex Study Guide), Rithin Skaria, 2022, Syber.
- 4 Microsoft Azure Fundamentals Certification and Beyond, Steve Miles, 2022, Packt Publishing.

23CC3051 - MICROSOFT CERTIFIED: AZURE IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3051	MICROSOFT CERTIFIED: AZURE IOT	MC-AIOT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Internet of Things (IoT), covering its definition, history, common applications, and key technologies like sensors, connectivity, and AI, with a special focus on its relevance in education.	3	PO2, PO5, PO7, PSO1
CO2	Apply Gain insights into the architecture and key components of IoT systems, including edge devices, gateways, cloud services, communication protocols, and popular IoT platforms and devices.	3	PO2, PO5, PO7, PSO1

Syllabus

Cloud Computing & Microsoft Azure Fundamentals: Introduction to Azure Different segments SaaS, PaaS, and IaaS Azure Regions and Data Centers Understanding of Microsoft Azure portal Introduction to all Azure services Windows Azure Subscription Setting Up a Trial Subscription

Azure Virtual Machines: Operating System Images Supported Virtual Machine instances Azure VM types and Pricing Types of Provisioning Disks & Images Virtual Machine management, automation and scripting Cloud Service and Resource Model Deployment Setting up VM in Availability set using Load Balanced Endpoint VM Availability using Availability Sets

Reference Books

- 1 Microsoft Certified Azure Fundamentals Study Guide: Exam AZ-900, James Boyce, 2013-1st Edition, ONLINE.
- 2 Azure for Architects: Implementing Cloud Design, DevOps, IoT, and Serverless Solutions on Microsoft Azure, Ritesh Modi, 2012-1st Edition, ONLINE.
- 3 Microsoft Azure: Designing and Implementing Cloud Solutions, Manoj Sharma, 2023-1st Edition, ONLINE.
- 4 Microsoft Azure Essentials: Fundamentals of Azure, Michael S. Collier and Robin E. Shahan, 2023-1st Edition, ONLINE.

23CC3059 - NI CLAD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3059	NI CLAD	NI-CL	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various data types and its functions in Graphical system design platform using LabVIEW	3	PO1, PSO2
CO2	Analyze various loop structures ,arrays, Clusters and its functions using LabVIEW.	4	PO1, PO2, PSO2
CO3	Analyze various debugging ,error handling techniques ,File I/O operations and State machine architecture.	4	PO1, PO2, PSO2
CO4	Analyze and design real time engineering applications using NI hardware.	5	PO1, PO2, PO3, PSO2

Syllabus

Introduction To LabVIEW: Introduction to graphical system design (GSD), working on GSD platform, Benefits of GSD, Text based programming Vs LabVIEW, Introduction to LabVIEW Environment, Front Panel Window Toolbar, Block Diagram Window Toolbar, Introduction to VIs, Data types, Data Representation, Coercion dot, Selecting a Tool, Shortcut Keys, Basic debugging techniques, Introduction to Digital Electronics, Boolean operations , Digital Circuit design, string operations, Various Display Types (Normal, code, Password, HEX display), Exploring string functions

Graphical Programming using LabVIEW: Introduction to loop concept, Type of Loops, For loop, Nested For loop, While loop(Stop if true and Continue if True), hybrid nested loop, Feedback Node, Shift Register and Stack Shift register, Introduction to tunnel and its type, Auto-Indexing, Last Value, Concatenating, Introduction to Arrays, operations of Array Functions, 1-D Array, 2-D Array, Introduction to Clusters, Cluster Function, Difference between Array and Cluster, Chart, Graph, Difference between Chart and Graph by Execution Exercise, Signal Generation and Plotting, Introduction to parallelism, Local Variable, Global Variable, Property Nodes, Invoke Nodes.

Structures Using LabVIEW: Introduction to Case structures, Case Control using Enumerated data type, Enum with type definition, Introduction to Flat Sequence, Create New Sub VI from Scratch, Input and Output Sub VI Connectors, Icon Editor, Making Sub VI from existing VI, Using Sub VIs Exercises, Finding Errors, Error handling and Debugging Techniques. File I/O: Introduction to File I/O, reading a Data from file, Writing a Data to file, Understanding File I/O using RefNum, File I/O Function Pallet, Introduction to Event Structure and operations, Design Technique, Introduction to Architecture, State machine Architecture.

Introduction NI Hardware: myDAQ architecture, Pin diagram ,connections, myRIO Internal architecture, Pin and Ports structure, Programming myRIO using LabVIEW, real time applications.

Reference Books

- 1 Hands-On Introduction to LabVIEW for Scientist and Engineers, John Essick, 2011, OXFORD University Press.
- 2 LabVIEW for Everyone, J. Travis & Jim Kring, 2012, PRENTICE Hall .
- 3 Circuit Analysis with MultiSim, David Baez-Lopez & Felix E. Guerrero- Castro, 2009, Morgan and Claypool Publisher.
- 4 LabVIEW for Everyone, J. Travis & Jim Kring, 2010, PRENTICE Hall.

23CC3060 - PCAP - CERTIFIED ASSOCIATE IN PYTHON PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3060	PCAP - CERTIFIED ASSOCIATE IN PYTHON PROGRAMMING	PCAP	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of Python to understand challenges and opportunities in Python projects, setting the stage for further exploration into Python infrastructure, data analysis, and ethical considerations in subsequent parts of the course.	3	PO5, PSO1, PSO2
CO2	Apply the OOP concepts of Python to understand challenges and opportunities in Python OOP-based projects, setting the stage for further exploration into Python OOP concepts, data analysis, and ethical considerations in subsequent parts of the course.	3	PO5, PSO1, PSO2

Syllabus

What is a Python, Installation Process, First Program, Indentation, Variables, Reserved Words, Data types, Numeric, Strings, String methods, Formatting String, Boolean, Python Operators, List, Tuples, Sets, Dictionaries, Conditional Statements- if, Loops (while & For Loop), Functions, Import and use modules and packages, Perform evaluations using the math module, Generate random values using the random module, Discover host platform properties using the platform module, Create and use user-defined modules and packages

Handle errors using Python-defined exceptions, Extend the Python exceptions hierarchy with self- defined exceptions, Understand the Object-Oriented approach, Employ class and object properties, Equip a class with methods, Discover the class structure, Build a class hierarchy using inheritance, Construct and initialize objects, Build complex lists using list comprehension, Embed lambda functions into the code, Define and use closures, Input/Output operations

Reference Books

- 1 Python Crash Course, Eric Matthes, 2nd (2019), No Starch Press.
- 2 Automate the Boring Stuff with Python, Al Sweigart, 2nd (2015), Tata McGraw Hill.
- 3 Learning Python, Mark Lutz, 5th (2013), O'Reilly Media.
- 4 Python Pocket Reference, Mark Lutz, 5th (2014), O'Reilly Media.

23CC3061 - PCCET: PALO ALTO NETWORKS CERTIFIED CYBERSECURITY ENTRY-LEVEL TECHNICIAN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3061	PCCET: PALO ALTO NETWORKS CERTIFIED CYBERSECURITY ENTRY-LEVEL TECHNICIAN	PCCET	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand core cybersecurity principles and implement essential security measures to protect digital assets and information systems. This includes identifying common threats and vulnerabilities, designing, implementing, and managing key network security components such as firewalls and intrusion detection/prevention systems, and employing secure network protocols to safeguard networked environments.	4	PO2, PO6, PSO2
CO2	Demonstrate proficiency in cloud computing concepts, architectures, and services, ensuring security and compliance in cloud environments. Additionally, operate security tools and processes, conduct incident response, and apply best practices for maintaining operational security within an organization.	4	PO1, PO8, PSO2

Syllabus

In this course, students will learn fundamental principles associated with the current cybersecurity landscape and identify concepts required to recognize and potentially mitigate attacks against enterprise networks as well as mission critical infrastructure. Students will also learn how to initially setup and configure security zones, authentication, and policies on a next generation firewall. In this Network Security Fundamentals course you will gain an understanding of the fundamental tenants of network security and review the general concepts involved in maintaining a secure network computing environment. Upon successful completion of this course you will be able to describe general network security concepts and implement basic network security configuration techniques.

In this Cloud Security Fundamentals course you will learn basic principles associated with securing the cloud and SaaS-based applications through Secure Access Service Edge architecture and identify concepts required to recognize and potentially mitigate attacks against traditional and hybrid datacenters as well as mission critical infrastructure. The course also demonstrates how to initially setup and configure containers on a docker bridge network and test the container security through the use of vulnerability scans and reports. In this Security Operations Fundamentals course you will gain an understanding of Security Operations and the role it plays in protecting our digital way of life, for businesses and customers. You will focus on continuous improvement processes to collect high-fidelity intelligence, contextual data, and automated prevention workflows that quickly identify and respond to fast-evolving threats. The course also demonstrates how to leverage automation to reduce strain on analysts and execute the Security Operation Centers mission to identify, investigate, and mitigate threats.

Reference Books

- 1 Palo Alto Networks Certified Cybersecurity Entry Level Technician (PCCET) Study Guide, Palo Alto Networks, 3rd Edition June 2022, Palo Alto Networks.
- 2 Palo Alto Networks Certified Cybersecurity Entry-Level Technician (PCCET) Certification Guide, Jason Dion, 1st Edition 2021, Dion Training Solutions.
- 3 Learning Palo Alto Networks: Next-Generation Firewall Technologies, Rajesh Kumar, Naveen Kumar, 1st Edition 2022, Packt Publishing.
- 4 Mastering Palo Alto Networks, Tom Piens, 1st Edition 2022, Packt Publishing.
- 5 Palo Alto Networks Cybersecurity Fundamentals, Michael Wiley, 1st Edition 2022, Independently Published.

23CC3071 - PROGRAMMING USING PYTHON (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3071	PROGRAMMING USING PYTHON	PUP	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Python Modules and Packages	2	PO1, PO5
CO2	Apply Exception handling and string methods in Python	3	PO1, PO5
CO3	Apply object-oriented programming in python	3	PO1, PO5
CO4	Apply functions and Input/Output operations in python	3	PO1, PO5

Syllabus

Modules and Packages: Import and use modules and packages, Perform evaluations using the math module, Generate random values using the random module, Discover host platform properties using the platform module, Create and use user-defined modules and packages.

Exceptions: Handle errors using Python-defined exceptions, Extend the Python exceptions hierarchy with self-defined exceptions. Strings: Understand machine representation of characters, Operate on strings, Employ built-in string methods.

Object-Oriented Programming: Understand the Object-Oriented approach, Employ class and object properties, Equip a class with methods, Discover the class structure, Build a class hierarchy using inheritance, Construct and initialize objects.

Miscellaneous: Build complex lists using list comprehension, Embed lambda functions into the code, Define and use closures, Understand basic Input/Output terminology, Perform Input/Output operations.

Reference Books

- 1 Programming Python, Mark Lutz, 2001, O'Reilly Media.
- 2 Learning Python: Powerful Object-Oriented Programming, Mark Lutz, 2013, O'Reilly Media.
- 3 Python for Everyone, Cay Horstmann and Rance Necaise, 2016, John Wiley & Sons, Inc..
- 4 Programming and Problem Solving with Python , Ashok Namdev Kamthane and Amit Ashok Kamthane, 2018, McGraw Hill Education (India) Private Limited.
- 5 Starting Out with Python , Tony Gaddis, 2019, Pearson Education Limited.

23CC3080 - SALESFORCE CERTIFIED ADMINISTRATOR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3080	SALESFORCE CERTIFIED ADMINISTRATOR	SFCA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Be able to understand how to manage changes to business processes, technology, and people with Salesforce. Be able to improve the efficiency of business operations by proactively undertaking regular process analysis and documentation. Be able to customize the user experience and manage profiles, permissions, roles, and groups with Salesforce. Be able to apply the Beginner mind and continually stay up to date with new Salesforce technology and inspire others too.	4	PO1, PO2, PO5, PSO1, PSO2
CO2	Be able to manage the end-to-end implementation of Salesforce, including the overall strategy and day-to-day activities involved in administering Salesforce..	5	PO1, PO2, PO5, PSO1, PSO2

Syllabus

Salesforce Platform Basics : Get Started with the Salesforce Platform, Discover Use Cases for the Platform, Understand the Salesforce Architecture, Navigate Setup, Power Up with AppExchange. Prepare Your Salesforce Org for Users : Set Up the Exchange Rate, Update the Exchange Rate with ACM, Customize the Home Page, Create a Unique Account List View, Create Chatter Groups User Management: Add New Users, Control What Your Users Can Access. Customize an Org to Support a New Business Unit: Manage User Access, Manage Chatter, Modify Your Data Model, Configure an Email Letterhead and Template, Automate Your Business Process Identity Basics: Get to Know Salesforce Identity, Get To Know Your Salesforce Identity Users, Learn the Language of Identity. Data Security : Overview of Data Security, Control Access to the Org, Control Access to Objects, Control Access to Fields, Control Access to Records, Create a Role Hierarchy, Define Sharing Rules Permission Set Groups: Get Started with Permission Set Groups, Create a Permission Set Group, Mute Permissions in Permission Set Groups Protect Your Data in Salesforce: Restrict Login Hours and IP Ranges, Create New Users and Allow a User to Delete Accounts, Set Organization-Wide Defaults and Create a Role Hierarchy, Create Sharing Rules, Set Up Account Teams. Data Modeling: Understand Custom & Standard Objects, Create Object Relationships, Work with Schema Builder Lightning Experience Customization: Set Up Your Org, Create and Customize Lightning Apps, Create and Customize List Views, Customize Record Highlights with Compact Layouts, Customize Record Details with Page Layouts, Create Custom Buttons and Links, Empower Your Users with Quick Actions Customize a Salesforce Object: Work with Standard and Custom Fields, Create Picklists and Field Dependencies, Create Lookup Filters, Create Formula Fields, Create Record Types, Create Account Page Layouts, Enable Account Field History Tracking, Create Validation Rules. Lightning App Builder: Get Started with the Lightning App Builder, Build a Custom Home Page for Lightning Experience, Build a Custom Record Page for Lightning Experience and Salesforce Mobile App, Build an App Home Lightning Page, Work with Custom Lightning Components Formulas and Validations: Use Formula Fields, Implement Roll-Up Summary Fields, create validation rules. Accounts & Contacts for Lightning Experience: Store Information About Your Customers, Understand Account and Contact Relationships Leads & Opportunities for Lightning Experience: Create and Convert Leads as Potential Customers, Work Your Opportunities, Sell as a Team and Split the Credit, Visualize Success with Path and Kanban Products, Quotes, & Contracts: Create Price Books to Track Your Products, Configure Quotes for Your Customers and Track Contracts. Campaign Basics: Meet Salesforce Campaigns, Organize Campaigns, Determine Who You're Marketing To, Report on Your Campaigns Customize a Sales Path for Your Team: Customize a Sales Path, Customize Opportunity Stages, Work with Opportunities in the Kanban View

Service Cloud for Lightning Experience: Begin Your Customer Service Journey, Administer Service Cloud, Automate Case Management, Create Digital Engagement on Multiple Channels. Set Up the Service Console: Set Up the Lightning Service Console, Customize Your Lightning Service Console Pages, Add the Softphone Utility to Your App, Set Up Web Chats for Your Console. Create a Process for Managing Support Cases: Create Support Processes, Create Record Types, Create an Escalation Rule Set Up Case Escalation and Entitlements: Create Support Processes, Create Case Queues and Assignment Rules, Create a Case Escalation Rule, Create an Automation with Flow Builder, Enable Entitlements and Set Up Service Contracts, Create an Entitlement Process, Create Service Contracts with Entitlements. Chatter Administration for Lightning Experience: Get Started with Chatter, Work with Chatter Groups, Enable Feed Tracking, Approve Records from a Chatter Feed, Develop a Rollout Strategy AppExchange Basics: Get Started with AppExchange, Navigate AppExchange, Explore AppExchange Listings, Install AppExchange Packages, Connect and Contribute to the AppExchange Community. Data Management: Import Data, Export Data Duplicate Management: Improve Data Quality in Salesforce, Resolve and Prevent Duplicate Data in Salesforce Import and Export with Data Management Tools: Use the Data Import Wizard, Use Dataloader.io to Export Data, Use Dataloader.io to Update Data. Reports & Dashboards for Lightning Experience: Introduction to Reports and Dashboards in Lightning Experience, Create Reports with the Report Builder, Format Reports, Visualize Your Data with the Lightning Dashboard Builder, Extend Your Reporting Strategy with AppExchange Create Reports and Dashboards for Sales and Marketing Managers: Create Report and Dashboard Folders, Create a Simple Custom Report, Filter Your Reports, Group and Categorize Your Data, Use Summary Formulas in Your Reports, Manage Reported Data, Visualize Your Data Approve Records with Approval Processes: Customize How Records Get Approved, Build an Approval Process Build a Discount Approval Process: Prepare Your Org, Create an Approval Process, Create Initial Submission Actions, Specify Final Approval and Rejection Actions Build a Simple Flow: Collect Contact Info from Your User, Check for a Matching Contact in Your Org, Branch the Flow, Create or Update a Contact Flow Builder Basics: Get Started with Automation, Go with the Flow, Meet Flow Builder, Learn About Flow Variables. Case Studies and Capstone Project : Complete the Capstone Project by taking a user case and work on the Trailhead

Reference Books

- 1 Salesforce for Beginners: A step-by-step guide to optimize sales and marketing and automate business processes with the Salesforce platform, Sharif Shaalan and Timothy Royer, 2nd Ed, PACKT Publishers.
- 2 Salesforce for Beginners : A Step-by-step Guide to Creating, Managing, and Automating Sales and Marketing Processes, Sharif Shaalan, 2nd Ed, PACKT Publisher.
- 3 Salesforce CRM - The Definitive Admin Handbook: Build, configure, and customize Salesforce CRM and mobile solutions, Paul Goodey, 5th Ed, PACKT Publisher.
- 4 Mastering Salesforce CRM Administration, Rakesh Gupta, 5nd Ed, PACKT Publisher.
- 5 Learn Salesforce Lightning: The Visual Guide to the Lightning UI, Felicia Duarte, Rachelle Hoffman, 2018, Wiley Apress.

23CC3082 - SERVICENOW CERTIFIED APPLICATION DEVELOPER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3082	SERVICENOW CERTIFIED APPLICATION DEVELOPER	SNCAD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Configuring Applications for Business by Creating Classic List Views and Workspace, SN Admin Activities	1	PO1, PO3, PO7, PO10, PSO2
CO2	Enabling Productivity by Creating Reports, Dashboards and Configuring Notifications. Service Catalog	2	PO1, PO3, PO7, PO10, PSO2
CO3	Create UI Policy and Business Rule Scripting, Workflows	3	PO1, PO3, PO7, PO10, PSO2
CO4	Understand by Creating System Update sets and migrate changes to Test Instance, Import Sets	4	PO1, PO3, PO7, PO10, PSO2
CO5	SN Admin Activities, Scripting, Service catalog, Workflows, Integrations, Import Sets	4	PO1, PO3, PO7, PO10, PSO2

Syllabus

Admin Activities: Architecture of ServiceNow, Movement of Updatesets, User Interface, List, Forms, Records, Filters and Breadcrumbs, User Creation, Group Creation, Roles Attachment, Events and Notifications, System Properties and Dictionary, Reporting and Dashboards, Themes and Branding. Service Portal: Creating Service Portal, Designing Portal Pages Scripting: I) Business Rules II) Client Scripts III) UI Policy IV) UI Actions V) Implementing both Client-Side and Server-Side Scripting.

Service Catalog: Creating Catalog Items using Variables and Variable Sets, Creating Record Producers, Design the flow using Workflow, Creating Execution Plans, Writing Catalog Client Scripts, Catalog UI Policies

Workflows: Creating Workflows on different Tables, Approvals using Workflows, Using Different Activities in Workflow.

Integrations: - Web Services: Direct Web Services, Transform Map Web Services

Integrations: Email Integration: Inbound Actions, Event Registry, Creating and Triggering Events. Import Sets: Loading Data of different Formats, Using Data Sources, Using Transform Maps, Transform Scripts

Reference Books

- 1 Vinay Poliseti, "Fundamentals of ServiceNow Administration and Scripting: Your ServiceNow Guide", Independently Published, 2019. , Vinay Poliseti, 2019, Independently Published, 2019.
- 2 "Learning ServiceNow: Get started with ServiceNow Administration and Development to Manage and Automate your IT Service Management Processes", Tim Woodruff, 2017, Packt Publisher, 2017.
- 3 ServiceNow Application Development: Transform the way you build apps for enterprises, Sagar Gupta, 1st Edition, Kindle Edition, Packt Publishing.
- 4 Mastering ServiceNow Scripting: Leverage JavaScript APIs to perform client-side and server-side scripting on ServiceNow instances, Andrew Kindred, 1st Edition, Kindle Edition, Packt Publishing.
- 5 Learning ServiceNow: Administration and development on the Now platform, for powerful IT automation, Tim Woodruff , 2nd Edition, Packt Publishing.

23CC3083 - SERVICENOW CERTIFIED SYSTEM ADMINISTRATOR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3083	SERVICENOW CERTIFIED SYSTEM ADMINISTRATOR	SNCSA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand and manage changes to business processes, technology, and people in Salesforce and ServiceNow Platform. Acquire a fundamental understanding of the CRM and Salesforce, ServiceNow tools necessary to effectively generate useful applications on the Salesforce, ServiceNow platform to support the customer requirements	2	PO1, PO2, PO8, PSO1
CO2	To apply the efficiency of business operations by proactively undertaking regular process analysis and documentation. Gain experience in using the Salesforce, ServiceNow tools and techniques of CRM to complete projects focused on obtaining actionable insights from complex data	3	PO1, PO2, PO8, PSO1
CO3	To apply the customize the user experience and manage profiles, permissions, roles, and groups with Salesforce, ServiceNow. Dive deeply into a Salesforce Developer, ServiceNow Admin practice to fully prepare to use knowledge gained in the course to add significant value in a professional setting.	3	PO2, PO3, PO8, PSO1
CO4	To apply the utilize knowledge and skills to continue learning and adapting to other advanced Salesforce, ServiceNow technologies	3	PO2, PO3, PO8, PSO1
CO5	To analyze the manage the end-to-end implementation of Salesforce, ServiceNow including the overall strategy and day-to-day activities involved in administering Salesforce, ServiceNow	3	PO2, PO3, PO8, PSO1

Syllabus

A Salesforce Administrator solves business problems by customizing the Salesforce Platform. They build, configure, and automate technology solutions to deliver business value. people in Salesforce and ServiceNow Platform. Acquire a fundamental understanding of the CRM and Salesforce, ServiceNow tools necessary to effectively generate useful applications on the Salesforce, ServiceNow platform to support the customer requirements

Salesforce Administrators work with stakeholders to define system requirements and customize the platform. Create and modify UI Policies, UI Policy Actions, Data Policies and UI Actions; Create a Business Rule; Create a Client Script

Core responsibilities include supporting users, managing data, maintaining security standards, and delivering actionable analytics. Add Users, Add new Group Automatically Associated with New User Record, Assign Roles to a Group, Add Users to new Groups, Create and test New Assignment Rule

A Salesforce Admin best understands how to make the platform work for their company goals. customize the platform. Create and modify UI Policies, UI Policy Actions, Data Policies and UI Actions; Create a Business Rule; Create a Client Script

The constantly increasing availability of customer data offers great opportunities for the organizations to gain managerial insights for attracting new customers and developing and maintaining relationships with existing customers

Reference Books

- 1 ServiceNow Certified System Administrator , Muhammad Zeeshan Ali, Kindle Edition 2022, Amazon.
- 2 ServiceNow Certified System Administrator (CSA) Handbook, Muhammad Zeeshan Ali, Kindle Edition 2023, Amazon.

- 3 ServiceNow Certified System Administrator (CSA) 10 Practice Exams, Saqib Javed John, Kindle Edition 2023, Amazon.
- 4 ServiceNow Certified System Administrator (CSA) Study Guide, Muhammad Zeeshan Ali (Author), Saqib Javed John (Author) , Kindle Edition 2023, Amazon.
- 5 ServiceNow IT Operations Management: Demystifying IT Operations Management, Ajaykumar Guggilla, Kindle Edition 2023, Amazon.

23CC3091 - UNITY CERTIFIED ASSOCIATE: GAME DEVELOPER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3091	UNITY CERTIFIED ASSOCIATE: GAME DEVELOPER	UCA-GD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of Game plan analysis in a Design Process	2	PO1, PO4, PO8, PSO2
CO2	Apply the classification model involved in the concept of a Development design	3	PO1, PO4, PO8, PSO2

Syllabus

Animation: Simple Unity Animation, Animator States, Scripting Animations, Animations and Colliders, Advanced Game Physics: Applying Forces, Unity Physics Joints, Unity2DEffectors, User Interfaces: Unity Buttons, Other UI Controls, UI Design Concepts, Project Publishing: Splash Screens, Credit Scenes and Icons, Publishing to PC, Mac and Linux Computers, Publishing to Smartphones, Publishing to Game Consoles, Entity component system.

Unity Colliders, Physics Materials, Scripting Collision Events, Organizing Game Objects Parent-Child Objects, Sorting Layers, Tagging Game Objects, Collision Layers, Managing Game Objects: Prefabs, Creating and Destroying Objects

Reference Books

- 1 Unity in Action, Joseph Hocking, 3, 2021, Manning Publication.
- 2 Learning C# by Developing Games with Unity 2020, Harrison Ferrone, 5, 2020, Packt Publishing.
- 3 Game Design Document Template, James McInerney, 1, 2021, Manning Publication .
- 4 Unity 2021 Cookbook, Matt Smith and Shaun Ferns, 4, 2021, Packt Publishing.
- 5 Mastering Unity 2D Game Development, Simon Jackson, 2, 2018, Packt Publishing.

23CC3096 - WIPRO TALENT NEXT JAVA FULL STACK CERTIFICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3096	WIPRO TALENT NEXT JAVA FULL STACK CERTIFICATION	WTNJFSC	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the core concepts of Java Fundamentals, Object-Oriented Programming (OOP), the basic features of Eclipse, the principle of Abstraction, the role of packages, the importance of Exception Handling, the structure of the Collection Framework, the purpose of Wrapper Classes, the function of I/O Streams, and the use of Annotations.	2	PO5, PO9, PSO2
CO2	Demonstrate how to use JUnit for testing, implement multithreading in Java applications, design and manage databases using RDBMS, write and execute SQL queries, develop PL/SQL programs, and connect Java applications to databases using JDBC.	3	PO5, PO9, PSO2
CO3	Apply HTML for structuring web content, utilize JavaScript and CSS for enhancing web interactivity and styling, develop dynamic web applications using Servlets and JSP, process and manipulate data with XML-I and XML-II, and implement asynchronous web functionalities using AJAX.	3	PO5, PO9, PSO2
CO4	Implement data persistence with Hibernate, develop applications using Spring Core, build and configure microservices with Spring Boot, create and consume REST web services, and develop dynamic single-page applications using Angular.	3	PO5, PO9, PSO2

Syllabus

Java Fundamentals, OOPS, Eclipse Overview, Abstraction, packages, Exception handling, Collection Framework, Wrapper classes, I/O streams, Annotations.

JUnit, Multithreading, RDBMS, SQL, PL/SQL, JDBC.

HTML, JavaScript/CSS, Servlets and JSP, XML-I, XML-II and AJAX

Hibernate, Spring Core, Spring Boot, REST web service, Angular

Reference Books

- 1 Java: The complete Reference, Herbert Schildt, 11th, 2022, McGraw Hill LLC.
- 2 Java Testing with Spock, Konstantinos Kapelonis, 1st, 2024, Manning Publications.
- 3 JUnit in Action, Petar Tahchiev, Felipe Leme, Vincent Massol, Gary Gregory, 3rd, 2022, Manning Publications.
- 4 Practical Unit Testing with JUnit and Mockito, Tomek Kaczanowski, 1st, 2024, Packt Publishing.
- 5 Java EE 7 Development with WildFly, Michal Cmil, Michal Matloka, Francesco Marchioni, 1st, 2024, Packt Publishing.
- 6 Java Persistence with Hibernate, Christian Bauer, Gavin King, 2nd, 2023, Manning Publications.

23CC3097 - WIPRO TALENT NEXT J2EE CERTIFICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CC3097	WIPRO TALENT NEXT J2EE CERTIFICATION	WTNJ2EEC	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the core concepts of Java Fundamentals, Object-Oriented Programming (OOP), the basic features of Eclipse, the principle of Abstraction, the role of packages, the importance of Exception Handling, the structure of the Collection Framework, the purpose of Wrapper Classes, the function of I/O Streams, and the use of Annotations.	2	PO5, PO9, PSO2
CO2	Demonstrate how to use JUnit for testing, implement multithreading in Java applications, design and manage databases using RDBMS, write and execute SQL queries, develop PL/SQL programs, and connect Java applications to databases using JDBC.	3	PO5, PO9, PSO2
CO3	Apply HTML for structuring web content, utilize JavaScript and CSS for enhancing web interactivity and styling, develop dynamic web applications using Servlets and JSP, process and manipulate data with XML-I and XML-II, and implement asynchronous web functionalities using AJAX.	3	PO5, PO9, PSO2

Syllabus

Java Fundamentals, OOPS, Eclipse Overview, Abstraction, packages, Exception handling, Collection Framework, Wrapper classes, I/O streams, Annotations.

JUnit, Multithreading, RDBMS, SQL, PL/SQL, JDBC

HTML, JavaScript/CSS, Servlets and JSP, XML-I, XML-II and AJAX

Reference Books

- 1 Java: The complete Reference , Herbert Schildt, 11th, 2022, McGraw Hill LLC.
- 2 Java Testing with Spock, Konstantinos Kapelonis, 1st, 2023, Manning Publications.
- 3 JUnit in Action, Petar Tahchiev, Felipe Leme, Vincent Massol, Gary Gregory, 3rd, 2022, Manning Publications.
- 4 Practical Unit Testing with JUnit and Mockito, Tomek Kaczanowski, 1st, 2023, Packt Publishing.
- 5 Java EE 7 Development with WildFly, Michal Cmil, Michal Matloka, Francesco Marchioni, 1st, 2024, Packt Publishing.

23SP2101 - ATHLETICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2101	ATHLETICS	ATH	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To remember the basic theory of Athletics History, Governing bodies, Track & Field, Starting Positions, Finishing Techniques, stager formulas, walking events, horizontal jumps & vertical jumps, throws.	2	PO1, PO7, PSO2
CO2	To remember the basic theory of Athletics History, Governing bodies, Track & Field, Starting Positions, Finishing Techniques, stager formulas, walking events, horizontal jumps & vertical jumps, throws.	2	PO1, PO7, PSO2

Syllabus

Remember the athletics history, governing bodies, track & field, Starting Positions, Finishing Techniques, stager formulas, walking events, horizontal jumps & vertical jumps, throws.

Remember the athletics history, governing bodies, track & field, Starting Positions, Finishing Techniques, stager formulas, walking events, horizontal jumps & vertical jumps, throws.

Reference Books

- 1 A comprehensive guide to sports skills tests and measurement , Collins, D. & Hodges, 2nd edition 2011, Scarecrow Press.
- 2 The Book of Athletics , Paul Withington, 3rd Edition 2016, Forgotten Books.
- 3 The Book of Athletics, Paul Withington, 1st Edition 2010, Forgotten Books.
- 4 An Alphabet of Athletics, Eustace Hamilton Miles, 2nd Edition 2018, Forgotten Books.

23SP2102 - BASKETBALL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2102	BASKETBALL	BKB	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To remember the basic theory of basketball history, governing bodies, Measurements: Court (playing court, back court) pillar, basket board, target area, ring, ball, net. Players, Officials, punishment cards. Rules and regulations. area, throw-in lines, no-charge semi-circle areas. Game clock: 3 second rule, 5 second rule, 8 second rule, 24 second rule. Time outs: General time out, charged time out. Defense: man to man defense, Zonal defense. Dribbling: low dribble, high dribble, Speed Dribble, Change of Pace Dribble, Crossover Drive dribble, Reverse Dribble, between the leg's dribbles. Passes: Chest Pass, Bounce Pass, Overhead Pass, Dribble Pass, Air Pass, Behind-the-Back Pass, Bounce Pass, Pick-and-Roll Pass. Fouls: personal foul, team foul, double foul, unsportsmanlike foul, technical foul.	2	PO1, PO7, PSO2
CO2	To remember the basic theory of basketball history, governing bodies, Measurements: Court (playing court, back court) pillar, basket board, target area, ring, ball, net. Players, Officials, punishment cards. Rules and regulations. area, throw-in lines, no-charge semi-circle areas. Game clock: 3 second rule, 5 second rule, 8 second rule, 24 second rule. Time outs: General time out, charged time out. Defense: man to man defense, Zonal defense. Dribbling: low dribble, high dribble, Speed Dribble, Change of Pace Dribble, Crossover Drive dribble, Reverse Dribble, between the leg's dribbles. Passes: Chest Pass, Bounce Pass, Overhead Pass, Dribble Pass, Air Pass, Behind-the-Back Pass, Bounce Pass, Pick-and-Roll Pass. Fouls: personal foul, team foul, double foul, unsportsmanlike foul, technical foul.	2	PO1, PO7, PSO2

Syllabus

Strengthens muscular endurance Builds healthy bones Improves balance and coordination Develops fundamental movement skills

Strengthens muscular endurance Builds healthy bones Improves balance

Reference Books

- 1 The Book of Basketball: The NBA According to The Sport , ONLINE, 2nd, 2015, SPORTS.
- 2 The Great Book of Basketball: Interesting Facts and Sports, Bill O'Neill, 3rd 2018, Lak Publishing.
- 3 Inaugural Ballers, Andrew Maraniss, 2nd 2016, Sports.
- 4 Basketball For Dummies, Richard Phelps, 3rd 2018, 3rd.

23SP2103 - BADMINTON (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2103	BADMINTON	BMT	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	: Introduction about Badminton and History	2	PO1, PO7, PSO2
CO2	badminton summary	2	PO1, PO7, PSO2

Syllabus

Famous players, How the game works competitions court measurements, Fore hand, Back hand drop, clearing , Smash, Service (shot service , long service), Sprint work out Foot work drills, Scoring, rules & regulations singles and doubles game differences, Game practice (singles), Game practice (doubles), Officiating signals game, Recall the history measurements.

Game practice (doubles), Officiating signals game, Recall the history measurements.

Reference Books

- 1 Badminton: Steps to Success, Tony Grice (Author), 2nd 2018, Human Kinetics.
- 2 Badminton Story , Bernard Adams, 1st 2015, BBC Books.
- 3 The Winning Edge in Badminton: Read Peter Gade's preface about the book, Andy Wood, 3rd 2018, Online.
- 4 Better Badminton, Carl H Jackson, 2nd 2019, Coachwhip Publications.

23SP2104 - CRICKET (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2104	CRICKET	CRKT	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Criclet and History	3	PO1, PO7, PSO2
CO2	cricket summary	2	PO1, PO7, PSO2

Syllabus

Origin & history of game Demon striation Game, Rules & Regular Skill grip, stands, back lift, skill demon striation. Skill front foot straight drive skill demonstration Skill front foot straight drive skill demonstration Skill front foot off drive skill demonstration Skill front foot cover drive skill demonstration skill demonstration Skill front foot cover drive skill demonstration

Reference Books

- 1 Original Laws of Cricket, Michael Rundell, 1st 2018, The Bodleian Library;.
- 2 The Forgotten Sons : Untold Stories of Indian Cricket, Trinanjan Chakraborty, 2nd 2016, online.
- 3 Indian Cricket: Then and Now, Venkat Sundaram, 1st 2018, Revised.
- 4 Sort of a Cricket Person , E.W. Swanton, 2nd 2016, Illustrated Edition.

23SP2105 - CHESS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2105	CHESS	CHS	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Chess and History	2	PO1, PO7, PSO2
CO2	chess summary	2	PO1, PO7, PSO2

Syllabus

1. Officiating: a) Measurements: Board. b) Officials, punishment cards. c) Rules and regulations. 2. Skills: Visualization, Calculation, Tactics, Evaluation / Analysis, Strategy, Openings, Endgames. 3. Chess Pieces: Pawn, Knight, Bishop, Rook, Queen, King. 4. Setup the Chessboard 5.Chess Pieces Moves 6.Special Rules of Chess 7.Castle in Chess 8.Chess Strategies 9.Touch-move 10.Clocks and Timers 11.Chess960 12.3-Check

Chess960 12.3-Check

Reference Books

- 1 Complete Book of Chess Strategy , Silman Jeremy, 2nd 2018, Siles Press,U.S..
- 2 English Chess Middle Game Combinations, Natarajan M, 2nd 2016, Chess Exercise Book.
- 3 Think Like A Grand MAster, Alexandria Kotov, 3rd 2016, Sports.
- 4 The Mammoth Book Of Chess, Graham Burges, 2nd 2018, Chess Exercise Book.

23SP2108 - KABADDI (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2108	KABADDI	KBD	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Kabaddi	2	PO1, PO7, PSO2
CO2	Kabaddi Summary	2	PO1, PO7, PSO2

Syllabus

1. Officiating: a) Measurements: Court b) Players, Officials, punishment cards. c) Rules and regulations. 2. Play field: end line, bonus line, baulk line, mid line. 3. Positions: Right-corner, Left-corner, Right-cover, Left-cover, Right-in, Left-in, Center. 4. Offensive Skills: Hand Touch, Foot Touch, Toe Touch, Sudden/Squat Leg Thrust, Side/Front/Back Kick, running hand touch, Scorpion Kick, dubki, eye-work. 5. Defensive Skills: Ankle Hold, Thigh Hold, Knee Hold/Double Knee Hold, Waist/Back/Trunk Hold, Block Tackle, Wrist Hold. 6. Escape tactics :Running, Dodging & Stooping, Skipping & Side/Back Stepping, Balancing (Dynamic Balance & Static Balance), Kicking (Back, Front & Side Kick). 7. Ride: successful ride, unsuccessful ride, golden ride, do or die ride. 8. Cant 9. Rider 10. Anti/ anti-rider 11. Lobby 12. Struggle 13. 30 seconds operator 14. Lona system. 15. Pursuit.

0 seconds operator 14. Lona system. 15. Pursuit.

Reference Books

- 1 Kabaddi by nature, Vivek Chaudhary , 1st 2018, Palimpsest Publisher.
- 2 Physical and Psychological Variables Kabaddi, Sridhar Kumar, 2nd 2016, Independent Author .
- 3 The Book of Kabaddi (The complete Guide) , G.KUMARESAN, 1st 2019, Sports Publication.
- 4 Pro-Kabaddi, Machale Kishor Govindrao , 1st 2018, KSK PUBLISHER AND DISTRIBUTORS.

23SP2109 - KHO-KHO (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2109	KHO-KHO	KHO	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction About Kho-Kho And History	2	PO1, PO7, PSO2
CO2	khokho summary	2	PO1, PO7, PSO2

Syllabus

1. Officiating: a) Measurements: Court & field, Post. b) Players, Officials, punishment cards. c) Rules and regulations. 2. Lines: pole line, shoulder line, centre line, side line, chesarus sitting squares. 3. Methods of giving kho: proximal method, distal method. 4. Seating methods of chasers: parallel toe method, bullet toe method. 5. Different kinds of Kho-Kho: simple kho, judgment kho, fake kho, late kho, advance/ early kho, Minus-Kho. 6. Chasing Skills: Giving Kho, Taking Direction, Sudden Change, Tapping, Turning Round the post, Trapping, Diving, Fake Kho, Late Kho. 7. Running Skills: Position on the court, Dodging, Avoiding trapping, front dodge, Back dodge, Positioning near the post, Round the post dodge, single chain, double chain, back ring, zig-zag run. 8. whistle: long whistle, short whistle, short continue whistles, long & short whistle. 9. Lobby 10. free zone

8. whistle: long whistle, short whistle, short continue whistles, long & short whistle. 9. Lobby 10. free zone

Reference Books

- 1 How to Learn Kho Kho , M.S. Tyagi, Sheetal Chauhan, Dr. Shubhra Kathuria, 1st 2018, K.S.K. PUBLISHERS AND DISTRIBUTORS.
- 2 KHO KHO Basics, H.V. Natraj, 2nd 2019, Shaja Publications.
- 3 KHO KHO , Dr. Amit Arjun Buddhé, 2nd 2019, Lakshay Publishers.
- 4 Kho-Kho Avlokan, Gauri Chakravarthi, 3rd 2020, Sports Publications.

23SP2110 - TENNIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2110	TENNIS	TNS	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Tennis and History	3	PO1, PO7, PSO2
CO2	Tennis summary	2	PO1, PO7, PSO2

Syllabus

1. Officiating: a) Measurements: Table, net, Racket, ball, court. b) Players, Officials, punishment cards. c) Rules and regulations 2. Skills: Serve (Forehand serve, Backhand Serve, backspin Serve, topspin serve, sidespin serve, High toss serve, Chop serves) Drive (Forehand drive, Backhand Drive) Push (Forehand push, Backhand push) block (forehand block, Backhand block) loop (forehand Loop, Backhand loop) flick (forehand flick, Backhand flick) chop (forehand chop, backhand chop) lob (forehand lob, Backhand lob) smash (forehand smash, Backhand smash) Holding the paddle (Shakehand Grip, Penhold Grip, Shallow Shake hand, Deep Shake hand.) 3. Stance and footwork: Feet, Ankles and knees, Back and shoulders, Arms. 4. Let 5. scoring system (singles, doubles, mixed doubles).

scoring system (singles, doubles, mixed doubles).

Reference Books

- 1 The Inner Game of Tennis, Timothy Gallwey, 1st 2018, Pan.
- 2 The Tennis Partner, Abraham Verghese, 1st 2016, Online.
- 3 Essential Tennis, Ian Westermann, 2nd 2015, Griffin.
- 4 The Inner Game of Tennis, W. Timothy Gallwey, 3rd 2017, Sports.

23SP2111 - TABLE TENNIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2111	TABLE TENNIS	TTS	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Table Tennis and History	3	PO1, PO7, PSO2
CO2	table tennis summary	2	PO1, PO7, PSO2

Syllabus

TEACHING SKILLS: 1. Officiating: a) Measurements: Table, net, Racket, ball, court. b) Players, Officials, punishment cards. c) Rules and regulations 2. Skills: Serve (Forehand serve, Backhand Serve, backspin Serve, topspin serve, sidespin serve, High toss serve, Chop serves) Drive (Forehand drive, Backhand Drive) Push (Forehand push, Backhand push) block (forehand block, Backhand block) loop (forehand Loop, Backhand loop) flick (forehand flick, Backhand flick) chop (forehand chop, backhand chop) lob (forehand lob, Backhand lob) smash (forehand smash, Backhand smash) Holding the paddle (Shakehand Grip, Penhold Grip, Shallow Shake hand, Deep Shake hand.) 3. Stance and footwork: Feet, Ankles and knees, Back and shoulders, Arms. 4. Let 5. scoring system (singles, doubles, mixed doubles).

.scoring system (singles, doubles, mixed doubles).

Reference Books

- 1 Table Tennis (Steps to Success, Richard Ernest McAfee, 1st 2018, Human Kinetics Publishers.
- 2 History of U.S. Table Tennis: 1, Tim Boggan, 2nd 2019, Createspace Independent Pub .
- 3 Expert In A Year: The Ultimate Table Tennis Challenge, Sam Priestley, 1st 2018, Sports.
- 4 Spin Tips and Tactics, Tom Lodziak, 3rd 2018, Independently.

23SP2113 - THROW BALL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2113	THROW BALL	THB	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Throwball and History	2	PO1, PO7, PSO2
CO2	Throwball summary	2	PO1, PO7, PSO2

Syllabus

1. Officiating: a) Measurements: Court, pole, net, antenna, ball. b) Players, Officials, punishment cards. c) Rules and regulations. 2. Service system 3. Zone system 4. Rotation Order & starting order 5. Scoring system 6. Fouls 7. Offensive & Defensive skills

Offensive & Defensive skills

Reference Books

- 1 Introduction about Throwball and History, Melaine D, 1st 2014, S.L.Y.M.
- 2 Throw ball , C Kinan, 3rd 2019, Sports.
- 3 THROWBALL FOR BEGINNERS, SAMUEL NOAH, 1st 2018, Sports.
- 4 The Ball Book, David Stein, 1st 2014, Phaidon Press.

23SP2114 - VOLLEYBALL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2114	VOLLEYBALL	VOB	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Volleyball and History	3	PO1, PO7, PSO2
CO2	Volletball summary	2	PO1, PO7, PSO2

Syllabus

1. Officiating: a) Measurements: Court, Pole, Net, Antenna, Ball. b) Players, Officials, punishment cards. c) Rules and regulations. 2. Zone: Front zone, Back zone, Free zone, Service zone, Libero Replacement zone, Substitution zone. 3. Service: Simple service, Side arm service, Round arm service, Tennis service, Floating service, Jump service. 4. Passes: Under arm pass/Dig pass, Upper head pass/Overhead pass, Carry, Doubles, Smash. 5. Blocking: Single block, double block, Triple block. 6. Time outs: General time out, Technical time out, Injury time out. 7. Player positions. 8. Rotation order. 9. Libero

Libero

Reference Books

- 1 Volleyball Fundamentals, Joel Dearing , 2nd Edition, Human Kinetics.
- 2 The Little Volleyball Poetry Book, Walter the Educator, 1st Edition, Silent King Books;.
- 3 The Volleyball Drill Book, American Volleyball Coaches Association, 1st Edition, Human Kinetics;.
- 4 Thinking Volleyball, Hebert Mike, kindle Edition, Human Kinetics Publishers.

23SP2116 - YOGA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23SP2116	YOGA	YOG	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction of Yoga and Asanas	2	PO1, PO7, PSO2
CO2	yoga summary	2	PO1, PO7, PSO2

Syllabus

Yoga and its preparation necessity of Yogain daily lifr Types of Yoga Hatha Yoga

Types of Yoga Hatha Yoga

Reference Books

- 1 Asana Pranayama Mudra Bandha, Swami Satyananda Saraswati, Illustrated Edition, Yoga Publications Trust.
- 2 Yoga For All: Discovering the True Essence of Yoga, Hansaji J. Yogendra, Kindle Edition, Rupa Publications.
- 3 Textbook of Yoga, Yogeswar, Sports, Penguin India.
- 4 The Yoga Book, Stephen Sturgess, Kindle Edition, Watkins Media.



(DEEMED TO BE U N I V E R S I T Y)

Y23: B.Tech. - Internet of Things

Category: Audit Courses (AUC)

22UC0009 - ECOLOGY AND ENVIRONMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22UC0009	ECOLOGY AND ENVIRONMENT	E&E	R	2	0	0	0	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Discuss natural resources and importance of environmental science.	2	PO7
CO2	Describe various ecosystems and applications of biodiversity.	2	PO7
CO3	Identify and discuss causes, preventive measures of environmental pollution.	2	PO7
CO4	Summarize constitutional acts for environmental science, knowledge on solid waste management and disaster management.	2	PO7, PO8

Syllabus

The Multidisciplinary nature of Environmental Studies Introduction to Environment Definition scope importance Multidisciplinary nature of Environmental Studies, Need for public awareness. Institutions and people in Environment. Natural Resources Renewable and Non Renewable Resources Forest resources Uses Deforestation causes, effects, and impacts, Afforestation Programmes-Socio-forestry, Agro forestry, Vanasamrakshana programs. Mining its impact on the environment mining, dams and their effects on forests and tribal people. Water resources: Distribution of surface and groundwater, Aquifers, floods drought conflicts over water, dams benefits and problems, Water conservation rain water harvesting watershed management, Cloud seeding Mineral resources: Use exploitation environmental effects. Food resources Changes in agricultural methodologies, comparison between old and new methods of farming, Green Revolution, Environmental Impact Assessment of conversion of agricultural lands effects of modern agriculture, Drip Irrigation fertilizer-pesticide problems, Eutrophication, Vermicompost water logging, blue baby syndrome Energy resources Growing energy needs renewable and non-renewable energy sources Solar, wind, geothermal, tidal, bioenergies. Land resources Land as a resource land degradation Soil erosion: Importance of soil, Types of soil erosion, Causes and effects of soil erosion. How to control soil erosion. Role of an individual in conservation of natural resources.

Ecosystems Concept of an ecosystem Structure and function of an ecosystem Producers consumers decomposers with examples, Energy flow in the ecosystem Ecological succession Food chains food webs and ecological pyramids. Types of ecosystems characteristic features, structure, and function of the following ecosystem a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem e. Aquatic ecosystems ponds, streams, lakes, rivers, oceans, estuaries. Biodiversity and its Conservation: Introduction Definition: genetic, species and ecosystem diversity. Biogeographical classification of India Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values Biodiversity at global, National, and local levels India as a mega-diversity nation Hotspots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts. Endangered and endemic species of India Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution Definition Causes, effects, and control measures of a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution. e. Noise pollution f. Thermal pollution g. nuclear hazards Solid waste Management Causes, effects, and control measures of urban and industrial wastes. Role of an individual in the prevention of pollution. Pollution case studies. Disaster management floods, earthquakes, cyclones, and landslides. Social Issues and the Environment from Unsustainable to Sustainable development Urban problems related to energy Water conservation. rainwater harvesting, watershed management.

Resettlement, and rehabilitation of people its problems and concerns. Case studies Environmental ethics issues and possible solutions. Climate change global warm acid rain, ozone layer depletion. nuclear accidents and holocaust. Case studies. Wasteland reclamation. Environmental Protection Act, Air (Prevention and Control of Pollution) Act Water (Prevention and control of Pollution) Act Wildlife Protection Act Forest Conservation Act Issues involved in the enforcement of environmental legislation. Public awareness Human Population and the Environment Population growth, Population explosion Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV AIDS Case Studies.

Reference Books

- 1 Text Book of Environmental Studies, Erach Bharucha, 2010 , 4, United Grants Commission, Universities Press (India) Pvt Ltd., Hyderabad .
- 2 Environmental Studies, Benny Joseph, 2009, 5, The McGraw-Hill Companies, New Delhi.
- 3 Textbook of Environmental Studies, Deeksha Deve and S.S. Kateswa , 2009, 3, Cengage Learning India Pvt ltd, New Delhi .
- 4 Environmental Studies, Anubha Kaushik, C.P. Kaushik , 2007, 4, New Age International.
- 5 Environmental Biology, P.D. Sharma, 2009, 7, Rastogi Publications, Meerut.

23UC0008 - INDIAN CONSTITUTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC0008	INDIAN CONSTITUTION	IC	R	2	0	0	0	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To acquire knowledge of the historical developments that culminated in the drafting of the Indian Constitution.	2	PO6
CO2	To understand the basic features of the Indian Constitution.	2	PO6
CO3	To understand the structure of the Federal government as defined by the Indian Constitution.	2	PO6
CO4	To understand the Indian Judicial system and election commission of india	2	PO6

Syllabus

Making of the Constitution: A brief analysis of National Movement, Constitutional Development with reference to Government of India Act 1909, 1919, 1935 and Indian Independence Act 1947. The Constituent Assembly of India. Basic features of the Indian Constitution: the Preamble, Fundamental Rights,

Basic features of the Indian Constitution and the Preamble, Fundamental Rights, Directive Principles of State Policy Fundamental Duties Government of the Union:

Government of the State:

Jurisdiction and functions, judicial review, Judicial activism, Independence of Judiciary In India. Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners

Reference Books

- 1 Indian Polity, M Laxmikanth , 7 Edition, McGraw Hill.
- 2 Democracy and Good Governance Some Guidelines for Today's Parliamentarians, Subhash Kashyap, 1 June 2017, Vitasta Publishing Pvt.Ltd.
- 3 Indian Administration, M. Sharma, 1 December 2004, Anmol Publisher.
- 4 Indian Constitutional Law , M P Jain , 4 February 2018, LexiNexis.

23UC0013 - GLOBAL LOGIC BUILDING CONTEST PRACTICUM (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC0013	GLOBAL LOGIC BUILDING CONTEST PRACTICUM	GLBCP	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate proficiency in identifying, analyzing, and solving problems using logical reasoning.	2	PO1, PO2, PO3, PSO1
CO2	Apply logical reasoning to global issues, considering multiple perspectives and potential solutions.	3	PO1, PO2, PO3, PSO1
CO3	Identify logical principles to assess ethical dilemmas and develop reasoned solutions.	3	PO1, PO2, PO3, PSO1
CO4	Inspect the ability to apply learned logical skills to new and unfamiliar challenges.	4	PO1, PO2, PO3, PSO1

Syllabus

Critical thinking skills necessary to identify, analyze, and solve problems effectively using logical reasoning through interactive exercises and practical applications.

Thinking Through Universal Challenges: Logical reasoning by exploring the challenges from multiple viewpoints and analyze potential solutions.

Explore principles like considering consequences, respecting rights, and upholding fairness to identify the core values in conflict. By applying these principles, Systematically analyze dilemmas, weigh options, and develop reasoned solutions that prioritize ethical conduct.

Logical reasoning skills honed can be applied beyond familiar situations, equipping you to tackle new and unexpected challenges by breaking them down, analyzing information effectively, and crafting sound solutions.

Reference Books

- 1 The art of thinking : a guide to critical and creative thought, Ruggiero, Vincent Ryan, 2012, Boston : Pearson Learning Solutions.
- 2 Thinking, Fast and Slow, Daniel Kahneman , 2015, PENGUIN UK.
- 3 Putnam and Beyond, Razvan Gelca , Titu Andreescu, 2007, Springer.
- 4 Problem Solving 101: A Simple Book for Smart People, Ken Watanabe, 2009, Portfolio.

23UC0014 - GLOBAL LOGIC BUILDING CONTEST PRACTICUM (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC0014	GLOBAL LOGIC BUILDING CONTEST PRACTICUM	GLBCP	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate proficiency in identifying, analyzing, and solving problems using logical reasoning.	2	PO1, PO2, PO3, PSO1
CO2	Apply logical reasoning to global issues, considering multiple perspectives and potential solutions	3	PO1, PO2, PO3, PSO1
CO3	Identify logical principles to assess ethical dilemmas and develop reasoned solutions	3	PO1, PO2, PO3, PSO1
CO4	Inspect the ability to apply learned logical skills to new and unfamiliar challenges	4	PO1, PO2, PO3, PSO1

Syllabus

Critical thinking skills necessary to identify, analyze, and solve problems effectively using logical reasoning through interactive exercises and practical applications.

Thinking Through Universal Challenges: Logical reasoning by exploring the challenges from multiple viewpoints and analyze potential solutions

Explore principles like considering consequences, respecting rights, and upholding fairness to identify the core values in conflict. By applying these principles, Systematically analyze dilemmas, weigh options, and develop reasoned solutions that prioritize ethical conduct.

Logical reasoning skills honed can be applied beyond familiar situations, equipping you to tackle new and unexpected challenges by breaking them down, analyzing information effectively, and crafting sound solutions

Reference Books

- 1 The art of thinking : a guide to critical and creative thought, Ruggiero, Vincent Ryan, 2012, Boston : Pearson Learning Solutions.
- 2 Thinking, Fast and Slow, Daniel Kahneman , 2015, PENGUIN UK.
- 3 Putnam and Beyond, Razvan Gelca , Titu Andreescu, 2007, Springer.
- 4 Problem Solving 101: A Simple Book for Smart People, Ken Watanabe, 2009, Portfolio.

23UC0017 - INDIAN KNOWLEDGE SYSTEMS: VEDIC MATHEMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC0017	INDIAN KNOWLEDGE SYSTEMS: VEDIC MATHEMATICS	IKSVM	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	List all the 16 sutras in Vedic Mathematics, Using Vedic mathematics sutras to perform basic arithmetic operations	2	PO1
CO2	Develop the critical thinking skills to solve Shakuntala Devi Puzzles .	3	PO1

Syllabus

Introduction to Indian knowledge system, Indian mathematicians and their contribution to the world, Vedic Mathematics: origin of Vedic mathematics, 16 sutras of Vedic Mathematics by swami Bharti Krishna Tirthji Maharaj, Ekadhiken Purvena, Nikhilam Navatacharamam Dasatah, Antyayoradaskaepi, Base method for multiplication (with base 10,100,1000,1000),Base method for multiplication (with base 50) Urdhva-tiryagbhyam ,Basic arithmetic operation by Vedic sutras by addition by subtraction, Puranapuranaabhyam Antyayoradaskaepi, Yavadunam, , Paravartya Yojayet, Nikhilam method.

Numbers, Ratio, Proportion, Variation, Averages, Percentages, Profit and loss, Time and Distance, Time and Work, Sets and Venn diagrams,logical connectives, Blood Relations and related Shakuntala Devi Puzzles. Deductions, Linear and circular arrangements. Clocks, Calendars, Cubes, Number and letter series, Coding and Decoding, Symbolic representations of given data, Binary Logic, Logical connectives, logical deductions,Non-Verbal reasoning and related Shakuntala Devi Puzzles.

Reference Books

- 1 .Math Sutras:The art of Vedic Speed calculations,, Gaurav Tekariwal, 2023, Penguin Group.
- 2 Vedic Mathematics or Sixteen simple Mathematical Formulae from the Vedas, SWAMI SRI BHARATI KRSNA TIRTHAJI MAHARAJA, , -, Motilal Banarasi Das Press,.
- 3 R. S. Agarwal, A Modern Approach to Verbal and Non-verbal Reasoning, , s chand, 2022, s chand publication.
- 4 Shakuntala Devi Puzzles, , Shakuntala Devi , -, -.
- 5 .Indian Knowledge System, Vol-1&2,, Kapil Kapoor and Avadhesh Kumar Singh,D. K, -, print world press.

23UC0018 - FUNDAMENTALS OF MATHEMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23UC0018	FUNDAMENTALS OF MATHEMATICS	FOM	R	3	0	0	0	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply matrix theory to solve system of linear equations.	3	PO1
CO2	Apply trigonometric identities to solve trigonometric equations and also predict the data by using concepts combinatorics	3	PO1
CO3	Apply calculus concept to determine areas and volumes and also solve differential equations.	3	PO1
CO4	Apply statistical methods to find central tendency of the given data and also find directional ratios by vector algebra concepts.	3	PO1

Syllabus

Matrix Algebra Concepts Notation Equality Types of Matrices zero and identity matrix transpose of a Matrix symmetric and skew symmetric Matrices Operations of Matrices Addition Subtraction Multiplication Determinant adjoint and inverse of a square matrix. Solving system of linear equations in two or three variables Matrix Method and Cramers Rule.

Trigonometry Generation of angles quadrants measurement of angles radians Trigonometric ratios and functions. Inverse trigonometric functions. Complex Numbers Complex Numbers and its properties Permutations and Combinations Fundamental Principle of counting. Applications on Permutations and Combinations

Differential and Integral Calculus Derivatives of polynomials and exponential functions product and quotient rules. derivatives of trigonometric functions and chain rule Derivatives of logarithmic functions. Basic problems on Integrations. Differential Equations Definition Formation of first order differential equation equations reduced by separation of variables and linear form. Integration.

Vector Algebra Introduction Magnitude Direction Ratios Types of vectors operations of vectors and its properties with applications Statistics Measures of Central Tendency mean mode median Standard deviation variance

Reference Books

- 1 Higher Engineering Mathematics, Dr. B.S. Grewal., 8th, Khanna Publisher.
- 2 Higher Engineering Mathematics,, Routledge, 8th, John Bird..
- 3 Advanced Engineering Mathematics , Erwin Kreyszig, 10th, John Wiley & Sons,.
- 4 Mathematical Statistics, J. N. Kapur , 12th, . Chand.

CADCATL1V1 - CAREER ADVANCEMENT: CAT, GMAT TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADCATL1V1	CAREER ADVANCEMENT: CAT, GMAT TRAINING	CAD: CAT-	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply mathematical concepts to solve complex quantitative problems and interpret various data formats effectively.	3	PO10, PO12
CO2	Apply their understanding of vocabulary, grammar, and logical reasoning to analyze complex texts, evaluate arguments, and solve challenging verbal reasoning problems.	3	PO10, PO12

Syllabus

Fundamentals of Quantitative Aptitude and Data Interpretation : Essential mathematical concepts such as number systems, arithmetic, algebra, geometry, and data interpretation. Topics will include properties of numbers, fractions, decimals, percentages, ratios, proportions, equations, inequalities, coordinate geometry, tables, graphs, and data analysis.

Verbal Ability and Logical Reasoning: This module will focus on developing verbal and logical reasoning skills. Topics will include reading comprehension, vocabulary, grammar, critical reasoning, and verbal reasoning. Students will learn to analyze passages, draw inferences, identify main ideas, improve vocabulary, understand grammatical rules, evaluate arguments, and solve logical puzzles.

Reference Books

- 1 Quantitative Aptitude for CAT, Arun Sharma, 11, McGrawHill.
- 2 How To Prepare For Verbal Ability & Reading Comprehension For CAT, Arun Sharma, Meenakshi Upadhyay, 11, McGrawHill.
- 3 How to Prepare for Data Interpretation for CAT, Arun Sharma, 8, McGrawHill.
- 4 Verbal Ability and Reading Comprehension for CAT, Nishit K. Sinha, 4, Pearson Education.

CADCORL1V1 - CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADCORL1V1	CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN	CAD: TICD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply advanced domain-specific concepts and emerging trends to address industry challenges and innovations.	3	PO1, PO2
CO2	Apply advanced problem-solving and strategic decision-making techniques to manage complex projects within the core domain.	3	PO1, PO2

Syllabus

Core Concepts, theories, and frameworks of the specific domain (e.g., finance, IT, healthcare, engineering), Advanced Domain-Specific Tools, innovations and their impact on the core domain, Real-world examples of how new trends are being applied within the domain

Domain specific challenges, Practical exercises to resolve complex issues in the domain, best practices for managing projects within the domain, Case Studies and Simulations.

CADCORL2V2 - CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADCORL2V2	CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN	CAD: TICD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply effective leadership styles and strategies to lead cross-functional teams and influence key stakeholders in domain-specific roles.	3	PO1, PO2
CO2	Apply industry-relevant practices to implement innovation and manage organizational change while fostering a culture of continuous improvement.	3	PO1, PO2

Syllabus

Leadership approaches in industry-specific environments, negotiation techniques with stakeholders, strategies to lead cross-functional teams, leadership strategies from domain leaders and industry executives.

Change in domain-specific projects, technology transitions, or organizational transformations, Case Studies on Innovation and Change, Industry Regulations and Compliance, Risk Management Techniques, Interactive sessions with domain experts.

CADENTL1V1 - CAREER ADVANCEMENT:ENTREPRENEURIAL CAREER PATHWAY TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADENTL1V1	CAREER ADVANCEMENT:ENTREPRENEURIAL CAREER PATHWAY TRAINING	CAD: ECPT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	apply essential entrepreneurial qualities such as resilience, innovation, and risk-taking, enabling them to pursue entrepreneurial career paths in various contexts, including startups, corporate roles, and freelancing.	3	PO9, PO11
CO2	Develop the skills to recognize potential business opportunities, conduct thorough market research, and validate ideas by addressing customer needs and evaluating feasibility, preparing them to create sustainable business solutions.	3	PO9, PO11

Syllabus

Defining entrepreneurship: What it means to be an entrepreneur; The distinction between entrepreneurial and traditional career paths; The entrepreneurial mindset: resilience, risk-taking, innovation, and adaptability; Exploring entrepreneurial career pathways in startups, corporate environments, freelancing, and social ventures.

Spotting opportunities: How to find unmet needs and gaps in the market; Market research: Tools and techniques for understanding trends and customer needs; Idea validation: Testing the feasibility of your business idea; Problem-solving for innovation: Leveraging customer pain points and inefficiencies.

Reference Books

- 1 The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, 1st (2011), Crown Business.
- 2 The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company, Steve Blank, Bob Dorf, 2nd (2020), K&S Ranch Press.
- 3 Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Alexander Osterwalder, Yves Pigneur, 1st (2010), Wiley.
- 4 The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Clayton M. Christensen, 1st (1997), Harvard Business Review.

CADGATL1V1 - CAREER ADVANCEMENT: GATE TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADGATL1V1	CAREER ADVANCEMENT: GATE TRAINING	CAD: GATE	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply advanced mathematical concepts and techniques to solve complex engineering problems	3	PO1, PO2
CO2	Apply their understanding of verbal ability, numerical ability, and general awareness to solve problems in a variety of contexts	3	PO1, PO2

Syllabus

This module will cover advanced topics in mathematics relevant to engineering disciplines. Topics may include linear algebra, calculus, differential equations, probability and statistics, numerical methods, and complex analysis. Students will learn to apply these concepts to solve engineering problems, analyze data, and develop mathematical models.

This module will focus on developing verbal ability, numerical ability, and general awareness. Topics may include reading comprehension, vocabulary, grammar, quantitative aptitude, logical reasoning, data interpretation, and current affairs. Students will learn to communicate effectively, solve mathematical problems, analyze data, and demonstrate general knowledge.

Reference Books

- 1 A Modern Approach To Verbal & Non-Verbal Reasoning, Dr. R.S. Aggarwal, 2024, S.Chand.
- 2 Advanced Engineering Mathematics, Erwin Kreyszig, 2015, Wiley.
- 3 Introductory Statistics, Sheldon M. Ross, 2017, Academic Press.
- 4 Quantitative Aptitude, R. S. Aggarwal, 2017, S. Chand Limited.

CADGREL1V1 - CAREER ADVANCEMENT: GRE, TOEFL & IELTS TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADGREL1V1	CAREER ADVANCEMENT: GRE, TOEFL & IELTS TRAINING	CAD: GRE-	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply vocabulary, reading comprehension strategies, and analytical writing techniques to solve verbal reasoning questions and compose structured essays across standardized test scenarios.	3	PO9, PO10
CO2	Apply effective time management, critical thinking, and communication strategies in listening, speaking, and writing tasks during test simulations to improve performance in real-world exam settings.	3	PO9, PO10

Syllabus

vocabulary building, reading comprehension strategies, critical thinking for analytical writing, and problem-solving techniques. Listening will focus on understanding academic conversations and lectures, while speaking skills emphasize fluency, coherence, and pronunciation. Writing will include essay structuring, argument development, and responding to prompts effectively.

Advanced reading of complex texts, mastering time management, and refining both written and spoken responses. verbal reasoning, quantitative reasoning Practice through mock tests

Reference Books

- 1 The Official Guide to the GRE General Test, ETS, 2022, Educational Testing Service.
- 2 The Complete Guide to the TOEFL Test, Bruce Rogers, 2019, Cengage Learning.
- 3 Cambridge IELTS 16 Academic Student's Book with Answers, CUP, 2021, Cambridge University Press.

CADUPSL1V1 - CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADUPSL1V1	CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING	CAD: UPSC	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the basics of Indian History and it's evolution	2	PO6, PO7, PO8
CO2	Understanding the basics of Indian Geography	2	PO6, PO7, PO8
CO3	Understanding the Evolution of Indian Constitution.	2	PO6, PO7, PO8
CO4	Understanding the evolution of Indian Economy	2	PO6, PO7, PO8

Syllabus

Ancient Indian History- IVC, Rig Vedic, Later Vedic, Buddhism, Jainism, Mahajanapadas, Mouryan Empire, Guptan Empire, Harshavardhana empire, Sangam Age.

Exploring The Physical and Social Geography of India: The Universe, Big Bang Theory, Solar system, Geological Time Scale, Earth's Interior, Earth's Magnetic Field.

Indian Polity and Constitution: Salient features of Indian constitution, Preamble, Fundamental Rights, Directive Principles of State Policy, Fundamental Duties, Indian Parliament.

Understanding India's Economy - Indian Economic Development, National Income, Public Finance, Indian Budget.

Reference Books

- 1 Indian Polity, M. Laxmikanth, 7, Tata Mc Graw Hill.
- 2 Indian Economy, Nitin Singhania, 5, Mc Graw Hill.
- 3 Ancient and Medieval India, Poonam Dalal Dahiya, 3, Mc Graw Hill.
- 4 Fundamentals of Physical Geography, Husain Majid, 5, Mc Graw Hill.

CADUPSL2V2 - CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CADUPSL2V2	CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING	CAD: UPSC	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and Evaluate the significant political, cultural, and social changes and its influence in contemporary society	2	PO6, PO7, PO8
CO2	Understand and assess the interactions between human activities and economic systems in shaping geographic landscapes.	2	PO6, PO7, PO8
CO3	Understand and analyze the structure and functioning of India's parliamentary and federal systems, including the intricacies of centre-state relations.	2	PO6, PO7, PO8
CO4	Understand and able to critically evaluate the key components of the Indian economy.	2	PO6, PO7, PO8

Syllabus

Medieval Indian History: Vijayanagaras, Kakatiyas, Delhi Sultanate, Mughal Empire and Later Mughals.

Human and Economic Geography: Population, Migration, Trade, Human settlements, Resources, Minerals and Industrial Development.

Indian Polity: Parliamentary system, Federal system, Centre-state relations, Emergency Provisions.

Indian Economy: Money and Banking, Inclusive Growth & Development, Agriculture, Subsidies, PDS, Food Security Industries,

Reference Books

- 1 Medieval Indian History, Satish Chandra, 5, Mc Graw Hill.
- 2 Indian Constitution, D D Basu, 27, Lexicon.
- 3 Indian Economy, Ramesh Singh, 15, Mc Graw Hill.
- 4 Physical, Human and Economic Geography, D R Khuller, 2, GKP/ Access Publications.

CRTCODL1V1 - CAMPUS RECRUITMENT: LOGIC BUILDING SKILLS TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTCODL1V1	CAMPUS RECRUITMENT: LOGIC BUILDING SKILLS TRAINING	CRT: LBST	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply logical principles and critical thinking skills to analyze and evaluate arguments, solve problems, and make informed decisions.	3	PO1, PO2
CO2	Identify various logical reasoning techniques to solve complex problems, identify patterns, and draw valid conclusions	3	PO1, PO2

Syllabus

Introduction to Logic and Critical Thinking: fundamentals of logic, including the concepts of statements, propositions, truth values, logical connectives (AND, OR, NOT, IF-THEN, IF-AND-ONLY-IF), truth tables, and logical equivalence. Students will learn to identify and analyze different types of arguments, including deductive and inductive reasoning. They will also develop critical thinking skills, such as evaluating evidence, identifying assumptions, and recognizing fallacies

Logical Reasoning and Problem-Solving: applying logical reasoning techniques to solve various types of problems. Students will learn about different problem-solving strategies, including problem decomposition, pattern recognition, working backward, and using analogies. They will practice solving logic puzzles, brain teasers, and real-world problems that require logical thinking. Additionally, students will explore the concepts of syllogisms, Venn diagrams, and conditional reasoning to enhance their problem-solving abilities

Reference Books

- 1 Introduction to Logic, Irving M. Copi, Carl Cohen, Victor Rodych, 2014, Routledge.
- 2 Critical Thinking, Richard Paul, Linda Elder, 2019, Pearson.
- 3 The Art of Logical Thinking; Or, The Laws of Reasoning, William Walker Atkinson, 2013, Public domain in the
- 4 Symbolic logic and The game of logic, Carroll, Lewis, 1958, Dover Publications.

CRTCODL2V2 - CAMPUS RECRUITMENT: CODING SKILLS TRAINING - DATA STRUCTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTCODL2V2	CAMPUS RECRUITMENT: CODING SKILLS TRAINING - DATA STRUCTURES	CRT: CST-DS	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Make use of arrays, linked lists, stacks, and queues to solve a variety of programming problems efficiently	3	PO1, PO2
CO2	Apply the knowledge of trees, graphs, heaps, and hash tables to design and implement efficient algorithms for complex data-intensive applications	3	PO1, PO2

Syllabus

This module will cover the basic building blocks of data structures. Students will learn about arrays, linked lists, stacks, and queues, their characteristics, operations, and applications. They will also practice implementing these data structures in a programming language and solving problems using them.

This module will delve into more complex data structures. Students will explore trees, graphs, heaps, and hash tables, their properties, algorithms, and use cases. They will learn to analyze and choose the appropriate data structure for a given problem and implement efficient solutions using these structures.

Reference Books

- 1 Data Structures and Algorithms Made Easy in Java, Narasimha Karumanchi, 2011, CareerMonk.
- 2 Introduction To Algorithms, Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, 2009, Open Source.
- 3 CRACKING the CODING INTERVIEW, Gayle Laakmann McDowell, 2015, CareerCup.
- 4 Algorithms, Robert Sedgewick and Kevin Wayne , 2024, Addison Wesley.

CRTCODL3V3 - CAMPUS RECRUITMENT: CODING SKILLS TRAINING - ALGORITHMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTCODL3V3	CAMPUS RECRUITMENT: CODING SKILLS TRAINING - ALGORITHMS	CRT: CST-ALG	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify various searching and sorting algorithms to efficiently solve problems involving large datasets	3	PO1, PO2
CO2	Design and implement dynamic programming algorithms to solve problems with overlapping subproblems	3	PO1, PO2

Syllabus

This module introduces essential algorithms and data structures for problem-solving. Topics include searching algorithms (linear search, binary search), sorting algorithms (bubble sort, insertion sort, selection sort, merge sort, quicksort), recursion, divide-and-conquer, greedy algorithms, and basic data structures (arrays, linked lists, stacks,

This module delves into more complex algorithms and techniques. Topics include dynamic programming (Fibonacci sequence, knapsack problem), graph algorithms (breadth-first search, depth-first search, Dijkstra's algorithm, minimum spanning trees), backtracking (n-queens problem, Sudoku solver), branch-and-bound (traveling salesman problem), and algorithmic analysis (time complexity, space complexity).

Reference Books

- 1 Introduction To Algorithms, Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, 2009, Open Source.
- 2 Algorithms, Robert Sedgewick and Kevin Wayne, 2011, Addison-Wesley Professional.
- 3 Data structures and algorithms in Java, Goodrich, Michael T, 2020, John Wiley and Sons.
- 4 Cracking the Coding Interview, Gayle Laakmann McDowell, 2015, CareerCup.

CRTCSSL1V1 - CAMPUS RECRUITMENT: COMMUNICATION SKILLS TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTCSSL1V1	CAMPUS RECRUITMENT: COMMUNICATION SKILLS TRAINING	CRT: CST	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	apply knowledge of communication of different types and techniques while analyzing body language and tone to enhance overall communication effectiveness.	3	PO10
CO2	apply active listening and feedback techniques, and analyzing effective participation in group discussions, while exploring roles in teamwork and strategies for managing conflicts, alongside professional communication practices such as writing emails and conducting meetings.	3	PO9

Syllabus

Communication: Basics, significance, types, verbal & non-verbal communication techniques, effective speaking and presentation skills tone and pacing in verbal interactions

Interpersonal skills, listening skills, feedback techniques, group communication and dynamics, group discussion, conflict management in professional communication, E-mail writing, report writing, presentations, interview skills.

Reference Books

- 1 Business Communication: A Problem-Solving Approach, Louis E. Boone & David L. Kurtz, 3rd Edition, McGraw Hill Education.
- 2 The Complete Guide to Business School Presentations", Jennifer D. D. McDonald, 2nd Edition, Pearson.
- 3 Listening: The Forgotten Skill", Geoffrey M. Cohen, 1st Edition, University Press of America.
- 4 Business Communication: Process and Product", Mary Ellen Guffey & Dana Loewy, 8th Edition, Cengage Learning.
- 5 Effective Communication Skills" Author, John Adair, 2nd Edition, Pan Macmillan.

CRTCSSL2V2 - CAMPUS RECRUITMENT: SOFT SKILLS TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTCSSL2V2	CAMPUS RECRUITMENT: SOFT SKILLS TRAINING	CRT: SST	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	apply and practice empathy, critical thinking, problem-solving, decision-making, effective communication, and interpersonal skills through real-life scenarios and interactive activities.	3	PO10
CO2	apply group discussion techniques, interview skills, and mock interviews through practical exercises, encouraging learners to practice and refine these skills in realistic settings.	3	PO9

Syllabus

Critical thinking, problem solving, decision making, communication skills, interpersonal skills

Grooming, group discussions, story narrations, interview skills, mock interviews

Reference Books

- 1 "Personality Development and Soft Skills", Barun K. Mitra, 2nd Edition, Oxford University Press.
- 2 "Communication Skills for Engineers", C. Muralikrishna & Sunita Mishra, 1st Edition, Pearson Education.
- 3 "Developing Soft Skills", Robert L. Katz, 1st Edition, McGraw Hill Education.

CRTINDL1V1 - CAMPUS RECRUITMENT: INDUSTRY-SPECIFIC TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTINDL1V1	CAMPUS RECRUITMENT: INDUSTRY-SPECIFIC TRAINING	CRT: IST	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate knowledge of industry-specific practices and standards relevant to their field of study through practical exposure and engagement in real-world projects.	3	PO9, PO10
CO2	Develop foundational technical skills by applying theoretical concepts in hands-on tasks, enabling them to contribute effectively in a professional environment.	3	PO9, PO10

Syllabus

overview of various industries, workplace ethics, and safety protocols. Students will also learn about industry-specific tools and technologies through hands-on workshops. Essential project management techniques will be covered, along with the development of soft skills such as communication, teamwork, and time management.

selecting a real-world project that allows them to apply their knowledge and skills collaboratively. presentation of project outcomes, demonstrate understanding of industry practices and work effectively in teams.

Reference Books

- 1 Engineering Management: Challenges in the New Millennium, C. M. Chang, 2007, Cengage Learning.
- 2 The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, 2011, Crown Business.
- 3 Project Management for Engineering and Technology, John M. Nicholas and Herman Steyn, 2017, Taylor & Francis.

CRTINDL2V2 - CAMPUS RECRUITMENT: INDUSTRY-SPECIFIC TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTINDL2V2	CAMPUS RECRUITMENT: INDUSTRY-SPECIFIC TRAINING	CRT: IST	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Exhibit advanced problem-solving abilities by analyzing complex industry challenges and proposing innovative solutions based on their training experiences.	3	PO9, PO10
CO2	Enhance professional communication skills by effectively presenting technical information and collaborating with industry professionals, demonstrating an understanding of workplace dynamics.	3	PO9, PO10

Syllabus

advanced industry practices and technical problem-solving. Key topics include current industry trends and innovations, quality assurance processes, and an understanding of regulatory requirements. Students will analyze real-world challenges through case studies and learn innovative solution development techniques, utilizing data analysis tools for informed decision-making.

professional communication and networking strategies, including effective presentation skills and writing technical reports. In the capstone project, students will identify and work on a complex industry-related project in collaboration with professionals, culminating in a final presentation to stakeholders to showcase their findings and solutions.

Reference Books

- 1 Quality Control and Industrial Statistics, Acheson J. Duncan, 1986, Duxbury Press.
- 2 Technical Communication, John M. Lannon and Laura J. Gurak, 2017, Pearson.
- 3 Problem Solving: A Complete Guide, John M. Carroll, 2005, Springer.

CRTTOLL1V1 - CAMPUS RECRUITMENT: TOOL BASED TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTTOLL1V1	CAMPUS RECRUITMENT: TOOL BASED TRAINING	CRT: TBT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply foundational knowledge of various software tools to perform basic tasks and create simple projects	3	PO1, PO2, PO5
CO2	Apply digital tools to create professional-quality content and presentations.	3	PO1, PO2, PO5

Syllabus

Productivity Tools: This module will introduce students to essential productivity tools like Microsoft Office Suite (Word, Excel, PowerPoint), Google Workspace (Docs, Sheets, Slides), and project management tools (Asana, Trello). Students will learn to use these tools efficiently for tasks such as document creation, data analysis, presentations, and project planning.

Communication Tools: This module will cover communication tools like email, social media platforms (LinkedIn, Twitter), video conferencing software (Zoom, Microsoft Teams), and collaboration tools (Slack, Google Chat). Students will learn effective communication strategies and best practices for using these tools professionally.

Reference Books

- 1 Microsoft Office 365: In Practice, Randy Nordell, 2021, McGraw-Hill Education.
- 2 Mastering Collaboration: Make Working Together Less Painful and More Productive, Gretchen Anderson, 2019, O'Reilly Media.
- 3 The Definitive Guide to Google Workspace, Scott La Counte, 2021, ClydeBank Media LLC.

CRTTOLL2V2 - CAMPUS RECRUITMENT: TOOL BASED TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTTOLL2V2	CAMPUS RECRUITMENT: TOOL BASED TRAINING	CRT: TBT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize advanced features of software tools to create complex and customized digital projects for professional applications.	3	PO5, PO9, PO10
CO2	Critically evaluate and apply specialized digital tools to solve real-world problems and improve workflow efficiency.	3	PO5, PO9, PO10

Syllabus

project management tools like Microsoft Project and Trello, advanced document and multimedia tools such as PowerPoint and Adobe Photoshop, and customization techniques using APIs and automation. Students will explore the integration of multiple tools for industry-specific applications like data analytics, design, and content creation.

data management with Excel and Power BI, process automation with tools like Zapier, and streamlining workflows in remote environments. Students will engage in hands-on projects, case studies, and a capstone project to apply digital tools in solving practical challenges.

Reference Books

- 1 Mastering Microsoft Project 2019, Cindy M. Lewis, 2019, Sybex (Wiley).
- 2 Adobe Photoshop Classroom in a Book, Andrew Faulkner & Conrad Chavez, 2020, Adobe Press.
- 3 Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking, Foster Provost & Tom Fawcett, 2020, O'Reilly Media.

CRTVQRL1V1 - CAMPUS RECRUITMENT: VERBAL APTITUDE TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTVQRL1V1	CAMPUS RECRUITMENT: VERBAL APTITUDE TRAINING	CRT: VAT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	apply and practice grammatical concepts like sentence formation, identifying odd words, using one-word substitutions, while enhancing understanding of idioms, phrases, spellings, and structures.	3	PO10
CO2	apply concepts like paragraph formation, sentence completion, reading comprehension, sentence correction, and correcting jumbled sentences, while enhancing word selection and sentence structure accuracy.	3	PO10

Syllabus

Synonyms, Antonyms, odd words, parts of speech, idioms and phrases, one word substitutions, odd words, formation of sentences

sentence completion, sentence correction, jumbled sentences, paragraph formation, reading comprehension, and sentence selection

Reference Books

- 1 The Pearson Guide to Verbal Ability and Logical Reasoning for the CAT", Nishit K. Sinha, 2nd Edition, Pearson.
- 2 Objective General English", S.P. Bakshi, 3rd Edition, Arihant Publications.
- 3 English Grammar in Use", Raymond Murphy, 5th Edition, Cambridge University Press.

CRTVQRL2V2 - CAMPUS RECRUITMENT: QUANTITATIVE APTITUDE TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTVQRL2V2	CAMPUS RECRUITMENT: QUANTITATIVE APTITUDE TRAINING	CRT: QAT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply principles of quantitative techniques to solve problems on Simple Equations, Simple & Compound Interest etc	3	PO9, PO10
CO2	Apply principles of quantitative techniques to solve problems on Divisibility, Functions, Surds & Indices etc	3	PO9, PO10

Syllabus

Simple Equations, Problem on Ages, Ratio & Proportion, Variation & Partnership, Percentages, Profit, Loss & Discounts, Simple & Compound Interest, Averages & Allegations or Mixtures

Numbers, Divisibility, Decimal Fractions, LCM & HCF, Simplification, Sequence, Series & Progressions, Linear Algebra, Quadratic Equations & Inequalities, Theory of Equations. Sets, Relations & Functions, Surds & Indices, Logarithms

Reference Books

- 1 Quantitative Aptitude by R.S. Agarwal, SCHAND Publications, R.S. Agarwal, 2021, SCHAND Publications.
- 2 A Modern Approach to Verbal Reasoning by R.S. Agarwal, SCHAND Publications, R.S. Agarwal, 2021, SCHAND Publications.

CRTVQRL3V3 - CAMPUS RECRUITMENT: REASONING APTITUDE TRAINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
CRTVQRL3V3	CAMPUS RECRUITMENT: REASONING APTITUDE TRAINING	CRT: RAT	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply principles of deductive logic to solve problems on syllogisms, Venn diagrams, etc	3	PO9, PO10
CO2	Apply principles of inductive logic to solve problems on assumptions and conclusions	3	PO9, PO10

Syllabus

Syllogism, Number & letter series, Number, letter & word Analogy, Odd man out, coding & decoding, Cubes & Dice, Logical Venn Diagrams

Statements & conclusions, statements & Arguments (Critical Reasoning), statements & Assumptions, logical connectives, Binary logic

Reference Books

- 1 A Modern Approach to Verbal Reasoning, R.S. Agarwal, 2022, SCHAND Publications.
- 2 Logical Reasoning for CAT, Arun Sharma, 2021, McGraw Hills.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Social Immersive Learning (SIL)

22UC0021 - SOCIAL IMMERSIVE LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22UC0021	SOCIAL IMMERSIVE LEARNING	SIL-1	R	0	0	0	4	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply effective communication and collaboration skills to work with diverse populations in addressing social issues within the community.	3	PO8, PO9, PSO2
CO2	Build technological solutions to real-world problems or challenges with peers to achieve common goals.	3	PO8, PO9, PSO2
CO3	Plan effectively to communicate ideas and collaborate with others to achieve artistic or recreational goals.	3	PO4, PSO2
CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment.	3	PO4, PO9, PSO2
CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences.	3	PO6, PSO2

Syllabus

Extension Activities and Social Outreach activities (ESO)

Technology Clubs (TEC)

Liberal arts, creative arts and hobby clubs (LCH)

Innovation, Incubation & Entrepreneurship (IIE)

Health & Well Being (HWB)

Reference Books

- 1 The Innovators Mindset Empower Learning, Unleash Talent and Lead a Culture of Creativity, George Couros, 1, georgecouros.com.
- 2 Reality+: Virtual Worlds and the Problems of Philosophy, Douglas Thomas and John Seely Brown, 2022, W. W. Norton & Company.
- 3 Immersive Education Designing for Learning, Paula MacDowell, Jennifer Lock, 2022, Springer.
- 4 A New Culture of Learning, John Seely Brown, Douglas Thomas, 2011, CreateSpace Independent Publishing.

22UC0022 - SOCIAL IMMERSIVE LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22UC0022	SOCIAL IMMERSIVE LEARNING	SIL-2	R	0	0	0	4	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply effective communication and collaboration skills to work with diverse populations in addressing social issues within the community.	3	PO8, PO9
CO2	Build technological solutions to real-world problems or challenges with peers to achieve common goals.	3	PO8, PO9
CO3	Plan effectively to communicate ideas and collaborate with others to achieve artistic or recreational goals.	3	PO3, PO8, PO9
CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment.	3	PO3, PO8, PO9, PS02
CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences.	3	PO3, PO8, PO9

Syllabus

Extension Activities and Social Outreach activities (ESO)

Technology Clubs (TEC)

Liberal arts, creative arts and hobby clubs (LCH)

Innovation, Incubation & Entrepreneurship (IIE)

Health & Well Being (HWB)

Reference Books

- 1 The Innovators Mindset Empower Learning, Unleash Talent and Lead a Culture of Creativity, George Couros, 1, georgecouros.com.
- 2 Immersive Education Designing for Learning, Paula MacDowell, Jennifer Lock, 2022, Springer.
- 3 Reality+: Virtual Worlds and the Problems of Philosophy, Douglas Thomas and John Seely Brown, 2022, W. W. Norton & Company.
- 4 A New Culture of Learning, John Seely Brown, Douglas Thomas, 2011, CreateSpace Independent Publishing.

22UC0023 - SOCIAL IMMERSIVE LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22UC0023	SOCIAL IMMERSIVE LEARNING	SIL-3	R	0	0	0	4	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply effective communication and collaboration skills to work with diverse populations in addressing social issues within the community.	3	PO8, PO9
CO2	Build technological solutions to real-world problems or challenges with peers to achieve common goals.	3	PO8, PO9
CO3	Plan effectively to communicate ideas and collaborate with others to achieve artistic or recreational goals.	3	PO3, PO9, PSO2
CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment.	3	PO3, PO9, PSO2
CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences.	3	PO3, PO6, PO9

Syllabus

Extension Activities and Social Outreach activities (ESO)

Technology Clubs (TEC)

Liberal arts, creative arts and hobby clubs (LCH)

Innovation, Incubation & Entrepreneurship (IIE)

Health & Well Being (HWB)

Reference Books

- 1 The Innovators Mindset Empower Learning, Unleash Talent and Lead a Culture of Creativity, George Couros, 1, georgecouros.com.
- 2 Immersive Education Designing for Learning, Paula MacDowell, Jennifer Lock, 2022, Springer.
- 3 Reality+: Virtual Worlds and the Problems of Philosophy, Douglas Thomas and John Seely Brown, 2022, W. W. Norton & Company.
- 4 A New Culture of Learning, John Seely Brown, Douglas Thomas, 2011, CreateSpace Independent Publishing.



(DEEMED TO BE U N I V E R S I T Y)

Y23: B.Tech. - Internet of Things

Category: Minor Degree Courses (MIN)

23MRAC01M - AI FOR BUSINESS STRATEGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAC01M	AI FOR BUSINESS STRATEGY	ABS	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the historical development of AI and its impact on various industries.	3	PO5
CO2	Apply machine learning algorithms for supervised, unsupervised, and reinforcement learning tasks.	3	PO5
CO3	Analyse the suitability of different AI frameworks and tools for specific business applications.	4	PO9
CO4	Analyse the future trends and opportunities in AI and formulate corresponding business strategies	4	PO9

Syllabus

Overview of AI and Its Applications: Definition and scope of AI, Historical context and milestones, AI applications in various industries Understanding Business Strategy: Basics of business strategy, Strategic planning frameworks, Importance of aligning AI with business objectives AI Strategy Development: Formulating an AI strategy, Identifying business opportunities with AI, Case studies of successful AI-driven business strategies Ethical and Regulatory Considerations: Ethical implications of AI in business, Regulatory frameworks and compliance. Addressing bias and fairness in AI algorithms

Foundations of Artificial Intelligence: Machine Learning Fundamentals: Introduction to machine learning, Supervised, unsupervised, and reinforcement learning, Feature engineering and model evaluation Deep Learning Basics: Neural networks and deep learning concepts, Convolutional Neural Networks (CNNs) for image recognition, Recurrent Neural Networks (RNNs) for sequence data

AI Technologies and Tools for Business: Practical AI Tools: Introduction to popular AI frameworks (TensorFlow, PyTorch), Hands-on experience with AI development platforms (Google AI Platform, Azure ML) Natural Language Processing (NLP) in Business, Introduction to NLP and its applications, Sentiment analysis, text summarization, and language translation, Case studies of NLP in business contexts

AI Implementation and Impact on Business Strategy: AI Implementation Challenges: Challenges in deploying AI solutions in business, Integration with existing systems and workflows, Change management and organizational readiness AI Business Strategy in Practice: Real-world examples of AI-driven business transformations, Strategic decision-making with AI insights, Future trends and opportunities in AI and business strategy

Reference Books

- 1 Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig , 2021, Pearson.
- 2 Competing in the Age of AI, Marco Iansiti and Karim R. Lakhani, 2020, Harvard Business Review Press.
- 3 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2017, MIT Press.
- 4 Decision Intelligence Analytics, P. Mary Jeyanthi, Tanupriya Choudhury, 2022, Springer.

23MRAC02M - AI STRATEGY AND GOVERNANCE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAC02M	AI STRATEGY AND GOVERNANCE	ASG	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and articulate the key concepts and components of AI strategy within engineering organizations.	2	PO1
CO2	Understand and analyse AI governance frameworks and policies, considering ethical, legal, and societal implications	2	PO2
CO3	Apply risk management strategies for AI projects, identifying potential risks and mitigation approaches	3	PO3
CO4	Formulate and implement AI strategies that align with organizational goals and regulatory requirements	4	PO4, PSO1, PSO2

Syllabus

Foundations of AI Strategy and Governance: Introduction to AI Strategy and Governance, Overview of AI in engineering, Importance of AI strategy, Key governance issues in AI. AI Strategy Fundamentals: Defining AI strategy, Components of a successful AI strategy, Case studies of AI strategy in engineering. AI Governance Frameworks: Overview of AI governance, Regulatory and compliance aspects, International standards and best practices

Ethical and Societal Considerations: Ethical Considerations in AI: Ethical implications of AI, Bias and fairness in AI, Privacy and data protection. Legal and Societal Implications of AI: Legal frameworks for AI, Societal impacts of AI, Role of public policy in AI governance. AI Risk Management: Identifying risks in AI projects, Risk assessment methodologies, Developing risk mitigation strategies.

AI Strategy Implementation: AI in Organizational Strategy: Integrating AI with business strategy, AI-driven innovation and competitive advantage, Strategic planning for AI implementation. Case Studies and Applications: Real-world applications of AI in engineering, Success stories and lessons learned, Group discussions and presentations. AI Policy Development: Crafting AI policies, Policy implementation and monitoring, Role of stakeholders in policy development

Advanced Topics and Future Trends: AI Governance in Practice: Best practices for AI governance, Tools and technologies for governance, Continuous improvement in AI governance. Future Trends in AI Strategy and Governance: Emerging trends and technologies, Future challenges and opportunities, Preparing for the future of AI. Course Review and Final Project Presentations: Review of key concepts, Final project presentations, Course wrap-up and feedback

Reference Books

- 1 Artificial Intelligence: A Guide for Thinking Humans, Melanie Mitchell, 1st Edition, 2019, Farrar, Straus and
- 2 The Ethics of Artificial Intelligence, Nick Bostrom and Eliezer Yudkowsky, 1st Edition, 2014, Cambridge University Press.
- 3 AI Superpowers: China, Silicon Valley, and the New World Order, Kai-Fu Lee, 1st Edition, 2018, Houghton Mifflin Harcourt.
- 4 HBR Guide to AI Basics for Managers, Eric Siegel, 2023, Harvard Business Review Press.

23MRAC03M - SUCCESSFUL AI STRATEGIES : A CEO'S PERSPECTIVES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAC03M	SUCCESSFUL AI STRATEGIES : A CEO'S PERSPECTIVES	SAI	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the strategic importance of AI in business leadership. Learn to articulate a clear AI vision and foster an AI-centric culture within an organization	2	
CO2	Analyze the skills to align AI initiatives with business objectives and build cross-functional teams. Gain insights into creating and implementing robust data strategies	3	PO1
CO3	Understanding the knowledge of the technological infrastructure required for scalable AI solutions. Understand the ethical considerations and social responsibilities associated with AI	2	PO6
CO4	Analyze the ability to measure and improve the performance of AI initiatives. Learn to plan and execute scalable AI strategies for global expansion	3	PO4

Syllabus

Introduction to AI in Business Overview of AI and its Impact on Industries AI Trends and Future Prospects Workshop: Identifying AI Opportunities in Various Sectors Vision and Leadership Articulating Fostering an AI Creating an AI Vision Statement for a Business -Centric Culture a Clear AI Vision

Strategic Integration Aligning AI with Business Objectives Building Cross-Functional AI Teams Successful AI Integration Case Studies Proposing AI Projects Aligned with Business Strategies Data Strategy Data Collection and Quality Data Governance and Security Designing a Data Strategy for AI Implementation

Technology and Infrastructure Scalable AI Infrastructure Emerging AI Technologies Insights from Leading Tech Companies Developing an AI Infrastructure Plan

Ethical AI and Social Responsibility Ethical Considerations in AI AI for Social Good Creating an Ethical AI Policy for an Organization Performance Measurement and Scalability Key Performance Indicators for AI Planning for Scalability and Global Expansion Presenting AI Strategies and Implementation Plans

Reference Books

- 1 "Artificial Intelligence: A Guide for Thinking Humans", Melanie Mitchell, 1 1984, Amazon Books.
- 2 "Artificial Intelligence: A Guide for Thinking Humans", Ajay Agrawal, Joshua Gans, and Avi Goldfarb, 1 2001, Taylor and Fransis.
- 3 "Human + Machine: Reimagining Work in the Age of AI", by Paul R. Daugherty and H. James Wilson, 1 2012, Amazon Books.
- 4 "Competing in the Age of AI: Strategy and Leadership When Algorithms and Networks Run the World", Marco Iansiti and Karim R. Lakhani, 1 2008, Harvard Business School.
- 5 AI Superpowers: China, Silicon Valley, and the New World Order, Kai-Fu Lee, 1 2010, Amazon Books.

23MRAC04M - CRAFTING A COMPETITIVE ADVANTAGE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAC04M	CRAFTING A COMPETITIVE ADVANTAGE	CCA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of competitive advantage.	2	PO1
CO2	Understand the role of innovation, differentiation, and cost leadership in competitive environment.	2	PO4
CO3	Apply the concept of competitive environment and market dynamics for decision making.	3	PO5
CO4	Apply the strategic initiatives to create and sustain competitive advantage for organisations.	3	PO5

Syllabus

Introduction to Competitive Advantage: Definition and Importance of Competitive Advantage, Historical Perspectives, Core Concepts: Value Creation, Value Capture Industry Analysis and Competitive Forces: Porter's Five Forces Framework Industry Structure and Profitability

Internal Analysis and Resource-Based View: Resource-Based View (RBV) of the Firm, Core Competencies and Capabilities, VRIO Framework (Value, Rarity, Imitability, Organization) Strategy Formulation: Cost Leadership and Differentiation Cost Leadership Strategy Differentiation Strategy Focus Strategy

Innovation and Disruption: Role of Innovation in Competitive Advantage, Disruptive Innovation Theory, Blue Ocean Strategy Sustaining Competitive Advantage: Barriers to Imitation, Dynamic Capabilities, Continuous Improvement

Strategic Alliances and Partnerships: Role of Strategic Alliances in Competitive Advantage, Types of Alliances: Joint Ventures, Partnerships, Mergers Global Strategies for Competitive Advantage: Globalization and Competitive Advantage Multinational vs. Global Strategies Cross-Cultural Considerations

Reference Books

- 1 Competitive Advantage: Creating and Sustaining Superior Performance, Porter, M. E. , 1985, Free Press.
- 2 Firm Resources and Sustained Competitive Advantage, Jay B. Barney, 1991, Journal of Management, Sage Publications.
- 3 Blue Ocean Strategy: How to Create Uncontested Market Space and Make the Competition Irrelevant, W. Chan Kim and Ren?e Mauborgne, 2015, Harvard Business Review Press.
- 4 Essentials of Strategic Management: The Quest for Competitive Advantage, John E. Gamble, Arthur A. Thompson Jr., and Margaret A. Peteraf, 2018, McGraw-Hill Education.

23MRAG01 - INTRODUCTION TO GAME MATH (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAG01	INTRODUCTION TO GAME MATH	IGM	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the solid foundations of basic arithmetic, algebra, geometry, and trigonometry, essential for implementing game mechanics and algorithms.	1	PO1, PO3
CO2	Explore the principles of coordinate geometry, trigonometry, and vectors to solve complex problems in mathematical and practical contexts, demonstrating a deep understanding of the underlying concepts.	2	PO2, PO4
CO3	Apply mathematical concepts such as vectors, matrices, and quaternions to solve practical problems in 2D and 3D game development, including transformations, rotations, and collision detection.	3	PO1, PO3
CO4	Analyze to integrate mathematical knowledge with game design and development, creating functional game mechanics, realistic physics simulations, and efficient algorithms for AI and procedural generation.	4	PO2

Syllabus

Introduction to the course and its objectives, Overview of game development and the role of mathematics, Basic arithmetic operations, Order of operations (PEMDAS/BODMAS), Basic Algebra, Variables and constants Solving linear equations, Functions and their graphs, Geometry Fundamentals, Points, lines, and angles, Basic 2D and 3D shapes, Perimeter, area, and volume.

Coordinate Geometry, Cartesian coordinate system, 1D, 2D, 3D, Left hand and right hand coordinate system, Left and Right hand rotation rule, Plotting points and lines, Distance formula and midpoint formula, Introduction to Trigonometry, Understanding sine, cosine, and tangent, Right triangle relationships, Basic trigonometric identities, Vectors in 2D, Definition and properties of vectors, Vector addition, subtraction, Dot product and applications.

Linear Algebra Basics, Introduction to matrices, Matrix operations (addition, subtraction, multiplication), Transformations: Translation, rotation, scaling, Advanced Trigonometry, Trigonometric functions and their graphs, Inverse trigonometric functions, , Solving trigonometric equation.s

Analyze to introduce Quaternions, Understanding quaternions and their advantages, Basic quaternion arithmetic, Using quaternions for 3D rotations, Probability and Randomness, Basic probability theory, Random number generation, Probability distributions, Graph Theory Basics, Graphs and networks, , Pathfinding algorithms (introduction to A*), State machines and their uses in AI.

Reference Books

- 1 Essential Mathematics for Games and Interactive Applications , James M. Van Verth , Lars M. Bishop , 3rd edition , A K Peters/CRC Press .
- 2 Computer Graphics: Principles and Practice , ohn Hughes , Andries van Dam, Morgan McGuire , David Sklar , James Foley, Steven Feiner , Kurt Akeley, 3rd edition , Addison-Wesley Professional .
- 3 3D Math Primer for Graphics and Game Development , Fletcher Dunn , 2nd edition , A K Peters/CRC Press .
- 4 Mathematics for 3D Game Programming and Computer Graphics , Eric Lengyel , 3rd edition , Cengage Learning, Inc .

23MRAG02 - DRAWING BASICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAG02	DRAWING BASICS	DBS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction of drawing concepts & utilities	2	PO1
CO2	The necessity of drawing to compositing new ideas in a practical way with proper examples	2	PO2
CO3	The techniques of drawing for various purposes and planning of compositions and its expressions. From anatomy to contemporary contours students must learn the variations and its utilities	3	PO3

Syllabus

Cultural Drawing: Different civilizations approach withdrawing from Cave paintings, medieval art, and design, Folk art, traditional arts, pre, and postindependence art, and contemporary art practice. Transformation Drawing: Process of converting an idea

Animation & game Oriented Drawing: Caricature, Character Design, Still and motion drawings, story board preparation- content oriented script based. Aero Dynamic Drawing: Product Design oriented and Auto mobile Dynamic Design operation according to science principles

Environment composition preparation with drawings suitable for various fields

Reference Books

- 1 Heads, Features and Faces (Dover Anatomy for Artists, George B Bridgman, 5 February 2016, Echo Point Books & Media; Reprint ed..
- 2 Drawing: A Complete Guide (Art of Drawing, Giovanni Civardi, 10 March 2010, Search Press; Illustrated.
- 3 The Big Book of Realistic Drawing Secrets: Easy Techniques for drawing people, animals, flowers, Carrie Stuart Parks, 16 May 2009, North Light Books.
- 4 History of ART, H.W. Jonson, January 1, 1962, Thames Hudson.

23MRAG03 - GRAPHIC DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAG03	GRAPHIC DESIGN	GDS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the different Design techniques and their relative advantages of logo design, Stationery design, Marketing Collateral designs, of different applications.	2	PO1
CO2	Understand Design basics principles and advanced techniques in Graphic design for present different industry needs	2	PO2
CO3	Apply different Design techniques and their relative advantages of Creating 3-D Packages in Illustrator and Photoshop, Editing photographs for use in for projects, of different applications.	3	PO3

Syllabus

Graphic Design interaction of text and image, Typography and images to design magazine layouts, Fundamental components of graphic communication,

Graphic design independent and creative solutions to a series problems

Exposure to contemporary design issue, History of Graphic design , design process, creative brainstorming, conceptualizing, critical thinking, collaboration, and presentation, Print stage using Adobe Photoshop.

Reference Books

- 1 The Graphic Design Bible: The definitive guide to contemporary design, Theo Inglis , 28 September 2023, Ilex Press.
- 2 Digital Creative'S Survival Guide: Everything You Need for a Successful Career in Web, App, Multimedia and Broadcast Design H, Paul Wyatt , 31 May 2013, HOW Books.
- 3 The History of Graphic Design, Julius Wiedemann , 29 March 2022, Taschen America .
- 4 Design Basics, Stephen penthak, 1 January 2017, Wadsworth Pub Co.
- 5 Inspirations for Graphic Design from India, Jaya Jaitly & Dimple Bahl, 5 November 2023, Arthshila Trust.
- 6 Logo Modernism , Jens Muller, 26 October 2022, Taschen GmbH.

23MRAG04 - CONCEPTS OF 3D (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAG04	CONCEPTS OF 3D	C3D	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand about 3D interface environment and its functioning	1	PO1
CO2	Explore the basics of 3d interface and 3d environment design	2	PO1, PO2, PO4
CO3	Apply basic level 3d interface and its tools for design	3	PO2, PO3
CO4	Analyze basic level 3d interface and its tools for design and Animation	4	PO4

Syllabus

Introduction about the 3D environment, Installing Maya, Introduction about the Maya user interface

Understand the Maya 3D scene, Components and attributes Introduction to Modeling using 2D reference images, for making a polygon models

Applying 3D procedural texture nodes, and apply Textures using Adobe Photoshop Introduction to Lighting, the concepts of Scene and Mood of the scene like Day & Night

Analyze basics of joints and types of IK Handles, skinning & types fitting skeletons to a mesh. Generating Basic character Animation as referred in Autodesk Maya.

Reference Books

- 1 Introducing Autodesk Maya , Dariush Derakhshani, 1st Edition 2015, Sybex.
- 2 Autodesk Maya 2020 Basics Guide, Kelly Murdock, 1st Edition, SDC Publications.
- 3 Mastering Autodesk Maya 2016, Todd Palamar, 1st Edition, Sybex.
- 4 Maya Professional Tips and Techniques, Lee Lanier, 1st Edition, Sybex.

23MRAP01M - INTRODUCTION TO ANTHROPOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAP01M	INTRODUCTION TO ANTHROPOLOGY	ITA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the development of a systematic study of humans and their societies. and holistic Science: An interdisciplinary approach that considers all aspects of human life.	2	
CO2	Understand regarding defining anthropology and outlining its areas of study. & the impact of colonialism on the development and practice of anthropology.	2	
CO3	Understand the evolution and growth of the study of human biological diversity and evolution & human societies, cultures, and their development.	2	
CO4	Understanding the historical evolution of applied anthropology and its practical applications & Investigating the impact of anthropological research on policy development and governance practices.	2	

Syllabus

Emergence of Anthropology 2. Holistic Science 3. Understanding Diversity and Variation 4. Issues Related to the Study of Diversity and Variation: Racism and Ethnic Conflict 5. Understanding Diversity and Variation in the Indian Context 6. Comparative Study of Culture and Population 7. Development of Comparative Method in Social Anthropology 8. Relevance of Comparative Method: Present Perspective Suggested readings 1. Mair, Lucy. 1972. An Introduction to Social Anthropology. Oxford: Oxford University Press. 2. Srinivas, M.N. (ed). 1958. Methods in Social Anthropology: Select Essays by A.R. Radcliffe Brown. Chicago: University of Chicago Press.

MEANING, SCOPE AND BACKGROUND 1. Introduction 2. Anthropology, its Meaning and Scope 3. Anthropology and its Background 4. Anthropology as a Natural and Social Science 5. Anthropology and Colonialism 6. Holistic Perspective: Cultural and Biological Suggested readings: 1. Tylor, Edward B. (1881) 1921. Anthropology: An Introduction to the Study of Man and Civilization. New York: D. Appleton and Co. 2. Encyclopedia Britannica, Book of the Year. Chicago: Encyclopedia Britannica.

BRANCHES OF ANTHROPOLOGY -Physical/Biological Anthropology-History and Development Fields of Study ,Socio-cultural Anthropology, Archaeological Anthropology Linguistic Anthropology-,Suggested Reading Ember, Carol R., Melvin R. Ember and Peter N. Peregrine. 2010. Anthropology (13th Edition). Ontario: Pearson Education Canada.

Anthropology-As an Applied Discipline. History and its Development, its Present Scenario, Emerging Fields in Anthropology ,Anthropology in Management and Corporate World , Anthropology in Policy Making and Governance,Suggested Reading Giovannini, Maureen J. and Lynne M.H. Rosanky (eds). 1990. Napa Bulletin 9: Anthropology and Management Consulting: Forging a New Alliance. Virginia: American Anthropological Association Lewis I.M. 2004. History and Social Anthropology. London: Routledge. Majumdar, D. N. 1958. Race and Culture of India. Bombay: Asia Publishing House.

Reference Books

- 1 An Introduction to Social Anthropology , D.N.Majumdar, T. N. Madan, 9th Edition, Jan'2020, Mayur Books DELHI.
- 2 An Introduction To Anthropological Thought , Makhan Jha, 7th Edition 2018, S Chand Delhi.
- 3 Anthropology, Peter N. Peregrine Carol R. Ember, Melvin R. Ember, 10th Edition 2022, Pearson Education.

23MRAP02M - CULTURAL EVOLUTION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAP02M	CULTURAL EVOLUTION	CET	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the development from prehistoric to protohistoric periods, including contributions of tribal cultures and major religious impacts.	2	
CO2	Understand the traditional and changing social systems, settlement patterns, inter-caste relations, agrarian relations, and the impact of globalization.	2	
CO3	Understand the issues faced by Scheduled Castes, Scheduled Tribes, and Other Backward Classes.	2	
CO4	Comparative study of tribal communities in India and other countries.	2	

Syllabus

Evolution of the Indian Culture and Civilization, Prehistoric during Paleolithic, Mesolithic, Neolithic and Neolithic Chalcolithic, Protohistoric during Indus Civilization. Pre Harappan, Harappan and post Harappan cultures. Contributions of the tribal cultures to Indian civilisation. Palaeo, Anthropological evidence from India with special reference to Siwaliks and Narmada basin (Ramapithecus, Sivapithecus and Narmada Man). Ethno-archaeology in India: The concept of Ethnoarchaeology; Survivals and Parallels among the hunting, foraging, fishing, pastoral and peasant communities including arts and crafts producing communities. Demographic profile of India Ethnic and linguistic elements in the Indian population and their distribution. Indian population factors influencing its structure and growth. The structure and nature of the traditional Indian social system Varnashrama, Purushartha, Karma, Rina and Rebirth. Caste system in India Structure and characteristics Varna and caste, Theories of origin of caste system, Dominant caste, Caste mobility, Future of caste system, Jajmani system. Tribe-case continuum. Sacred Complex and Nature-Man-Spirit Complex. . Impact of Buddhism, Jainism, Islam and Christianity of Indian society.

Emergence, growth and development in India Contributions of the 18th, 19th and early 20th Century scholar, and administrators. Contributions of Indian anthropologists to tribal and caste studies. Indian Village Significance of village study in India; Indian village as a social system; Traditional and changing patterns of settlement and inter-caste relations; Agrarian relations in Indian villages; Impact of globalization on Indian villages. Linguistic and religious minorities and their social, political and economic status. Indigenous and exogenous processes of socio and cultural change in Indian society: Sanskritization, Westernization, Modernization; Inter-play of little and great traditions; Panchayati Raj and social change; Media and Social Change.

Tribal situation in India Bio-genetic variability, linguistic and socio-economic characteristics of the tribal populations and their distribution. Problems of the tribal Communities Land alienation, poverty, indebtedness, low literacy, poor educational facilities, unemployment, under-employment, health and nutrition. Developmental projects and their impact on tribal displacement and problems of rehabilitation. Development of forest policy and tribals. Impact of urbanisation and industrialization on tribal populations. Problems of exploitation and deprivation of Scheduled Castes, Scheduled Tribes and Other Backward Classes. Constitutional safeguards for Scheduled Tribes and Scheduled Castes. Social change and contemporary tribal societies: Impact of modern democratic institutions, development programmes and welfare measures on tribals and weaker sections. The concept of ethnicity; Ethnic conflicts and political developments; Unrest among tribal communities; Regionalism and demand for autonomy; Pseudo-tribalism. Social change among the tribes during colonial and post-independent India.

Impact of Hinduism, Buddhism, Christianity, Islam and other religions on tribal societies. Tribe and nation-state a comparative study of tribal communities in India and other countries. History of administration of tribal areas, tribal policies, plans, tribal development programmes and their implementation. The concept of PTGs (Primitive Tribal Groups), their distribution, and special programmes for their development. Role of N.G.O.s in tribal development. Role of anthropology in tribal and rural development. Contributions of anthropology to the understanding of regionalism, communalism and ethnic and political movements.

Reference Books

- 1 An Introduction To Social Anthropology , D.N. Majumdar and T.N. Madan , 9th Edition Jan'2020, Mayoor Delhi.
- 2 Cultural Evolution, Ronald F. Inglehart, University of Michigan, Ann Arbor, 7th Edition 2018, Cambridge University Press.
- 3 Primitive Culture , Edward Burnett Tylor, 10Edition 2022, Legare Street Press .

23MRAP03M - HUMAN ECOLOGY AND ECOLOGICAL ANTHROPOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAP03M	HUMAN ECOLOGY AND ECOLOGICAL ANTHROPOLOGY	HEEA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of human ecology.	2	PO3, PO6, PO9, PSO1
CO2	Understand the impact of human activities on natural environments	2	PO3, PO6, PO9, PSO1
CO3	Evaluate strategies for sustainable resource management.	2	PO3, PO6, PO9, PSO1
CO4	Apply ecological concepts to contemporary environmental issues.	2	PO3, PO6, PO9, PSO1

Syllabus

Introduction to Human Ecology Overview of human ecology Key concepts and definitions Ecological Principles
 Basic ecological concepts (ecosystems, biomes, energy flow) Human impact on ecological systems Population Dynamics
 Human population growth Effects of population on resource consumption and environmental impact Resource
 Management Types of resources (renewable vs. non-renewable) Strategies for sustainable resource management

Environmental Health Interaction between environmental factors and human health Pollution and its effects on health
 Climate Change and Human Systems Understanding climate change Impacts on agriculture, water resources, and
 human settlements Urban Ecology Urbanization and its ecological impacts Sustainable urban planning Human
 Adaptation and Resilience How humans adapt to environmental changes Case studies of adaptation strategies
 Environmental Policy and Ethics Environmental policy frameworks Ethical considerations in environmental decision-
 making Future Directions in Human Ecology Emerging issues and technologies Review and future trends

Introduction to Ecological Anthropology Overview of ecological anthropology Key concepts and methods Theoretical
 Frameworks Theories in ecological anthropology (e.g., cultural ecology, political ecology) Major scholars and their
 contributions Cultural Adaptation to Environments Case studies of cultural adaptation Adaptation strategies in different
 environments (e.g., deserts, rainforests) Traditional Ecological Knowledge Definition and significance Examples from
 various cultures Human-Environment Interactions How cultural practices affect environmental management Rituals,
 taboos, and conservation practices

Resource Management and Sustainability Indigenous resource management practices Comparative analysis with modern
 practices Globalization and Environmental Change Impact of globalization on local environments and cultures Case
 studies of cultural and environmental change Fieldwork Methods in Ecological Anthropology Ethnographic methods
 Challenges and ethical considerations in fieldwork Policy and Advocacy Role of anthropologists in environmental
 advocacy Case studies of successful interventions Review and Future Directions Emerging trends in ecological
 anthropology Review of key concepts and theories

Reference Books

- 1 The Cambridge Handbook of Environmental Sociology, Kenneth A. Gould and Tammy L. Lewis, 3rd, 1991, Lexington Books publisher.
- 2 Human Adaptability: An Introduction to Ecological Anthropology, Peter J. Brown and Robert A. Smith, 2nd, 2002, University of Illinois Press is an American university press.
- 3 Human Ecology: Basic Concepts for Sustainable Development, John L. Seager, 1st, 1983, Pluto Press .
- 4 Introduction to Human Ecology: A Systems Approach, Gary Machlis and Joan ELang, 1st, 1988, Sean Kingston Publishing House.

- 5 Ecology and the Environment: A Human Perspective, Charles A. McMahon and William G. W. Smith, 4th, 2012, University of British Columbia Press .

23MRAP04M - FUNDAMENTALS IN ARCHEOLOGICAL ANTHROPOLOGY CHRONOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAP04M	FUNDAMENTALS IN ARCHEOLOGICAL ANTHROPOLOGY CHRONOLOGY	FAAC	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Origin and Scope of Archaeological Anthropology, 1 Prehistory/Archaeological Anthropology 2 Definition of Archaeological Anthropology 3 Origin and Development 4 Three Age System 5 History of Development of Prehistoric Archaeology in India	2	
CO2	Relationship of Archaeological Anthropology with other Disciplines, 1 Anthropology and Archaeological Anthropology 2 Archaeological Anthropology 3 Relationship of Archaeological Anthropology with other Disciplines 4 History 5 Earth Sciences 6 Geology 7 Geography 8 Archaeology 9 Physical Science/Natural sciences 10 Anthropology 11 Methods of Studying Archaeological Anthropology.	2	
CO3	Methods Of Studying Archaeological Anthropology 1 Archaeological Sites 2 Types of Sites 3 Methods of Study 4 Exploration 5 Aim and Objective of Exploration 6 Area Selection for Exploration 7 Extensive Exploration 8 Intensive Exploration 9 Grid System 10 Collection of Materials 11 Analysis, Result and Interpretation	2	
CO4	DATING METHODS AND RECONSTRUCTION OF THE PAST, Dating Methods, Methods of Climatic Reconstruction, Cenozoic Era with Special Reference to Quaternary Period. UNDERSTANDING PREHISTORIC CULTURES. Prehistoric Technology, Prehistoric Typology, Cultural Chronology, Earliest Evidences of Culture in the World,	2	

Syllabus

Origin and Scope of Archaeological Anthropology, Origin and Scope of Archaeological Anthropology, 1 Prehistory/Archaeological Anthropology 2 Definition of Archaeological Anthropology 3 Origin and Development 4 Three Age System 5 History of Development of Prehistoric Archaeology in India

Relationship of Archaeological Anthropology with other Disciplines, 1 Anthropology and Archaeological Anthropology 2 Archaeological Anthropology 3 Relationship of Archaeological Anthropology with other Disciplines 4 History 5 Earth Sciences 6 Geology 7 Geography 8 Archaeology 9 Physical Science/Natural sciences 10 Anthropology 11 Methods of Studying Archaeological Anthropology.

Methods Of Studying Archaeological Anthropology 1 Archaeological Sites 2 Types of Sites 3 Methods of Study 4 Exploration 5 Aim and Objective of Exploration 6 Area Selection for Exploration 7 Extensive Exploration 8 Intensive Exploration 9 Grid System 10 Collection of Materials 11 Analysis, Result and Interpretation

DATING METHODS AND RECONSTRUCTION OF THE PAST, Dating Methods, Methods of Climatic Reconstruction, Cenozoic Era with Special Reference to Quaternary Period. UNDERSTANDING PREHISTORIC CULTURES. Prehistoric Technology, Prehistoric Typology, Cultural Chronology, Earliest Evidences of Culture in the World,

Reference Books

- 1). An Introduction to Prehistoric Archaeology. New York: Holt, Rinehart and Winston., Hole, F., & Heizer, 9, Publisher New York, Holt, Rinehart and Winston.
- 2 The Orion, Or, Research Into the Antiquity of the Vedas, Tilak, B. G. (1893)., 9, Bombay: Mrs. Radhabai and Atmaram Sagoon Bookseller & Publishers.
- 3 PHYSICAL ANTHROPOLOGY , P. NATH , 12, HIGHER PUB .

23MRAR01 - FUNDAMENTALS OF MACRO-ECONOMICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAR01	FUNDAMENTALS OF MACRO-ECONOMICS	FME	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the nature and scope of macroeconomics and various concepts related to national income.	2	PO1, PSO1
CO2	Understand the consumption and investment functions.	2	PO4
CO3	Apply the concept of money and banking framework in India.	3	PO3
CO4	Analyse the phenomenon of inflation and business cycle in macro economics trend and pattern.	4	PO5, PSO1

Syllabus

National Income Meaning Definitions: National Income, GNP & NNP, GDP & NDP, Personal Income (PI), Disposable Income (Di), Per Capita Income (PCI), Real National Income (RNI) Methods of Estimation of National Income (NI) Measurement of National Income in India Recent Trends in National Income

Trade cycles Meaning and definition Phases of a trade cycle Inflation Definition Types of Inflation Causes and effects of inflation Measures to control inflation Inflation and Un Employment Types and Estimates. Philips Curve.

Concept of aggregate consumption Factors influencing consumption functions private vs public consumption- average and marginal property to consumer multiplier concept. Investment Function concept savings function.

Money Meaning, functions and Classification of Money M1, M2, M3, M4, Supply of Money, and Demand for Money Functions of Commercial banks credit creation- credit control methods. Central Banking System, Monetary Policy, Fiscal Policy.

Measure the macro Economics indicators like employment and inflation, GNP and other relative factors , which influences economy .

Reference Books

- 1 Advanced Macroeconomics, David Romer, ed5, 2018, McGraw-Hill Education.
- 2 Monetary Economics: theories, evidence and policy, Butter worths., David, G Pierce and Peter J Tysome, Edi0 3, 2010, McGraw-Hill.
- 3 Macro Economics: Theory & Policy, H. L. Ahuja , edi 20, 2019, S Chand Publishing.
- 4 PRINCIPLES OF MACROECONOMICS, Devid N. Gregory Mankiw , EDITION 08, 2022, Cengage India.
- 5 MACRO ECONOMICS, N. GREGORY MANKIw, Edi 09, 2010, Worth Publishers.

23MRAR02 - BASICS OF ECONOMETRICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAR02	BASICS OF ECONOMETRICS	BOE	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Nature of Econometrics and Economic Data Definition of Econometrics, Steps in Empirical Economic Analysis, Econometric Model.	2	PO5, PSO1
CO2	Understand the two Variable Linear Regression Model: Assumptions, Estimation of Parameters, Tests of Significance and Properties of Estimators, Functional forms of Regression models	2	PO2, PO9, PSO2
CO3	Application of the econometrics identifying the problems like Multicollinearity, Autocorrelation and consequences in simple as well as multiple linear regression models.	3	PO5, PSO1
CO4	Analyse the data by using testing multiple linear restrictions using the F-test, relationship between F and t statistics, the R-squared form of the F-statistic, and computing p-values for F tests:	4	PO2, PO9

Syllabus

Introduction, Nature of Econometrics and Economic Data Definition of Econometrics, Steps in Empirical Economic Analysis, Econometric Model, The Role of Measurement in Economics, The Structure of Economic Data: Cross-Sectional data, Time Series data, Pooled Cross Section data, Panel Data. Classical Linear Regression Model.

Introduction, Nature and scope of Econometrics, Definition of the Simple regression Model, Simple Regression Model Two Variable Linear Regression Model: Assumptions, Estimation of Parameters, Tests of Significance and Properties of Estimators, Functional forms of Regression models, Loglinear models, Semi log- models and Reciprocal models, Choice of Functional Form.

Econometric Problems, Multicollinearity- Nature, consequences, detection and remedial measures, Autocorrelation, Nature, consequences, detection, and remedial measures Heteroskedasticity, Nature, consequences, detection and remedial measures. Inference; Introduction, Sampling Distribution of the OLS Estimators, Testing Hypotheses about a Single Population parameter: The t Test, Confidence Intervals, Testing Hypotheses about a Single Linear Combination of the Parameters, Testing Multiple Linear Restrictions.

The F Test, Relationship between F and t Statistics, The R-Squared Form of the F Statistic, Computing p-Values for F Tests, The F Statistic for Overall Significance of a Regression, Testing General Linear Restrictions; Reporting Regression Results, Summary.

Reference Books

- 1 Basic Econometrics, Gujarati, Damodar, 4e, 2007, McGraw-Hill.
- 2 Introduction to Econometrics, Maddala, G. S., 1e, 1992, Macmillan Publishing Company.
- 3 Introductory Econometrics: A Modern Approach, Jeffrey M Wooldridge, 7e, 2022, Thomson South Western.
- 4 Introduction to Econometrics: Principles and Applications, G.M.K. Madnani, 8e, 2015, Paperback.

23MRAR03 - INTERNATIONAL RELATIONS: THEORIES AND CONCEPTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAR03	INTERNATIONAL RELATIONS: THEORIES AND CONCEPTS	IRTC	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of International Relations.	2	PO2, PO3, PO6, PO9, PO12
CO2	Understand the role of International Organizations.	2	PO2, PO3, PO6, PO9, PO12
CO3	Understand the basic structure of Indian foreign policy.	2	PO2, PO3, PO6, PO9, PO12
CO4	Apply the factors determinants of Indian foreign policy.	3	PO2, PO3, PO6, PO9, PO12
CO5	Analyze the significant issues of Indian foreign policy.	4	PO2, PO3, PO6, PO9, PO12

Syllabus

Meaning, scope and nature of International Relations, Evolution of International Relations Theories: Realist, Liberal, Marxist and Critical Theories of IR, Emergence of nation states and nationalism, Power Politics: Balance of Power, Geopolitics, Bipolarity, Unipolarity, Multipolarity and Polycentrism. Pre-World War I International System, Post-World War II Period, and Cold War

International Organizations and Global Governance Role of International Organizations in International Peace and Security, Development, cooperation and Democratization, United Nations: Role, Relevance, and Reforms, SAARC, BRICS, G20, Global Governance: Issues and Challenges

Determinants of Indian Foreign Policy, Mission and Objective of Indian Foreign Policy, Evolution of Indian Foreign policy, and Institutional Framework of Indian Foreign policy, Indian diplomacy, Non-Alignment, Panchsheel Agreement, Look East Policy, Act East, Impact of LPG, Liberalization, Globalization and Privatization.

Issues in Indian foreign policy. India and Pakistan, India and China, India and Bangladesh, India and Myanmar, India and Afghanistan, and India and Sri Lanka Relations.

India and USA, India and USSR, Recent trends in Indian foreign policy, and Major recent challenges in Indian foreign policies.

Reference Books

- 1 International Relations and World Politics Since 1919, Dhar, S.N, 1965 2nd Edition , Kalyani Publisher.
- 2 International Relations, Vinay Kumar Malhotra, 2016, 1st Editon, Anmol Publications.
- 3 The Oxford Handbook of International Organizations, Jacob Katz Cogen, 2016, 1st Edition, Oxford University Press.
- 4 International relations the basics, Peter Sutch and Juanita Elias, 2007, 1st Edition, Taylor and France Publishers.

23MRAR04 - BEHAVIOURAL ECONOMICS AND POLICY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAR04	BEHAVIOURAL ECONOMICS AND POLICY	BEP	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the foundational concepts of behavioral economics, including deviations from the traditional economic theory of rational choice.	2	PO2, PSO1
CO2	Understand how behavioral economics principles can inform regulatory policy. Explore the use of behavioral insights to design regulations that improve compliance and outcomes.	2	PO5, PO7
CO3	Applied behavioral economics principles to design and implement effective tax policies that improve compliance and optimize revenue collection.	3	PO2, PSO1
CO4	Analyze standard economic approaches to environmental issues and identify their strengths and weaknesses.	4	PO7

Syllabus

Behaviour economics, cognition , choice, policy design, bounded rationality, bounded self control, bounded self interest, public policy implications and application, Incentives, norms and public policy, social forces in markets and collective action problem, social norms versus market incentives, getting incentives and norms right.

Behaviour economics and regulatory policy, nudge, policy design, simplification of information and choice, default and convenience. Salience and attention, debiasing and decision quality, regulatory methods, regulatory delivery, Taxation and tax compliance, tax attitude by individual tax payers, regulation, strategies, interaction between tax payers and tax authorities, practical implications,

Standard economic approach to environment- psychology of environmentally sustainable, image motivation, loss aversion, saliency and availability bias, mental accounting, discounting, psychology of unsustainable consumption, Case Studies in Behavioral Policy: Health, Finance, and Environment, Designing Effective Incentives and Defaults,.

Practical Skills and Applications, Conducting Behavioral Experiments and Field Studies, Data Analysis and Interpretation in Behavioral Research, Policy Simulation and Evaluation Techniques, Ethical Considerations, Ethics of Nudging and Behavioral Interventions, Balancing Autonomy and Social Welfare, Final Projects and Presentations

Reference Books

- 1 Behaviour economics and policy designs., Donald Low, 1e, 2011, World Scientific.
- 2 Bounded Rationality and Public Policy- perspectives from behavioural economics, Alistar Munro, 1e, 2009, Springer.
- 3 Regulatory Policy and Behavioural Economics, Pete Lunn, 1e, 2014, OECD.
- 4 Behavioural Economics and Policy Design, Peter Earl, 1e, 2022, World Scientific Publishing Company.

23MRBA01M - ORGANIZATIONAL BEHAVIOUR (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRBA01M	ORGANIZATIONAL BEHAVIOUR	OBR	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To demonstrate the applicability of organizational behavior concepts to understand the individual behavior in the organization	2	PO9, PO10, PSO1
CO2	To analyze the complexities associated with management of individual behavior in the organization.	4	PO9, PO10, PO12, PSO1, PSO2
CO3	To analyze the complexities associated with management of group behavior in the organization	4	PO9, PO10, PO12, PSO1, PSO2
CO4	To analyze the facets of organizational culture and manage organizational change and work stress	4	PO9, PO10, PO12, PSO1, PSO2

Syllabus

Organizational Behavior Nature and Significance of OB Contributing Disciplines to the OB field Challenges and Opportunities for OB Developing an OB Model, Personality Determinants of personality, The Big Five Model, Major personality attributes influencing OB Emotions Emotions and Moods, Emotional Labour Emotional Intelligence, Values Types of Values, Attitudes Types of Attitudes, work related attitudes

Learning Theories of learning Learning and OB, Perception Perceptual process Perceptual errors, Improving perception, Motivation Hierarchy of Needs Theory, Two-Factor Theory Expectancy theory, Applications of Motivation

Foundations of Group Behavior: Groups Types of groups Stages of Group Development Groups and Teams, Communication Communication Process Directions of Communication, Barriers to Effective Communication, Leadership Styles Theories of Leadership Trait, Behavioral and Contingency theories, Power & Politics Bases of Power, Organizational politics, Conflict The Conflict process Managing conflict

Organizational Culture: Functions, creating and sustaining organizational culture, Organizational Change, Forces for change Resistance to change Approaches to Managing Organizational Change, Organization Development Techniques, Work Stress Causes and Consequences of Stress, Stress Management Techniques

Reference Books

- 1 Organizational Behavior, Robbins, Stephen, P., Timothy A Judge & Niharika Vohra, 14, Pearson.
- 2 Organizational Behavior: An Evidence Based Approach, Fred Luthans, 12, Mc.Graw Hill,.
- 3 Organizational Behavior, Aswathappa, 3, Himalaya.
- 4 Organizational Behavior: A Skill-Building Approach, Christopher P. Neck, Jeffery D. Houghton, and Emma L. Murray, 2, Sage.

23MRBA02M - MARKETING MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRBA02M	MARKETING MANAGEMENT	MMG	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the key terms, definitions, and concepts used in the study of Marketing Management and understand the changing Marketing Environment	2	PO1
CO2	Apply the knowledge of Segmentation, Targeting and Positioning to strategize the marketing program regarding product and PLC	3	PO2
CO3	Apply the knowledge of marketing program regarding Pricing, Distribution channel and Physical Distribution	3	PO2
CO4	Analyze the need for Promotion methods, ethics in marketing and the importance of social and green marketing	4	PO8

Syllabus

Introduction Need Want and Demand Marketing Definition Concepts Significance and functions of Marketing Consumer Behaviour Nature Scope Significance and Determinants Organizational Buying Behaviour. Marketing Environment-Internal and External forces of Marketing Environment Marketing Research Marketing research process.

Market Segmentation Targeting and Positioning Strategies. Marketing Mix 4 Ps of Marketing Product Concept of Product Product Planning and New Product Development Product life cycle Branding Packing and labelling

Price Meaning Importance Objectives Factors affecting pricing Pricing policies Methods of pricing Distribution channel and physical distribution Distribution channels concepts and types of distribution channel Channel conflict Retailer and Wholesaler Physical Distribution of goods Transportation Warehousing.

Promotion Methods of Promotion Advertising Media their merits and limitations Personal selling and sales force management Sales Promotion and publicity. Marketing organization Marketing control Ethics in Marketing Social Marketing Green marketing Online Marketing

Reference Books

- 1 Marketing Management, Phillip Kotler and Kevin Keller, 15,2017, Pearson Education.
- 2 Marketing: Concepts and Cases, Etzel, Walker Stanton and Pandit, 14th, 2018, TMH.
- 3 Marketing Management Planning Implementation and Control, Rama Swamy and NamaKumari, 5th, 2020, McMillan.
- 4 Upstream Marketing: Unlock Growth Using the Combined Principles of Insight, Identity, and Innovation, Tim Koelzer and Kristin Kurth, 2th, 2019, Upstream.

23MRBA03M - FINANCIAL MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRBA03M	FINANCIAL MANAGEMENT	FMG	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To enable the students understand the Finance Functions and types of Business	2	PO2
CO2	To evaluate the long term and short term investment decisions	3	PO2
CO3	To understand the working capital requirements in a company	3	PO1
CO4	To learn different Capital Structure and dividend policies in Practice	3	PO1

Syllabus

Introduction to Financial Management: Financial Management, Definitions, Investment Decision, Finance Decision, Dividend Decision, Objective of Financial Management, Shareholders Wealth Maximisation. Types of Business, Proprietary company, Partnership Company, Company, Features, Merits and Demerits, Private Limited Company Vs. Public Limited Company, Classification of companies, Franchisee, Cooperative Society

Capital Budgeting and Cost of Capital Meaning, Features, Techniques of Capital Budgeting, Traditional methods- Payback Period, ARR and Modern Methods- NPV, IRR & Profitability Index, Case studies on Capital Budgeting. Sources of Finance: Short term sources_ Cash credit limit, Overdraft, Bill Discounting, Short term loans, Long term sources: Equity, Preference, Bond/ Debenture, Term loans, Venture capital financing. Calculation of Weighted Average Cost of Capital and Specific Cost of Capital

Working Capital Management Gross working capital, Net working Capital, operating cycle, Determinants of Working Capital, Computation of working capital Requirement, Case studies Cash Management, Receivables and Inventory Mgt.

Capital Structure and Dividend Operating Leverage, Financial Leverage, Combined Leverage, EBIT EPS Analysis, Capital structure Theories, NI, NOI, Traditional Theory, MM Hypothesis. Dividends, Meaning, Types of Dividend, Dividend Policies in Practice, Walter, Gordon and MM Hypothesis, EBIT EPS case study

Reference Books

- 1 Fundamentals of Financial Management, Prasanna Chandra, 21, TMH.
- 2 Fundamentals of Financial Management, Jonathan Berk, Peter Demarzo, 10, pearson.
- 3 Fundamentals of Financial Management, Prasanna Chandra, 9, TMH.
- 4 Fundamentals of Financial Management, I.M.Pandey, 12, vikas publication.

23MRBA04M - HUMAN RESOURCE MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRBA04M	HUMAN RESOURCE MANAGEMENT	HRM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basics of HRM and integrated perspective on role of HRM in modern business.	2	PO9, PSO2
CO2	Understand the planning of human resources and gain competency to recruit employees.	2	PO7, PO8
CO3	Apply the skills on training and appraising the performance of employees.	3	PO8
CO4	Apply the knowledge on compensation and salary administration and handling employee issues.	3	PO9

Syllabus

Introduction: Meaning and Definition, Importance of HRM, Functions of HRM, Nature & Scope of HRM, Objectives of HRM, Challenges of Human Resource Management; Personnel management vs Human Resource Management.

Manpower planning: objectives, importance, process; Job Analysis: Job Description, Job specification, uses of job analysis; Job design: Techniques of Job design; Employee Recruitment: sources of recruitment, methods of recruitment; Selection: process of selection, Types of interviews, Interview Tests; Placement and Induction, Transfer, Promotion and Separation

Training and Development: Training vs Development, methods of training: on-the job and off- the job methods; Performance Appraisal: process of performance appraisal, methods of appraisal, Errors in appraisal, Job evaluation: Methods of job evaluation; Employee Compensation: Objectives of compensation, Components of compensation; Employee Benefits, Employee Welfare and Safety.

Employee Grievances, Employee Discipline, Industrial Relations, Trade Unionism, Collective Bargaining, Managing Ethical issues in HRM, HR audit and Evaluation, International HRM, eHRM, HRIS, Recent trends in HRM: Managing Diversity, Downsizing, Contingent workforce, Tele commuting, Competency Mapping, Talent

Reference Books

- 1 Human Resource Management, Gary Dessler, 2019, Pearson Education.
- 2 Human Resource Management, Raymond Andrew Noe, John R. Hollenbeck, Barry Gerhart, Patrick M Wright, 2014, The McGraw Hill Pub.
- 3 Managing Human Resources, Louis & Gomitz Mejia, 2010, Pearson Education.
- 4 Human resource management Text and cases, Aswathappa K, 2020, Tata McGraw Hill Pub.

23MRCA01 - INTRODUCTION TO CREATIVE ARTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCA01	INTRODUCTION TO CREATIVE ARTS	ICA	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the present research and study the comprehensive knowledge of combined creative areas of specialisation and build a theoretical framework for students creative practice	2	PO1
CO2	Understand synthesise and articulate student critical, contextual and conceptual knowledge and understanding into a coherent critique of advanced academic standard	2	PO2
CO3	Apply the techniques of pioneers work of art and their thought process of creative thinking , student own criteria of judgement, review.	3	PO3

Syllabus

Experience Creative Arts -practicing art & craft in a playfull mode with different materials

Creative Arts Relations-Using personal experiences and textual knowledge, Writing Skills,Art of Poetry , Scriptwriting, Drawing Skills, Graphic Design ,Core Concepts , Illustration- Key Steps in Illustration

The Practice of Painting ,Photography Expressing Your Vision Printmaking ,Sculpture ,Textiles ,Visual Studies Writing Short Fiction , Form and Experience ,Understanding Visual Culture

Reference Books

- 1 Drawing on the Right Side of the Brain, Betty Edwards, January 2012, Penguin Books .
- 2 The Crafter's Devotional: 365 Days of Tips, Tricks, and Techniques for Unlocking Your Creative Spirit, Barbara Call, 1 September 2010, Quarry Books .
- 3 THE DESIGN OF EVERYDAY THINGS, Don Norman , 5 November 2013, Basic Books.
- 4 On Writing: A Memoir of the Craft, Stephen King, 2 June 2020, Scribner.

23MRCA02 - DRAWING AND SKETCHING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCA02	DRAWING AND SKETCHING	DAS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand the drawing anatomy ,Skull planes, Masses, Details, Proportions, Portraiture, Compositional Analysis, Theories, and treatments.	2	PO1
CO2	Understand various kinds of Mediums in drawing for painting & sculpting	2	PO2
CO3	Apply the principles and theories of Drawing to the contemporary ideas and experiments to get new forms and new meanings .	3	PO3

Syllabus

Skull planes, Masses, Details, Proportions, Portraiture, Compositional Analysis, Theories, and treatments. Unit-I Anatomy Drawing: Starting from the construction of skull-planes and masses of head, details such as eyes, nose, mouth, etc. Relative proportions amongst head, neck, and shoulders. The student has to prepare for every part of the body like the skull, Torso, legs, hands, body in movement, foreshortening views, etc detailed study of Bone, muscle, the contour of human, animal, and bird. Freehand Sketching: At least 10 sketches daily related to the subject assignments to improve their ability towards the professional way.

Cultural Drawing: Different civilizations approach withdrawing from Cave paintings, medieval art, and design, Folk art, traditional arts, pre, and post-independence art, and contemporary art practice. Transformation Drawing: Process of converting an idea into drawing with aesthetic values, specific rules and regulations use full for creative and innovative design ideas

Animation Oriented Drawing:Caricature,Character Design,Still and motion drawings ,story board preparation-content oriented script based. Aero Dynamic Drawing:Product Design oriented and Auto mobile Dynamic Design operation according to science principles. Advertising Drawings : Ad making traditional practice and also with Photoshop soft ware Creative Drawing: Contemporary Art treatments and Art theories .

Reference Books

- 1 Drawing and Sketching Portraits: How to Draw Realistic Portraits for Beginners- , Jacquelyn Descanso , 12 November 2015, Createspace Independent Pub.
- 2 Drawing: A Complete Guide, Giovanni Civardi, Mar 10 2010, Search Press; Illustrated edition .
- 3 The Big Book of Realistic Drawing Secrets: Easy Techniques for drawing people, animals, flowers and nature , Carrie Stuart Parks , Jun 13 2009, Rick Parks.
- 4 The Complete Book of Poses for Artists: A comprehensive photographic and illustrated reference book for learning to draw more than 500 poses , Ken Goldman, 16 January 2017, Walter Foster Publishing.

23MRCA03 - PAINTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCA03	PAINTING	PNT	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental processes of visual perception and artistic expressions from the art works of great artists series	2	PO1
CO2	Understand the painting mediums and various methodologies from history of art	2	PO2
CO3	Apply the techniques, processes into art making with the support of history of art evaluation	3	PO3

Syllabus

DRAWING (MANMADE & NATURE): Study from manmade objects and nature with emphasis on construction. Perspective and rendering in linear and massive drawing. Experience with material quality for feel, Values in grey, Texture and colour in rendering.

Art practices through history of art from prehistoric to 20th century traditional and folk art

Apply the aesthetics with 20th century ART Practices and also study in past- present ideologies in Indian & western cultures

Reference Books

- 1 Chinese Techniques of Water Colour,, Lian Quan Zhen, 2020, North Light Books, Cincinnati, Ohio, China -2002.
- 2 History of art , HW jason , 2019, johnson & jonson.
- 3 Drawing and Painting: Materials and Techniques for Contemporary Artists, Kate Wilson , 2017, Thames & Hudson.
- 4 Modern Acrylic: A contemporary exploration of acrylic painting (Modern Series), Blakely Little , 2 October 2018, Walter Foster Publishing.

23MRCA04 - CREATIVE WRITING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCA04	CREATIVE WRITING	CWT	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop original and compelling narratives, characters, and dialogue suitable for film and media projects.	3	PO1
CO2	Apply industry-standard formatting and techniques to write professional-quality scripts and screenplays for various media formats.	3	PO6
CO3	Critique and revise their own and peers' creative works, providing constructive feedback and implementing revisions to enhance the overall quality of the writing.	3	PO8

Syllabus

The Power of Story: Understanding the importance of storytelling in film and media. Elements of Story Structure: Exploring the Three-Act Structure, plot points, and narrative arcs. Developing Engaging Characters: Creating dynamic characters, including protagonists, antagonists, and supporting roles. Screenplay Formats and Conventions: Learning industry-standard formatting for scripts and screenplays. Writing Effective Dialogue: Techniques for crafting authentic and compelling dialogue.

Genre and Audience Considerations: Writing for different genres (e.g., drama, comedy, thriller) and understanding target audiences. Scene Construction and Sequencing: Building effective scenes and sequencing them for maximum impact. Visual Storytelling: Using descriptions and actions to convey visual elements and emotions. Adaptation Techniques: Adapting existing works (e.g., books, plays) into screenplays and scripts. Feedback and Revision: Techniques for revising and improving scripts based on feedback.

Self-Editing Techniques: Methods for self-revision, focusing on structure, clarity, and coherence. Peer Review Workshops: Participating in peer review sessions, learning to give and receive constructive feedback. Final Project: Revising and polishing a substantial piece of creative writing for publication or presentation, incorporating feedback and self-editing techniques.

Reference Books

- 1 Screenplay: The foundations of screenwriting., Field, S. , 2005, Delta.
- 2 Story: Substance, structure, style, and the principles of screenwriting., McKee, R., 1997, ReganBooks..
- 3 Writing screenplays that sell , Seger, L. , 2010, Michael Wiese Productions..
- 4 The Screenwriter's Bible: A complete guide to writing, formatting, and selling your script , Trottier, D. , 2014, Silman-James Press..

23MRCL01 - PRINCIPLES OF COMPANIES ACT AND CORPORATE GOVERNANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCL01	PRINCIPLES OF COMPANIES ACT AND CORPORATE GOVERNANCE	PCACG	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To provide a comprehensive understanding of the legal framework governing the formation, operation, and winding up of companies in India	2	PO2
CO2	To develop a strong foundation in corporate governance principles and practices.	2	PO9
CO3	To equip students with the knowledge to analyze and evaluate corporate legal and governance issues.	2	PO5
CO4	To foster critical thinking and problem-solving skills in relation to corporate law and governance challenges.	3	PO7
CO5	To prepare students for professional roles in corporate law, compliance, and governance	3	, PSO1

Syllabus

Formation and Incorporation of Companies Nature and Definition of a Company Corporate Personality Classification of Companies Incorporation Procedure Memorandum and Articles of Association Doctrine of Ultra Vires Prospectus and Share Capital

Management and Administration of Companies Corporate Management Structure Board of Directors: Appointment, Powers, Duties, and Liabilities Meetings of the Company Dividends and Bonus Shares Debentures Alteration of Memorandum and Articles of Association

Corporate Governance and Corporate Social Responsibility Concept of Corporate Governance Principles of Corporate Governance Corporate Social Responsibility Independent Directors Committees of the Board Risk Management Corporate Governance Codes

Students will understand the ethical responsibilities of directors and other corporate stakeholders and the role of corporate governance in promoting ethical business conduct

Reference Books

- 1 Company Law, Avtar Singh, 2023, Lexis Nexis.
- 2 Principles of Modern Company Law, Gower, 2020, Eastern.
- 3 Company Law, A.K. Majumdar, 2019, Lexis Nexis.
- 4 Law of Corporate Governance, Deepankar Sharma, 1st Edition, 2020, Central Law Publication.

23MRCL02 - MERGERS, ACQUISITIONS AND PRIVATE EQUITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCL02	MERGERS, ACQUISITIONS AND PRIVATE EQUITY	MAPE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the strategic perspective & strategic approaches to M & A.	2	PO2
CO2	Understand the Merger Process and process of merger intergration	2	PO8
CO3	Understand the methods of financing mergers.	2	PO4
CO4	Apply the Taxation and Accounting aspects of Mergers and Acquisitions	3	
CO5	Evaluate the issues involved in takeover process and identify areas of reform.	4	PO3

Syllabus

Introduction

Corporate Restructuring

Valuations and Takeovers

Legal Taxation and Accounting Aspects

Reference Books

- 1 Value Creation From Mergers And Acquisitions, SudiSudarsanam, 2014, Pearson Education.
- 2 Merger Acquisitions & Corporate Restructuring, Chandrashekar Krishna Murthy & Vishwanath. S.R, 2012, S.R, Sage Publication..
- 3 Takeovers, Restructuring And Corporate Governance , Weston, Mitchel And Mulherin, 2012, Pearson Education.
- 4 Corporate Growth Through Mergers And Acquisitions, Shiv Ramu, 2016, Response Books.
- 5 Mergers And Acquisitions, P Mohan Rao, 2016, Deep And Deep Publications.

23MRCL03 - INSOLVENCY AND BANKRUPTCY LAW (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCL03	INSOLVENCY AND BANKRUPTCY LAW	IBL	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	A comprehensive knowledge of bankruptcy and insolvency laws.	2	
CO2	Understand international bankruptcy and dispute resolution regarding cross-border insolvency.	2	
CO3	Understand the procedures to be followed in case of corporate insolvency.	2	
CO4	Analyse the new Insolvency and Bankruptcy Code, 2016 and its implication.	3	
CO5	Analyse the implications of Insolvency and Bankruptcy laws.	3	

Syllabus

Origin and Development of bankruptcy and insolvency law - need of bankruptcy and insolvency law

Companies Act; 1956 RDBFI Act, 1993; SARFAESI Act, 2002; SICA Act, 1985; The Presidency Towns Insolvency Act, 1909; The Provincial Insolvency Act, 1920; Chapter XIII of the LLP Act, 2008; Corporate Debt Restructuring Scheme, Strategic Debt Restructuring, and Scheme for Sustainable Structuring of Stressed Assets

Challenges in the Transition to the New Insolvency and Bankruptcy Code

Contemporary issues

Reference Books

- 1 The Law of Insolvency in India, Sir. Dinshaw Fardunji Mulla, 2013, Lexis Nexis.
- 2 Guide to Insolvency and Bankruptcy Code 2016, Sir. Dinshaw Fardunji Mulla, 2017, Taxmann Publications Pvt. Ltd.
- 3 Commentary on the Insolvency and Bankruptcy Code, 2016, Manzar Saeed, 2017, Lexis Nexis.
- 4 Personal Insolvency in the 21st Century: A Comparative Analysis of the US and Europe, Iain Ramsay, 2017, Hart Publishing.
- 5 Guide to SARFAESI Act 2002 & Recovery of Debts and Bankruptcy Act 1993, Murdoch, 2016, Taxmann Publications Pvt. Ltd.

23MRCL04 - COMPETITION LAW AND PRACTICE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCL04	COMPETITION LAW AND PRACTICE	CLP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles of fair competition and constitutional perspectives.	2	PO6
CO2	Differentiate various types of anti-competitive practices	2	PO1
CO3	Understand and able to conduct research on emerging trends in competition law.	2	PO2
CO4	Analyse the international perspectives of competition law.	3	
CO5	Analyse the role Competition Act, 2002 in regulating anti-competitive practices, promote fair competition and enforcement procedures.	3	PO5

Syllabus

History of Competition law, Development in UK and US, An Overview of Legal Framework in USA and UK and EC

Competition law in India History and Development of Competition Law in India - Sachar Committee, MRTP Act - Salient features and its amendment in 1991 - Liberalization and Globalization - Raghavan Committee Report

The Competition Act, 2002: An Overview of Competition Law in India - Important Definitions under the Competition Act, 2002 Anti- Competitive Agreements under the Competition Act, 2002

Authority : Enforcement Mechanisms under the Competition Act, 2002 ; Competition Commission of India ; Constitution of the CCI ; Powers and Functions, Jurisdiction of the CCI , adjudication and appeals - Director General , Competition Appellate Tribunal- Enforcement Mechanisms under the EU, UK and US Laws.

Reference Books

- 1 Commentary on the MRTP Law, Competition Law & Consumer Protection Law, S. M. Dugart, 2006, 4th Edition, Wadhwa & Co.
- 2 Competition Law & Cartels, P. S. Prasad, 2007, 10th Edition, The ICFAI University.
- 3 An introduction Guide to EC Competition Law & Practice, Valentine Korah, 2007, 2nd Edition, Hart Publishers.
- 4 Competition Law and Practice, D. P. Mittal, 2010, 5th Edition, Taxman Publications (P.) Ltd.
- 5 The Political Economy of Competition Law in Asia, Mark Williams, 2013, 8th Edition, Edward Elgar Publishing.

23MRCM01 - LINEAR ALGEBRA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCM01	LINEAR ALGEBRA	LAG	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop vector matrices and operations, properties of scaling and addition, matrix multiplication, generalized vectors.	3	PO1
CO2	Apply the concepts of linear Equations and solve system of linear equations with matrix methods,	3	PO3
CO3	Apply the concepts of Transposes and Inverses Column Picture of Matrix Multiplication named Algorithms Pivots, Ranks, Inverses and built the orthonormal basis by Gram Smith Orthogonalization process	3	PO5
CO4	Identify the concepts of Eigen vectors invariant subspaces and Jordan Normal Forms Algorithms, Singular Value Decomposition and Fundamental Spaces and SVD	3	PO5

Syllabus

Introduction, Numerical Computations, Functions, Equations and Linearity, Linearity the Big Picture Vectors, Matrices and Their Operations Vectors Vector Operations Linear Independence of Vectors Matrices, Matrix Operations, Properties of Scaling and Addition, Matrix Multiplication, Generalized Vectors.

Transposes and Determinants Transpose of a Matrix Definitions and Matrices with Special Properties, Determinant of a Matrix Numerical Computations Gaussian Elimination Solvability of System of Linear Equations Gaussian Elimination Applications of Gaussian Elimination More Examples beyond Gaussian Elimination Ranks and Inverses of Matrices Rank of a Matrix, Gauss Jordan Elimination Inverse of a Matrix Left and Right Inverses, Cramers Rule Algebraic View of Linear Algebra.

IVector Spaces, Basis and Dimensions Linear Combinations, Vector Spaces and Subspaces Basis and Dimensions, Geometry of Linear Equations, Change of Basis, Orthogonally and Gram-Schmidt, Basis and Components Change of Basis Basis of Subspaces, Orthogonally Gram Schmidt Process Rotation Matrices A Generalization Product Rules: Transposes and Inverses Column Picture of Matrix Multiplication Named Algorithms Pivots, Ranks, Inverses and Determinants Two Geometries the Four Fundamental Spaces, Column Space Null Space, Row Space Left Null Space Computing the Four Fundamental Subspaces Summary of the Four Spaces Computing the Spaces Review, Complete Solutions.

Projection, Least Squares and Linear Regression Projection Revisited, Projection to Subspace Meaning of Projection Linear Regression. Eigenvalue Decomposition and Diagonalization Definition and Notation Examples of Eigenvalues and Eigenvectors Computing Eigenvalues and Finding Eigenvectors Properties Unit Circles and Ellipses Diagonalization Fibonacci Numbers Applications of Eigenvalues and Eigenvectors Special Matrices, Similarity and Algorithms, Real, Symmetric Matrices Hermitian Matrices Eigen Properties of Hermitian Matrices Markov Matrices Positive Definite Matrices Gram Matrix, Matrix Similarity, Jordan Normal Forms Algorithms, Singular Value Decomposition What SVD Does How SVD Works Why SVD Is Important Fundamental Spaces and SVD

Reference Books

- 1 Linear algebra for computer science, M. THULASIDAS, 1, ASIAN BOOKS Singapore-2021.
- 2 Discrete Mathematics and Its Applications, Kenneth H. Rosen, 7, McGraw-Hill, a business unit of The McGraw-Hill Companies-2012.
- 3 Linear Algebra, K. Hoffman and R. Kunze, 2, Prentice Hall of India-2005.
- 4 Linear Algebra Done Right, Axler, 2, Springer UTM 1997.

23MRCM02 - ADVANCED NUMERICAL ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCM02	ADVANCED NUMERICAL ANALYSIS	ANA	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Compute the largest and small eigen values of a matrix using different methods.	3	PO1, PO3, PO5, PSO1, PSO2
CO2	Demonstrate the initial value problems, inverse interpolating and finite difference method.	3	PO1, PO3, PO5, PSO1, PSO2
CO3	Explain nature of the elliptic, parabolic and hyperbolic partial differential equations.	3	PO1, PO3, PO5, PSO1, PSO2
CO4	Apply collocation, least squares, and Rayleigh-Ritz methods to obtain the solution of initial value problems	4	PO1, PO3, PO5, PSO1, PSO2

Syllabus

Computations of Eigen Values of a Matrix Power method for dominant, sub-dominant and smallest eigen-values, Method of inflation, Jacobi, Givens and Householder methods for symmetric matrices, LR and QR methods. Initial Value Problems Multistep methods, their error analysis and stability analysis.

Inverse interpolation their developments and applications Finite Difference Review of finite difference operators finite difference methods. Elliptic PDE Five point formulae for Laplacian, replacement for Dirichlet and Neumanns boundary conditions, curved boundaries

Solution on a rectangular domain blocks tri-diagonal form and its solution using method of Hockney, condition of convergence. Parabolic PDE Concept of compatibility, convergence and stability, Explicit, full implicit, Crank Nicholson, du-Fort and Frankel scheme, ADI methods to solve two-dimensional equations with error analysis.

Hyperbolic PDE Solution of hyperbolic equations using FD, and Method of characteristics, Limitations and Error analysis. Weighted residual methods Collocation, least squares, Galerkins, Rayleigh Ritz methods and their compatibility.

Reference Books

- 1 Applied Numerical Analysis, Gerald, C. F. and Wheatly P. O, 6TH EDITION, Addison-Wesley Publishing, 2002.
- 2 Numerical Solution of Partial Differential Equations, Smith, G. D, 2001, Oxford University Press..
- 3 Numerical Solution of Differential Equations, . Jain, M. K, 1991, John Wiley..
- 4 Applied Numerical Analysis, . Fausett, L. V, 2nd Ed. 2007, Prentice Hall,.
- 5 Introduction to Numerical Analysis, Froberg, C. E, 2nd Ed. 2004, Addison Wesley..

23MRCM03 - MATHEMATICAL MODELLING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCM03	MATHEMATICAL MODELLING	MML	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply difference equations to model and solve real life problems.	3	PO1, PO3, PSO1
CO2	Apply method of least squares for the best fitting linear and nonlinear models.	3	PO1, PO3, PSO1
CO3	Apply simulation modeling to Interpret real life problems.	3	PO1, PO3, PSO1
CO4	Apply mathematical modelling through differential equations	3	PO1, PO3, PSO2
CO5	Verify the solution of the equations using MATLAB	3	PO4, PSO2

Syllabus

Modeling Change, Proportionality, and Geometric Similarity: Modeling Change with Difference Equations, A Savings Certificate, Mortgaging a Home, Approximating Change with Difference Equations, Solutions to Dynamical Systems. Mathematical Models, Modeling Using Proportionality, Modeling Using Geometric Similarity

To apply Method of least squares to Model Fitting: Fitting Models to Data Graphically, Analytic Methods of Model Fitting, Applying the Least-Squares Criterion, Choosing a Best Model, Vehicular Stopping Distance, Comparing the Criterion. Determining a Production Schedule. Simulation Modeling: Simulating Deterministic Behavior, Area Under a Curve, Generating Random Numbers, Simulating Probabilistic Behavior, Inventory Models

To Model and solve differential Equation: Population Growth, Graphical Solutions of Autonomous Differential Equations, Drawing a Phase Line and Sketching Solution Curves, Logistic Growth, Numerical Approximation Methods, Using Euler's Method

To apply difference equation to model and solve a Savings Certificate Revisited, Separation of Variables, Newton's Law of Cooling, Population Growth with Limited Resources, Graphical Solutions of Autonomous Systems of First-Order Differential Equations, A Competitive Hunter Model, A Predator-Prey Model.

To Apply MATLAB to validate the solutions of the mathematical equations

Reference Books

- 1 Mathematical Modelling, Kapur J. N, 1, New Age International Publishers, 2007.
- 2 Mathematical Modelling Models, Analysis and Applications, Banerjee Sandip, 1, CRC Press, Taylor & Francis Group, 2014.
- 3 A first course in mathematical modeling, Giordano, F. R., Fox W. P., and Horton S. B., 1, Brooks/Cole, 2014.
- 4 A concrete approach to mathematical modeling, Mesterton-Gibbons, M., 1, Addison-Wesley.

23MRCM04 - STOCHASTIC PROCESSES & OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCM04	STOCHASTIC PROCESSES & OPTIMIZATION	SPO	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize the concept of Markov process and Poisson Process. solve real life applications	3	PO1, PO2, PSO1
CO2	Apply Queueing models and Demonstrate the concepts of Brownian motions and applications	3	PO1, PO2, PSO1
CO3	Construct LPP and solve LPP. Model and solve Transportation and Assignment problems.	3	PO1, PO2, PSO1
CO4	Apply Geometric programming and Ant-colony Optimization and PSO. Solve decision making techniques to solve real life problems.	3	PO1, PO2, PSO1

Syllabus

Discrete-Time Markov Models: Discrete-Time Markov Chains, Transient Distributions, Occupancy Times, Limiting Behavior, First-Passage Times. Poisson Processes: Poisson Processes, Superposition of Poisson Processes, Thinning of a Poisson Process, Compound Poisson Processes. Continuous-Time Markov Models: Continuous-Time Markov Chains, Transient Analysis: Uniformization, Occupancy Times, Limiting Behavior, First-Passage Times. Generalized Markov Models: Renewal Processes, Cumulative Processes, Semi-Markov Processes.

Queueing Models: Queueing Systems, Single-Station Queues, Birth and Death Queues. Brownian Motion: Standard Brownian Motion, Brownian Motion, First-Passage Times, Martingales and Semimartingales, Black Scholes Formula.

Introduction to LPP: Formulation of LP models, Graphical procedure of solution, Convex functions and their properties, Basic feasible solution, Optimal solution. Simplex method, Transportation Problems: VAM Method, Optimality Test, Degeneracy, Unbalanced Transportation problem, Assignment problems, Travelling salesman problem. Integer LPP - Branch and Bound Algorithm, Cutting Plane Algorithm.

Geometric Programming: Problems with one-degree of difficulty with positive coefficients, Geometric programming with constraints, Problems with positive and negative coefficients. Heuristic and Meta heuristics, Single solution vs. population-based, Parallel meta heuristics, Evolutionary algorithms, Nature-inspired meta heuristics, Genetic Algorithm, Ant-colony optimization, Particle swarm optimization, Simulated annealing.

Reference Books

- 1 Operations Research: An Introduction, Taha H A, 9 Edition, 2012, MacMillan Pub Co.
- 2 Optimization, Rao s s, 4 Edition, 2019, Wiley Eastern India.
- 3 Linear Programming, Hadley E, Paper Back, 2013, Addison-Wesley.
- 4 Operations Research: Principles and Practice, Ravindran, A., Phillips, D.T. and Solberg, J.J, 2 Edition, 2007, John Wiley and Sons.
- 5 Introduction to Operation Research, Hillier F.S. and Lieberman G.J, 9 Edition, 2018, Mc Graw Hill.

23MRCM05 - FUZZY MATHEMATICS AND ITS APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCM05	FUZZY MATHEMATICS AND ITS APPLICATIONS	FMAA	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of fuzzy sets and fuzzy logic.	2	PO1
CO2	Apply the various operations on fuzzy sets and their properties.	3	PO1
CO3	Apply fuzzy logic to real-world problems and systems.	3	PO2
CO4	Apply fuzzy techniques in various fields such as control systems, decision-making, and pattern recognition.	3	PO2

Syllabus

Introduction to Fuzzy Sets and Systems Classical Sets vs. Fuzzy Sets Definition and examples of fuzzy sets Membership functions Basic operations on fuzzy sets Union, intersection, and complement T norms and T conorms Properties of fuzzy sets Convexity, normality, and support.

Fuzzy Relations and Fuzzy Logic Fuzzy Relations Definition and examples Operations on fuzzy relations Composition of fuzzy relations Fuzzy Logic Introduction to fuzzy propositions Fuzzy connectives Fuzzy inference rules.

Fuzzy Inference Systems Mamdani Fuzzy Models Structure of a fuzzy inference system Fuzzification and defuzzification methods Sugeno Fuzzy Models Linear and constant outputs Comparison between Mamdani and Sugeno models Applications in control systems Design of fuzzy controllers Real-world examples Applications of Fuzzy Mathematics Decision Making with Fuzzy Information Fuzzy decision-making models Multi-criteria decision making.

Fuzzy Pattern Recognition Fuzzy clustering algorithms Fuzzy C-means algorithm Fuzzy Systems in Engineering Fuzzy logic in control engineering Applications in industrial automation Fuzzy Optimization Introduction to fuzzy optimization problems Solution techniques Fuzzy Neural Networks Basics of neural networks Integration of fuzzy logic and neural networks.

Reference Books

- 1 Fuzzy Logic with Engineering Applications, Timothy J. Ross, 1, (1995), Wiley.
- 2 Introduction to Fuzzy Sets and Fuzzy Logic, M. Ganesh, 2, (2006), Prentice Hall India Learning Private Limited.
- 3 Fuzzy Sets, Uncertainty, and Information, George J. Klir and Tina A. Folger, 3, (1988), Prentice Hall.
- 4 Fuzzy Set Theory and Its Applications, H J Zimmermann, 1, (1985), Springer.

23MRDM01M - FUNDAMENTALS OF DIGITAL MARKETING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRDM01M	FUNDAMENTALS OF DIGITAL MARKETING	FDM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the key concepts of digital marketing to understand the digital customer	3	PO2, PSO1
CO2	Apply Digital marketing communication and channel mix	3	PO3, PSO1
CO3	Apply the key Components of digital marketing	3	PO5, PSO2
CO4	Analyse the Digital Business Present and future marketing concepts	4	PO7, PSO2

Syllabus

: Fundamental Need Scope of Digital marketing Traditional v. Digital Marketing the Opportunity of Digital Marketing Characteristics of Digital Marketing Implications of Digital Marketing Digital marketing framework delivering enhanced customer value market opportunity analysis and digital services development ASCOR digital marketing framework Application of digital marketing critical success factor for digital marketing

Designing the communications mix Marketing communications steps to creating marketing communication strategy developing communications messaging communication mix across digital channels. Introduction to digital marketing channels- Search marketing Display marketing social media marketing Partner direct content and platform based marketing channels

Website marketing Search engine marketing online marketing email marketing blog marketing social media marketing Audio video and interactive marketing mobile marketing public relations multimedia marketing.

The Indian view India digital spend overview India digital advertising spend key digital advertising trends in India India Digital marketing/tools landscape Digital marketing emerging trends and concepts Big data and IoT B2B and SMB SoLoMo. Career in Digital Marketing- Emerging opportunities for digital marketing professionals The changing role of CMO in Organisations Building a career in Digital marketing Top Digital marketing areas as career tracks Approaching a career in digital marketing.

Reference Books

- 1 Fundamentals of Digital marketing , Puneet Singh Bhatia, 3, 2019, Pearson Indian Publisher.
- 2 B2B Digital marketing , 2. Michael Miller , 2015, Pearson Indian Publishe.
- 3 Social Media Marketing Successfully For Beginners Create Successful Campaigns Gain More Fans And Boost Sales., F R Media, 2018, Pearson.
- 4 Digital Marketing, Kailash Chandra Upadyaya, 2016, Notion Press.

23MRDM02M - SOCIAL MEDIA MARKETING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRDM02M	SOCIAL MEDIA MARKETING	SMM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles and concepts of social media marketing.	2	PO11
CO2	Understand different social media platforms to identify the most appropriate ones for specific marketing goals	2	PO11
CO3	Apply and manage social media campaigns using tools and techniques to optimize reach and engagement	3	PO11
CO4	Analyse the effectiveness of social media campaign	4	PO11

Syllabus

Overview of Social Media Marketing-Definition and significance-Evolution of social media-Differences between traditional and social media marketing. Social Media Platforms-Major platforms-Facebook, Twitter, Instagram, LinkedIn, YouTube, Pinterest. Social Media Ethics and Legal Considerations-Ethical issues in social media marketing-Legal regulations and compliance- Privacy and data protection.

Consumer Behavior in Social Media-Understanding social media users-Consumer decision-making process-Trends in social media usage- Platform demographics and user behaviors. Creating a Social Media Strategy- Setting goals and objectives- Identifying target audience-Selecting the right platforms.

Content Creation and Management- Content Marketing Fundamentals-Importance of content in social media-Types of content text, images, videos, infographics. Content Creation Techniques. Engagement Strategies-Building community and fostering engagement-Responding to comments and messages-Managing negative feedback-Influencer and Affiliate Marketing-Identifying and collaborating with influencers-Measuring influencer impact.

Social Media Analytics-Campaign Management and Optimization-Analytics and Reporting. Overview of analytics tools-Google Analytics, platform-specific analytics-Data collection and interpretation-Measuring ROI and campaign effectiveness

Reference Books

- 1 Digital Marketing, Seema Gupta, 3rd Edition 2022, McGraw Hill.
- 2 Social Media Marketing, Tracy L. Tuten, Michael R. Solomon, Bikramjit Rishi, 3rd Edition 2023, SAGE Publications India Pvt Ltd.
- 3 Social Media Marketing All-in-One For Dummies, Michelle Krasniak, Jan Zimmerman, Deborah Ng, 5th Edition 2021, For Dummies.
- 4 Social Media Marketing 2024: Mastering New Trends & Strategies for Online Success, Robert Hill, 2023, Independently Published.

23MRDM03M - SERACH ENGINE OPTIMIZATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRDM03M	SERACH ENGINE OPTIMIZATION	SEO	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To examine and explore the role and importance of search engine optimization in today's rapidly changing business environment	2	PO2
CO2	To know the key elements of a digital marketing strategy	2	PO2
CO3	Use optimization tools and metrics to analyze strategies, and effectively manage and improve SEO efforts.	4	PO2
CO4	To demonstrate advanced practical skills in search engine optimization	4	PO2

Syllabus

Search Engine Basics What Is a Search Engine Anatomy of a Search Engine Query interface Crawlers, spiders, and robots Databases Search algorithms Retrieval and ranking Characteristics of Search Classifications of Search Engines Primary search engines Secondary search engines Targeted search engines Putting Search Engines to Work for You Manipulating Search Engine Creating an SEO Plan Understanding Why You Need SEO Setting SEO Goals Creating Your SEO Plan Prioritizing pages Site assessment Finishing the plan Follow-up Understanding Organic SEO Achieving Organic SEO Web-site content Google Analytics Internal and external links User experience Site interactivity

Building Your Site for SEO Page elements Understanding Web-Site Optimization Domain-naming tips Understanding usability Components of an SEO-Keywords and Your Web Site The Importance of Keywords Picking the Right Keywords Taking Advantage of Organic keywords PayperClick and SEO How Pa-perClick Works Determining visitor value Putting pay-per-click to work Pay-per-Click Categories Service pay-per-click Keyword suggestion tools Choosing Effective Keywords Maximizing PayperClick Increasing Keyword Success Managing Keyword and PPC Campaigns Keyword Tools and services Tagging Your Web Site The Content Piece of the Puzzle Understanding the Role of Links and Linking

Optimizing Search Strategies Adding Your Site to Directories Pay for Inclusion Services Robots Spiders and Crawlers The Truth About SEO Spam Adding Social Media Optimization Automated Optimization

SEO Beyond the Launch Using Content Management Systems SEO Problems and solutions Content scraping Click fraud Analysing Success Analysing SEO Successes Managing SEO expectations www.it-ebooks.info Find yourself Analysing web stats Competitive Analysis Conversion Analysis Analysing Server Logs

Reference Books

- 1 SEO-BIBLE , JERRY L LEDFORD, 2008, Wiley Publishing, Inc..
- 2 The Beginners guide search engine optimization , SpeckyGeek, 2020, SpeckyGeek.
- 3 A complete guide to getting started in SEO, SEJ Search engine journal , 2018, Alpha Brand Media.
- 4 Mastering Search Engine Optimization , E m agency, 2023, E m agency.

23MRDM04M - ARTIFICIAL INTELLIGENCE IN MARKETING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRDM04M	ARTIFICIAL INTELLIGENCE IN MARKETING	AIM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of AI and machine learning in marketing.	2	PO7
CO2	Explore how AI is used for customer segmentation, targeting, and personalization	3	PO7
CO3	Analyze the role of AI in content creation, recommendation engines, and marketing automation. .	4	PO7
CO4	Discuss the ethical considerations and challenges of using AI in marketing.	4	PO7

Syllabus

Introduction to AI in Marketing Understanding AI and Machine Learning, The Marketing Landscape and AI Integration, Benefits and Challenges of AI in Marketing, Customer Segmentation with AI, Predicting Customer Behavior

AI-powered Marketing Automation Building Customer Profiles with AI, Personalization and Hyper-personalization, Chatbots and Virtual Assistants in Marketing, Content Creation with AI (e.g., AI-powered copywriting)

AI in Marketing Channels AI for Search Engine Optimization (SEO) and Marketingm Optimizing Paid Advertising with AI, AI-driven Social Media Marketing, Dynamic Pricing Strategies with AI.

The Future of AI in Marketing AI-powered Recommendation Engines, Optimizing Marketing Mix with AI, Emerging AI Trends and Applications, Ethical Considerations of AI in Marketing, The Future of Human-AI Collaboration

Reference Books

- 1 Marketing Artificial Intelligence: AI, Marketing, and the Future of Business, Paul Roetzer and Chris Kaput, 2022, Matt Holt.
- 2 Artificial Intelligence for Marketing Management, Thaichon Quach, 1, Routledge.
- 3 Artificial Intelligence for Marketing: Practical Applications , Christopher Penn, 1, Wiley.
- 4 "Artificial Intelligence in Marketing", Andreas Kaplan, 1st Edition (2019), Routledge.

23MRFA01M - FOUNDATIONS AND APPLICATIONS OF FINANCIAL TECHNOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFA01M	FOUNDATIONS AND APPLICATIONS OF FINANCIAL TECHNOLOGY	AFT	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the historical context and evolution of financial technology.	2	PO2
CO2	Understand key technologies driving the FinTech revolution.	2	PO3
CO3	Understand the impact of FinTech on traditional financial services.	2	PO6
CO4	Develop practical skills through case studies and project-based learning.	2	PO6

Syllabus

Introduction to Financial Technology, History and Evolution of FinTech Overview of the financial services industry, Key drivers of FinTech innovation, Blockchain and Cryptocurrencies: Introduction to blockchain technology, Cryptocurrencies: Bitcoin, Ethereum, and others. Applications of blockchain in financial services and Regulatory and security issues

Digital Payments and Remittances: Evolution of payment systems, Mobile payments and digital wallets, Cross-border remittances and Case studies: PayPal, Venmo, and others Peer-to-Peer Lending and Crowdfunding, Overview of peer-to-peer (P2P) lending, Crowdfunding platforms and models Risk management and regulatory challenges and Case studies: LendingClub, Kickstarter, and others

Robo-Advisors and Wealth Management: Introduction to robo-advisors, Algorithms and AI in wealth management, Benefits and limitations of automated financial advice and Case studies: Betterment, Wealth front, and others. InsurTech: Innovation in Insurance, Overview of InsurTech Data analytics and AI in insurance, Personalized insurance products and Case studies: Lemonade, Oscar Health, and others

RegTech and Compliance: Introduction to RegTech, Technologies for regulatory compliance, Anti-money laundering (AML) and Know Your Customer (KYC) solutions and Case studies: Onfido, ComplyAdvantage, and others Cybersecurity in Financial Services: Importance of cybersecurity in FinTech Common threats and vulnerabilities, Security protocols and technologies and Case studies: Equifax breach, other relevant incidents

Reference Books

- 1 The Financial Technology Handbook for Investors, Entrepreneurs, and Visionaries, usanne Chishti and Janos Barberis, 1st Edition (2016), Wiley.
- 2 A Non-Technical Introduction in 25 Steps, Daniel Drescher, 1st Edition (2017), Apress.
- 3 Digital Finance: Big Data, Startups, and the Future of Financial Services, Baxter Hines, 1st Edition (2020), Wiley.
- 4 Handbook of Blockchain, Digital Finance, and Inclusion, Volume 1: Cryptocurrency, FinTech, InsurTech, and Regulation, David Lee Kuo Chuen and Robert Deng, 1st Edition (2017), Academic Press.

23MRFA02M - DECENTRALISED FINANCE: THE FUTURE OF FINANCE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFA02M	DECENTRALISED FINANCE: THE FUTURE OF FINANCE	DFFF	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles and technologies underlying DeFi.	2	PO2
CO2	Examine the key components and technologies behind DeFi.	3	PO3
CO3	Analyze the risks, challenges, and opportunities associated with DeFi.	3	PO4
CO4	Analyze the regulatory and legal aspects of DeFi.	4	PO5

Syllabus

Introduction to Decentralized Finance: Overview of traditional finance vs. decentralized finance, History and evolution of DeFi, Key components and terminology. Blockchain Technology and Cryptocurrencies: Fundamentals of blockchain technology, Overview of major cryptocurrencies (Bitcoin, Ethereum, etc) , Role of blockchain in DeFi.

Components of DeFi: Cryptocurrencies and Tokens, Bitcoin, Ethereum, and Altcoins, Introduction to Smart Contracts: Definition and Importance of Smart Contracts, Smart Contracts Work.

Decentralized Exchanges (DEXs), Functioning of DEXs (e.g., Uni swap, Sushi Swap), Lending and Borrowing Platforms, Aave, Compound, Yield Farming and Liquidity Mining, Stable coins and Synthetic Assets, Types and Uses of Stable coins. DeFi Security and Risk Management: Security Challenges in DeFi, Common Vulnerabilities and Hacks, Risk Management Strategies.

Regulatory and Legal Aspects of DeFi: Overview of Global Regulatory Landscape, Regulatory Frameworks for Cryptocurrencies, Legal Challenges and Considerations, Future of DeFi Regulation, Future Trends and Innovations: Emerging Trends in DeFi, Potential Disruptions in Traditional Finance. Predictions and Future Directions.

Reference Books

- 1 DeFi and the Future of Finance, Campbell R. Harvey, Ashwin Ramachandran, and Joey Santoro, 1st Edition, 2021, Wiley.
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, rvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, 1st Edition, 2016, Princeton University Press.
- 3 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications", Imran Bashir, 2nd Edition, 2020, Packt Publishing.
- 4 The Bitcoin Standard: The Decentralized Alternative to Central Banking, Saifedean Ammous, 1st Edition, 2018, Wiley.

23MRFA03M - FINTECH INNOVATIONS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFA03M	FINTECH INNOVATIONS	FIV	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fintech landscape including its history evolution and impact on the financial industry.	2	PO1
CO2	Understand the role of artificial intelligence (AI) and machine learning (ML) in fintech	2	PO4, PO5
CO3	Understand blockchain technology and its applications, with a particular focus on cryptocurrencies and their role in the fintech sector.	2	PO4, PO5
CO4	Understand the innovations in digital payments and lending, new business models and technologies transforming these areas.	2	PO4, PO5

Syllabus

Introduction to Fintech: History and Evolution of Fintech Key Drivers of Fintech Innovation Major Fintech Segments (Payments, Lending, Wealth Management, Insurtech, Regtech) Fintech Ecosystem (Startups, Incumbents, Regulators) Key Technologies in Fintech (Blockchain, AI, Big Data, APIs) Case Studies of Successful Fintech Companies

AI and Machine Learning in Fintech: Introduction to AI and Machine Learning Applications of AI in Financial Services (Robo-Advisors, Fraud Detection, Credit Scoring) Natural Language Processing (NLP) and Chatbots in Fintech Predictive Analytics and Customer Insights Algorithmic Trading and Wealth Management Ethical Considerations and Bias in AI. Case Studies of AI in Fintech

Blockchain and Cryptocurrencies: Fundamentals of Blockchain Technology Consensus Mechanisms (Proof of Work, Proof of Stake) Cryptocurrencies (Bitcoin, Ethereum, Altcoins) Initial Coin Offerings (ICOs) and Tokenization Decentralized Finance (DeFi) Regulatory and Compliance Issues in Cryptocurrencies Security and Risk Management in Blockchain

Digital Payments and Lending: Evolution of Digital Payments (Mobile Payments, E-wallets) Real-time Payments and Cross-border Transfers Peer-to-Peer (P2P) Lending Platforms Crowdfunding and Alternative Lending Models Digital Banking and Neobanks Risk anagement and Fraud Prevention in Digital Payments Regulatory Considerations in Digital Payments and Lending

Reference Books

- 1 FinTech Innovation: From Robo-Advisors to Goal Based Investing and Gamification, Paolo Sironi, First, Wiley.
- 2 FinTech: The New DNA of Financial Services, Pranay Gupta, T. Mandy Tham, and Raymond Yeung, First, Walter de Gruyter GmbH.
- 3 FinTech Revolution: Universal Inclusion in the New Financial Ecosystem, Sofie Blakstad and Robert Allen, First, Palgrave Macmillan.
- 4 Blockchain and FinTech: A Comprehensive Guide, Spiros Margaritis, Richard Kastelein, and Alexis Nicolau, First, Palgrave Macmillan.
- 5 The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Susanne Chishti and Janos Barberis, First, Wiley.

23MRFA04M - USING MACHINE LEARNING IN TRADING AND FINANCE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFA04M	USING MACHINE LEARNING IN TRADING AND FINANCE	ML	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply TensorFlow to write small programs.	3	PO2
CO2	Able to Analyse the data using TensorFlow and Keras.	4	PO3
CO3	Able to Analyse the data using Momentum Trading using ML algorithms.	4	PO3, PSO1
CO4	Able to develop a Pair Trading Strategy.	4	PO3, PSO2

Syllabus

Introduction to Quantitative Trading and Machine Learning, Basic Trading Strategy Entries and Exits Endogenous Exogenous, Trading Strategy Building a Trading Model, Advanced Concepts in Trading Strategies, Welcome to Using Machine Learning in Trading and Finance, Introduction to TensorFlow, Introduction to TensorFlow, TensorFlow API Hierarchy, Components of tensorflow Tensors and Variables, Getting Started with Google Cloud Platform and Qwiklabs, Lab Intro Writing low-level TensorFlow programs, Working in-memory and with files, Training on Large Datasets with tf.data API, Getting the data ready for model training.

Training Neural Networks with TensorFlow2 and keras, Activation functions, Activation functions, it falls to avoid in Backpropagation, Neural Networks with Keras Sequential API, Serving models in the cloud, Lab Intro to Keras Sequential API, Neural Networks with Keras Functional API, Regularization Basics, Regularization: L1, L2, and Early Stopping, Dropout, Lab Intro to Keras Functional API.

Build a Pair Trading Strategy Prediction Model, Introduction to Pair Trading, Picking Pairs, Picking Pairs with Clustering, How to implement a Pair Trading Strategy, Evaluate Results of a Pair Trade, Backtesting and Avoiding Overfitting, Next Steps for Improvements to your Pairs Strategy, Lab Intro to Pairs Trading, Kalman Filter Introduction and Trading Applications. Co4: To develop a Pair Trading Strategy.

Build a Pair Trading Strategy Prediction Model, Introduction to Pair Trading, Picking Pairs, Picking Pairs with Clustering, How to implement a Pair Trading Strategy, Evaluate Results of a Pair Trade, Backtesting and Avoiding Overfitting, Next Steps for Improvements to your Pairs Strategy, Lab Intro to Pairs Trading, Kalman Filter Introduction and Trading Applications. Co4: To develop a Pair Trading Strategy.

Reference Books

- 1 Machine Learning for Finance , Saurav Singla, 1, BPB Publications.
- 2 Stock Market Prediction and Efficiency Analysis using Recurrent Neural Network, Joish Bosco, 1, University.
- 3 Machine Learning in Finance: From Theory to Practice, Mathew F Dixon, 1, Springer.
- 4 MACHINE LEARNING IN FINANCE: RISK MANAGEMENT, TRADING, AND FRAUD DETECTION (, Dr. Aman Gupta, Dr. Hafizah, Subharun Pal, Syamsu Rijal, 1, Xoffencer International Publication.

23MRFM01 - FILM AESTHETICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFM01	FILM AESTHETICS	FAS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the formal elements of film (such as cinematography, mise-en-scène, editing, sound, and narrative structure) to understand how they contribute to the overall aesthetic experience.	4	PO8
CO2	Evaluate different film movements and styles, assessing their historical and cultural significance and their impact on contemporary cinema.	5	PO10
CO3	Apply critical and theoretical concepts to the analysis of films, demonstrating an understanding of aesthetic principles and their practical implications in filmmaking.	3	PO10

Syllabus

Introduction to Film Aesthetics: Defining aesthetics and its importance in film. Cinematography: The art of visual storytelling, including composition, lighting, and camera movement. Mise-en-scène: The arrangement of everything that appears in the frame, including settings, props, and actors. Editing: The techniques and impact of cutting, continuity editing, montage, and rhythm. Sound: The role of sound design, music, and dialogue in enhancing the filmic experience. Film Analysis Exercise: Watch a selected film and analyze its use of cinematography, mise-en-scène, editing, and sound.

Classical Hollywood Cinema: Narrative and stylistic conventions. European Art Cinema: Characteristics and key directors. Film Noir: Visual and thematic elements. New Wave Cinemas: French New Wave, New Hollywood, and other global movements. Experimental and Avant-Garde Film: Breaking the norms of narrative and form. Movement Analysis Exercise: Research and present on a specific film movement, highlighting its key characteristics and influence. Film Screening and Discussion: Watch a film from a notable movement and discuss its aesthetic and thematic contributions.

Classical Film Theory: Theoretical foundations laid by early film theorists. Contemporary Film Theory: Modern approaches and their relevance. Psychoanalytic Theory: Understanding the psychological underpinnings of film aesthetics. Feminist Film Theory: Examining gender representations and their aesthetic implications. Postmodernism in Film: Characteristics and examples of postmodern aesthetics. Theoretical Application Essay: Write an essay applying a specific theoretical framework to a film of choice. Group Debate: Debate the merits and limitations of different film theories in understanding film aesthetics.

Reference Books

- 1 Film art: An introduction , Bordwell, D., & Thompson, K., 2019, McGraw-Hill Education.
- 2 The cinema book, Cook, P., 2018, Bloomsbury Academic..
- 3 How to read a film: Movies, media, and beyond, Monaco, J. , 2009, Oxford University Press..
- 4 Film theory: An introduction., Stam, R. , 2000, Wiley-Blackwell.

23MRFM02 - SCREEN WRITING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFM02	SCREEN WRITING	SWT	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop compelling narratives and well-structured scripts by applying key principles of screenwriting, including plot, character development, and dialogue.	3	PO1
CO2	Analyze and critique screenplays to identify strengths and areas for improvement, utilizing industry-standard formatting and storytelling techniques.	3	PO7
CO3	Create original screenplays that demonstrate an understanding of various genres, styles, and audience expectations.	3	PO3

Syllabus

Introduction to Screenwriting: Understanding the role and responsibilities of a screenwriter. Story Structure: The Three-Act Structure, plot points, and narrative arcs. Character Development: Crafting multidimensional characters, including protagonists, antagonists, and supporting roles. Creating Conflict: Techniques for building tension and driving the narrative forward. Screenplay Formatting: Industry-standard script formatting and conventions.

Writing Effective Dialogue: Crafting authentic and compelling dialogue. Scene Construction: Building effective scenes that advance the plot and develop characters. Genre and Style: Understanding different genres and writing styles. Visual Storytelling: Using descriptions and actions to convey visual elements and emotions. Revision Techniques: Strategies for revising and improving your screenplay.

Theme and Subtext: Incorporating deeper meanings and themes into your screenplay. Writing for Different Media: Adapting screenwriting techniques for television, web series, and other formats. Collaborative Writing: Working with directors, producers, and other writers. Pitching and Selling Scripts: Techniques for pitching your screenplay and navigating the business side of screenwriting. Final Draft and Polishing: Preparing your screenplay for submission.

Reference Books

- 1 Screenplay: The foundations of screenwriting., Field, S. , 2005, Delta.
- 2 Story: Substance, structure, style, and the principles of screenwriting., McKee, R., 1997, ReganBooks..
- 3 Writing screenplays that sell , Snyder, B. , 2005, Michael Wiese Productions..
- 4 The Screenwriter's Bible: A complete guide to writing, formatting, and selling your script, Trottier, D., 2014, Silman-James Press..

23MRFM04 - SOUND DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFM04	SOUND DESIGN	SDS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the principles of sound design and their application in various media, including film, television, and interactive media.	4	PO3
CO2	Create and manipulate audio elements using industry-standard tools and techniques to enhance storytelling and audience engagement.	3	PO8
CO3	Evaluate the effectiveness of sound design in media projects, providing constructive feedback and incorporating revisions to improve the overall soundscape.	5	PO10

Syllabus

Introduction to Sound Design: The role and importance of sound in media. Basic Audio Theory: Understanding sound waves, frequency, amplitude, and timbre. Microphones and Recording Techniques: Types of microphones, placement, and techniques for capturing high-quality audio. Field Recording: Capturing natural and environmental sounds. Digital Audio Workstations (DAWs): Introduction to popular software for sound editing and mixing.

Sound Editing Techniques: Cutting, trimming, crossfading, and time-stretching. Sound Restoration and Noise Reduction: Cleaning up audio recordings. Creating Sound Effects: Foley, synthesis, sampling, and using sound libraries. Ambient and Environmental Sounds: Designing background sounds to enhance scenes. Sound Mixing Principles: Balancing audio elements, EQ, dynamics, and spatial effects.

Surround Sound and Immersive Audio: Techniques for creating immersive sound experiences. Dialogue and Voiceover: Recording, editing, and mixing dialogue and voice performances. Audio Effects and Processing: Reverb, delay, modulation, and other creative effects. Finalizing Sound Mixes: Mastering, exporting, and delivering sound for various platforms. Sound Design for Interactive Media: Implementing sound in video games, VR, and interactive installations.

Reference Books

- 1 Sound for film and television , Holman, T., 2010, Focal Press..
- 2 Sound design: The expressive power of music, voice, and sound effects in cinema. , Sonnenschein, D. , 2001, Michael Wiese Productions..
- 3 Practical art of motion picture sound , Yewdall, D., 2012, Focal Press..
- 4 The sound effects Bible: How to create and record Hollywood style sound effects. , Viers, R. , 2012, Michael Wiese Productions. .

23MRFT01 - INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFT01	INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY	IFST	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the basic principles of food science and technology	2	PO1, PO7, PO8
CO2	Determine the structure, composition, nutritional quality and postharvest changes of various plant foods.	3	PO1, PO7, PO8
CO3	Determine the structure and composition of various animal foods	3	PO1, PO7, PO8
CO4	Discover about various dairy products	3	PO1, PO7, PO8
CO5	Demonstrate use various basic food processing techniques with an aim to preserve the foods	3	PO1, PO7, PO8

Syllabus

historical evolution of food processing technology. Cereals and millets Structure and composition, properties and nutritional attributes of rice, wheat, maize, barley, millet and oats, malting, gelatinization of starch, types of browning Maillard & caramelization, rice parboiling of rice advantages and disadvantages.

Structure and composition of pulses, toxic constituents in pulses, processing of pulses soaking, germination, decortications, cooking and fermentation. Fats and Oils-classification of lipids, types of fatty acids saturated fatty acids, unsaturated fatty acids, essential fatty acids, trans fatty acids. Refining of oils, types- steam refining, alkali refining, bleaching, steam deodorization, and hydrogenation. Rancidity Types- hydrolytic and oxidative rancidity and its prevention.

Fruits and Vegetables-Classification of fruits and vegetables, general composition, enzymatic browning, names and sources of pigments, Dietary fiber. Post-harvest changes in fruits and vegetables Climacteric rise, horticultural maturity, physiological maturity, physiological changes, physical changes, chemical changes, pathological changes during the storage of fruits and vegetables.

Introduction to poultry and dairy sectors

Analzing the various characteristics of foods

Reference Books

- 1 Food Science , Bawa. A.S, O.P Chauhan et al, 2013, New India Publishing agency.
- 2 Food Science, Roday,S, 2011, oxford publication.
- 3 Food science, Srilakshmi, 2002, New Age Publishers.
- 4 Outlines of Dairy Technology, De Sukumar, 2007, oxford publication press.

23MRFT02 - FOOD ANALYSIS AND QUALITY ASSURANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFT02	FOOD ANALYSIS AND QUALITY ASSURANCE	FAQA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the analytical aspects of foods in quality and regulatory perspective.	2	PO3, PO5, PO6, PSO2
CO2	Apply the analytical methods for chemical and nutritional properties of foods.	3	PO3, PO5, PO6, PSO2
CO3	Apply the analytical methods for thermal and rheological properties of foods.	3	PO3, PO5, PO6, PSO2
CO4	Apply sensory and microbiological analysis on different processed foods.	3	PO3, PO5, PO6, PSO2
CO5	Analyze the project on Quality assurance	4	PO3, PO5, PO6, PSO2

Syllabus

Introduction to Food Analysis, Importance of various food components, purpose, sampling requirements. Quality different aspects of food analysis, Properties, parameters, methods, techniques. Regulatory aspects involved in the food analysis

Chemical and Physico-Chemical analysis of foods, Chemical analysis such as carbohydrate, protein, fat, mineral content analysis. Study on different physical properties such as colour, size, shape, composition and interfacial properties.

Different Thermal and Rheological Properties. Thermal properties such as transition (glass and melting) and degradation temperatures, thermal conductivity, specific heat and thermal diffusivity of different foods. Different rheological properties such as flow properties, studies on shear stress and shear rate in different foods.

Study on microbial effect in different types of foods. Study on microbial diseases transmitted through foods. Study of different sensory parameters, study on advanced sensory software tools. Study on advanced microbiological techniques.

Evaluate the project on Quality analysis including Practical Safety evaluation of foods for heavy metal content and pesticides residue, Analyse the water activity in different foods, Analyse the texture of different foods, Analyse the quality parameters of water, Evaluate the thermal properties of different foods, Analyse the flow properties of different foods, Evaluate the microbial quality of selected food products.

Reference Books

- 1 Handbook of Food Analysis Instruments , Semih Otles , 1st Edition, 2009, CRC Press.
- 2 Instrumental Methods in Food and Beverage Analysis, David L. B. Wetzel, George Charalambous, 1st Edition, 1998 , Elsevier.
- 3 Vitamin Analysis For The Health And Food Sciences, Ronald Ray Eitenmiller, Lin Ye, W. O. Landen, 2nd Edition, 2007, CRC Press.
- 4 Methods of Analysis of Food Components and Additives, Semih Otles, 2nd Edition, 2012, CRC Press.

23MRFT03 - FOOD SAFETY AND REGULATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFT03	FOOD SAFETY AND REGULATIONS	FSR	R	3	1	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the overall concept of food safety , hazards	2	PO6, PO8
CO2	Apply the food safety regulations such as ISO and safety management systems like HACCP	3	PO6, PO8
CO3	Apply food safety measures to hazard control	3	PO6, PO8
CO4	Apply food safety management systems to hazard control	3	PO6, PO8

Syllabus

Definitions, Types of hazards, biological, chemical, physical hazards, Factors affecting Food Safety, Importance of Safe Foods. Physical and Chemical Food Hazards Introduction, Physical Hazards with common examples, Chemical Hazards Impact on health, Control measures

Biological Food Hazards Introduction, Indicator Organisms, Food borne pathogens: bacteria, viruses, eukaryotes, Seafood and Shell fish poisoning, Mycotoxins.

Hazard Management Need, Control of parameters, Temperature control, Food storage, Product design. Hygiene and Sanitation in Food Service Establishments Introduction, Sources of contamination, Control methods using physical and chemical agents, Waste disposal, Pest and Rodent Control, Personal hygiene, Food Safety Measures.

Food Safety Management Tools Concept, Prerequisites- GHPs ,GMPs, SSOPs etc, HACCP, ISO, TQM concept and need for quality, components of TQM, Kaizen Risk analysis, Accreditation and Auditing. Microbiological Hazards Microbiological standards and limits Microbiological Assessment and categories of food based on microbial quality, Sampling, Basic steps in detection of food borne pathogens, Water analysis, Assessment of Surface Sanitation and Personal Hygiene

Reference Books

- 1 The microbiological safety and quality of food, Barbara M. Lund, Tony C. Baird-Parker, G. W. Gould, 2000, Aspen Publishers, Gaithersburg, Md., .
- 2 Chemistry and Safety of Acrylamide in Food, Margareta T?rnqvist (auth.), Mendel Friedman, Don, 2005, MottramSpringer Science & Business Media,.
- 3 Food safety handbook, Ronald H. Schmidt, Gary E. Rodrick, 2003, Global Publishing House.
- 4 HACCP, Sara E. Mortimore, Carol Wallace, Christos Cassianos, Online, 2001, Cambridge University Press.
- 5 Food Plant Sanitation- Design, Maintenance, and Good Manufacturing Practices, Michael M Cramer, 2013, Taylor & Francis Group.

23MRFT04 - FOOD ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFT04	FOOD ENGINEERING	FEG	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand unit operations and plant design.	2	PO6, PO8
CO2	Apply principles of fluid flow to food processing	3	PO6, PO8
CO3	Apply principles of heat transfer.to food processing	3	PO6, PO8
CO4	Apply principles of phase change to food processing	3	PO6, PO8
CO5	Conduct Food Engineering Experiments to food processing	3	PO6, PO8

Syllabus

Unit Operations and Food Plant Design: Concept of Unit operation. Units and dimensions, Unit conversions, dimensional analysis. Mass and Energy Balance. Important considerations for designing of food plants, types of layouts. Equipment used in food industry.

Fluid Flowing Food Processing, Liquid Transport System

Heating and Cooling Systems Heating thermal properties of food, modes of heat transfer, application of steady state heat transfer, superheating. Heating equipment heat exchangers types, design characteristics. Refrigeration Concept, selection of a refrigerant, refrigeration cycle, sub cooling,

Steam, Evaporation and Dehydration: Steam Generation, construction and functions of fire tube and water tube boilers. Evaporations types, design of single effect evaporators, basic drying process, moisture content on wet basis and dry basis, design of dehydration systems

Reference Books

- 1 Introduction to Food Engineering, Paul Singh, R. and Dennis R. Heldman. 2009. Introduction to Food Engineering, 4, Academic press, New York, USA..
- 2 Unit Operations in Food Engineering., Albert Ibarz and Gustavo V. Barbosa, C?novas. 2003. Unit Operations in Food Engineering., 2003, CRC Press LLC, Florida.
- 3 Food Process Engineering and Technology., Zeki Berk. 2009. Food Process Engineering and Technology., 2009, Academic press, New York, USA..
- 4 Unit operations in Food Processing., R.L. Earle. 1983. Unit operations in Food Processing., 1983, Pergamon Press, New York, USA..

23MRGD01 - INTRODUCTION TO GRAPHIC DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRGD01	INTRODUCTION TO GRAPHIC DESIGN	IGD	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Students will be able to list and describe the fundamental principles and elements of graphic design.	2	PO1
CO2	Understand Students will be able to explain the significance of typography, color theory, and layout in creating effective designs	2	PO2
CO3	Apply Students will be able to apply basic design principles to create visually appealing and functional graphic design projects using industry-standard software.	3	PO3
CO4	Articulate Students will be able to analyze and critique the effectiveness of various graphic designs, identifying strengths and areas for improvement based on design principles	3	PO4
CO5	Analyze Students will be able to develop a comprehensive graphic design project, incorporating advanced techniques and original concepts to produce a professional-quality	4	PO5

Syllabus

Principles of Design: Balance, Contrast, Emphasis, Movement, Proportion, Rhythm, Unity

Exploration of typography and color theory as essential components of effective design. Typography: Typefaces, Fonts, Hierarchy, Legibility, Pairing

Understanding the arrangement of visual elements to create effective compositions.

Software Basics: Adobe Photoshop, Illustrator, InDesign, Digital Illustration: Vector vs. Raster Graphics, Pen Tool, Brush Tool

Portfolio Basics: Selecting Works, Presentation Techniques, Branding Critique Methods: Self-Critique, Peer Review, Professional Feedback

Reference Books

- 1 "Graphic Design: The New Basics", by Ellen Lupton and Jennifer Cole Phillips, 1st, by Ellen Lupton and Jennifer Cole Phillips.
- 2 "Thinking with Type" , by Ellen Lupton Description: A comprehensive gu, 2nd, by Ellen Lupton Description: A comprehensive gu.
- 3 "The Elements of Graphic Design" , by Alex W. White, 1st, by Alex W. White.
- 4 "Color: A Workshop for Artists and Designers", by David Hornung, 2nd, by David Hornung.

23MRGD02 - TYPOGRAPHY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRGD02	TYPGRAPHY	TPY	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the graphic design composition principles	2	PO1
CO2	Understand the types of typography utilities	2	PO2
CO3	Apply the Principles of Typography such as Typographic hierarchy ,Grid systems and layout principles ,Readability and legibility considerations in students projects	3	PO3

Syllabus

Type setting Techniques as Kerning, tracking, and leading Alignment and justification Optical adjustments vs. mechanical adjustments and also Typography and Branding Creating as typographic identity case studies of successful brand typography ,and also experience the Experimental Typography as Typographic art and installations

The Cultural influences on typography in different languages and also scripts of Ethical considerations in typography

The Typesetting Techniques as Kerning, tracking, and leading Alignment and justification Optical adjustments vs. mechanical adjustments and also Typography and Branding Creating as typographic identity case studies of successful brand typography ,and also experience the Experimental Typography as Typographic art and installations

Reference Books

- 1 The Elements of Typographic Style., Brighurst, R., 15 January 2013, Hartley & Marks Inc.,U.S.
- 2 Designing with Type: A Basic Course in Typography, Designing with Type: A Basic Course in Typography, 1 February 1992, Watson-Guptill.
- 3 Design as Art, Bruno Munari, 25 September 2008, PENGUIN UK.
- 4 Why Fonts Matter a multisensory analysis of typography and its influence, Sarah Hyndman, 28 January 2016, Virgin Books .

23MRGD03 - VISUAL IDENTITY AND BRANDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRGD03	VISUAL IDENTITY AND BRANDING	VIB	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basics of Design, Design culture and consumer behaviour and perception.	2	PO2, PO7
CO2	Apply the basics of design in branding	3	PO2, PO5, PO7
CO3	Create digital storytelling.	6	PO2, PO3, PO7

Syllabus

Introduction to design, elements of design, principles of design, gestalt's law, design culture, Visual design, negotiating visual identity, Understanding consumer behaviour, consumer perception, brand guidelines, law of perceptual organization..

Introduction to branding, color psychology, typography, typographic system brand guidelines, brand design, Logo design, package design, brand competitors, brand identity, brand repositioning,

Data Visualization, digital Storytelling, Case studies..

Reference Books

- 1 Designing Brand Identity: An Essential Guide for the Whole Branding Team, Alina Wheeler, 5th Edition, 8th Dec, 2017, Wiley.
- 2 Branding: In Five and a Half Steps, Michael Johnson, Illustrated, Thames and Hudson.
- 3 Logo Design Love: A Guide to Creating Iconic Brand Identities, David Airey, 2014, David Airey.
- 4 The Brand Gap: How to Bridge the Distance Between Business Strategy and Design, Marty Neumeier, 2003, New Riders.
- 5 How to Style Your Brand: Everything You Need to Know to Create a Distinctive Brand Identity, Fiona Humberstone, 2015, Copper Beech Press.
- 6 Identity Designed: The Definitive Guide to Visual Branding, David Airey, 2019, Rockport Publishers.
- 7 Building A StoryBrand: Clarify Your Message So Customers Will Listen , Donald Miller, 2017, HarperCollins Leadership.

23MRGD04 - PRINT DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRGD04	PRINT DESIGN	PRDG	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design basics understanding their properties and Recaptureing print media properties with important utilities in society	2	PO1
CO2	Study of Print techniques and their advantages	2	PO2
CO3	Mastery of raster graphics and photo editing techniques. Integrating Photoshop with InDesign for image-rich layouts.	3	PO3

Syllabus

prepress workflow and file preparation---Overview of printing techniques: screen printing, etc.

Print making Series of projects integrating learned principles (e.g., brochure, poster, book design). Emphasis on conceptualization, execution, and presentation.

Experimenting with traditional and contemporary press workflow and file preparation. Overview of printing techniques: offset, digital, screen printing, etc.

Reference Books

- 1 Thinking with Type, Ellen Lupton , 6 October 2010, Princeton Architectural Press.
- 2 Grid Systems in Graphic Design, Josef Müller-Brockmann, 1 January 1999, Niggli Verlag.
- 3 IDEAS THAT CHANGED GRAPHIC DESIGN, Steven Heller , 21 January 2019, Laurence King Publishing.
- 4 The Graphic Design Bible: The definitive guide to contemporary and historical graphic design, Theo Inglis, 28 sep 2023, Ilex Press.

23MRIB01M - INTERNATIONAL BUSINESS ESSENTIALS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIB01M	INTERNATIONAL BUSINESS ESSENTIALS	IBET	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to International Business	2	PO1
CO2	International Trade and Investment	2	PO2
CO3	Global Market Entry Strategies	3	PO2
CO4	Cross-Cultural Management	3	PO3

Syllabus

Definition and scope of international business Globalization and its impact Theories of international trade

Comparative advantage and competitive advantage Trade policies and barriers Foreign direct investment (FDI)

Modes of entry: Exporting, licensing, franchising, joint ventures, wholly-owned subsidiaries Strategic alliances and partnerships

Cross-Cultural Management

Reference Books

- 1 Global Business Today, Charles W.L. Hill, 2005, McGraw-Hill Education.
- 2 International Economics, Paul Krugman, Maurice Obstfeld, Marc Melitz, 2007, Pearson.
- 3 International Business: Competing in the Global Marketplace, Charles W.L. Hill, G. Tomas M. Hult, 2009, McGraw-Hill Education.
- 4 Cultures and Organizations: Software of the Mind, Geert Hofstede, Gert Jan Hofstede, Michael Minkov, 2015, McGraw-Hill Education.

23MRIB02M - INTERNATIONAL BUSINESS ENVIRONMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIB02M	INTERNATIONAL BUSINESS ENVIRONMENT	IBEV	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the fundamentals of international business and the global business environment.	2	PO7
CO2	Analyze the impact of political, economic, social, and technological factors on international business operations.	4	PO7, PO8
CO3	Evaluate different international trade theories and their application in global markets.	5	PO7
CO4	Formulate strategies for managing international business risks and leveraging global opportunities.	5	PO7

Syllabus

Introduction to International Business Environment: Overview of international business and globalization. Key drivers and challenges of globalization. Analysis of the global business environment, including political, economic, social, and technological factors. Case studies on the impact of globalization on businesses.

International Trade and Investment: Examination of international trade theories such as absolute advantage, comparative advantage, and Heckscher-Ohlin theory. Understanding trade policies, tariffs, and trade agreements. Foreign direct investment (FDI) and its role in global business. Case studies on successful international trade and investment strategies.

Cultural and Ethical Issues in International Business: Understanding cultural differences using frameworks like Hofstede's cultural dimensions and Trompenaars' model. Impact of culture on business practices and communication. Ethical issues in international business, including corruption and corporate social responsibility (CSR). Case studies on navigating cultural and ethical challenges.

International Business Strategy and Risk Management: Formulating and implementing international business strategies. Risk management in international business, including political risk, economic risk, and currency risk. Strategies for entering and expanding in global markets, such as exporting, joint ventures, and wholly owned subsidiaries. Case studies on strategic decision-making and risk management.

Reference Books

- 1 "International Business: Competing in the Global Marketplace" , Charles W. L. Hill, G. Tomas M. Hult , 12th , McGraw-Hill Education.
- 2 "Global Business Today", Charles W. L. Hill, G. Tomas M. Hult, 10th, McGraw-Hill Education.
- 3 "International Business: The New Realities", S. Tamer Cavusgil, Gary Knight, John Riesenberger, 5th , Pearson.
- 4 "International Business: Environments and Operations", John D. Daniels, Lee H. Radebaugh, Daniel P. Sullivan, 16th, Pearson.

23MRIB03M - INTERNATIONAL BUSINESS OPERATIONS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIB03M	INTERNATIONAL BUSINESS OPERATIONS	IBO	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts and theories of international business.	2	PO1
CO2	Understand global business environment and its impact on business operations.	2	PO2
CO3	Apply the operational issues related to international trade, investment, and management.	3	PO6
CO4	Apply the strategies used by multinational enterprises (MNEs) in markets.	3	PO6

Syllabus

Introduction to International Business: Course overview and expectations, Globalization and its impact on business. Theories of International Trade and Investment: Comparative advantage and competitive advantage, Foreign direct investment theories.

The Global Economic Environment: Economic systems and development, International monetary system. Political and Legal Environment: Political systems and risk, Legal environment and regulatory issues.

Cultural Environment of International Business: Understanding cultural differences, Cross-cultural communication and negotiation. International Market Entry Strategies: Exporting, licensing, and franchising, Joint ventures and wholly-owned subsidiaries.

International Marketing and R&D: Global marketing strategies, International product development and R&D. Risk Management in International Business: Identifying and managing international business risks, Political and economic risk assessment.

Reference Books

- 1 International Business: Competing in the Global Marketplace, Charles W. L. Hill and G. Tomas M. Hult, 2022, McGraw-Hill Education.
- 2 International Business, John D. Daniels, Lee H. Radebaugh, and Daniel P. Sullivan, 2019, Pearson.
- 3 International Management: Culture, Strategy, and Behavior, Fred Luthans and Jonathan P. Doh, 2017, McGraw-Hill Education.
- 4 The International Business Environment, Leslie Hamilton and Philip Webster, 2018, Oxford University Press.

23MRIB04M - INTERNATIONAL BUSINESS MODELS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIB04M	INTERNATIONAL BUSINESS MODELS	IBM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a clear understanding of the core concepts and principles of international business models.	2	PO11
CO2	Apply international business strategies and frameworks to real-world scenarios and case studies.	3	PO11
CO3	Analyze international market entry strategies and business operations in different cultural, economic, and political contexts.	4	PO6
CO4	Evaluate ethical issues and corporate social responsibility practices in international business settings.	5	PO8

Syllabus

Introduction to International Business - Overview of international business and globalization; Comparative advantage, trade barriers, and trade agreements; Global market dynamics.

International Business Strategies - Global, transnational, international, and multidomestic strategies; Strategic planning and implementation; real-world scenarios and case studies.

Market Entry Strategies - Exporting, licensing, franchising Joint ventures, strategic alliances, wholly owned subsidiaries; Cultural dimensions and frameworks; political and economic systems.

Legal and Ethical Issues in International Business - International business law and regulations, Corporate social responsibility and ethical considerations; Opportunities and challenges in emerging markets; Future trends in international business.

Reference Books

- 1 International Business: Competing in the Global Marketplace, Charles W.L. Hill, G. Tomas M. Hult, 14th, 2023, McGraw-Hill Education.
- 2 International Business, John D. Daniels, Lee H. Radebaugh, Daniel P. Sullivan, 17th, 2021, Pearson Higher Ed.
- 3 International Business: Theory and Practice, Ehud Menipaz, Amit Menipaz, 2nd, 2011, Sage Publications.
- 4 International Business: The Challenges of Globalization, John J. Wild, Kenneth L. Wild, 9th, 2019, Pearson Education.

23MRID01 - INTRODUCTION TO INTERIOR DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRID01	INTRODUCTION TO INTERIOR DESIGN	IID	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand principles of interior design to conceptualize and propose layouts, lighting schemes, material selections, and furnishings that meet the functional and aesthetic requirements of various interior spaces.	2	PO1
CO2	Understand interplay of fundamental elements such as space, line, form, color, texture, and pattern in interior design, and apply this understanding to create cohesive and visually engaging interior spaces.	2	PO3
CO3	Understand fundamental principles of interior design, including balance, harmony, emphasis, rhythm, proportion, scale, and contrast, to develop aesthetically pleasing and functionally effective interior spaces.	2	PO3
CO4	apply the multifaceted role of interior designers, including client collaboration, concept development, layout creation, material and furnishing selection, and project oversight, while also demonstrating an understanding of industry trends, building codes, and sustainability practices essential for creating well-informed and effective interior designs.	3	PO5
CO5	Apply current trends and innovations in interior design, including sustainable design, smart home technology integration, biophilic design principles, flexible space concepts, and minimalistic approaches, in order to inform their design decisions and adapt to evolving industry practices.	3	, PSO2

Syllabus

Interior design is more than just arranging furniture and choosing colors. It is about creating spaces that are functional aesthetically pleasing, and reflect the personality and needs of the inhabitants. Interior designers work with architects contractors and clients to transform empty spaces into livable environments. They consider factors such as layout lighting materials and furnishings to enhance the quality of life within a space.

The Elements of Interior Design Several elements form the foundation of interior design. These include: Space: The foundation of any design, space defines the boundaries within which everything else exists. Line: Lines can create movement, define shapes, and guide the eye throughout a space. Form: Form refers to the shape and structure of objects within a space. Color: Color can evoke emotions, set moods, and visually expand or contract spaces. Texture: Texture adds depth and interest to a space, whether through fabrics, finishes, or materials. Pattern: Patterns add visual interest and can be used to create focal points or unify a space. Understanding how these elements interact is essential for creating harmonious and cohesive interior designs.

Principles of Interior Design In addition to understanding the elements, interior designers must also adhere to certain principles to create successful designs. These principles include: Balance: Achieving visual equilibrium through the distribution of elements within a space. Harmony: Creating a sense of unity and cohesion through the consistent use of elements and principles. Emphasis: Highlighting key elements or focal points to draw attention and create visual interest. Rhythm: Establishing a sense of movement and flow through repetition, progression, or alternation of elements. Proportion and Scale: Ensuring that the size of objects and elements within a space is appropriate to the overall context. Contrast: Using differences in elements such as color, texture, or form to create visual impact and drama. By applying these principles, designers can create spaces that are visually appealing, functional, and comfortable.

The Role of the Interior Designer Interior designers play a crucial role in the design and execution of interior spaces. They collaborate with clients to understand their needs, preferences, and budget constraints. Designers then develop concepts, create layouts, select materials and furnishings, and oversee the implementation of the design plan. Additionally, interior designers must stay abreast of industry trends, building codes, and sustainability practices to ensure that their designs meet both aesthetic and functional requirements.

Trends and Innovations in Interior Design The field of interior design is constantly evolving, influenced by changes in technology, culture, and lifestyle. Some current trends include: **Sustainable Design:** Increasing emphasis on environmentally friendly materials and practices. **Smart Home Technology:** Integration of technology to enhance comfort, convenience, and energy efficiency. **Biophilic Design:** Incorporating elements of nature into interior spaces to promote well-being and connectivity to the environment. **Flexible Spaces:** Designing multifunctional spaces that can adapt to changing needs and activities. **Minimalism:** Simplified, clutter free designs that emphasize clean lines and functionality.

Reference Books

- 1 Space Planning Basics, Karen Mark , 1992, 4th Edition , Van Nostrand Reinhold.
- 2 Interior Design Illustrated , Francis.D. Ching & orky Bingelli , 1992, 4th Edition , Wiley Publishers.
- 3 Modern Houses In India , Creativity 13 , 2017, 1st Edition , Creativity 13.
- 4 The Interior Design Handbook , Frida Ramstedt , 2020,1st Edition , Particular Books.

23MRID02 - SPACE PLANNING AND LAYOUT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRID02	SPACE PLANNING AND LAYOUT	SPL	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand fundamental principles of space planning in interior design, including analyzing spatial requirements, identifying client needs, determining functional requirements, and maximizing space efficiency through the strategic arrangement of furniture and fixtures, while also considering circulation flow, zoning, and the incorporation of flexible design elements to create functional and aesthetically pleasing interiors.	2	PO1
CO2	Understand fundamental design principles such as balance, proportion, scale, and rhythm to create effective spatial layouts. Students will analyze how these principles influence spatial arrangements and make informed design decisions accordingly.	2	PO3
CO3	Understand interior spaces into functional zones based on user activities and requirements. Students will learn techniques for creating clear spatial divisions while ensuring smooth transitions between zones to enhance usability and flow within the space.	2	PO3
CO4	Apply spatial layouts to accommodate multi-functional uses, maximizing flexibility and adaptability. Students will explore methods for incorporating versatile spaces that can serve varying purposes, thereby enhancing the overall functionality of the design	3	PO4
CO5	Apply furniture arrangement strategies to enhance both ergonomic usability and visual appeal within a space. Through the consideration of focal points, traffic patterns, and ergonomic principles, students will learn to position furniture to optimize comfort, usability, and aesthetic coherence.	3	, PSO2

Syllabus

Understanding Space Planning Fundamentals Introduction to Space Planning, Defining space planning in interior design, Importance of effective space planning in creating functional and aesthetically pleasing interiors. Analyzing Spatial Requirements. Identifying client needs and preferences. Determining functional requirements for each space. Considering circulation flow and zoning within the space. Space Utilization Techniques . Maximizing space efficiency through proper arrangement of furniture and fixtures. Incorporating flexible design elements to accommodate varying needs . Balancing open areas with enclosed spaces for privacy and functionality

Principles of Space Layout Design Principles Overview. Exploring key design principles such as balance, proportion, scale, and rhythm . Understanding how these principles influence spatial layout decisions. Zoning and Functionality. Dividing the space into zones based on functionality and user activities . Ensuring smooth transitions between different zones to enhance usability and flow. Incorporating multi-functional spaces to optimize flexibility and adaptability. Furniture Placement Strategies. Arranging furniture to facilitate ergonomic use and enhance visual appeal. Considering focal points and traffic patterns when positioning furniture within the space. Experimenting with different layout configurations to find the optimal arrangement

Spatial Analysis and Optimization Site Analysis and Evaluation. Conducting site surveys to assess existing conditions and constraints. Analyzing site features, such as orientation, views, and natural light availability. Identifying opportunities and challenges that may influence spatial layout decisions. Space Optimization Techniques. Utilizing design strategies to maximize space utilization and functionality. Exploring creative solutions for compact or irregularly shaped spaces. Incorporating storage solutions and built in features to minimize clutter and maximize usable area

Designing for Human Experience Human Centered Design Principles. Prioritizing user comfort, safety, and well-being in spatial design. Incorporating universal design principles to accommodate diverse user needs and abilities. Enhancing user experience through thoughtful consideration of sensory elements, such as lighting, acoustics, and material textures. Psychological Effects of Space. Understanding how spatial layout and design elements influence human behavior and perception. Creating environments that promote relaxation, productivity, and social interaction. Incorporating biophilic design elements to enhance connection with nature and improve overall well being

Integration and Adaptation Integration of Technology and Innovation. Incorporating technology seamlessly into the spatial layout to enhance functionality and convenience. Exploring innovative solutions, such as smart home systems and interactive interfaces, to improve user experience. Adaptation and Future-Proofing. Designing flexible spaces that can adapt to evolving needs and technologies .Considering sustainability principles in spatial design to minimize environmental impact. Future-proofing designs by incorporating resilient and adaptable features that can withstand changing trends and requirements

Reference Books

- 1 Space Planning Basics , Karen Mark , 1992 , Van Nostrand Reinhold.
- 2 The Interior Design Handbook , Frida Ramstedt , 2020 , Particular Books.
- 3 Modern Houses In India , Creativity 13 , 2017 , Creativity 13.
- 4 Interior Design Illustrated , Francis.D. Ching & orky Bingelli , 1992 , Wiley Publishers.

23MRID03 - INTERIOR MATERIAL AND FINISHES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRID03	INTERIOR MATERIAL AND FINISHES	IMF	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the fundamental concepts of interior materials and finishes, including their definitions, importance, and roles in creating ambiance, functionality, and aesthetics within interior design.	2	PO1
CO2	Understanding of the characteristics, properties, and applications of various natural materials such as wood, stone, leather, and natural fibers in interior design.	2	PO3
CO3	Understanding of the advantages and limitations of using synthetic materials such as plastics, laminates, and engineered wood in interior design.	2	PO5
CO4	Apply, evaluate, and synthesize finishes and surface treatments to achieve sophisticated and compelling interior environments.	3	, PSO1
CO5	Synthesizing theoretical knowledge and practical application, students will forecast future developments in materials and finishes and assess their potential implications for the evolving landscape of interior design practice.	3	PO12

Syllabus

Introduction to Materials and Finishes. Definition and importance of materials and finishes in interior design. The role of materials in creating ambiance, functionality, and aesthetics. Overview of different types of materials and finishes commonly used in interior design, such as wood, metal, glass, fabric, paint, and wallpaper.

Natural Materials . Exploration of natural materials like wood, stone, leather, and natural fibers. Characteristics, properties, and applications of each natural material in interior design. How to incorporate natural materials to enhance warmth, texture, and visual interest in spaces. Sustainable sourcing and eco-friendly alternatives for natural

Synthetic Materials . Examination of synthetic materials such as plastics, laminates, and engineered wood. Advantages and limitations of using synthetic materials in interior design. Innovative uses of synthetic materials in modern interior design, including high-performance polymers and composite materials. Considerations for durability, maintenance, and environmental impact when selecting synthetic materials.

Finishes and Surface Treatments. Understanding the role of finishes in defining the look and feel of interior spaces. Different types of finishes, including matte, glossy, textured, and reflective. Techniques for applying finishes such as painting, staining, varnishing, and polishing. Creative ways to combine finishes for visual contrast and aesthetic appeal.

Trends and Future Directions. Exploration of current trends in materials and finishes in interior design. Emerging technologies and materials shaping the future of interior design, such as smart materials and 3D printing. The influence of sustainability and wellness on material selection and design choices. Predictions for future developments in materials and finishes and their impact on the practice of interior design

Reference Books

- 1 In detail Interior Spaces , Christian Schittich, 1st, 2002, K?sel GmbH & Co. KG, Kempten.
- 2 Designing Interior Architecture, Sylvia Leydecker, 1st, 2013, Birkhauser,.
- 3 The Interior Design Business Handbook: A Complete Guide to Profitability, Mary V. Knackstedt, 1st, 2001, Wiley, Year: 2001.
- 4 Building Materials: Material Theory and the Architectural Specification, Katie Lloyd Thomas, 1st, 2022, Bloomsbury Visual Arts, Year: 2022.

23MRID04 - FURNITURE AND ACCESSORIES DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRID04	FURNITURE AND ACCESSORIES DESIGN	FAD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand comprehensive knowledge and practical skills in the selection, placement, and utilization of furniture and accessories to enhance interior spaces.	2	PO1
CO2	Understand and articulate the principles of selecting and arranging furniture in interior spaces.	2	, PSO1
CO3	Understand various types of accessories, such as decorative objects, artwork, and textiles, and explain how these elements contribute to the overall aesthetic of a space.	2	PO2
CO4	Applying different design styles and their characteristic features and strategies for mixing and matching furniture and accessories from different styles	3	PO3
CO5	Apply current trends and innovations within the furniture and accessories industry and able to examine emerging materials, technologies, and design approaches, and analyze case studies that highlight innovative uses of furniture and accessories in contemporary design.	3	PO4

Syllabus

Co1: Introduction to Furniture and Accessories in Interior Design. Overview of the role of furniture and accessories in interior design. Importance of selecting the right furniture and accessories for different spaces. Basic principles of design that apply to furniture and accessories. Historical overview of furniture and accessory styles. Introduction to key terminology and concepts.

Co2: Furniture Selection and Placement. Understanding the function and purpose of each room. Factors to consider when selecting furniture (e.g., size, style, material). Tips for creating a cohesive look with furniture styles. Guidelines for arranging furniture to maximize space and functionality. Importance of traffic flow and ergonomics in furniture placement.

Co3: Accessories: Adding Personality and Flair. Definition and types of accessories in interior design (e.g., decorative objects, artwork, textiles). How accessories contribute to the overall aesthetic of a space. Tips for selecting accessories that complement the furniture and enhance the design theme. Creative ways to display and arrange accessories for visual impact. DIY and budget-friendly ideas for accessorizing.

Co4: Mixing and Matching Styles. Understanding different design styles and their characteristic features. Strategies for mixing and matching furniture and accessories from different styles. Examples of successful design combinations and how they create visual interest. Balancing cohesion and contrast when integrating diverse elements. Common mistakes to avoid when blending styles.

Co5: Trends and Innovations in Furniture and Accessories. Exploration of current trends in furniture and accessories. Emerging materials, technologies, and design approaches shaping the industry. Case studies highlighting innovative uses of furniture and accessories in contemporary design. Sustainable and eco-friendly options in furniture and accessories. Predictions for future directions in furniture and accessory design.

Reference Books

- 1 Furniture Design: An Introduction to development materials and manufacturing, Stuart Lawson, 1st, 2013, Laurence King Publishing.
- 2 Ergonomics Principles in Design: An Illustrated Fundamental Approach, Prabir Mukhopadhyay, 1st, 2022, CRC Press.

- 3 Furniture Design, Jerzy Smardzewski, 1st, 2015, Springer.
- 4 Design: History, Theory and Practice of Product Design, Bernhard E. B?rdek, 1st, 2005, Springer Science+Buisness Media.

23MRIM01 - APPLIED DESIGN THINKING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIM01	APPLIED DESIGN THINKING	ADT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop a deep understanding of user needs through empathy and research techniques.	2	
CO2	Define clear and actionable problem statements based on user insights.	3	PO2
CO3	Generate a wide range of innovative ideas through brainstorming and ideation techniques.	4	PO9, PSO2
CO4	Create and test prototypes to refine ideas and solutions.	5	
CO5	Implement and evaluate design solutions in real-world contexts.	6	PO3

Syllabus

Introduction to Design Thinking: Overview of design thinking principles; The design thinking process: empathize, define, ideate, prototype, test; Historical context and contemporary applications. Empathy and User Research: Techniques for understanding users (interviews, observations, surveys); Building empathy maps; Identifying user needs and pain points; Case studies on successful user research.

Problem Definition: Framing the right problem; Crafting problem statements and how-might-we questions; Tools for analysis and synthesis (affinity diagrams, journey maps); Group activities to practice problem definition

Ideation Techniques: Brainstorming methods (mind mapping, SCAMPER, role-playing); Encouraging creativity and divergent thinking; Evaluating and selecting ideas; Collaborative ideation workshops

Prototyping: Types of prototypes (low-fidelity, high-fidelity), Rapid prototyping techniques, Tools for prototyping (paper, digital tools), Iterative testing and feedback loops. Testing and Feedback: Designing and conducting usability tests, Gathering and analyzing feedback, Refining prototypes based on user feedback, Case studies on successful prototyping and testing.

Implementation and Impact Evaluation: Strategies for implementing design solutions, Measuring the impact of design solutions, Scaling and sustaining innovations, Real-world project work and presentations.

Reference Books

- 1 Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Tim Brown, 1st Edition, Harper Business.
- 2 Design Thinking: Understanding How Designers Think and Work, Nigel Cross, 1st Edition, Berg Publishers.
- 3 The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems, Michael Lewrick, Patrick Link, and Larry Leifer, 1st Edition, Wiley.
- 4 Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days, Jake Knapp, 2016, Simon & Schuster.

23MRIM02 - BUSINESS MODEL INNOVATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIM02	BUSINESS MODEL INNOVATION	BMI	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the importance of business model innovation using real-world case studies.	4	PO2, PO11, PSO2
CO2	Utilize the Business Model Canvas to create and assess business models.	3	PO2, PO11, PSO2
CO3	Analyze the impact of disruptive innovation on existing business models.	4	PO2, PO11, PSO2
CO4	Develop a plan for implementing digital transformation in an existing business model.	6	PO2, PO11, PSO2
CO5	Develop a sustainable business model using appropriate tools.	6	PO2, PO11, PSO2

Syllabus

The definition of a business model, the importance of business model innovation, an overview of popular business models, the historical evolution of business models, and case studies of successful business model innovations.

Business Model Canvas, the Value Proposition Canvas, SWOT Analysis, PESTEL Analysis, and the Blue Ocean Strategy.

The definition and characteristics of disruptive innovation, how disruptive innovation impacts business models, case studies of disruptive innovations, and strategies for leveraging disruptive innovation.

The definition of digital transformation, the impact of digital technologies on business models, examples of digital business models, and implementing digital transformation in business models.

The definition of sustainable business models, principles of sustainable business model innovation, case studies of sustainable business models, and tools for developing sustainable business models.

Reference Books

- 1 Business Model Generation, Alexander Osterwalder, Yves Pigneur, 1st (2010), Wiley.
- 2 Blue Ocean Strategy, W. Chan Kim, Ren?e Mauborgne, Expanded Edition (2015), Harvard Business Review Press.
- 3 The Innovator's Dilemma, Clayton M. Christensen, 1st (2013), Harvard Business Review Press.
- 4 Leading Digital: Turning Technology into Business Transformation, George Westerman, Didier Bonnet, Andrew McAfee, 1st (2014), Harvard Business Review Press.

23MRIM03 - VENTURE MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIM03	VENTURE MANAGEMENT	VMT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the fundamentals of venture management, including the different types of ventures, the entrepreneurial ecosystem, and the roles of incubators and accelerators.	2	PO2, PO11, PSO1
CO2	apply techniques for market research, idea generation, and feasibility analysis to develop comprehensive business plans and financial projections for new ventures.	3	PO2, PO11, PSO1
CO3	analyze various funding strategies, legal structures, and regulatory requirements to determine the most effective approaches for launching and growing a new venture.	4	PO2, PO11, PSO1
CO4	evaluate growth strategies, marketing plans, and operational processes to optimize efficiency, market expansion, and strategic partnerships for scaling ventures.	5	PO2, PO11, PSO1
CO5	evaluate risk management strategies, corporate social responsibility initiatives, and exit plans to ensure the sustainability and ethical management of ventures, and to prepare for successful exits through mergers, acquisitions, or IPOs.	5	PO2, PO11, PSO1

Syllabus

Overview of venture management; Types of ventures: startups, SMEs, and corporations; Entrepreneurial ecosystems; Role of incubators and accelerators; Networking and building entrepreneurial communities; Identifying opportunities and idea generation; Market research and analysis; Feasibility analysis and business models; Lean startup methodology

Business planning and components of a business plan; Writing a compelling business plan; Financial planning and projections; Funding strategies: bootstrapping vs. external funding; Venture capital, angel investors, and crowdfunding; Preparing for investor meetings and pitches; Legal structures for new ventures; Intellectual property rights; Regulatory compliance and licenses; Team building and management; Leadership and management skills; Human resource strategies for startups.

Growth strategies: organic growth vs. scaling; Market expansion and diversification; Strategic partnerships and alliances; Operations and supply chain management; Designing efficient operations; Supply chain management for startups; Technology and process optimization; Marketing and sales strategies; Developing a marketing strategy; Sales techniques and customer relationship management (CRM); Digital marketing and social media; Financial management and control; Financial statements and analysis; Budgeting and cash flow management; Performance metrics and KPIs.

Innovation and continuous improvement; Fostering a culture of innovation; Continuous improvement processes; Adapting to market changes; Risk management and crisis handling; Identifying and assessing risks; Developing risk mitigation strategies; Crisis management and recovery plans; Corporate social responsibility (CSR); Ethical issues in entrepreneurship; Building a sustainable business; Exit strategies: mergers, acquisitions, IPOs; Succession planning and leadership transition; Preparing for life after the venture.

Reference Books

- 1 The Lean Startup, Eric Ries, 1st (2011), Crown Business.
- 2 Business Model Generation, Alexander Osterwalder, Yves Pigneur, 1st (2010), Wiley.
- 3 Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist, Brad Feld, Jason Mendelson, 3rd (2016), Wiley.
- 4 The Startup Owner's Manual, Steve Blank, Bob Dorf, 1st (2012), K&S Ranch.

23MRIM04 - BUSINESS AND LEADERSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIM04	BUSINESS AND LEADERSHIP	BL	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and evaluate various leadership theories and models, applying them to real-world business scenarios.	2	PO6, PO7, PO8, PSO1
CO2	Develop effective communication and conflict resolution skills essential for leading and managing teams, Demonstrate an understanding of ethical decision-making frameworks and apply them to leadership challenges.	2	PO6, PO8, PO9, PSO2
CO3	Examine and critically assess the impact of organizational culture on leadership practices and strategies for fostering a positive organizational environment.	3	PO4, PO5, PO6, PSO1
CO4	Plan, design, and execute a comprehensive capstone project that addresses a specific leadership challenge, incorporating strategic thinking and practical leadership skills.	4	PO4, PO5, PO6, PSO2
CO5	Apply leadership theories and models in practical settings, Enhance self-assessment and personal development planning, Demonstrate effective ethical decision-making, communication, and conflict resolution, Lead and manage teams effectively, Execute strategic planning and organizational change initiatives, Innovate and solve complex problems and Complete and present a capstone project.	5	PO5, PO6, PO7, PSO1

Syllabus

Foundations of Leadership: Introduction to leadership; Course overview and expectations; Definition and importance of leadership; Overview of leadership theories; Trait Theory; Behavioral Theory; Contingency Theory; Transformational and Transactional Leadership; Leadership self-assessment tools; Identifying personal leadership styles and strengths; Setting personal development goals

Ethics, Communication, and Team Leadership: Role of ethics in leadership; Ethical decision-making frameworks; Case studies on ethical leadership; Effective communication skills for leaders; Active listening and feedback; Leading through conflict resolution; Building and leading effective teams; Understanding team roles and dynamics; Strategies for team motivation and engagement.

Strategic and Organizational Leadership: Strategic thinking and planning; Change management and leadership; Innovation and leadership in a global context; Impact of organizational culture on leadership; Creating and sustaining a positive organizational culture; Leading organizational change.

Decision Making, Challenges, and Capstone Project: Leadership decision-making processes and models; Critical thinking and problem-solving; Case studies on leadership decision-making; Current trends and challenges in leadership; Leadership in the digital age; Future directions in leadership research; Capstone project preparation; Project planning and proposal development; Group discussions and feedback; Capstone project presentations; Peer review and feedback; Course wrap-up and reflections.

Leadership Practicum Lab: This module provides a practical, hands-on approach to applying the leadership theories, models, and skills from Modules 1 to 4. Through interactive exercises, simulations, and real-world applications, students will refine their leadership abilities, focusing on self-assessment, ethical decision-making, communication, conflict resolution, team dynamics, strategic planning, organizational culture, change management, innovation, critical thinking, and capstone project execution..

Reference Books

- 1 Leadership: Theory and Practice, Peter G. Northouse, 9th Edition (2021), Sage Publications.
- 2 Ethical Leadership, Joanne B. Ciulla, 1st Edition (2004), McGraw-Hill Education.

- 3 Strategic Leadership: Theory and Research on Executives, Top Management Teams, and Boards, Sydney Finkelstein, Donald C. Hambrick, and Albert A. Cannella, 1st Edition (2008), Oxford University Press.
- 4 Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World, Thomas L. Saaty, 3rd Edition (2012), RWS Publications.
- 5 Experiential Learning: Experience as the Source of Learning and Development, David A. Kolb, 2nd Edition (2014), Pearson.

23MRIP01 - EMERGENCE AND DEVELOPMENT OF IPR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIP01	EMERGENCE AND DEVELOPMENT OF IPR	EDIPR	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the historical foundations and philosophical justifications for Intellectual Property Rights.	3	PO5
CO2	Critically evaluate the different types of IPR (patents, copyrights, trademarks, etc.) and their application in the Indian and international contexts.	3	PO2
CO3	Identify and explain the key international treaties and organizations governing IPR.	2	
CO4	Examine the contemporary challenges and debates surrounding IPR, such as access to knowledge, biopiracy, and the digital divide.	3	PO11
CO5	Apply their understanding of IPR principles to real-world scenarios involving innovation, creativity, and competition	3	PO4, PSO2

Syllabus

Introduction to Intellectual Property Rights (IPRs) Concept and historical development of IPRs Theories justifying IPR protection (natural rights, utilitarian, etc.) The economic and social importance of IPRs in a globalized world

Types of Intellectual Property Rights Patents: Subject matter, patentability criteria, infringement, and enforcement Copyrights: Originality, scope of protection, fair use limitations, and digital copyright issues Trademarks: Functions, registration process, infringement, and dilution Trade Secrets: Protection of confidential information and unfair competition

The Indian IPR Regime Constitutional provisions and legislative framework for IPRs in India The Indian Patent Act, Copyright Act, Trademark Act, and other relevant laws The role of Indian Patent Office, Copyright Office, and Trademark Registry Enforcement mechanisms for IPR violations in India

The International IPR Landscape Major international treaties and conventions governing IPR (e.g., Paris Convention, Berne Convention, TRIPS Agreement) The role of World Intellectual Property Organization (WIPO) Harmonization vs. national interests in international IPR regimes

Contemporary Issues and Debates in IPR Access to knowledge and essential medicines Biopiracy and the protection of traditional knowledge The digital divide and its impact on IPR enforcement Open-source software and alternative licensing models The future of IPR in a knowledge-based economy

Reference Books

- 1 The Law of Intellectual Property, Graeme B. Dinwoodie , 2nd , Carolina Academic Pr; 2nd edition (4 November 2008).
- 2 INTELLECTUAL PROPERTY: LAW & THE INFORMATION SOCIETY Cases & Materials , James Boyle William Neal Reynolds & Jennifer Jenkins Clinical Professor of Law (Teaching) & Director, Center for the Study of the Public Domain Duke Law School , Fifth Edition, 2021 , Center for study of public domain.
- 3 Intellectual Property Rights, P.S. Narayanan, 3rd , Eastern Law House Private Ltd; Third Edition (1 January 2001).
- 4 Law Relating To Intellectual Property, 2011, B.L. Wadehra, 1st, Universal Law Publishing - An imprint of LexisNexis; Fifth edition (1 January 2016).

23MRIP02 - LAW OF COPYRIGHT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIP02	LAW OF COPYRIGHT	LOCR	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the foundational principles of Indian copyright law, including its historical development, scope, and application to various works.	2	PO2
CO2	Understanding the complex copyright infringement cases, applying relevant legal tests and defenses to determine the outcome. They will also be able to evaluate the effectiveness of remedies available for copyright infringement.	2	PO7
CO3	Understand the interplay between copyright law and technological advancements, including the challenges and opportunities posed by the digital environment.	2	PO5
CO4	Analyzing the contemporary copyright issues, proposing potential solutions and evaluating their impact on the creative industry and society at large.	3	, PSO1
CO5	Analyse the contemporary legal developments in Copyrights Case laws	4	PO11

Syllabus

Concept of Copyright Definition, nature, and scope of copyright Copyright as a bundle of rights Subject matter of copyright Author and ownership of copyright BTL Levels: Remember, Understand, Apply

Historical Development of Copyright Law Copyright law in India: A brief overview International copyright conventions Impact of technological advancements on copyright law BTL Levels: Remember, Understand, Analyze

Infringement of Copyright Primary and secondary infringement Tests of infringement (literal copying, substantial similarity) Defenses to copyright infringement Remedies for copyright infringement BTL Levels: Understand, Apply, Analyze

Moral Rights of Authors Concept of moral rights Rights of paternity and integrity Limitations on moral rights Remedies for violation of moral rights BTL Levels: Understand, Apply, Evaluate

Fair Use and Fair Dealing Concept of fair use and fair dealing Factors to consider for fair use/fair dealing Exceptions to copyright infringement BTL Levels: Understand, Apply, Analyze

Copyright Term and Ownership Duration of copyright Ownership of copyright Assignment and license of copyright BTL Levels: Understand, Apply, Analyze

Copyright in Digital Environment Copyright issues in the digital age Copyright and software Copyright and internet BTL Levels: Understand, Analyze, Evaluate

Emerging Challenges and Future Trends Copyright and artificial intelligence Copyright and 3D printing Copyright and open source BTL Levels: Analyze, Evaluate, Create

Reference Books

- 1 Law of Copyright and Industrial Designs , P. Narayanan, 2023, Eastern Law House .
- 2 : Law of Copyright and Intellectual Property, Sushma Malik, 2023, LexisNexis Butterworths.
- 3 Intellectual Property Rights: Law and Practice, R.K. Dhawan, 2023, LexisNexis Butterworths .
- 4 Cyber Crimes and Ecommerce, Dr. K.I.Pavan Kumar, 2021 1st Edition, Rubicon Publications.

23MRIP03 - LAW OF PATENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIP03	LAW OF PATENTS	LOPS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts and history of patent law.	1	PO1, PO3, PO5, PO8, PSO2
CO2	Analyse the criteria for patentability and the process of obtaining a patent.	3	PO1, PO3, PO5, PO8, PSO2
CO3	Evaluate the rights and obligations of a patent holder. .	4	PO1, PO3, PO5, PO8, PSO2
CO4	Apply knowledge of patent law to assess infringement and enforcement issues.	4	PO1, PO3, PO5, PO8, PSO2
CO5	Explore the impact of patents in various engineering fields and the ethical considerations involved	4	PO1, PO3, PO5, PO8, PSO2

Syllabus

Introduction to Patent: Law History and development of patent law Types of patents Importance of patents in technology and engineering International treaties and conventions (e.g., TRIPS, PCT)

Patentability Criteria and Application Process: Patentable subject matter Novelty, inventive step, and industrial applicability Patent application process Patent search and drafting Filing procedures and timelines Patent examination and prosecution

Rights and Obligations of a Patent Holder: Scope and duration of patent rights Licensing and assignment of patents Obligations and maintenance of patents Patent marking and notice

Infringement, Enforcement, and Ethical Considerations: Types of patent infringement Legal remedies and defenses against infringement Patent litigation process Alternative dispute resolution (ADR) in patent disputes Ethical issues in patenting and technology

Reference Books

- 1 Patent Law and Policy: Cases and Materials , Robert P. Merges, John F. Duffy , 2017, Carolina Academic Press.
- 2 Principles of Patent Law: Cases and Materials , Roger E. Schechter and John R. Thomas , 2016, West Academic Publishing.
- 3 Patent Law: A Practitioner's Guide, Barry L. Grossman and Gary M. Hoffman, 2013, Practising Law Institute (PLI).
- 4 Intellectual Property: Patents, Trademarks, and Copyright, Richard Stim, 2020., NOLO.

23MRIP04 - LAW OF TRADEMARK (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIP04	LAW OF TRADEMARK	LOTM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understanding the concept and purpose of trademarks within the broader intellectual property (IP) framework.	2	PO5
CO2	Analyze the provisions of the Indian Trademark Act, 1999 including registrability of trademarks, classification of goods and services, and the registration process	3	PO6, PSO2
CO3	Evaluate the concept of trademark infringement and remedies available under Indian law.	3	PO9
CO4	Compare and contrast the Indian trademark regime with key international treaties and conventions like the Paris Convention for the Protection of Industrial Property and the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).	3	PO7
CO5	Develop skills in identifying and conducting trademark searches in India and internationally. Apply trademark law principles to practical scenarios such as brand development, licensing, and enforcement actions.	4	PO8

Syllabus

Introduction to Trademarks Definition and nature of trademarks Functions and importance of trademarks Types of trademarks (logos, slogans, etc.) Historical development of trademark law

The Indian Trademark Act, 1999 Key provisions of the Act Registrable and non-registrable trademarks Classification of goods and services The registration process

Trademark Infringement and Remedies Concept of trademark infringement Tests for determining infringement Defenses to infringement actions Remedies for trademark infringement (injunctions, damages, etc.)

International Trademark Law Introduction to international treaties and conventions (Paris Convention, TRIPS) International registration system (Madrid Protocol) Comparative analysis of trademark protection in different jurisdictions

Practical Applications of Trademark Law Conducting trademark searches Brand development and trademark selection strategies Trademark licensing agreements Enforcement of trademark rights in India and abroad

Reference Books

- 1 The Trade Marks Act, 1999 - Bare Act pen_spark, Parliament, 1st, Parliament.
- 2 Law of Trade Marks & Passing off , P Narayanan, 6th, EASTERN LAW HOUSE.
- 3 15% Saving Great Deals Law of Trademarks - Including International Registration under Madrid Protocol and Geographical Indications, K C Kailasam, Ramu Vedaraman, 4th, Lexis Nexis.
- 4 Law Relating To Trade Marks, Passing Off and Geographical Indication of Goods, D P Mittal, 2022 2nd, Commercial Law Publishers.

23MROB01M - ORGANIZATIONAL BEHAVIOUR (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MROB01M	ORGANIZATIONAL BEHAVIOUR	POM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of OB to implement different models of OB	3	PO11
CO2	Apply the concepts of individual behaviour to deal with different types of people at work place	3	PO9
CO3	Apply the concepts of groups and dynamics to deal with groups of employees at work place	3	PO9
CO4	Apply the knowledge of organisational culture, change, conflict, development and stress to develop appropriate model in the organisation.	3	PO11

Syllabus

Introduction to Organizational Behavior, Evolution of management thought, five functions of management, Evolution of OB, models of OB (Autocratic, Custodial, Supportive, Collegial and SOBC), Importance of Organizational Behavior

Foundations of Individual Behavior: Personality, Personality determinants; Personality traits: MBTI , The Big Five Model, Major personality attributes influencing OB; Psycho,Analytic Theory , Johari Window , Values , Types of Values; Perception, Perceptual process; Factors influencing Perception; perceptual distortion; Linkage between perception and individual decision making Theories of Motivation , Hierarchy Needs Theory , Two,Factor Theory , Expectancy Theory; Applications of Motivation; Attitudes , Source of attitudes; Types of Attitudes, Attitudes and consistency , Cognitive Dissonance theory. Learning, Theories of learning; Principles of learning;

Foundations of Group Behavior: Groups , Nature of groups; Types of groups; Stages of Group Development; Group Cohesiveness; Group Decision-Making; Leadership , Nature; Theories of leadership: Trait Theories, Behavioral Theories and Contingency Theories;

Conflict Management, Transactions in conflict thought, Functional versus Dysfunctional conflict, The Conflict process, Conflict Management. Stress, Causes and consequences of stress, Stress management. Organizational Culture and Change Management: Nature and Functions of culture, Creating and sustaining Organizational Culture, Forces for change, Resistance to change, Approaches to Managing Organizational Change, Organizational Development, Techniques of organizational development.

Reference Books

- 1 Organizational Behavior, Neharika Vohra Stephen P. Robbins, Timothy A. Judge, 18 (2022), Pearson.
- 2 Organizational Behavior: An Evidence - Based Approach, Fred Luthans, 12 (2017), McGraw Hill Education.
- 3 Organisational Behavior, Mary Von Glinow, Steven Mcshane , 7 (2014), McGraw-Hill Education.
- 4 ORGANIZATIONAL BEHAVIOUR: TEXT AND CASES, K. Chitale, Avinash , Prasad Mohanty, Rajendra , Rajaram Dubey, Nishith , 2 (2019), PHI.

23MROB02M - ORGANIZATIONAL BEHAVIOUR MODELS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MROB02M	ORGANIZATIONAL BEHAVIOUR MODELS	OBM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand key concepts and theoretical frameworks in organizational behaviour, including classical and contemporary models.	2	PO9
CO2	Apply advanced theories and models to analyze individual behavior and psychological processes within organizations.	3	PO12, PSO2
CO3	Analyze group dynamics, teamwork, and leadership theories to understand their impact on organizational performance.	4	PO9
CO4	Appraise strategies for organizational development and change management, integrating theory with practical application.	5	PO9

Syllabus

Foundations of Organizational Behaviour: Overview of OB, its definition, importance, and historical development. Theoretical frameworks and models including classical, human relations, and systems approaches. Examination of organizational culture, its dimensions, types, and effects on behavior. Analysis of organizational structure, including design principles, types, and influencing factors.

Individual Behavior in Organizations: Investigation of personality theories and assessments, focusing on workplace implications. Study of major motivation theories, emphasizing their practical applications. Examination of job satisfaction and organizational commitment theories and their outcomes. Analysis of emotional intelligence and the management of emotions in organizational contexts.

Group Dynamics and Teamwork: Study of group dynamics, including formation, roles, norms, and cohesiveness. Examination of factors contributing to team effectiveness, such as composition and development stages. Exploration of various leadership theories and styles, and their impact on team performance. Analysis of communication processes, barriers, and techniques for effective organizational communication.

Organizational Development and Change: Introduction to OD principles and practices, focusing on planned change strategies. Study of change management theories and models, with emphasis on managing organizational change. Exploration of factors fostering a creative climate and strategies to drive innovation. Discussion of emerging trends and future directions, including technology and globalization impacts.

Reference Books

- 1 ORGANIZATIONAL BEHAVIOUR, Robbins, S. P., & Judge, T. A., 18th, 2010, Pearson.
- 2 "Organization Theory: Modern, Symbolic, and Postmodern Perspectives", Hatch, M. J., & Cunliffe, A. L., 3rd, 2013, Oxford University Press.
- 3 "Organizational Culture and Leadership", Schein, E. H., 5th, 2010, Wiley.
- 4 "Organizations and Organizing: Rational, Natural, and Open Systems Perspectives", Scott, W. R., & Davis, G. F., 2015, Routledge.

23MROB03M - ORGANIZATIONAL CHANGE AND DEVELOPMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MROB03M	ORGANIZATIONAL CHANGE AND DEVELOPMENT	OCD	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the theories and models of organizational change and development.	2	PO9
CO2	Analyze the process and challenges of implementing organizational change.	4	PO8, PO9
CO3	Evaluate the effectiveness of different change management strategies and interventions.	5	PO9
CO4	Formulate strategies to manage resistance and ensure successful organizational change and development.	5	PO9

Syllabus

Introduction to Organizational Change and Development: Overview of organizational change and development. Key concepts and definitions. Theories and models of change, including Lewin's Change Management Model, Kotter's 8-Step Change Model, and ADKAR Model. Case studies on organizational change.

The Change Process: Steps in the change process: identifying the need for change, planning for change, implementing change, and sustaining change. Understanding the role of change agents and leadership in the change process. Case studies on successful and unsuccessful change initiatives.

Change Interventions and Strategies: Types of change interventions: structural, technological, and behavioral. Techniques for managing change: communication, training, and development, team building, and coaching. Evaluating the effectiveness of change interventions. Case studies on different change strategies.

Managing Resistance and Ensuring Success: Identifying sources of resistance to change. Strategies for overcoming resistance: participation, negotiation, and coercion. Measuring the impact of change and ensuring sustainability. Case studies on overcoming resistance and achieving successful change.

Reference Books

- 1 "Organizational Change: An Action-Oriented Toolkit", Tupper F. Cawsey, Gene Deszca, Cynthia Ingols, 4th , SAGE Publications.
- 2 "Managing Organizational Change: A Multiple Perspectives Approach", Ian Palmer, Richard Dunford, Gib Akin, 3rd , McGraw-Hill Education.
- 3 "The Theory and Practice of Change Management", John Hayes, 5th, Palgrave Macmillan.
- 4 "Organization Development: The Process of Leading Organizational Change", Donald L. Anderson, 5th , SAGE Publications.

23MROB04M - LEADERSHIP IN ORGANIZATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MROB04M	LEADERSHIP IN ORGANIZATION	LIO	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand leadership in changing business environment	2	PO9
CO2	Apply leadership skills & tactics, appropriate style for the given situation	3	PO9
CO3	Analyze the strategic role of a leader in present day organizations	4	PO9
CO4	Make use of coaching and mentoring skills learnt for developing leaders in organizations	3	PO9

Syllabus

From Management to Leadership; Nature and Importance of Leadership; Difference between Leadership and Management; Leadership Theories; Trait Theories; Behavioral Theories; Scandinavian Studies; Contingency Approaches; Situational Theories; Servant Leadership; Adaptive Leadership.

Leadership Skills and Leadership Styles ; Leadership Skills and Tactics: Social Skills; Persuasion Skills ; Motivational Skills ; Communication and Conflict Resolution Skills ; Role Models; Story Telling; Leadership Styles; The Impact of Leadership Styles on Work Climate.

Strategic Leadership by Executives; The Nature of Strategic Leadership; How leaders influence organizational performance; Constraints on Executives; Conditions Affecting the Need for Strategic Leadership; Political Power and Strategic Leadership; Research on Effects of CEO Leadership; Strategic Leadership by Executive Teams, Women CEOs.

Leadership Development and Succession; Development through Self Awareness and Self Discipline; Development through Education; Experience and Mentoring; Leadership Development Programs; Developing next Generation Leaders; Leadership Development and Organizational Goals ; Coaching Leaders ; Leadership Succession ; Choosing the Right CEO.

Reference Books

- 1 Leadership in Organizations, Yulk, Gary, 2020, Pearson Education.
- 2 Principles of Leadership, Dubrin, Andrew J, 2017, Cengage Learning.
- 3 Leadership Myths and Realities, Robert J. Allio , 2000, Tata Mcgraw Hill.
- 4 Leadership: Theory and Practice, Peter G Northouse, 2021, Sage.

23MRPA01 - FUNDAMENTALS OF AGRONOMY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPA01	FUNDAMENTALS OF AGRONOMY	FOA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of agronomy with interdisciplinary approach with Botany, Soil Science, Irrigation, plant protection, Plant Genetics and Breeding, Agrometeorology	2	PO2, PO6, PO7, PSO2
CO2	Understand the various nutrients and their effects on plant health and irrigation measures	2	PO2, PO6, PO7, PSO2
CO3	Interpret weeds, sustainable agricultural production, and apply scientific methods and tools in field preparation	3	PO2, PO6, PO7, PSO2
CO4	Apply the impact of the professional agricultural solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development	3	PO2, PO6, PO7, PSO2
CO5	Demonstrate the Identification and proper crop management practices with practical knowledge to produce food for humans.	3	PO2, PO6, PO7, PSO2

Syllabus

Introduction to Agriculture, Agronomy, Tillage and Types with modern concepts of tillage, Seed and sowing, methods and crop geometry. Objectives of tillage, Characteristics of ideal seed bed, Effect of tillage on soil properties, Types of tillage,

Plant population, soil fertility, Crop nutrition and their symptoms, manures and fertilizers and Irrigation and methods and importance with crop growth and development, Types of manures and fertilizers, Factors influencing methods and time of fertilizer application, Bio-fertilizers, Irrigation, Importance of Irrigation , Objectives of irrigation

Herbicides- Definition, advantages and limitations of herbicide usage in India.- Bioherbicides, Classification of herbicides based on chemical nature, time and method of application, Herbicidal formulations

Selectivity and resistance Selectivity of herbicides, Fundamental principles of selectivity, Differences in morphology and growth habit of plants, advantages and limitations of herbicide usage in India, Bioherbicides, Classification of herbicides based on chemical nature, time and method of application,

Visit to college farm and identification of major crops and varieties, Practice of primary tillage implements and puddling, Practice of secondary tillage implements, active ingredient- Acid equivalent- Nomenclature of herbicides, Adjuvants and their use in herbicide application, Types of adjuvants

Reference Books

- 1 Principles of Agronomy., Reddy, S.R. , 5th edition, 2016, Kalyani Publishers.
- 2 Principles of Agronomy, Yellamanda Reddy, T. and Sankara Reddi, G. H, 3, 2016, Kalyani Publishers, Ludhiana.
- 3 Fundamentals of Agronomy., Gopal Chandra de, 4th, 1989, Oxford & IBH Publishing Co. Pvt. Ltd. , New Delhi..
- 4 Modern weed management., Gupta, O.P., 5th edition, 2011, Agrobios (India), Jodhpur..

23MRPA02 - INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPA02	INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE	IACC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Estimate the behaviour of the atmosphere and agroclimatic zones.	2	PO2, PO5
CO2	Understand agrometeorology in agriculture and the changes of individual weather elements and their relation to crop production.	2	PO2, PO5
CO3	Understand the management of weather hazards for improving crop productivity	2	PO2, PO5
CO4	Demonstrate weather forecasting and impact of climate change on agriculture	3	PO2, PO5
CO5	Record and estimate and analyzing the meteorological instruments from the agro meteorological observatory.	3	PO2, PO5

Syllabus

Earth atmosphere, composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, long wave and thermal radiation, net radiation, albedo;

Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification

Artificial rainmaking; Monsoon, mechanism and importance in Indian agriculture; Weather hazards, drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and coldwave; Agriculture and weather relations, modifications of crop microclimate, climatic normals for crop and livestock production

Weather forecasting, types of weather forecast and their uses; Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture. Practical Visit of Agrometeorological observatory, site selection of observatory, exposure of instruments and weather data recording;

Measuring the pressure of the atmosphere and analyzing atmospheric conditions, assessing wind speed and direction, and creating visualizations of wind patterns, meteorologists gain valuable insights into weather phenomena

Reference Books

- 1 Principles and practices of agricultural disaster management., Radha Krishna Murthy,V., 2016, B.S Publications, Koti,Hyderabad..
- 2 Introduction to Agriculture and Agrometeorology. , Reddy, S.R , 1. 2014., B.S Publications, Koti, Hyderabad .
- 3 Agrometeorology: Principles and Applications of Climate Studies in Agriculture, H.D. Singh, 9. 1994 , CRC Press.
- 4 Agrometeorology: A Modern Synthesis, S. Nagarajan and S.S. Dhingra , 2002 , Kluwer Academic Publishers.

23MRPA03 - GEOINFORMATICS AND NANOTECHNOLOGY FOR PRECISION FARMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPA03	GEOINFORMATICS AND NANOTECHNOLOGY FOR PRECISION FARMING	GNPF	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Integrate about the concept of precision farming and the techniques involved in precision farming.	2	PO6, PO7
CO2	Familiarize about the applications of nanotechnology in tillage operation, seed sowing, fertilizer application, plant protection management.	2	PO6, PO7
CO3	Apply the techniques involved in soil mapping. It allows the student to learn about remote sensing practical applications in the field.	3	PO6, PO7
CO4	Interpretation of the data in this course. Geo-referencing those data and classifying the supervised and unsupervised data of RS images.	3	PO6, PO7
CO5	Apply and Demonstrate and Practical Knowledge on GIS technology and Precision Farming	3	PO6, PO7

Syllabus

Precision agriculture: concepts and techniques-Issues and concerns for Indian agriculture Geo-informatics- definition, concepts, tools and techniques and their use in Precision Agriculture Crop discrimination and Yield monitoring techniques Principles and practices of precision agriculture.Application of nanotechnology in agriculture - tillage, seed, water, fertilizers, plant protection for scaling-up farm productivity

Crop discrimination and Yield monitoring, soil mapping fertilizer recommendation using geospatial technologies Spatial data and their management in GIS Geodesy and its basic principles Remote sensing concepts and application in agriculture Image processing and interpretation Global system (GPS), components and its functions Nanotechnology, definition, concepts and techniques Nano scale definition Nano-particles , materials occurrence properties Characterization of nano-materials structural characterization Nano sensors

System Simulation- Concepts and principles, Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs STCR approach for precision agriculture Nanotechnology, definition, concepts and techniques, brief introduction about nanoscale effects Concepts and principles, Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs STCR approach for precision agriculture

Nano-particles, nano-pesticides, nano-fertilizers, nano-sensors, Use of nanotechnology in tillage, seed, water, fertilizer, plant protection for scaling-up farm productivity.geospatial technologies Spatial data and their management in GIS Geodesy and its basic principles Remote sensing concepts and application in agriculture Image processing and interpretation Global system (GPS), components and its functions Nanotechnology, definition, concepts and techniques Nano scale definition Nano-particles , materials occurrence properties Characterization of nano-materials structural characterization Nano sensors

Reference Books

- 1 Remote sensing and image interpretation on Agriculture , Jonathan Chipman, Ralph W. Kiefer, Thomas Lillesand , 7 ,2015, John Wiley and Sons .
- 2 Remote sensing and image interpretation. , Lillesand, T.M. and Kiefer, R. W. , 2, 1994 , B.S. Publications, Hyderabad .
- 3 Text book of Remote sensing and Geographical Information Systems, , Anji Reddy, M., 3, 2006 , , B.S. Publications, Hyderabad. .
- 4 NANO: The Essentials:Understanding Nanoscience and Nanotechnolgy , Pradeep. T. , 2, 2007, Tata McGraw-Hill Publishing Company Limited, New Delhi .

23MRPA04 - PROTECTED CULTIVATION AND POST-HARVEST TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPA04	PROTECTED CULTIVATION AND POST-HARVEST TECHNOLOGIES	PCPHT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of greenhouses, its history, greenhouse effect, types of green houses and greenhouse environment	2	PO6, PO7
CO2	Applying the knowledge and skills to design, construct and manage the greenhouse effectively	3	PO6, PO7
CO3	Applying the concepts of engineering properties and aero-dynamic properties to design various post-harvest equipments	3	PO6, PO7
CO4	Analyze the drying parameters of various grains and performance evaluation of various commercial grain dryers, material handling equipments etc.	4	PO7
CO5	Analyze the working of different types of greenhouses based on shape and performance evaluation of various post-harvest equipments	4	PO6, PO7

Syllabus

Introduction to greenhouses, history, definition, greenhouse effect, advantages of green houses. Brief description of types of greenhouses, greenhouses based on shape, utility, construction, covering materials and cost, shade nets. Plant response to greenhouse environments i.e. light, temperature, relative humidity, ventilation and carbon dioxide and environmental requirement of agriculture and horticulture crops inside green houses. Equipment required for controlling greenhouse environment, summer cooling and winter cooling, natural ventilation, forced ventilation and Planning of greenhouse facility, site selection and orientation, structural design and covering materials. Materials for construction of greenhouses. Design criteria and constructional details of greenhouses, construction of pipe framed greenhouses, material requirement, preparation of materials and procedure of erection. Greenhouse heating and distribution systems, greenhouse utilization, off-season drying of agricultural produce. Economic analysis of greenhouse production, capital requirement, economics of production and conditions influencing returns.

Irrigation system used in greenhouses, rules of watering, hand watering, perimeter watering, overhead sprinklers, boom watering and drip irrigation. Important engineering properties such as physical, thermal and aero-dynamic properties of cereals, pulses and oil seeds. Designing post-harvest equipment based on physical and thermal properties. Winnowing, manual and power operated winnowers, care and maintenance. Groundnut decorticators, hand and power operated decorticators, principle of working, care and maintenance

Moisture measurement, equilibrium moisture content (EMC), importance, Drying theory Drying and dehydration. Commercial grain dryers, deep bed, flat bed, tray, fluidized bed, recirculated and solar dryers will be dealt. Material handling equipment and their selection. Primary processing of cereals, pulses and oil seeds. Cleaning, grading and packaging

Familiarization with renewable energy gadgets, biogas plants, production process of biodiesel, briquetting machine - production process of bio-fuels - Familiarization with different solar energy gadgets, solar photovoltaic system, Solar light, Solar pumping, Solar fencing, solar cooker, solar drying system, solar distillation and solar pond

Reference Books

- 1 Greenhouse technology and management, Radha Manohar, K and Igathinathane. C., 2 (2007), BS Publications.
- 2 Greenhouse technology for Controlled Environment, Tiwari, G.N., 1 (2003), Narosa Publishing house Pvt. Ltd..
- 3 Advances in protected cultivation, Singh Brahma and Balraj Singh, 1 (2015), New India publishing company.

- 4 Unit operations of agricultural processing, Sahay, K.M. and Singh, K. K., 1(2004), Vikas publishing house pvt. Ltd. New Delhi..
- 5 Post-harvest technology of cereals, pulses and oil seeds, Chakraverty, A., 1 (2019), Oxford and IBH publishing Co. Ltd., New Delhi.
- 6 Principles of Agricultural Engineering, vol. I,, Ojha, T. P. and Michael, A. M., 14 (2021), Jain brothers, Karol Bag, New Delhi.

23MRPY01 - BASICS OF PHARMACOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPY01	BASICS OF PHARMACOLOGY	BOP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the pharmacological actions of different categories of drugs	2	PO1, PO4, PSO2
CO2	Understand the mechanism of drug action at the organ system/subcellular/macromolecular level	2	PO1, PO4, PSO2
CO3	Apply the basic knowledge of pharmacology in PNS	3	PO1, PO4, PSO2
CO4	Apply the effect of drugs on CNS	3	PO1, PO4, PSO2
CO5	Analyze practical applications of Pharmacology	4	

Syllabus

General Pharmacology a. Introduction to Pharmacology- Definition, historical landmarks and scope of pharmacology, nature and source of drugs, essential drugs concept and routes of drug administration, Agonists, antagonists(competitive and non-competitive), spare receptors, addiction, tolerance, dependence, tachyphylaxis, idiosyncrasy, allergy. b. Pharmacokinetics- Membrane transport, absorption, distribution, metabolism and excretion of drugs .Enzyme induction, enzyme inhibition, kinetics of elimination

Principles and mechanisms of drug action. Receptor theories and classification of receptors, regulation of receptors. drug receptors interactions signal transduction mechanisms, G-protein coupled receptors, ion channel receptor, transmembrane enzyme linked receptors, transmembrane JAK STAT binding receptor and receptors that regulate transcription factors, dose response relationship, therapeutic index, combined effects of drugs and factors modifying drug action. b. Adverse drug reactions. c. Drug interactions pharmacokinetic and pharmacodynamic d. Drug discovery and clinical evaluation of new drugs Drug discovery phase, preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance

Pharmacology of drugs acting on peripheral nervous system a. Organization and function of ANS. b. Neurohumoral transmission,co transmission and classification of neurotransmitters. c. Parasympathomimetics, Parasympatholytics, Sympathomimetics, sympatholytics. d.Neuromuscular blocking agents and skeletal muscle relaxants peripheral. e. Local anesthetic agents. f. Drugs used in myasthenia gravis and glaucoma .

Pharmacology of drugs acting on central nervous system .General anesthetics and preanesthetics.Sedatives, hypnotics and centrally acting muscle relaxants. Anti epileptics . Alcohols and disulfuram .Pharmacology of drugs acting on central nervous system .Psychopharmacological agents: Antipsychotics, antidepressants, anti anxiety agents, anti manics and hallucinogens. Drugs used in Parkinsons disease and Alzheimers disease. CNS stimulants and nootropics. Opioid analgesics and antagonists. Drug addiction, drug abuse, tolerance and dependence

Reference Books

- 1 Rang and Dales Pharmacology, Churchill Livingstone Elsevier , Rang H. P. Dale M. M., Ritter J. M.Flower R. J, 10 (2020), Elsevier.
- 2 Basic and clinical pharmacology , Katzung B. G. Masters S. B.Trevor A. J , 15 (2021) , Lea& Febigur.
- 3 Text book of Medical Pharmacology, KD Tripathy , 9 (2019), Jaypee.
- 4 The Pharmacological Basis Of therapeutics , Goodman Gilman, Louis S. Goodman, Alfred Goodman, and Theodore W. Rall. , 16 (2021), Mc Graw Hill.

5 Text Book pof experimental pharmacology , Mathew, 1(2022) , Pritham.

23MRPY02 - ADVANCED PHARMACOLOGY - I (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPY02	ADVANCED PHARMACOLOGY - I	AP-I	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Pharmacology of cardio vascular system drugs: congestive heart failure drugs, Anti-hypertensive drugs, Anti-anginal drugs, Anti-arrhythmic drugs, Antihyperlipidemic drugs	2	PO1, PO11, PSO1
CO2	Understanding the pharmacology of shock, Hematinics, coagulants and anticoagulants, Fibrinolytics and antiplatelet drugs, diuretics and autocoids	2	PO1, PO11, PSO1
CO3	Understand the Pharmacology of drugs acting on endocrine system. Anterior Pituitary hormones, Thyroid hormones, Insulin, Oral Hypoglycemic agents and glucagon, ACTH and corticosteroids.	2	PO1, PO11, PSO1
CO4	Undesrtand the principles of Bio-Assays	2	PO1, PO11, PSO1
CO5	Applying the pharmacological activity of drugs on Cardiac and Renal system and dose responses on isolated tissues (Insilco)	3	PO1, PO11, PSO1

Syllabus

Pharmacology of drugs acting on cardiovascular system Introduction to hemodynamic and electrophysiology of heart. Drugs used in congestive heart failure Antihypertensive drugs. Antianginal drugs. Anti-arrhythmic drugs. Antihyperlipidemic drugs. Pharmacology of drugs acting on cardiovascular system Drug used in the therapy of shock. Hematinics, coagulants and anticoagulants. Fibrinolytics and antiplatelet drugs. Plasma volume expanders.

Pharmacology of drugs acting on urinary system Diuretics, Antidiuretics. Autocoids and related drugs Introduction to autocoids and classification, Histamine, 5HT and their antagonists. Prostaglandins, Thromboxanes and Leukotrienes. Angiotensin, Bradykinin and Substance P. Non- steroidal anti-inflammatory agents, Antigout drugs, Antirheumatic drugs

Pharmacology of drugs acting on endocrine system Basic concepts in endocrine pharmacology., Anterior Pituitary hormones- analogues and their inhibitors. Thyroid hormones analogues and their inhibitors. Hormones regulating plasma calcium level Parathormone, Calcitonin and VitaminD. Insulin, Oral Hypoglycemic agents and glucagon. ACTH and corticosteroids

Pharmacology of drugs acting on endocrine system Androgens and Anabolic steroids. Estrogens, progesterone and oral contraceptives. Drugs acting on the uterus. Bioassay Principles and applications of bioassay. b. Types of bioassay Bioassay of insulin, oxytocin, vasopressin, ACTH, dtubocurarine, digitalis, histamine and 5HT.

1. Introduction to in-vitro pharmacology and physiological salt solutions. 2. Effect of drugs on isolated frog heart. 3. Effect of drugs on blood pressure and heart rate of dog. 4. Study of diuretic activity of drugs using rats mice. 5. DRC of acetylcholine using frog rectus abdominis muscle. 6. Effect of physostigmine and atropine on DRC of acetylcholine using frog rectus 7. abdominis muscle and rat ileum respectively. 8. Bioassay of histamine using guinea pig ileum by matching method. 9. Bioassay of oxytocin using rat uterine horn by interpolation method. 10. Bioassay of serotonin using rat fundus strip by three-point bioassay. 11. Bioassay of acetylcholine using rat ileum colon by four-point bioassay. 12. Determination of PA2 value of prazosin using rat anococcygeal muscle by Schilds plot method 13. Determination of PD2 value using guinea pig ileum. 14. Effect of spasmogens and spasmolytics using rabbit jejunum

Reference Books

- 1 P. Goodman and Gilman's The pharmacological Basis of therapeutics, Goodman Gilman, A., Rall, T.W., Nies, A.I.S. and Taylor, 14, 2022, Mc Graw Hill, Pergamon press..
- 2 Basic and clinical pharmacology Katzung, B, Katzung, B.G, 1st edition, 2010, Prentice Hall, International.

- 3 Essentials of medical pharmacology, Tripathi, K. D , 8th edition, 2008, Jaypee, Delhi.
- 4 Hand book of Experimental Pharmacology, S. K. Kulakarni, 2nd edition, 2021, Vallabh Prakashan.

23MRPY03 - EXPERIMENTAL PHARMACOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPY03	EXPERIMENTAL PHARMACOLOGY	EPC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the uses of various commonly used laboratory animals in preclinical research	2	PO4, PSO1
CO2	Understand the animal screening models for various indications	2	PO4, PSO1
CO3	Understand the animal screening models for nervous system related indications	2	PO4, PSO1
CO4	Understand the importance of biostatistics and research methodology in clinical and preclinical research	2	PO4, PSO1
CO5	Apply Pharmacological screening methods to identify the activity of drugs	3	PO4, PSO1

Syllabus

Laboratory Animals: o Study of CPCSEA and OECD guidelines for maintenance, breeding and conduct of experiments on laboratory animals. o Common lab animals: Description and applications of different species and strains of animals. Popular transgenic and mutant animals. o Techniques for collection of blood and euthanasia. o Common routes of drug administration in laboratory animals. o Dose selection, calculation and conversions, preparation of drug solution/suspensions. Grouping of animals and importance of sham negative and positive control groups

Study of screening animal models for various indications o Rationale for selection of animal species and sex for the study. o Diuretics o Anti-asthmatics o Analgesic o Antipyretic o Anti-inflammatory o Drugs acting on eye o Antihypertensives o Antiarrhythmics o Anti-dyslipidemics o Anti-aggregatory o Coagulants o Anticoagulants o Antiulcer o Antidiabetic o Anticancer

Study of screening animal models for nervous system related indications o Nootropics & Alzheimer's disease o Anti-Parkinson's o General anesthetics o Sedative and hypnotics o Antipsychotic o Antidepressant o Antiepileptic o Sympathomimetics o Sympatholytics o Parasympathomimetics o Parasympatholytics o Skeletal muscle relaxants o Local anesthetics

Research methodology and Bio-statistics o Selection of research topic o Review of literature o Research hypothesis o Study design o Pre-clinical data analysis o Interpretation using Students 't' test and One-way ANOVA. o Graphical representation of data

Reference Books

- 1 Fundamentals of Experimental Pharmacology , M. N. Ghosh , 2008, Hilton and Company .
- 2 Hand book of Experimental Pharmacology , S. K. Kulakarni , 2014, VALLABH PRAKASHAN .
- 3 Introduction to biostatistics and research methods , PSS Sundar Rao and J Richard , 2012, PHI Learning Pvt. Ltd. .
- 4 Drug discovery and Evaluation by , Vogel H.G. , 1996, Springer .

23MRPY04 - ADVANCED PHARMACOLOGY - II (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPY04	ADVANCED PHARMACOLOGY - II	AP-II	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the mechanism of drug action and its relevance in the treatment of different infectious diseases	2	PO4, PSO2
CO2	Understand the mechanism of drug action antibiotics and drugs used commonly infected diseases	2	PO4, PSO2
CO3	Understand the immunopharmacology	2	PO4, PSO2
CO4	Apply the principles of toxicology and treatment of various poisonings	3	PO4, PSO2
CO5	Apply the knowledge on introduction to experimental Pharmacology, common laboratory animals, agonist and antagonist activities of drugs on isolated tissues. Get trained on screening of anti-allergic drugs, anti-ulcer drugs and gastro intestinal activity	3	PO4, PSO2
CO6	Estimation of different biochemical parameters using semi auto analyser and obtain a knowledge on screening of hypo glycaemic drugs, Pyrogen testing, Trained in performing of toxicity studies, and get knowledge in application of Biostatistics in Pharmacological research.	3	PO4, PSO2

Syllabus

Pharmacology of drugs acting on Respiratory system a. Anti -asthmatic drugs b. Drugs used in the management of COPD c. Expectorants and antitussives d. Nasal decongestants e. Respiratory stimulants Pharmacology of drugs acting on the Gastrointestinal Tract a. Antiulcer agents. b. Drugs for constipation and diarrhoea. c. Appetite stimulants and suppressants. d. Digestants and carminatives. e. Emetics and anti-emetics.

Chemotherapy a. General principles of chemotherapy. b. Sulfonamides and cotrimoxazole. c. Antibiotics- Penicillins, cephalosporins, chloramphenicol, macrolides, quinolones and fluoroquinolones, tetracycline and aminoglycosides d. Anti-tubercular agents e. Anti-leprotic agents f. Antifungal agents g. Antiviral drugs h. Anthelmintics i. Antimalarial drugs j. Anti-amoebic agents

Chemotherapy l. Urinary tract infections and sexually transmitted diseases. 2. Chemotherapy of malignancy. Immunopharmacology a. Immunostimulants b. Immunosuppressant Protein drugs, Monoclonal antibodies, target drugs to antigen, biosimilars

Principles of toxicology a. Definition and basic knowledge of acute, subacute and chronic toxicity. b. Definition and basic knowledge of genotoxicity, carcinogenicity, teratogenicity and mutagenicity c. General principles of treatment of poisoning d. Clinical symptoms and management of barbiturates, morphine, Organophosphorus compound and lead, mercury and arsenic poisoning. Chrono pharmacology a. Definition of rhythm and cycles. b. Biological clock and their significance leading to chronotherapy.

Reference Books

- 1 P. Goodman and Gilman's The pharmacological Basis of therapeutics, Goodman Gilman, A, Rall, T.W, Nies, A.I.S. and Taylor, 2022, Mc Graw Hill, Pergamon press.
- 2 Modern Pharmacology, Craig, C.R. and Stitzel, R.E, 2012, Little Brown and company.
- 3 Pharmacology, Rang, H.P. and Dale, M.M., 2023, Churchill Living stone.
- 4 Basic and clinical pharmacology, Katzung, B.G, 2023, Prentice Hall, International.

- 5 Essentials of medical pharmacology, Tripathi, K. D , 2018, Jaypee, Delhi .

23MRTP01 - INTRODUCTION TO TECHNOLOGICAL ENTREPRENEURSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRTP01	INTRODUCTION TO TECHNOLOGICAL ENTREPRENEURSHIP	ITEP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of technological entrepreneurship and the entrepreneurial ecosystem.	2	PO2
CO2	Develop skills for identifying and evaluating technological opportunities.	3	, PSO2
CO3	Create viable business models and strategies for technology-based startups.	4	
CO4	Develop and pitch a technology-based business plan.	5	PO3
CO5	Implement strategies for launching and scaling technology startups.	6	PO11

Syllabus

Introduction to Technological Entrepreneurship: Definition and significance of technological entrepreneurship, Overview of the entrepreneurial ecosystem, Characteristics of successful technology entrepreneurs

Opportunity Identification and Evaluation: Techniques for identifying technological opportunities, Market research and analysis, Feasibility studies and validation

Business Model Development: Components of a business model, Business model canvas, Case studies of successful tech startups

Business Planning and Pitching: Elements of a business plan, Financial planning and projections, Pitching techniques and investor presentations

Launching and Scaling Startups: Strategies for launching technology startups, Growth hacking and scaling techniques, Managing resources and operations

Reference Books

- 1 The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, 1st, Crown Business.
- 2 Zero to One: Notes on Startups, or How to Build the Future, Peter Thiel, Blake Masters, 1st, Crown Business.
- 3 Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Alexander Osterwalder, Yves Pigneur, 1st, Wiley.
- 4 The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Clayton M. Christensen, 1st, Harvard Business Review Press.

23MRTP02 - LEAN STARTUP LAUNCHPAD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRTP02	LEAN STARTUP LAUNCHPAD	LSLP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and concepts of Lean Startup methodology and explain its importance for modern entrepreneurs.	2	PO2, PO11, PSO1
CO2	Identify target customer segments, develop detailed customer personas, and validate customer problems through effective interviews and analysis.	4	PO2, PO11, PSO1
CO3	Generate innovative solution ideas, formulate testable hypotheses, and design experiments to validate these hypotheses effectively.	6	PO2, PO11, PSO1
CO4	Develop a Minimum Viable Product (MVP) with limited resources, test it with real users, and iterate based on feedback to improve the product.	6	PO2, PO11, PSO1
CO5	Develop a Minimum Viable Product (MVP) with limited resources, test it with real users, and iterate based on feedback to improve the product.	5	PO2, PO11, PSO1

Syllabus

Introduction to Lean Startup Methodology: The definition and principles of Lean Startup, the importance of Lean Startup for entrepreneurs, an overview of the Build-Measure-Learn loop, and understanding hypothesis-driven development.

Customer Discovery and Problem Validation: Identifying and segmenting target customers, developing customer personas, conducting customer interviews, and validating customer problems.

Solution Ideation and Hypothesis Testing: Generating and prioritizing solution ideas, formulating hypotheses for solutions, designing experiments to test hypotheses, and metrics and measurement in Lean Startup.

Developing a Minimum Viable Product (MVP): The definition and purpose of an MVP, types of MVPs such as prototypes and landing pages, building an MVP with limited resources, and iterating based on feedback.

Business Model Validation and Preparation for Launch: The introduction to Business Model Canvas, validating revenue models and cost structures, testing market fit and scalability, pivoting based on validation results, developing a go-to-market strategy, building a pitch deck for investors, planning for scaling and growth, and understanding common pitfalls and challenges.

Reference Books

- 1 The Lean Startup, Eric Ries, 1st (2011), Crown Business.
- 2 The Four Steps to the Epiphany, Steve Blank, 2nd (2020), K&S Ranch.
- 3 Running Lean, Ash Maurya, 1st (2022), O'Reilly Media.
- 4 Business Model Generation, Alexander Osterwalder, Yves Pigneur, 1st (2010), Wiley.

23MRTP03 - ENTREPRENEURSHIP AND VENTURE CAPITAL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRTP03	ENTREPRENEURSHIP AND VENTURE CAPITAL	EVC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To Understand the entrepreneurial mindset and process.	2	PO11
CO2	To explore different business models and develop a viable business plan	3	PO12
CO3	To analyse the fundamentals of venture capital and the investment process	4	PO7
CO4	To gain insights into scaling startups and managing growth	4	PO9
CO5	Laboratory Experiments	4	PO2

Syllabus

Definitions and types of entrepreneurship, Characteristics of successful entrepreneurs, The entrepreneurial ecosystem, Creativity and innovation in entrepreneurship, Techniques for idea generation, Identifying and evaluating, Business model canvas, Components of a business plan, Case studies of successful startups.

Importance of market research, Methods for market analysis, Understanding customer needs and segmentation, Roles and responsibilities in a startup team, Recruitment and team dynamics, Leadership and management skills, Lean startup methodology, Minimum viable product (MVP), Iterative development and user feedback.

Overview of venture capital industry, Types of venture capital firms, Stages of venture capital funding, Preparing for fundraising, Crafting a compelling pitch, Approaching and negotiating with investors, Creating financial projections, Understanding startup valuation, Dilution and cap tables

Key components of a term sheet, Negotiating deal terms, Common deal structures, Strategies for scaling, Managing rapid growth, Operational challenges and solutions, Legal considerations for startups, Intellectual property and patents, Ethical dilemmas in entrepreneurship

Reference Books

- 1 The Lean Startup: How Constant Innovation Creates Radically Successful Businesses, Ries, Eric, 2011, Crown Business.
- 2 Venture Deals: Be Smarter Than Your Lawyer and Venture Capitalist, Brad Feld and Jason Mendelson, 2019, Wiley.
- 3 Entrepreneurship: Successfully Launching New Ventures, Bruce R Barringer, Duane Ireland, 2012, Pearson.
- 4 Strategic Management of Venture Capital, Neelkant Sharma , 2002, New Century Publications.
- 5 Venture deals, Brad Feld, 2019, Wiley.

23MRTP04 - BUILDING AND SUSTAINING A SUCCESSFUL ENTERPRISE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRTP04	BUILDING AND SUSTAINING A SUCCESSFUL ENTERPRISE	BSSE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and evaluate the fundamental principles and strategic processes involved in building and sustaining a successful enterprise.	2	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2
CO2	Develop comprehensive market analyses and identify business opportunities using competitive analysis techniques.	3	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2
CO3	Apply financial management techniques, including planning, forecasting, and key financial ratio analysis, to ensure business sustainability.	4	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2
CO4	Design effective marketing and sales strategies, incorporating digital marketing and customer relationship management to enhance business growth.	4	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2
CO5	Plan, execute, and present a capstone project that demonstrates practical application of course concepts in creating and maintaining a successful enterprise.	5	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2

Syllabus

Foundations of Building a Successful Enterprise Introduction to Building Successful Enterprises; Key components of a successful enterprise; Overview of entrepreneurial thinking and mindset; Defining vision, mission, and goals; Strategic planning processes; Tools and techniques for strategic execution

Market Analysis and Innovation Understanding market trends and dynamics; Identifying and evaluating business opportunities; Conducting competitive analysis; Role of innovation in business success; Fostering a culture of innovation; Case studies on innovative businesses; Different types of business models; Creating and delivering value to customers; Evaluating and refining business models

Financial Management and Marketing Strategies Financial planning and forecasting; Managing cash flow and capital; Key financial ratios and their implications; Developing effective marketing strategies; Sales techniques and customer relationship management; Digital marketing and its impact on business

Leadership, Sustainability, and Capstone Project Recruitment and selection processes; Team dynamics and performance management; Leadership styles and their impact on team success; Creating and maintaining a strong organizational culture; Leading through change and uncertainty; Case studies on organizational transformation; Identifying and managing business risks; Legal aspects of running a business; Intellectual property and compliance issues; Expanding businesses internationally; Understanding global market dynamics; Strategies for entering and succeeding in foreign markets; Importance of sustainability in business; Implementing CSR initiatives

Integration and Practical Application: This module focuses on integrating the foundational concepts, analytical skills, and strategic approaches learned throughout the course. It emphasizes practical application through case studies, simulations, and project-based learning to synthesize knowledge and skills essential for building and sustaining a successful enterprise.

Reference Books

- 1 Entrepreneurship: Successfully Launching New Ventures, Bruce R. Barringer, R. Duane Ireland, 6th Edition, Pearson.
- 2 Marketing Management, Philip Kotler, Kevin Lane Keller, 15th Edition, Pearson.
- 3 Financial Management: Theory & Practice, Eugene F. Brigham, Michael C. Ehrhardt, 15th Edition, Cengage Learning.
- 4 Leadership: Theory and Practice, Peter G. Northouse, 8th Edition, SAGE Publications, Inc.
- 5 Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Alexander Osterwalder, Yves Pigneur, 1st Edition, Wiley.

23MRWS02 - SOIL AND WATER CONSERVATION ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRWS02	SOIL AND WATER CONSERVATION ENGINEERING	SWCE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of soil, water, and wind erosion along with their various conservation practices.	2	PO6, PO7, PSO2
CO2	Understand about terraces, contours, and grasses waterways in order to prevent erosion at different grades of slopy land	2	PO6, PO7, PSO2
CO3	Understand the concepts of irrigation water measurement and various irrigation methods - micro-irrigation, underground pipeline system.	2	PO6, PO7, PSO2
CO4	Apply knowledge in the water conservation structure, and the systems associated with wells to drive water out of them to irrigate the agricultural land	3	PO6, PO7, PSO2
CO5	Analyse the real-life problems through laboratories work.	4	PO6, PO7, PSO2

Syllabus

Introduction to soil and water conservation, Causes of soil erosion, Definition and agents of soil erosion, Water erosion, Forms of water erosion, Gully classification and control measures, Soil loss estimation by Universal Soil Loss Equation, Soil loss measurement techniques, Principles of erosion control, Introduction to contouring, Strip cropping, Contour bund, Graded bund and bench terracing, Grassed water ways and their design, Water harvesting and its techniques, Wind erosion, Mechanics of wind erosion

Types of soil movement, Principles of wind erosion control and its control measures. Introduction to irrigation, Irrigation project classification, Methods of microirrigation, Importance of irrigation water measurements, Volumetric area velocity Discharge methods, Weirs, Orifice, Flumes, Types of wells, Water lifting devices

Importance of irrigation water measurements - Volumetric, area velocity, discharge methods - Weirs, orifice, flumes. Classification of pumps, capacity, Power, Discharge calculations, Open channel hydraulics, Discharge calculations, Underground pipeline systems

Functional components and working principle of underground pipeline systems and micro irrigation systems and its design like drip, Sprinkler etc. Water harvesting techniques - Lining of ponds, tanks and canal systems

Practicing survey - Principles and educating to use pacing technique for measurement. Area calculations through chain survey - GPS demo for tracking and area measurement, Construction of contour and graded bunds. Farm pond construction and its design aspects

Reference Books

- 1 Introduction to Soil and Water Conservation Engineering, Mal, B. C. , 1, 1995, Kalayani Publishers, Rajinder Nagar, Ludhiana.
- 2 Hydrology and Soil Conservation Engineering, including Watershed Management, Ghanshyam Das., 2012, 2, 2012, PHI Learning Private Limited, New Delhi - 110001.
- 3 Land and Water Management Engineering, Murthy, V. V.N., 2004, 2, 2004, Kalayani Publishers, New Delhi.
- 4 Irrigation Theory and Practice., Michael A.M., 2007, 2, 2007, Vikas Publishing House Pvt. Ltd.
- 5 Soil and water conservation engineering, R suresh, 1, 2005, Standard publishers distributors.

23MRWS03 - IRRIGATION WATER MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRWS03	IRRIGATION WATER MANAGEMENT	IWM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the knowledge of irrigation water management to maximize crop yield	2	PO4, PO6, PO7, PSO1
CO2	Understand the ways to improve crop performance by evaluating the different types of irrigation methods	2	PO4, PO6, PO7, PSO1
CO3	Understand the knowledge of various irrigation methods which are more efficient to minimize the water loss and improve the water use efficiency of crop	2	PO4, PO6, PO7, PSO1
CO4	Understand the knowledge on water requirements of crops, soil-plant- relationship, Irrigation requirement, duty and delta, Irrigation efficiencies	2	PO4, PO6, PO7, PSO1
CO5	Analyze the need for efficient and effective irrigation to maximize crop yield and quality whilst making best use of the water available.	4	PO4, PO6, PO7, PSO1

Syllabus

irrigation : Definition and objectives; Water resources, Irrigation projects (major, medium & minor) in India and Andhra Pradesh; Soil - plant - water relationships: Importance - Soil a three phase disperse system- Physical properties of soil viz., Depth, Soil texture, Soil structure, Particle density, Bulk density & Porosity influencing water retention, movement & availability.; Methods of soil moisture estimation and Water retention in soil

Kinds of water in soil- Gravitational water- Capillary water- Hygroscopic water - Their importance in crop production. Soil moisture constants- Saturation capacity- Field capacity- Permanent wilting point- Available soil moisture - Hygroscopic coefficient- Theories of soil water availability. Plant-water relationships and Root characteristics. Evapotranspiration- Soil evaporation & Plant transpiration and water requirement of crops

Scheduling of irrigation- Different criteria- Soil water regime approach- Feel & appearance method, Soil moisture tension & Depletion of available soil moisture method. Climatological approach- Lysimeters & IW/CPE ratio method. Plant indices approach- Visual plant symptoms, Soil-cum-sand mini plot technique, Growth rate, Relative water content, Plant water potential, Canopy temperature, Indicator plants & Critical growth stages. Methods of irrigation - Surface, Subsurface, Sprinkler and Drip irrigation

Irrigation efficiency and Water use efficiency- Crop water use & Field water use efficiency- Factors influencing WUE ; Quality of irrigation water- Salinity hazard, Sodium hazard, Residual sodium carbonate & Boron toxicity- Criteria & threshold limits- Management practices for using poor quality water. Water logging- causes for waterlogging- Agricultural drainage- Surface & Subsurface drainage systems- Relative merits.

Practical Measurement of bulk density, study of soil moisture measuring devices, determination of field capacity and permanent wilting point, measurement of infiltration rate, irrigation water, scheduling of irrigation by IW/CPE ratio method, calculations on soil moisture, irrigation water needs, duty of water and irrigation efficiencies, layout of surface methods of irrigation, demonstration of drip and sprinkler irrigation, visit to micro irrigation systems in farmers fields ,water management practices in different crops.

Reference Books

- 1 Irrigation Theory and Practice, Michael A M, 2 nd, 2008, Vikas Publishing House Pvt Ltd.
- 2 .Irrigation Agronomy , S R reddy and G K Reddy, 5th, 2019, Kalyani Publishers.
- 3 Efficient use of irrigation water, Reddy and Reddy, 1st, 2005, Kalyani publishers.

- 4 Irrigation Water Management- Principles and Practices, Dilip Kumar Majumdar, 2nd, 2013, Prentice Hall India Learning Private Limited.

23MRWS04 - RAINFED AGRICULTURE AND WATERSHED MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRWS04	RAINFED AGRICULTURE AND WATERSHED MANAGEMENT	RAWM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand about rainfed agriculture and its problems and prospects in India.	2	PO2, PO6, PO7, PSO2
CO2	Explain different tillage practices for rainfed crops, losses due to erosion, management of rainfed crops	2	PO2, PO6, PO7, PSO2
CO3	Apply different harvesting structures, conservation measures, use of fertilizers in rainfed areas and the different cropping systems in rainfed region	3	PO2, PO6, PO7, PSO2
CO4	Interpret about contingent crop planning, evapotranspiration and land capability classification	3	PO2, PO6, PO7, PSO2
CO5	Apply practical knowledge on cropping pattern of dryland areas, cultural practices in dryland areas, watershed and rainfall analysis	3	PO2, PO6, PO7, PSO2

Syllabus

Rainfed agriculture definition, dimensions of the problem, History of rainfed agriculture, watersheds in India, Problems and prospects of rainfed agriculture in India, Problems and prospects of rainfed agriculture in India soil characteristics soil fertility status soil moisture storage and retention capacity heavy weed infestation-soil crust and their effect on crop growth and soilsits management.

Tillage for rainfed crops, setline cultivation, modern concepts of tillage, Soil erosion, losses due to erosion, nature and extent of wind and water erosion, factors affecting erosion and universal soil loss equation, Water harvesting importance, its techniques Water harvesting structures arid region runoff farming water spreading

Water harvesting, importance, its techniques, Water harvesting structures, farm ponds, check dams, percolation tank, In-situ moisture conservation measures, mulching, Broad Bed and Furrow and leveling, In-situ moisture conservation measures ,bund forming bunding, ridge and furrow system conservation furrows inter plot water harvesting, mulching Broad Bed and Furrow (BBF) and leveling.

Contingent crop planning for aberrant weather conditions in red and black soils, Evapotranspiration, measures to reduce evapotranspiration, Fertilizer use in rainfed areas use of organic manures introduction of legumes in crop rotation organic recycling and bio-fertilizer use in rainfed agriculture time and method of fertilizer application

Study on weeding, use of mulches, chemicals, windbreaks and shelterbelts Land capability classification and alternate land use system Efficient utilization of water through soil and crop management practices agronomic measures mechanical measures for soil and water conservation gully control

Reference Books

- 1 Dryland Agriculture, Reddy, S. R. and Prabhakar Reddy, G. , 3, 2015, Kalyani Publishers. .
- 2 Crop Production in Dry Regions (Vol.I),, Arnon,I., 4, 1972, Leonard Hill Pub. Co, London..
- 3 Watershed Management in India, Dhruva Narayana, V.V., Sastry, G.S. and Patnaik, V.S., 5, 1999, CAR, New Delhi..
- 4 Dryland Agriculture in India: An agro-climatological and agro-meteorological perspective. , Jeevananda Reddy,S., 5, 2002, B S publications.



Y23: B.Tech. - Internet of Things

Category: Minor Skill Development Courses (MSDC)

23MRAC05 - AI APPLICATIONS FOR BUSINESS SUCCESS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAC05	AI APPLICATIONS FOR BUSINESS SUCCESS	AIA	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of AI and its applications in various business domains.	2	PO5
CO2	Analyze business problems and identify suitable AI techniques and algorithms for solution development.	3	PO4, PO5, PSO1
CO3	Implement AI solutions using programming languages and frameworks commonly used in business applications.	4	PO5
CO4	Evaluate the effectiveness and impact of AI applications on business success, including ethical and societal considerations.	5	PO5

Syllabus

Introduction to AI in Business: Overview of artificial intelligence and its branches. Applications of AI in business functions such as marketing, finance, operations, and human resources. Exploration of AI trends and future outlook. Case studies showcasing successful AI implementations in various industries.

AI Techniques for Business: In-depth study of machine learning algorithms including regression, classification, clustering, and neural networks. Introduction to reinforcement learning and its applications in business decision-making. Discussion on advanced AI techniques such as deep learning and generative adversarial networks (GANs).

Implementing AI Solutions: Practical implementation of AI solutions using popular programming languages for AI development such as Python and R. Hands-on experience with AI frameworks and libraries including TensorFlow, Keras, and PyTorch. Real-world projects focusing on building AI models for business applications.

AI Impact and Ethical Considerations: Evaluation of the impact of AI on business success, including ROI assessment and performance metrics. Discussion on ethical considerations in AI development and deployment, including bias mitigation and fairness. Exploration of societal impacts of AI adoption and responsible AI practices for sustainable business growth.

Reference Books

- 1 "Artificial Intelligence: A Modern Approach" , Stuart Russell, Peter Norvig, 3rd , Pearson.
- 2 "Python Machine Learning" , Sebastian Raschka, Vahid Mirjalili, 3rd, Packt Publishing.
- 3 "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" 2nd O'Reilly Media, Aurélien Geron, 2nd , O'Reilly Media.
- 4 "Machine Learning Yearning" , Andrew Ng , 1st , Self-published.

23MRAG05 - DIGITAL ART (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAG05	DIGITAL ART	DTA	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Students will be able to identify key tools and features of digital art software (e.g., Adobe Photoshop, Illustrator) and recall fundamental digital art terminology.	2	PO1, PSO1
CO2	Apply Students will be able to use digital art software to create original artworks, applying techniques such as digital painting, photo manipulation, and vector illustration.	2	PO3, PSO1
CO3	Analyze Students will be able to critique digital artworks by breaking down the elements and principles of design used, assessing the effectiveness of the techniques and tools employed.	3	PO7, PSO2
CO4	Create Students will be able to develop a portfolio of digital artworks that showcases their ability to integrate various techniques and tools creatively, demonstrating a personal style and artistic vision.	3	PO10, PSO2
CO5	Evaluate Students will be able to assess the quality and impact of digital artworks, including their own and others', using established criteria and providing constructive feedback aimed at improving artistic techniques and conceptual expression.	4	PO12

Syllabus

Introduction to digital art software, basic tool usage, and simple projects.

Creating digital sketches, developing digital paintings, and exploring various illustration styles.

Photo retouching, color correction, blending techniques, and creating composites.

Pen tool mastery, working with shapes and paths, typography, and logo design, Designing logos, creating vector illustrations, and developing infographics.

Advanced project work, developing a cohesive portfolio, and peer reviews, 3D modeling basics, animation, interactive media, and portfolio presentation.

Reference Books

- 1 Digital Art Masters, 3dtotal Publishing, 2nd, 3dtotal Publishing.
- 2 Digital Painting Techniques, 3dtotal Publishing, 1st, 3dtotal Publishing.
- 3 A Complete Guide for Fine Artists, Photographers, and Digital Designers, Sylvie Covey, 1st, by Sylvie Covey.
- 4 The Adobe Illustrator WOW, by Sharon Steuer, 2nd, by Sharon Steuer.

23MRAP05 - SOCIAL CULTURE ANTHROPOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAP05	SOCIAL CULTURE ANTHROPOLOGY	SCA	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts and theories in social and cultural anthropology.	2	PO3, PO7, PO11, PSO1
CO2	Understand the diversity of human cultures and social practices.	2	PO3, PO7, PO11, PSO1
CO3	Apply anthropological methods and approaches to study different societies.	2	PO3, PO7, PO11, PSO1
CO4	Critically evaluate the impact of globalization and other contemporary issues on cultures.	2	PO3, PO7, PO11, PSO1

Syllabus

Introduction to Anthropology Overview of anthropology as a discipline Key concepts and history of social and cultural anthropology Introduction to anthropological methods Culture and Society Definition of culture and its components (values, norms, symbols) The concept of society and social organization Theories of culture (e.g., cultural relativism, ethnocentrism) Methods in Anthropology Ethnographic research methods Participant observation and fieldwork Ethical considerations in anthropological research

Language and Communication The role of language in culture Linguistic anthropology and the study of language use Non-verbal communication and symbolism Social Structure and Organization Kinship and family systems Social hierarchies and class structures Political organization and leadership

Religion and Ritual The role of religion in society Comparative study of religious practices and beliefs Rituals and their social functions Economic Systems and Production Types of economic systems subsistence agriculture, market economies Theories of exchange and economic behavior The impact of globalization on local economies Gender and Identity The study of gender roles and identities Intersectionality and cultural constructions of gender Global perspectives on gender issues Health, Illness, and Medicine Medical anthropology and the study of health systems Cultural beliefs about illness and healing practices Global health issues and their cultural dimensions

Globalization and Cultural Change The effects of globalization on local cultures Cultural hybridization and transnationalism Contemporary issues in cultural preservation and change Review and Contemporary Issues Review of key concepts and theories Discussion of current trends and challenges in anthropology Case studies of recent anthropological research

Reference Books

- 1 Anthropology: The Basics, Peter Metcalf, 1st, 1995, University of Western Australia Publishing .
- 2 Cultural Anthropology: A Toolkit for a Global Age, Kenneth J. Guest, 4th, 2009, Emerald Publishers.
- 3 The Encyclopedia of Anthropology, H. James Birx, 5th, 1993, University of Wisconsin Press.
- 4 Social and Cultural Anthropology: A Very Short Introduction, Peter Metcalf, 2nd, 2000, Arizona Press .
- 5 The Interpretation of Cultures, Clifford Geertz, 3rd, 1988, Berghahn Books company.

23MRAR05 - SOCIAL GEOGRAPHY AND CARTOGRAPHY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRAR05	SOCIAL GEOGRAPHY AND CARTOGRAPHY	SGC	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand of the basic concepts and theoretical frameworks of social geography, and interpret the complex relationships between society, space, and place.	2	PO7, PO9, PSO2
CO2	Understand of the complex interplay between social processes and spatial dynamics in the formation and transformation of social regions.	2	PO7, PO9, PSO2
CO3	Apply the social structure, diversity, and well-being in India, as well as the challenges and opportunities for building a more equitable and inclusive society.	3	PO7, PO9, PSO2

Syllabus

Basic Concepts: Meaning, scope and approaches of Social Geography; Concept of tribe, ethnicity, society, gender, social space; Social differentiation and stratification; Social morphology.

Social Regionalization: Social differentiation and region formation; Bases of social region formation; Racism and racial discrimination; Ethnicity, identity and urban segregation; Social stratification and exclusion.

Social Structure in India: Peopling of India; Evolution of social regions; Tribes and their distribution; Caste: concept & hierarchy; Unity in diversity; Gender and human development. Social Well-being in India:

Concept of social well being. Social issues: crime, health care, education, and housing; Gender issues; Social policies and planning; Social impact assessment. Maps: Components and classification Survey of India topographical maps, Thematic maps: Proportional squares, pie diagrams with proportional circles, dots and spheres

Reference Books

- 1 Social Geography, Ahmed A, 2002, 1st Edition, Rawat Publications .
- 2 Social Geography: An Introduction to Contemporary Issues, Cater, J. and Jones T, 1989, 1st Edition, Hodder Arnold.
- 3 Introducing Social Geographies,, Rachel, P., Burke, M., Fuller, D., Gough, J., Macfarlane, R. and Mowl, G, 2001, 1st Edition, xford University Press .
- 4 Social Geographies: Space and Society, Valentine, G, 2001, 1st Edition, Routledge.

23MRBA05M - LOGISTICS AND SUPPLY CHAIN MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRBA05M	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	LSCM	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Importance of logistics, Logistics - A systems concept	2	PO1, PSO1
CO2	Analyze about logistics as a part of supply chain management	4	PO2
CO3	Understand the modes of transportation, inbound logistics, and outbound logistics	2	PO3, PSO2
CO4	Understand about warehousing activity	2	PO4

Syllabus

Definition of Logistics Management, Functions and Objectives, Importance of logistics, Logistics-A systems concept, Logistics and customer service: Elements of customer service, Phases in customer service, Customer Retention, Extension to customer service. Introduction to Logistics Specialists and industry stakeholders: Airlines, Shipping Lines, NVOCCs Freight Forwarders, Custom House Agents, Export Packers, 3PL & 4PL Companies, Trends, Issues, and Challenges in Logistics management, Sub-Sectors of Logistics.

Introduction to Supply Chain Management Evolution and Concept Logistics Versus Supply Chain Management Drivers of Supply Chain Logistical Drivers and Cross Functional Drivers Role of Logistics in SCM Concept of Value Chain Role of inventory in logistics Importance Types of inventory Functions of inventory Costs for holding inventory Inventory levels Need for controlling inventory Types of selective inventory control techniques Inventory planning models

Transportation Mode and Mix Documentation and Processes Rail road waterway airways and pipelines Transport mode Selection Performance Characteristics Policy Reforms and Govt Initiatives MultiModal Transportation Role of MTO Concept and definition of Inbound logistics Decision making for inbound and outbound improving inbound logistics performance A DHL Case study Strategic Sourcing Process Concept of Outbound Logistics Sameday Parts Deliveries to Automotive Service Centers

Ware house concept and Operations Types of warehouses Warehouse decisions Site selection and methods of location Design Product mix analysis Expansion Role of CWCFCI Introduction To Material Handling Techniques Introduction to material Handling and Types of MHEs Criteria for selecting MHE

Reference Books

- 1 Supply Chain Logistics Management, Bowersox, D. J., Closs, D. J., & Cooper, M. B. , 2013, Ohio: McGraw-Hill Education. .
- 2 Logistics Management, Sople, V. V. , 2012, Pearson Education..
- 3 Business Logistics Management, Ballou, R. H. , 2007, Pearson Education..
- 4 Logistics and Supply chain management. , Christopher, M., 2010, Prentice Hall.

23MRCA05 - SCULPTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCA05	SCULPTURE	SCP	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the significance of Sculpture art and its operations.	2	PO1
CO2	Evaluate the role of sculpture in different areas and Learn Problem-solving techniques to rectify the errors during creating new concept with sculptural point of view.	2	PO2
CO3	Analyzing the workflow in Studio by different pioneers of Art and Apply basic special Effects to the concept.	3	PO3

Syllabus

Introduction to concept visualization- Study from Geometric Principles. 1. Elements of Art: (i) Line (ii) Form (iii) Color (iv)Tone (v) Texture (v) Space 2. Principles of Composition: (i) Unity (ii) Harmony (iii) Balance (iv)Emphasis (v) Rhythm (vi)Proportion 3. Creative Process: (i) Observation (ii)Incubation (iii)Insight (iv)Evaluation (v)Elaboration. - Study of Basic Human , Bird and Animal Anatomy- in relief and 3 dimensional sculpture with detail drawings.

Purpose of Art .- for Delight, commentary, worship and Ritual, commemoration, Ritual, Commemoration, Persuasion and self-Expression. 5 Transformations- A study from Nature .- To develop and understand the sense of sculptural structure through nature

transformations in art forms and art ideas from pre historic to 21 century study and experimenting with those thoughts.

Reference Books

- 1 Digital Sculpting with Mudbox: Essential Tools and Techniques for Artists, Mike de la Flor, 28 May 2010, Routledge; .
- 2 Tradigital Maya: A CG Animator's Guide to Applying the Classical Principles of Animation, Lee Montgomery, 24 November 2011, Lee Montgomery .
- 3 Mastering Sculpture: The Figure in Clay: A Guide to Capturing the Human Form for Ceramic Artists (Mastering Ceramics), Cristina C?rdova, 14 June 2022, Quarry Books.
- 4 Anatomy for the Artist , Sarah Simblet, 4 August 2020, DK; Reissue edition.

23MRCL05 - COMMERCIAL CONTRACT DRAFTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCL05	COMMERCIAL CONTRACT DRAFTING	CCD	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a thorough understanding of the fundamental principles of commercial contract drafting.	2	PO5
CO2	Master the ability to construct clear, concise, and legally sound clauses covering critical aspects like consideration, warranties, representations, indemnification, confidentiality, breach of contract, dispute resolution, termination, and force majeure.	3	PO7
CO3	Gain the ability to analyze existing contracts, identify their strengths and weaknesses, and advise clients on their rights and obligations.	4	PO2, PSO2

Syllabus

Foundations of Commercial Contract Drafting

Drafting Core Contract Clauses

Advanced Contract Drafting and Negotiation

Reference Books

- 1 Practical Guide To Drafting Commercial Contracts, Bhumesh Verma, 2023, OakBridge Publishing.
- 2 Drafting Corporate and Commercial Agreements- Legal Drafting Guidelines, Forms and Precedents , Rodney D Ryder, 2016, Universal Law Publishing House.
- 3 COMMERCIAL CONTRACTS, R. Kumar, 2024, Bharat Law House.
- 4 Drafting Commercial Agreements, Stuart Cakebread and Juliette Levy, 2018, Law Society.

23MRCM06 - TRANSFORM TECHNIQUES FOR ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCM06	TRANSFORM TECHNIQUES FOR ENGINEERING	TTE	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Fourier transforms to solve partial differential equations and integral equations.	6	PO1, PO3, PO4
CO2	Apply Z transforms to solve Difference Equations.	6	PO1, PO3
CO3	Apply numerical methods to solve the algebraic, transcendental methods.	6	PO4
CO4	Apply numerical techniques to solve ordinary differential equations .	6	PO6

Syllabus

Solving Partial Differential Equations and Integral Equations by Fourier Transform Techniques: Introduction, Fourier Transforms, Fourier Sine Transforms, Fourier Cosine Transforms. Inverse Fourier Transforms. Apply Fourier Transform Techniques to Solve PDE and Integral Equations.

Solving Difference Equations Using Z-Transforms: Standard Z Transforms, Inverse Z Transforms, Apply Z-Transform Techniques to Solve Difference Equations. Hankel Transforms: Introduction to Hankel Transforms, Elementary Transformation, Applications of Hankel Transforms.

Solution of Algebraic and Transcendental Equations: Bisection Method, Regula-Falsi Method, Newton-Raphson Method. Iterative Methods

Taylor's, Euler Method, Modified Euler Method, Runge-Kutta Method of Second Order, Runge-Kutta Method of Fourth Order.

Finite Difference, Forward, Backward, and Central Differences, Operators: Shift Operators, Average Operators, and Relations between Difference Operators. Interpolation: Lagrange and Newton's Divided Difference Formula.

Numerical Integration: Trapezoidal Rule, Simpson's rule

Reference Books

- 1 Numerical Methods for Scientific and Engineering Computation, B.S. Grewal, 2015, Khana Publishers.
- 2 Numerical Methods for Scientific and Engineering Computation, M.K. Jain, S. R. K. Iyengar and R.K. Jain, 2008, New Age International Publishers.
- 3 Advanced Engineering Mathematics, Erwin Kreyszing, 2020, John Wiley.
- 4 The Hankel Transforms, R. Piessens, 2000, CRC Press LLC.

23MRCM07 - STATISTICS WITH R PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCM07	STATISTICS WITH R PROGRAMMING	SWRP	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the basic functions in R programming and identify the operators using in it.	3	PO1
CO2	CO 2 Doing Math and Simulation in R: Basic Math Functions, Calculating Probability, Cumulative Sums and Products, Minima and Maxima, Calculus, Functions For Statistical Distribution, Sorting, Linear Algebra Operation on Vectors and Matrices, Vector cross Product, Finding Stationary Distribution of Markov Chains, Set Operation, Input /output, Accessing the Keyboard and Monitor, Reading and Writing Files. STRING MANIPULATION: An Overview of String-Manipulation Functions; Regular Expressions.	3	PO1
CO3	CO 3 Probability Distributions, Normal Distribution, Poisson Distributions, Binomial Distribution, Other Distribution, Correlation and Covariance, Basic Statistics, T-Tests, ANOVA, Clustering Techniques. Creating Graphs, Graphics, The Workhorse of R Base Graphics, the plot Function, Customizing Graphs, Saving Graphs to Files.	3	PO1
CO4	CO 4 Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression, Poisson Regression, other Generalized Linear Models, Survival Analysis, Nonlinear Models, Splines, Decision, Random Forests.	3	PO1
CO5	Statistical data analysis using R Programming.	3	PO1
CO6	R programming for Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression, Poisson Regression, other Generalized Linear Models, Survival Analysis, Nonlinear Models, Splines, Decision, Random Forests.	3	PO1

Syllabus

Introduction, How to run R, R Sessions, and Functions, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes. Doing Math and Simulation in R, Math Function.

Extended Example Calculating Probability, Cumulative Sums and Products, Minima and Maxima, Calculus, Functions For Statistical Distribution, Sorting, Linear Algebra Operation on Vectors and Matrices.

Extended Example: Vector cross Product, Extended Example: Finding Stationary Distribution of Markov Chains, Set Operation, Input /output, Accessing the Keyboard and Monitor, Reading and Writer Files.

Probability Distributions, Normal Distribution, Poisson Distributions, Binomial Distribution, Other Distribution, Correlation and Covariance, Basic Statistics, T-Tests, ANOVA. Creating Graphs, Graphics,

The Workhorse of R Base Graphics, the plot Function, Customizing Graphs, Saving Graphs to Files. Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression,

Reference Books

- 1 Practical Data Science with R, Nina Zumel, John Mount, 3, Manning Publications.
- 2 Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, 3, Cambridge University Press, 2014..
- 3 Programming with R, Garrett, 2, Oreilly publishers.
- 4 Learning R for Everyone,, Lander, 3, Pearson.

23MRCM08 - MATRIX COMPUTATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRCM08	MATRIX COMPUTATION	MCT	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply sophisticated scientific computing and visualization environments to solve application problems involving matrix computation algorithms and Explain the effects of errors in computation and how such errors affect solutions.	3	PO1, PSO1
CO2	Analyse numerical algorithms, and understand the relationships between the computational effort and the accuracy of these algorithms.	3	PO2, PSO1
CO3	Apply the results produced by computer implementations of numerical algorithms.	3	PO3, PSO1
CO4	Apply Rayleigh quotient iterations and Explicit and implicit QR algorithms	3	PO4, PSO1
CO5	Apply and demonstrate the necessary analytical background for further studies leading to research in Machine Learning	3	PO3, PSO1
CO6	Apply MATLAB commands for solving problems on MatrixComputations.	3	PO3, PSO1

Syllabus

Floating point computations, IEEE floating point arithmetic, analysis of roundoff errors; Sensitivity analysis and condition numbers; Linear systems, LU decompositions, Gaussian elimination with partial pivoting.

Banded systems, positive definite systems, Cholesky decomposition - sensitivity analysis; Gram-Schmidt orthonormal process, Householder transformation, Givens rotations; QR factorization, stability of QR factorization.

Solution of linear least squares problems, normal equations, singular value decomposition(SVD), polar decomposition, Moore-Penrose inverse; Rank deficient least-squares problems; Sensitivity analysis of least-squares problems; Review of canonical forms of matrices; Sensitivity of eigenvalues and eigenvectors.

Reduction to Hessenberg and tridiagonal forms; Power, inverse power and Rayleigh quotient iterations; Explicit and implicit QR algorithms for symmetric and non-symmetric matrices; Reduction to bi-diagonal form; Golub- Kahan algorithm for computing SVD.

Reference Books

- 1 Fundamentals of Matrix Computations, D. S. Watkins, 2nd Ed., (2002), John Wiley.
- 2 Numerical Linear Algebra, L. N. Trefethen and D. Bau, 2nd Ed. (1997), SIAM.
- 3 Matrix Computations, G. H. Golub and C. F. Van Loan, 3rd Ed., (1996), John Hopkins University Press.
- 4 Applied Numerical Linear Algebra, J. W. Demmel, 1st Ed.,(1997), SIAM.

23MRDM05 - CONTENT MARKETING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRDM05	CONTENT MARKETING	CM	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the Behavioral Framework within a content marketing context,	3	
CO2	Content Maturity Model, Six principles of content marketing, Treating content as an asset, Building audience personas, Defining the engagement cycle, Developing on-brand content, Creating brand ambassadors	3	PO2, PO4, PO7, PO10
CO3	- Analyzing current content assets, Developing different types of content, Finding good content within your organization, Creating content your audience wants	4	PO2, PO4
CO4	Marketing Content and Evaluating Impact - Content Marketing Pyramid, Brief overview analytics and tracking 10 Module 5 Ethics/Diversity in Content Marketing - Importance of considering diversity in developing and marketing content	5	PO7, PO10

Syllabus

Introduction to Content Marketing - Applying the Behavioral Framework within a content marketing context, A content marketing business model.

Defining Your Content Niche and Strategy - Content Maturity Model, Six principles of content marketing, Treating content as an asset, Building audience personas, Defining the engagement cycle, Developing on-brand content, Creating brand ambassadors, Enhanced branding through content marketing.

Developing and Distributing Content - Analyzing current content assets, Developing different types of content, Finding good content within your organization, Creating content your audience wants, Developing an 16 effective editorial calendar.

Marketing Content and Evaluating Impact - Content Marketing Pyramid, Brief overview analytics and tracking

Ethics/Diversity in Content Marketing - Importance of considering diversity in developing and marketing content, Ethical issues in the digital age.

Putting it All Together - Best practices in content marketing, Applying principles in real world case studies

Reference Books

- 1 Social Marketing in India, Sameer Deshpande, Philip Kotler, Nancy R. Lee, 1st Edition (2013)., tmh.
- 2 Content Marketing for Dummies, Susan Gunelius, 2nd Edition (2021), For Dummies.
- 3 A Revolutionary Approach to Inbound Sales, Content Marketing, and Today's Digital Consumer, Marcus Sheridan, Updated Edition (2019)., Wiley.
- 4 Made to Stick: Why Some Ideas Survive and Others Die, Chip Heath, Dan Heath, 1st Edition (2007)., Random House.

23MRFA05 - TRADING ALGORITHMNS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFA05	TRADING ALGORITHMNS	TA	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts and methodologies of algorithmic trading, including the different types of trading algorithms and their roles in financial markets.	2	PO2
CO2	Describe the process of backtesting trading strategies using historical market data, including the importance of risk management and performance evaluation.	2	PO3
CO3	Implement basic machine learning models, such as linear regression and decision trees, to develop predictive models for trading strategies using financial data.	3	PO3, PSO1
CO4	Design and implement a simple trading strategy using programming languages like Python, incorporating statistical methods such as mean reversion and momentum.	3	PO3, PSO2
CO5	Evaluate the performance of different trading algorithms by comparing their risk-adjusted returns and analyzing their behavior under various market conditions.	4	PO3, PSO2
CO6	Critically assess the limitations and challenges of applying machine learning techniques in trading, including overfitting, data snooping, and the impact of market microstructure.	4	PO3, PSO2

Syllabus

Overview of algorithmic trading, market microstructure, types of trading algorithms (execution, statistical arbitrage, market making), basics of backtesting and simulation, introduction to algorithmic trading platforms, role of latency in trading, regulatory considerations in algorithmic trading.

Statistical methods in trading (mean reversion, momentum strategies), time series analysis and forecasting, introduction to machine learning models (linear regression, support vector machines, decision trees), feature engineering for financial data, overfitting and model validation, unsupervised learning techniques (clustering, PCA), reinforcement learning basics, risk-adjusted performance metrics.

Design and implementation of trading strategies, risk management techniques in algorithmic trading, portfolio optimization methods, execution algorithms (VWAP, TWAP, implementation shortfall), slippage management, backtesting frameworks and libraries, stress testing trading strategies, optimization techniques (genetic algorithms, simulated annealing).

High-frequency trading (HFT) strategies, machine learning in high-frequency trading, blockchain and cryptocurrencies in algorithmic trading, advanced portfolio management techniques, regulatory and ethical considerations in algorithmic trading, market impact modeling, flash crashes and market anomalies, emerging trends in algorithmic trading (AI, quantum computing, decentralized finance).

Reference Books

- 1 Algorithmic Trading: Winning Strategies and Their Rationale, Ernie Chan, 2nd Edition (2021), Wiley.
- 2 Advances in Financial Machine Learning, Marcos Lopez de Prado, 1st Edition (2018), Wiley.
- 3 High-Frequency Trading: A Practical Guide to Algorithmic Strategies and Trading Systems, Irene Aldridge, 2nd Edition (2013), Wiley.
- 4 Trading and Exchanges: Market Microstructure for Practitioners, Larry Harris, 1st Edition (2003), Oxford University Press.

23MRFM05 - DIGITAL PHOTOGRAPHY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFM05	DIGITAL PHOTOGRAPHY	DPG	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Camera Functions and Settings digital camera functions and settings, including aperture, shutter speed, ISO, white balance, and focus modes, to control exposure	1	PO1, PO4
CO2	Composition and Aesthetics: principles such as rule of thirds, leading lines, symmetry, and framing, enabling them to create visually compelling and balanced photographs.	2	PO2, PO3
CO3	Lighting Techniques: Implement various lighting techniques, both natural and artificial, to enhance the mood, texture, and depth of their photographs, understanding the effects of light direction, quality, and color.	3	
CO4	Post-Processing and Editing: Editing techniques using software like Adobe Photoshop and Lightroom, enabling them to enhance and manipulate images for optimal presentation	4	PO4
CO5	Portfolio Development : Showcasing their best work, demonstrating their growth and versatility as photographers, and refine their skills and artistic vision.	5	PO2, PO5

Syllabus

History and evolution of photography Types of digital cameras and their components Basic camera settings: aperture, shutter speed, ISO, Camera Operation and Techniques

Understanding and using different camera modes (Manual, Aperture Priority, Shutter Priority, Program) Focusing techniques and depth of field Introduction to lenses and focal lengths

Rule of thirds and other composition techniques Framing and perspective Leading lines and symmetry Using color and contrast effectively. Lighting Natural vs artificial lighting

Techniques for shooting in different lighting conditions (golden hour, low light, indoors) Understanding and using flash. Introduction to post-processing software (Adobe Photoshop, Lightroom, etc.) Basic editing techniques: cropping, exposure adjustment, color correction Advanced editing techniques: retouching, filters, and special effects

Portrait photography: tips and techniques Landscape photography: capturing natural scenes Macro photography: close-up techniques Action and sports photography: capturing movement. Portfolio Development

Reference Books

- 1 Understanding Exposure, Bryan Peterson, 2016, Amphoto Books.
- 2 Digital Photography Complete Course, David Taylor, 2019, Amphoto Books.
- 3 Mastering Digital Photography, David D. Busch, 2008, Course Technology PTR.
- 4 The Adobe Photoshop Lightroom Classic CC Book for Digital Photographers, Scott Kelby, 2019, New Riders.

23MRFT05 - FOOD PACKAGING TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRFT05	FOOD PACKAGING TECHNOLOGY	FPT	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand designing and development of safe food packaging material.	2	PO1, PO3
CO2	Apply packaging requirement for food products and different types of food packaging systems.	3	PO1, PO3
CO3	Apply various packaging materials and equipment used in packaging industry.	3	PO1, PO3
CO4	Apply suitable packaging for a given food product.	3	PO1, PO3
CO5	Apply the learning toward establishing marketable food products.	3	PO1, PO3
CO6	Apply advanced packaging to select foods.	3	

Syllabus

Outline of Food packaging: Need, Role of packaging in extending shelf life of foods, designing packaging materials, testing of packaging materials, package performance tests, Principles of developing safe and protective packing, Safety assessment of food packaging materials.

Food packaging systems: Product characteristics and package requirements, Introduction of food packaging system, Different forms of packaging, Rigid, semi-rigid, flexible forms of packaging, Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods.

Packaging materials. Types, characteristics, uses. Paper (Pulping, Fibrillation, Beating, Types of papers, testing methods). Glass (Composition, Properties, Types, Methods of bottle making). Metals (Tinplate, Types of cans, Aluminum containers, Lacquers). Plastics (Types, films, laminated and co-extruded plastic materials).

Package accessories and advances in Packaging technology: Introduction, Active packaging, MAP, Aseptic packaging, Packages for convenience, Biodegradable plastics, Coatings. Packaging equipment and machinery (Vacuum packaging, CA & MA packaging, Sealing, shrink packaging, FFS, Aseptic packaging, Retort, Bottling, Carton making, Printing).

Packaging technology to preserve perishable foods. Select perishable foods. Identify their preservation requirements to achieve a longer shelf-life. Design a suitable packaging for the select foods by conducting the necessary testing.

Application of advanced packaging systems for shelf-life extension of foods.

Reference Books

- 1 A Handbook of Food Packaging, P. John Jacob, 2010, Daya Publishing House.
- 2 Handbook of Food Packaging Technology, EIRI Board, 2015, EIRI.
- 3 Fundamentals of Packaging Technology, Walter Soroka, 2009, IOPP.
- 4 FOOD PACKAGING: PRINCIPLES AND PRACTICE, ROBERTSON L. GORDON, 2016, CRC Press.

23MRGD05 - PUBLICATION DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRGD05	PUBLICATION DESIGN	PUDG	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Mastery of basic design principles such as balance, contrast, alignment, repetition, proximity, and white space.	2	PO1
CO2	Skills in editing and enhancing images to be used in publications. Ability to integrate images effectively with text and other design elements.	2	PO2
CO3	Apply typography, color theory, and grid systems effectively.	3	PO3

Syllabus

Design Principles and Elements Layout and composition Introduction to grid systems Importance of white space , Typography Basics of typography Font selection and pairing Hierarchy and readability, Color Theory Basics of color theory Creating a color palette Using color to convey messages, Working with Images and Graphics Image selection and quality Integrating images into layouts Creating and using graphics, Tools and Software Introduction to Adobe InDesign Overview of Photoshop and Illustrator for publication design Basic tools and functions, Print Publications Designing for print specification.

Designing for digital media Interactive elements (links, multimedia) Responsive design principles , Cover Design Principles of effective cover design Creating engaging and informative covers Case studies and examples ,Advanced Layout Techniques

Production Processes Pre-press and printing techniques Digital publication optimization Guest lecture from industry professional, Project Management in Publication Design Planning and executing design projects Working with clients and teams Hands-on exercise: Developing a project plan for a publication ,Critical Analysis and Feedback Analyzing publication designs Providing and receiving constructive feedback Hands-on exercise: Peer review session ,Portfolio Development Assembling a professional portfolio Presenting and discussing design work Hands-on exercise: Portfolio review and critique , Final Project Presentation Final project completion

Reference Books

- 1 Making and Breaking the Grid, Second Edition, Updated and Expanded: A Graphic Design L, Timothy Samara, January 17, 2015, Rockport Publishers.
- 2 Thinking with Type: A Critical Guide for Designers, Writers, Editors, & Students, Ellen Lupton, 2nd edition, 6 October 2010, Princeton Architectura.
- 3 The Elements of Typographic Style, Robert Bringhurst , 2nd edition ,30 September 1996, Hartley & Marks Inc.
- 4 Designing Books: Practice and Theory, Jost Hochuli and Robin Kinross, April 1, 2004, Hyphen Press .

23MRIB05 - PROFESSIONAL SKILLS FOR INTERNATIONAL BUSINESS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIB05	PROFESSIONAL SKILLS FOR INTERNATIONAL BUSINESS	PIB	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the importance of cultural awareness in international business	2	PO6
CO2	Understand the role of protocol in fostering business relationships.	2	PO7
CO3	Apply the impact of economic policies on international business.	3	PO7
CO4	Interpret the effective marketing strategies for international markets.	3	PO11

Syllabus

Cross-Cultural Communication and Negotiation-Introduction to Cross-Cultural Communication,Cultural Dimensions and Models,Effective Communication Strategies,Cross-Cultural Negotiation,

International Business Etiquette and Protocol-Introduction to Business Etiquette,Meeting and Greeting Protocols,Business Dress and Attire,Dining Etiquette and Social Norms,Gift giving and receiving

International Trade and Economics-Introduction to International Trade,Trade Theories and Models,Trade Policies and Agreements,International Economic Institutions

International Marketing Strategies-Introduction to International Marketing,Market Research and Analysis,Market Entry Strategies,Global Branding and Positioning

Reference Books

- 1 International Business: Competing in the Global Marketplace, Charles W. L. Hill, 11th edition, 2017, McGraw-Hill Education.
- 2 Global Business Today, Charles W. L. Hill and G. Tomas M. Hult, 10th edition, 2017, McGraw-Hill Education.
- 3 International Business: The Challenges of Globalization, John J. Wild and Kenneth L. Wild, 9th edition, 2019, Pearson.
- 4 Cross-Cultural Management: Essential Concepts, David C. Thomas and Mark F. Peterson, 4th edition, 2016, Sage Publications.

23MRID05 - DESIGN PRESENTATION AND COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRID05	DESIGN PRESENTATION AND COMMUNICATION	DPC	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and explain the fundamental concepts of design presentation and communication in interior design and recognizing the importance of effective communication in conveying design ideas, describing various methods of design presentation such as sketches, renderings, mood boards, and 3D models	2	PO2
CO2	Understanding the target audience and tailoring communication accordingly, the significance of clear and concise messaging, and the utilization of visual elements such as color, typography, and imagery to enhance communication	2	PO4
CO3	Understand the tools and techniques essential for effective design presentation in interior designs including an overview of various tools and software such as Adobe Creative Suite, SketchUp, and AutoCAD, and a step-by-step guide to creating different types of design presentations like mood boards, concept sketches, digital renderings, and virtual walkthroughs.	2	PO4
CO4	Applying and demonstrating strategies for effective client interaction and collaboration in the design process. This includes understanding the importance of collaboration and client feedback, employing strategies to communicate design concepts to clients with varying levels of design knowledge, building rapport and establishing trust through clear communication, and managing client expectations and concerns.	3	, PSO2
CO5	Applying and demonstrating the principles and strategies for presenting sustainable design solutions in interior design. This includes understanding sustainable design principles and their importance, integrating sustainable design solutions into presentations, effectively communicating the environmental and social benefits of sustainable design to clients, and analyzing case studies of projects that prioritize sustainability.	3	PO9

Syllabus

Co1: Understanding Design Presentation. Introduction to design presentation in interior design. Importance of effective communication in conveying design ideas. Overview of different methods of design presentation: sketches, renderings, mood boards, 3D models, etc. Exploring the role of technology in modern design presentations. Case studies showcasing successful design presentations and their impact on projects.

Co2: Elements of Effective Communication. Exploring the principles of effective communication in interior design. Understanding the target audience and tailoring communication accordingly. Importance of clear and concise messaging in design presentations. Utilizing visual elements, such as color, typography, and imagery, to enhance communication. Strategies for conveying design concepts and ideas with clarity and persuasion.

Co3: Tools and Techniques for Design Presentation. Overview of various tools and software used in design presentation, such as Adobe Creative Suite, SketchUp, AutoCAD, etc. Step-by-step guide to creating different types of design presentations, including mood boards, concept sketches, digital renderings, and virtual walkthroughs. Tips for selecting the most appropriate presentation method based on project requirements and client preferences. Incorporating storytelling techniques to engage and captivate the audience. Best practices for organizing and structuring design presentations for maximum impact.

Co4: Client Interaction and Collaboration. Importance of collaboration and client feedback in the design process. Strategies for effectively communicating design concepts to clients with varying levels of design knowledge. Building rapport and establishing trust with clients through clear and transparent communication. Techniques for managing client expectations and addressing concerns during the design presentation. Case studies illustrating successful client collaboration and its impact on project outcomes.

Co5: Presenting Sustainable Design Solutions. Overview of sustainable design principles and their importance in modern interior design. Strategies for integrating sustainable design solutions into design presentations. Communicating the environmental and social benefits of sustainable design to clients. Showcasing case studies of projects that prioritize sustainability in their design presentations. Exploring future trends in sustainable interior design and their implications for design communication. Each chapter should delve into the intricacies of design presentation and communication within the context of interior design, providing both theoretical frameworks and practical guidance for professionals in the field

Reference Books

- 1 Presentation Zen Design: A simple approach to presenting in today's world, Garr Reynolds, 1st, 2014, New Riders.
- 2 Presentation Zen Design: Simple Design Principles and Techniques to Enhance Your Presentations, Garr Reynolds, 1st, 2009, New Riders.
- 3 Presentation Zen: Simple Ideas on Presentation Design and Delivery, Garr Reynolds, 1st, 2008, New Riders.
- 4 Interior Design Visual Presentation: A Guide to Graphics, Models & Presentation Techniques, Maureen Mitton, 2nd, 2004, Wiley, 2004.

23MRIM05 - PROJECT INNOVATE: STRATEGIES FOR ENTREPRENEURIAL GROWTH (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIM05	PROJECT INNOVATE: STRATEGIES FOR ENTREPRENEURIAL GROWTH	PISEG	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	to analyze market opportunities for entrepreneurial growth.	4	PO2, PO5, PO11, PSO1
CO2	to develop strategic plans and innovative approaches for entrepreneurial ventures.	6	PO2, PO5, PO11, PSO1
CO3	to implement scaling strategies and sustainability practices for long-term entrepreneurial success.	3	PO2, PO5, PO11, PSO1

Syllabus

Foundations of Entrepreneurial Growth: the introduction to entrepreneurship, characteristics of successful entrepreneurs, identifying opportunities for growth, market research and analysis, developing a growth mindset, and case studies of entrepreneurial success.

Strategic Planning and Innovation: strategic planning for startups, business model innovation, product development and innovation, lean startup methodology, design thinking for entrepreneurs, and competitive analysis and strategy.

Scaling and Sustaining Growth : scaling strategies for entrepreneurial ventures, financial planning and management, building and leading high-performance teams, leveraging technology for growth, navigating legal and regulatory challenges, and long-term sustainability and impact.

Reference Books

- 1 The Lean Startup, Eric Ries, 1st (2011), Crown Business.
- 2 The Four Steps to the Epiphany, Steve Blank, 2nd (2020), K&S Ranch.
- 3 Business Model Generation, Alexander Osterwalder, Yves Pigneur, 1st (2020), Wiley.
- 4 Blue Ocean Strategy, W. Chan Kim, Ren?e Mauborgne, 1st (2018), Harvard Business Review Press.

23MRIP05 - LAW OF DESIGNS, GEOGRAPHICAL INDICATIONS AND PLANT VARIETIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRIP05	LAW OF DESIGNS, GEOGRAPHICAL INDICATIONS AND PLANT VARIETIES	LODGP	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles relating to the Intellectual Property Rights and Design Law.	2	
CO2	Understand the emerging dimensions of IPR	2	
CO3	Understand the Farmers and bio diversity related IP Rights.	2	
CO4	Understand the Bio-Technology Law & IP Rights	2	

Syllabus

Definition & Conception of Industrial Designs under Design Act, 2000, Definition and Conception of Trade marks,

Salient Features of Geographical Indications of Good Act, 2000, Geographical Indication & Protection of Traditional knowledge

Notion & Concept of Farmer & Breeder Right under Protection of Plant Variety Act, 2001, Conservation Bio-diversity & Diversity Related IP Rights, Laws & Flaws Relating to Conservation of Biological Diversity.

Notion and concept of bio technology law, Nexus Between Bio-Technology and Law, bio ethics and related IP Rights.

Reference Books

- 1 Law Relating to Intellectual Property Rights, V.K.Ahuja, 2nd, Lexis Nexis.
- 2 Intellectual Property Rights, Elizabeth Verkey, 4th, Eastern Book Company.
- 3 Law of Trademark, Copyrights, Patents and Designs, Roy Chowdhary, 5th, Kamal Law house.
- 4 Intellectual Patent Rights, P.Narayanan, 6th, Eastern Law House.

23MROB05 - TEAM BUILDING AND COLLABORATION SKILLS FOR MANAGERS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MROB05	TEAM BUILDING AND COLLABORATION SKILLS FOR MANAGERS	TBCM	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the importance of team building and collaboration in an organization	2	PO9
CO2	Apply communication and feedback in teams for better collaboration	3	PO10
CO3	Identify different types of conflict resolution in teams	3	PO9
CO4	Identify the importance of concept of motivation and to describe different motivational theories	3	PO11

Syllabus

Introduction to Team Building and Collaboration-Importance of Team Building and Collaboration, Key Principles of Effective Team Building and Collaboration, Strategies for Promoting Collaboration within Team

Understanding Team Roles and Responsibilities- Team Charter, Team Roles and Responsibilities, Communication and Feedback in Teams.

Conflict Resolution in Teams-Types of Conflict, Conflict Resolution Strategies, Building a Positive Team Culture

Motivational Theories-Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, Expectancy Theory, Equity Theory, Goal-Setting Theory, Social Learning Theory

Reference Books

- 1 Reimagine Teams: The Missing Piece in Team Building to Achieve Breakthrough Results, Mark Samuel , 1st edition, 2021, USA Today.
- 2 TeamWork: How to Build a High-Performance Team, Natlie Dawson, 1st edition, 2021, Houndstooth Press .
- 3 LEADERSHIP AND TEAM BUILDING, Uday Kumar Haldar, 1st edition, 2010, Oxford University Press.
- 4 Team Building for Diverse Work Groups: A Practical Guide to Gaining and Sustaining Performance in Diverse Teams , Selma G. Myers, 4th edition, 1996, Oxford University Press.

23MRPA05 - MODERN FARMING TECHNIQUES AND INNOVATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPA05	MODERN FARMING TECHNIQUES AND INNOVATIONS	AELP	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the impact of technological innovations on agricultural productivity.	3	PO6, PO7
CO2	Analyze about sustainable and environmentally friendly farming practices.	4	PO6, PO7
CO3	Analyze and develop practical skills in using advanced farming technologies.	4	PO6, PO7

Syllabus

Modern farming and sustainable agriculture practices aim to enhance food production efficiency while minimizing environmental impact, promoting soil health, conserving water, reducing chemical inputs, and ensuring economic viability for farmers. These practices incorporate advanced technologies, organic farming, crop rotation, integrated pest management, and agroecological principles to create resilient agricultural systems that support long-term food security and ecosystem health.

Sterile Techniques: Essential for preventing contamination by microorganisms. Includes autoclaving equipment and media, using laminar flow hoods, and employing aseptic techniques during handling. **Synthetic and Natural Media Components:** Media provides essential nutrients for plant growth in vitro. Synthetic media: Typically includes inorganic salts, vitamins, amino acids, and carbon sources like sucrose. Natural media: May include coconut milk, potato extract, or banana puree to supplement nutrients. **Growth Regulators:** Critical for directing plant growth and development in vitro. Auxins (e.g., IAA, NAA): Promote root formation. Cytokinins (e.g., BAP, Kinetin): Promote shoot formation. Gibberellins: Stimulate stem elongation, seed germination. Absciscic acid: Induces dormancy, stress responses.

Greenhouse Technology and Management: **Structure:** Greenhouses are enclosed structures with transparent materials like glass or plastic to trap solar energy. **Climate Control:** Includes heating, cooling, ventilation, and humidity control to create optimal growing conditions. **Irrigation Systems:** Drip irrigation, misting, and automated watering systems ensure consistent moisture levels. **Lighting:** Supplemental lighting (LEDs, HPS) extends growing seasons and enhances plant growth. **Pest and Disease Management:** Integrated Pest Management (IPM) and biological controls are used to minimize pesticide use. **Vertical Farming Systems:** **Structure:** Multi-layered, vertically stacked growing systems often housed in urban settings or unused industrial spaces. **Lighting:** Uses artificial lighting (LEDs) to provide uniform light distribution. **Hydroponics and Aeroponics:** Soil-less growing techniques using nutrient-rich solutions. **Automation:** Advanced technologies for climate control, nutrient delivery, and monitoring systems. **Hydroponics and Aquaponics:** **Hydroponics:** System: Plants are grown in a nutrient-rich water solution. Media: May use inert media like perlite, rock wool, or coco coir for plant support. Benefits: Efficient water and nutrient use, faster plant growth, and higher yields.

Reference Books

- 1 Precision Agriculture Technology for Crop Farming, Qin Zhang, 1(2015), CRC Press.
- 2 The New Harvest: Agricultural Innovation in Africa, Calestous Juma, 1(2019), Oxford Academic.
- 3 Sustainable Agriculture and Food Systems, Stephen R. GliessmanStephen R. GliessmanStephen R. Gliessman, 3(2015), CRC Press.
- 4 Plant Tissue Culture : Techniques and Experiments., Smith, R.H, 3(2012), Academic Press, San Diego, CA, USA..

23MRPY05 - PRACTICAL PHARMACOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRPY05	PRACTICAL PHARMACOLOGY	PRI	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analysis of pharmacological agents in solutions and biological fluids using analytical tools	3	PO2, PO4
CO2	Apply knowledge on Handling of laboratory animals routes of drug administration Techniques of blood sampling, anesthesia and euthanasia of experimental animals. Functional observation battery tests (modified Irwin test)	4	PO2, PO4
CO3	Apply knowledge to understand the MOA of CNS Pharmacological agents and others	4	PO2, PO4
CO4	Apply knowledge and experiment to understand DNA and RNA isolated from organisms and analysis of the same by diagnostic tests	4	PO2, PO4
CO5	Apply knowledge to test agents for the toxicity including genotoxicity	4	PO2, PO4
CO6	Apply knowledge to extract biological fluids to determine the drug concentrations in it by analytical techniques	4	PO2, PO4

Syllabus

Analysis of pharmacopoeial compounds and their formulations by UV Vis spectrophotometer Simultaneous estimation of multi component containing formulations by UV spectrophotometry Experiments based on HPLC Experiments based on Gas Chromatography Estimation of riboflavin/quinine sulphate by fluorimetry Estimation of sodium/potassium by flame photometry

Handling of laboratory animals. Various routes of drug administration. Techniques of blood sampling, anesthesia and euthanasia of experimental animals. Functional observation battery tests (modified Irwin test)

Evaluation of CNS stimulant, depressant, anxiogenics and anxiolytic, anticonvulsant activity. Evaluation of analgesic, anti-inflammatory, local anesthetic, mydriatic and miotic activity. Evaluation of diuretic activity. Evaluation of antiulcer activity by pylorus ligation method. Oral glucose tolerance test.

Isolation and identification of DNA from various sources Bacteria, Cauliflower, onion, Goat liver. Isolation of RNA from yeast Estimation of proteins by Bradford Lowry in biological samples. Estimation of RNA and DNA by UV Spectroscopy Gene amplification by PCR.

Protein quantification Western Blotting. Enzyme based in vitro assays MPO, AChEs, alpha amylase, alpha glucosidase. Cell viability assays MTT Trypan blue SRB. DNA fragmentation assay by agarose gel electrophoresis. DNA damage study by Comet assay.

Apoptosis determination by fluorescent imaging studies. Pharmacokinetic studies and data analysis of drugs given by different routes of administration using softwares Enzyme inhibition and induction activity Extraction of drug from various biological samples and estimation of drugs in biological fluids using different analytical techniques Extraction of drug from various biological samples and estimation of drugs in biological fluids using different analytical techniques

Reference Books

- 1 Animal Cell Culture: A Practical Approach, John R. Masters, 3rd (2000), Oxford University Press.
- 2 Practical Manual of Experimental and Clinical Pharmacology, Bikash Medhi, Ajay Prakash, 2nd (2016), Jaypee Brothers Medical Publishers Pvt. Ltd..
- 3 Spectrometric Identification of Organic Compounds, Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, 8th (2014), Wiley.

- 4 Drug Discovery and Evaluation: Pharmacological Assays, Hans G. Vogel, J?rgen Maas, Franz J. Hock, Dieter Mayer, 4th (2015), Springer.
- 5 Fundamentals of Experimental Pharmacology, M.N. Ghosh, 6th (2015), Hilton & Company.

23MRTP05 - TECH INNOVATION PROJECT FOR ENTREPRENEURS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23MRTP05	TECH INNOVATION PROJECT FOR ENTREPRENEURS	TIPFE	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	to develop innovative tech project ideas by identifying opportunities, conducting market research, and creating detailed project proposals.	3	PO5, PO11, PSO2
CO2	to create and iteratively improve prototypes using appropriate techniques and methodologies, incorporating user feedback and Agile practices to refine their Minimum Viable Product (MVP).	6	PO5, PO11, PSO2
CO3	to implement a comprehensive business plan and go-to-market strategy, effectively pitch their projects to potential investors, and navigate the challenges of scaling and launching their tech innovations.	3	PO5, PO11, PSO2

Syllabus

Identifying and Evaluating Tech Opportunities, Techniques for Idea Generation and Brainstorming, Customer Discovery and Market Research, Developing and Refining Concepts, Creating Detailed Customer Personas, Formulating Value Propositions, Project Proposal Development

Prototyping Techniques and Tools, Physical and Digital Prototypes, User Testing and Feedback, Iterative Development and Continuous Improvement, Minimum Viable Product (MVP) Development, Agile and Lean Methodologies, User-Centered Design

Creating a Comprehensive Business Plan, Market Analysis and Competitive Positioning, Developing a Go-to-Market Strategy, Funding and Investment Strategies, Pitching to Potential Investors, Scaling and Managing Growth, Navigating Legal and Regulatory Challenges, Final Presentation and Pitching

Reference Books

- 1 Zero to One, Peter Thiel, Blake Masters, 1st (2019), Crown Business.
- 2 The Startup Owner's Manual, The Startup Owner's Manual Steve Blank, Bob Dorf, 1st (2012), K&S Ranch.
- 3 The Innovator's Dilemma, Clayton M. Christensen, 1st (2013), Harvard Business Review Press.
- 4 Innovation Management, Keith Goffin, Rick Mitchell, 1st (2016), Palgrave Macmillan.



(DEEMED TO BE UNIVERSITY)

Y23: B.Tech. - Internet of Things

Category: Second Major Flexi Core Courses (SMFC)

22CE1201 - ENGINEERING GEOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22CE1201	ENGINEERING GEOLOGY	EGY	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the significance of engineering geology, basics of geological processes that modify the surface of the earth, earthquakes, landslides	2	PO1, PO6, PO8, PSO2
CO2	Understand the basics of minerals and rocks, geological structures	2	PO1, PO6, PO8, PSO2
CO3	Understand the geological conditions to identify suitable site for civil engineering projects.	2	PO1, PO6, PO8, PSO2
CO4	Understand Geological conditions to identify potential sites for groundwater, sites for dam and reservoir and tunnels	2	PO1, PO6, PO8, PSO2
CO5	Apply and analyze the geological conditions for suitability of the site for a major civil engineering project	3	PO1, PO6, PO8, PSO2

Syllabus

INTRODUCTION: Importance of geology from Civil engineering point of view, **PHYSICAL GEOLOGY:** Introduction; Weathering Process, types of weathering and its importance in civil engineering; Soil formation, Soil profile, soil conservation measures; Geological action of Rivers, stages in a river system, features of river erosion and deposition. **EARTHQUAKES AND SEISMIC HAZARDS:** Terminology; Classification, Causes and effects of earthquakes; seismic waves, measuring instruments, seismic zones of India, Seismic belts, seismic hazards in India ; Civil Engineering considerations in seismic areas. A step towards urban earthquake vulnerability reduction **LAND SLIDES:** Classification; Causes and effects of Landslides; Preventive measures of Landslides.

MINERALOGY Definition of mineral; physical properties of minerals. Study of common rock forming minerals Quartz, Feldspar, Muscovite, Asbestos calcite, Talc, Kaolin **PETROLOGY** Introduction, Rock Cycle, major rock types, formation of Igneous rocks, Structures of Igneous rocks. Formation of Sedimentary rocks, Structures of Sedimentary Rocks. agents of metamorphism, Structures of Metamorphic rocks, distinction of major rock types, **ENGINEERING PROPERTIES OF ROCKS** Different Engineering property of rocks. Description of some important Rocks Granite Basalt Dolerite Sand Stone Lime Stone Shale Laterite Granite gneiss schist Marble Khondalite Charnockite. **STRUCTURAL GEOLOGY** Introduction; Strike and Dip Outcrop. Parts and classification of Folds Faults Joints and their importance in Civil Engineering constructions.

SITE INVESTIGATION TECHNIQUES FOR CIVIL ENGINEERING PROJECTS: Introduction, Different stages of site investigation, toposheets/topographic maps; Geological maps and their interpretation in site investigation; Geophysics in civil engineering, electrical resistivity investigations, seismic survey, remote sensing , Geographical information systems and their application

GROUND WATER sources of ground water, factors controlling ground water, water bearing properties of rocks and soils, types of aquifers, exploration of ground water **DAMS** Dams terminology Types of dams and suitable foundations guidelines for major dam and reservoir investigations **TUNNELS** Purpose of tunneling types of tunnels, tunnels and underground excavations methods of site selection, tunnel excavation in various rock types, geological problems, Geology of some tunnel sites

Reference Books

- 1 Engineering Geology, D.Venkat Reddy, 1, Vikas Publishing House Pvt.Ltd .
- 2 Engineering and General Geology, Parbin Singh, 2, S. K. Kataria & Sons.
- 3 Engineering Geology and Geo techniques, Krynine and Judd, 2, Mc Graw Hill Book Company. .

- 4 Engineering geology, Subinoy Gangopadhyay , 2, Oxford University Press.
- 5 Geology for Civil Engineers, C.D. Gribble, 1, Elsevier.

22CM1203 - DATA ANALYSIS WITH EXCEL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22CM1203	DATA ANALYSIS WITH EXCEL	DAWE	R	0	0	0	4	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Learners will gain familiarity with Excel's interface, learn to create and manage workbooks, and understand basic navigation.	2	PO11
CO2	Applying advanced conditional formatting rules based on cell values, formulas, and data bars to visualize data insights.	3	PO11
CO3	Building charts that combine different chart types (line, bar, pie) to visualize multiple data series effectively.	3	PO11
CO4	Calculating descriptive statistics (mean, median, standard deviation, etc.) using Excel's Analysis ToolPak.	3	PO11
CO5	Analyzing financial statements to evaluate profitability, liquidity, and solvency ratios.	3	PO11

Syllabus

Introduction to Excel and Basic Data Handling: Introduction to Excel and Creating Workbooks Saving Workbooks and File Management Data Entry and Editing Techniques Working with Different Data Types Worksheet Formatting Basics Number Formatting in Excel Introduction to Excel Tables, Applying Filters and Sorting Data

Advanced Worksheet Operations Advanced Cell Formatting Using the Name Manager Conditional Formatting Techniques Working with Dates and Times Introduction to Formulas and Functions Advanced Formulas and Functions Mastering Lookup Functions Pivot Tables for Data Analysis

Data Visualization and Charting Introduction to Data Visualization Creating Combination Charts Discriminating Series and Category Axis Adjusting Chart Elements Adding Data Labels in Charts Creating Hand Charts Building Gantt Charts in Excel Pivot Charts and Their Applications

Advanced Analysis and Financial Functions Descriptive Statistics with Analysis Tool Pack Covariance and Correlation Analysis Regression Analysis in Excel Random Number Generation in Excel t-test and z-test Applications ANOVA in Excel Financial Functions: Present Value, Interest Rates, Loan Term Capital Budgeting Techniques and Applications of Excel

Excel Lab Projects Ratio Analysis: Profitability, Liquidity and Solvency Budgeting Analysis: Fixed Budget and Flexible Budget

Reference Books

- 1 Data Analysis with Excel , Manisha Nigam, 1st, 2019, BPB Publisher.
- 2 Data Analysis with Microsoft Excel , K. Berk, Partrick Carey, 1st, 2003, Duxbury Press .
- 3 DATA ANALYSIS AND BUSINESS MODELLING USING MICROSOFT EXCEL, MANOHAR, HANSA LYSANDER, 1st, 2016, PHI Learning.
- 4 MICROSOFT EXCEL 2019: DATA ANALYSIS&BUSINESS MODEL, L. Winston Wayne, 1st, 2019, PHI Learning.

22CM1206 - ADVANCED COST ACCOUNTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22CM1206	ADVANCED COST ACCOUNTING	ACA	R	3	2	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the cost concepts; cost classification, installation of costing system and Material costing Job Cost Cards, Collecting Direct Costs, Allocation of Over heads and its Applications	3	PO6
CO2	Apply the Labour cost and labour cost methods. Unit Costing and Multiple Costing, Application, Identification of Cost Unit and Cost Determination and Control	3	PO3
CO3	Apply the overhead cost and ascertainment of service department cost to production departments. Break even Analysis Cost Volume Profit Analysis P/V Ratio and its Significance - Margin of Safety	3	PO5
CO4	Apply the Job costing and contract costing. Various Types of Standards - Installation of Standard Costing System for Material, Labour and Overhead	3	PO5

Syllabus

Job Costing : Job Cost Cards, Collecting Direct Costs, Allocation of Over heads and its Applications. Batch Costing : Features and Applications, Contract Costing: Features, Distinction between Job and Contract Costing, Progress Payments, Retention Money, Escalation Clause, Contract Accounts, Accounting for Material, Accounting for Plant Used in a Contract, Contract Profit and Accounting Entries.

Features, Applications and Types of Process Costing, Process Loss, Abnormal Gains and Losses, Equivalent Units, Inter - Process Profit, Joint Products, By- Products and Accounting, Service Costing: Features and Applications, Unit Costing and Multiple Costing, Application, Identification of Cost Unit and Cost Determination and Control.

Meaning, Advantages, Limitations and Applications Break even Analysis Cost Volume Profit Analysis P/V Ratio and its Significance - Margin of Safety-Absorption Costing: System of Profit Reporting and Stock Valuation - Difference between Marginal Costing and Absorption Costing, Income Measurement under Marginal Costing and Absorption Costing-Application of Marginal costing techniques for decision making like make or buy decision, shut down decision, product mix decision, sales mix decision, key factor or limiting factor.

Definition, Significance and Applications Various Types of Standards - Installation of Standard Costing System for Material, Labour and Overhead, Variance Analysis for Materials, Labour and Over heads and Accounting Treatment of Variances - Benchmarking for Setting of Standards - Variance Reporting to Management.

Reference Books

- 1 Advanced Cost Accounting, M. N. Arora, June 2016, Vikas Publishing House.
- 2 Advanced Cost Accounting, B. B. Tandon, January 2013, S. Chand & Company Ltd..
- 3 Advanced Cost and Management Accounting, Saxena, V. / Vashist, C. D., February 2021, Sultan Chand & Sons.
- 4 Advanced Management Accounting, Robert S. Kaplan, Anthony A. Atkinson, Ella Mae Matsumura, S. Mark Young, August 2018, Pearson.

22CM21B2 - INCOME TAX LAW & PRACTICE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22CM21B2	INCOME TAX LAW & PRACTICE	ITLP	R	3	2	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the basics of Income tax law and its provisions in practical applicability, various terms used in income tax	2	PO8, PSO2
CO2	Apply the use of the treatment of calculation of Income from Salary, with consideration of allowances and hra and exempted allowances.	3	PO8, PSO2
CO3	Apply the knowledge of computing Income from House Property with calculation of different exemptions .	3	PO9, PSO2
CO4	Apply the knowledge to compute Income from Business, capital gains and other sources for the purpose of calculation of total income.	3	PO10, PSO2

Syllabus

Meaning and terms used: Person, Assessee, Previous year, Assessment year, Income, Gross Total Income, Total Income, Agricultural Income, and Exempted Income ,Fully exempted , Partially Exempted Residential Status: Rules for determining residential status of Individual, HUF, Firm and Company, need to determine residential status, Incidence of tax and residential status, Practical problems.

Salary, Allowances, perquisites and retirement benefits, deductions, computation of salary income.

Annual Value, let out property, self occupied properties, deductions, computation of house property income

Depreciation and other permissible deductions, Disallowable expenses, income and expenses of illegal business, computation of Business income , Income from Profession Capital Income from other sources, Specific income, deductions, grossing up, computation of income from other sources, practical problems.

Reference Books

- 1 Law and Practice of Income tax, Bhaghavathi Prasad, 2020, , New Age International Publisher New Delhi.
- 2 , Direct Taxes Law and Practices, 2. Vinod K. Singhania, 2018, Taxmann Publications.
- 3 Income Tax Law & Practice , jain and narang, 2022, kalyani.
- 4 Principles of Taxation and Tax Laws, S R Myneni, 2022, Allaha.

22CM31B5 - ACCOUNTING & REPORTING STANDARDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22CM31B5	ACCOUNTING & REPORTING STANDARDS	ARS	R	3	2	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the accounting standards and its application.Accounting Standards Interpretations and Guidance Notes on various accounting aspects issued by the ICAI and their applications.	2	PO1, PSO2
CO2	Have knowledge in International Accounting standards.international Financial Reporting Standards (IFRS), Interpretations by International Financial Reporting Interpretation Committee (IFRIC)	3	PO1, PSO2
CO3	Know about the corporate financial reporting. Merchant bankers, Stock and commodity market intermediaries - Meaning, recognition, derecognition	3	PO3, PO8, PSO2
CO4	Learn the developments in financial reporting. Measurement of financial instruments - Hedge accounting - Disclosures	3	PO3, PO8, PSO2

Syllabus

Accounting Standards, Accounting Standards Interpretations and Guidance Notes on various accounting aspects issued by the ICAI and their applications.

Contingencies and Events occurring after the Balance Sheet Date, AS 5 : Net Profit or Loss for the Period, Prior Period Items and Changes in Accounting Policies

International Financial Reporting Standards (IFRS), Interpretations by International Financial Reporting Interpretation Committee (IFRIC), International Accounting Standard Board (IASB), structure of IASB, Worldwide accounting diversity, Factors leading to diversity, Harmonization of accounting standards, need for harmonization,

Understanding of US GAAP - Applications of IFRS and US GAAP Significant differences between US GAAP and Indian GAAP, US GAAP & IFRS, IFRS and Indian Accounting Standards. s.

Reference Books

- 1 Accounting Standards,, Vijay Kumar,, 10th Edition,2011, Asia Law House, 2011, New Delhi.
- 2 Accounting Standards and Corporate Accounting Practices, T. P. Ghosh, 12th Edition,2011, Taxman Publications.2011, New Delhi..
- 3 Taxman Students Guide to Accounting Standards, D. S. Rawat, 18th Edition,2011, Taxman Publications,2011, 18th Edition, New Delhi.
- 4 Advance Accounting II, M.C. Shukla and T.S. Grewal, 15th Edition,2011, S. Chand and Co 2011.
- 6 Taxman Accounting Standards, D. G. Sharma and Srinivasan Anand, 7th Edition,2010, Taxman Publications, 2010, 7th Edition, New Delhi..

22FT1102 - FOOD CHEMISTRY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT1102	FOOD CHEMISTRY	FC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the chemical composition of food and behavior of water in food.	2	PO1, PO7
CO2	Apply micro-nutrients in foods and toxicity.	3	PO1, PO7
CO3	Apply food pigments, pigmentation processes in foods, and colloids.	3	PO1, PO7
CO4	Apply understanding of dispersions and gels; effects of processing on chemical composition.	3	PO1, PO7
CO5	Apply the knowledge to estimating various chemical properties of foods and their components.	3	PO1, PO7

Syllabus

Need for learning food chemistry. To study fundamentals of food chemistry. To study chemical composition of various foods. State of water in food. Structure of water and ice. Types of water. Interaction of water with solutes. Sorption phenomenon. Water activity and its relation with packaging and spoilage.

Classification of vitamins. Structures of vitamins. Properties of vitamins. Functions of vitamins. Stability of vitamins. Major minerals in foods. Minor minerals in foods. Metal uptake. Toxic metals in foods.

Food pigments - Introduction and classification. Structures and properties of food pigments. Browning Reactions in foods (Enzymatic). Browning Reactions in foods (Non-enzymatic, Maillard). Browning Reactions in foods (Caramelization, Ascorbic acid oxidation). Introduction to colloids. Colloids from proteins (classification and structure). Colloids from proteins (plant- and animal-based). Colloids from carbohydrates (classification and structure). Colloids from carbohydrates (chemical reactions, modifications). Stabilization of colloidal system and application of colloidal chemistry to food preparation.

Introduction to dispersions. Characterization of dispersions. Types of dispersions and gels. Gels and syneresis. Emulsions and foams. Effects of processing on chemical composition (Physico-chemical changes). Effects of processing on chemical composition (Nutritional changes). Effects of processing on chemical composition (drying). Effects of processing on chemical composition (irradiation). Effects of processing on chemical composition (freezing, canning).

Estimation of moisture content. Determination of moisture sorption. Determination of pH of a food. Estimation of total ash. Determination of titratable acidity. Standardization of NaOH solution. Estimation of total fat content in a food. Determination of degree brix of food products.

Reference Books

- 1 Water Properties of Food, Pharmaceutical, and Biological Materials., Maria del Pilar Buera, Jorge Welti-Chanes, Peter J. Lillford, Horacio R. Corti, 1 (2006), Blackwell Publishing.
- 2 Water activity in foods: fundamentals and applications., Gustavo V. Barbosa-Cánovas, Anthony J. Fontana Jr., Shelly J. Schmidt, Theodore P. Labuza, 1 (2020), Blackwell Publishing & IFT.
- 3 Food Colloids: Proteins, Lipids and Polysaccharides, E Dickinson, B Bergenstahl, 1 (1997), Woodhead Publishing Limited.
- 4 Food Chemistry, Lillian Hoagland Meyer, 3 (2006), Avi Pub Co..

22FT1104 - INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT1104	INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY	IFST	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the basic principles of food science and technology.	2	PO1, PO5, PO8, PO11
CO2	Determine the structure, composition, nutritional quality and postharvest changes of various plant foods.	3	PO1, PO5, PO8
CO3	Determine the structure and composition of various animal foods	3	PO1, PO5, PO8, PO11
CO4	Discover about various dairy products	3	PO1, PO5, PO8
CO5	Demonstrate use various basic food processing techniques with an aim to preserve the foods	3	PO1, PO5, PO8

Syllabus

historical evolution of food processing technology. Cereals and millets Structure and composition, properties and nutritional attributes of rice, wheat, maize, barley, millet and oats, malting, gelatinization of starch, types of browning Maillard & caramelization, rice parboiling of rice advantages and disadvantages.

Structure and composition of pulses, toxic constituents in pulses, processing of pulses soaking, germination, decortications, cooking and fermentation. Fats and Oils-classification of lipids, types of fatty acids saturated fatty acids, unsaturated fatty acids, essential fatty acids, trans fatty acids. Refining of oils, types- steam refining, alkali refining, bleaching, steam deodorization, and hydrogenation. Rancidity Types- hydrolytic and oxidative rancidity and its prevention.

Fruits and Vegetables-Classification of fruits and vegetables, general composition, enzymatic browning, names and sources of pigments, Dietary fiber. Post-harvest changes in fruits and vegetables Climacteric rise, horticultural maturity, physiological maturity, physiological changes, physical changes, chemical changes, pathological changes during the storage of fruits and vegetables.

Introduction to poultry and dairy sectors

Performing various practical to Study different types of browning reactions: enzymatic and non-enzymatic, gelatinization behavior of various starches To study the concept of gluten formation of various flours To study malting and germination To study dextrinization in foods Identification of pigments in fruits and vegetables and influence of pH on them Quality inspection of animal foods Study of effect of heat on sugar etc

Reference Books

- 1 Food Science, Bawa. A.S, O.P Chauhan et al., 2013, New India Publishing agency.
- 2 Food Science, Roday,S, 2011, , Oxford publication.
- 3 Food science, B. Srilakshmi, 2002, New Age Publishers.
- 4 Outlines of Dairy Technology, De Sukumar, 2007, Oxford University Press.

22FT1105 - FOOD BIOCHEMISTRY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT1105	FOOD BIOCHEMISTRY	FBC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basics of Organic chemistry and its role in food To understand applications of biochemistry and its role in food industries in various departments	2	PO1, PO6
CO2	Applying basic principles to determine the structural and chemical nature of nutrients CHO & Proteins.	3	PO1, PO4
CO3	Applying basic principles to determine the structural and chemical nature of nutrients Lipids & Nucleic acids.	3	PO1, PO6, PO8
CO4	Applying basic principles to identify the metabolic changes of foods once it enters the human body.	3	PO1, PO4
CO5	Analyzing biochemicals and to demonstrate the knowledge of characterization of food components.	4	PO1, PO6

Syllabus

Introduction To Biomolecules - Overview - Basic principles of Organic Chemistry, Types of Biomolecules, Chemical nature, biological roles, biological buffers, Water and its importance in Biochemistry.

Structure and properties of Carbohydrates and Proteins in detail. forms of Isomerism, Physiological importance, Polysaccharides Starch, glycogen, Cellulose and their derivatives Chitin-Peptidoglycans- Glycosaminoglycan- Glycoconjugates, Test for Carbohydrates. Classification of Amino acids and Proteins, Structure of Proteins Primary-Secondary-Tertiary Myoglobin Hemoglobin

Structures & Properties Of Lipids, Nucleic Acids - Lipid - Classification Physiological importance, Significance of Cholesterol, Nucleic Acids - Ribonucleic acids - Deoxyribonucleic acids, Functions of Nucleotides -Regulatory Molecules.

Metabolic activities of biomolecules, significance of vitamins and minerals Krebs cycle, TCA, Gluconeogenesis

Analyzing various biomolecules in foods study of their chemical nature and estimation of carbohydrates proteins and fats by chemical analysis

Reference Books

- 1 Biochemistry, Lubert Stryer, 4th Edition 2000, WH. Freeman and co., 2000..
- 2 Food Biochemistry and Food Processing, Benjamin K. Simpson Ph.D, 2012, John Wiley & Sons, Inc..
- 3 FOOD BIOCHEMISTRY, DICKSON JK, 2020, CBS PUBLISHERS & DISTRIBUTORS PVT. LTD DICKSON JK.
- 4 Biochemistry Practical Book for Biomolecules & Food Analysis, Dr R Subashini, 2022, LAPublishers.
- 5 Fennema's Food Chemistry, Srinivasan Damodaran, Kirk L. Parkin, 5th Edition 2007, CRC Press.

22FT1207R - FOOD MICROBIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT1207R	FOOD MICROBIOLOGY	FMB	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the important microorganisms affecting food and human health.	2	PO2, PO5, PO8
CO2	Develop the nature of different microorganisms associated with food and their growth.	3	PO2, PO5, PO8
CO3	Identify the knowledge regarding the role of microbes in fermentation, spoilage and food-borne diseases.	3	PO2, PO5, PO8
CO4	Determine the spoilage of foods by common microorganisms, and cultivation of microorganisms	3	PO2, PO5, PO8
CO5	Demonstrate the knowledge in terms of testing aspects of food microbiology	3	PO2, PO5, PO8

Syllabus

History of microbiology, differences between Prokaryotes and Eukaryotes, Contributions of Louis Pasteur classification of Microbes and Detailed structure of Prokaryotic cell, light and electron microscope, Staining techniques, Gram staining. Characteristics and classification of fungi yeast and moulds.

Types of Sterilization, Nutritional classification of microorganisms, types of media, microbial culture collection. Isolation of Microbes platings, serial Dilution, Microbial Growth and Metabolism, Growth curve, Factors affecting Growth of microorganisms in food.

Importance of microorganisms in food, primary sources of microorganisms in food, intrinsic and extrinsic parameters of food affecting microbial growth, types of microorganisms in foods like meats, poultry, seafood, vegetables, dairy products, fruits and vegetables. Starter Cultures.

principles and types of spoilage, microbial spoilage of foods Microbial spoilage of Fruits, Vegetables, Grains and grain products, Meat, Poultry Fish, Factors influencing the spoilage and control, Measures to prevent microbial food

Reference Books

- 1 Fundamental Food Microbiology, Bibek Ray, 3rd, CRC Press.
- 2 "Food Safety Culture Creating a Behavior-Based Food Safety Management System", Frank Yiannas, 4th, Springer New York, NY.
- 3 Handbook of Culture Media for Food Microbiology., Janet E.L. Corry, G.D.W. Curtis and Rosamund M. Baird (Eds.), Third, RSC Publishing.
- 4 Safety of Meat and Processed Meat., Francis F. Busta, Bruce R. Cords, "Fidel Toldra? Editor", Springer.

22FT12C1 - PRINCIPLES OF FOOD PRESERVATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT12C1	PRINCIPLES OF FOOD PRESERVATION	PFP	R	1	0	0	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of food preservation technologies	2	PO2, PO4, PO6, PSO2
CO2	Apply conventional techniques for preserving foods	3	PO2, PO4, PO6, PSO2
CO3	Apply modern filtration technologies for food preservation	3	PO2, PO4, PO6, PSO2
CO4	Apply novel non-thermal food processing technologies for preservation of foods	3	PO2, PO4, PO6, PSO2
CO5	Apply the concepts for preservation of foods using different techniques	3	PO2, PO4, PO6, PSO2

Syllabus

Introduction to food preservation techniques: History, Scope and principles of food preservation; Preservation Methods- preservation by low temperature - processing, mechanism, refrigeration, chilling, freezing, freezing curve, changes occurring during freezing, types of freezing, thawing, and its effects.

Preservation by high temperature Different thermal operations sterilization, pasteurization, blanching, and UHT processing Canning canning equipment and operations. Types of canning containers. Thermal destruction of microorganisms D value, F value, Z value. Advantages and limitations. Chemical food preservation Types of chemical preservatives and their functions synthetic, natural permissible limits and safety aspects. Advantages and limitations.

Introduction to membrane processing General principles, dead end and cross flow, Classification of membrane system Reverse Osmosis. Classification of membrane system Nano Filtration, Ultra Filtration, Micro Filtration, Electrodialysis and Pervaporation. Commercial examples. Advantages and limitations.

Introduction to Irradiation, microwave, radio frequency, high pressure processing, pulsed electric field, hurdle technology. Ohmic heating, cold plasma, modified atmosphere packaging, vacuum packaging, aseptic processing, ultrasound. Advantages and limitations

Food Sampling for Analysis, Effect of blanching of fruits and vegetables on sensory properties, A comparative analysis of the sun and oven drying of fruits and vegetables, Effect of pasteurization on the microbial load of milk and fruit juice, Preparation of fermented products

Reference Books

- 1 Physical Principles of Food Preservation , Marcus Karel, Daryl B. Lund, 2nd - 2003, Marcel Dekker, Inc.
- 2 Food Processing Technology, Principles and Practice, J. P. Fellows, 5th - 2022, Wood Head Publishing.
- 3 Food Science, N. N. Potter and J. H. Hotchkiss, 5th - 1995, Springer.
- 4 Food Processing: Principles and Applications, H. Ramaswamy, M. Marcotte, 1st - 2005, CRC Press.
- 5 Preservation of Fruits and Vegetables, B. Lal, G. B. Siddappa and G. N. Tandon,, 2nd - 2009, ICAR.
- 6 Food Processing and Preservation, B. Sivasankar, 2nd - 2004, PHI Learning Pvt Ltd.

22FT2109R - PROCESSING OF HORTICULTURAL PRODUCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT2109R	PROCESSING OF HORTICULTURAL PRODUCE	PHP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of processing of fruits and vegetables	2	PO2, PO4, PO6, PSO1
CO2	Apply the concepts of the processing and market potential of the processed fruits and vegetables	3	PO2, PO4, PO6, PSO1
CO3	Apply post-harvest techniques for storage of fruits and vegetables	3	PO2, PO4, PO6, PSO1
CO4	Apply advanced techniques in processing of horticultural produce	3	PO2, PO4, PO6, PSO1
CO5	Apply processing techniques for preparation of value added products	3	PO2, PO4, PO6, PSO1

Syllabus

Different types and importance of horticultural produce, need and market potential for processing the produce, nutritional aspects

Reasons of spoilage, physical (moisture and temperature), chemical (browning, etc.), and biological (microbes, insects) factors of spoilage, physical and chemical methods of spoilage control: sanitation, fumigation, etc

Underground and above ground storage, godowns, containers, storage conditions, sanitation requirements and methods

Canning and bottling: Process factors and parameters, equipment, containers used, advantages and limitations. Beverage making: Juice extraction, deaeration, straining, filtration and clarification; preservation of fruit juices (pasteurization, chemically preserved with sugars, freezing, drying, tetra-packing, carbonation). Squashes: Processing, cordials, nectors, concentrates and powder. Jams: Constituents, selection of fruits, processing & technology. Jellies: Essential constituents (Role of pectin, ratio), theory of jelly formation, processing technology, defects. Marmalades: Types, preparation, processing technology, defects. Pickles, chutneys and sauces: Processing, types, spoilage and preservation. Tomato products: Selection of tomatoes, preparing pulp, juice, puree, paste, ketchup, sauce and soup of tomatoes. Dehydration: Sun drying and mechanical dehydration, process variations, packing and storage. Additives: Preservatives, colorants, acidity regulators

Estimation of total soluble solids (TSS). Estimation of pH and acidity of products. Estimation of brix/acidity ratio. Estimation of ascorbic acid and effect of heat treatment on it. To study the steps of can making process. Preparation and evaluation of pectin products. Dehydration of fruits and vegetables

Reference Books

- 1 Preservation of fruits & Vegetables, Girdharilal, Siddappaa, G.S and Tandon, G.L, 1st - 2009, ICAR.
- 2 Postharvest technology of fruits and vegetables: General concepts and principles, L.R. Verma, and Dr. V.K. Joshi, 1st - 2000, Indus Publishing Company.
- 3 Foods: Facts and Principles, Manay, S and Shadaksharaswami, M, 1st - 2001, New Age Publishing Pvt Ltd.
- 4 Commercial food and vegetable products, W B Cruess, 3rd - 2009, McGraw - Hill .

22FT2213R - BAKERY, CONFECTIONERY AND SNACKS TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT2213R	BAKERY, CONFECTIONERY AND SNACKS TECHNOLOGY	BCST	R	2	0	4	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the science and technology behind bakery and confectionary products and their place in global market.	2	PO2, PO4, PO7
CO2	Apply the concepts of the functioning of ingredients in baking and confectionary.	3	PO2, PO4, PO7
CO3	Apply the formulation concepts for bakery and confectionary products	3	PO2, PO4, PO7
CO4	Apply the concepts of food safety regulations for baked and snack products	3	PO2, PO4, PO7
CO5	Apply the concepts and knowledge of baking and confectionery for preparing value added products	3	PO2, PO4, PO7

Syllabus

Introduction to bakery products: Definition, classification, market, Ingredients and their functions; Machines & equipment for batch and continuous Processing of bakery products, major and minor equipment. Manufacturing of Breads, cakes, types of icings, pizza base, biscuits, cookies, rusk, pastry as per FSSAI standards

Introduction to Confectionary and chocolate Products: Types, specifications, compositions, role of ingredients, other aerating agents, cocoa powder, fruits, preserved fruits, dried fruits, nuts and chemical additives. Manufacturing of products - jam, gums, jellies, candies fondant, caramel, fudge, toffee, types of chocolate etc.

Production of bakery foods: Formulation - Ingredients (flour, yeast, sugar, egg, butter, salt, baking powder, coloring and flavoring agents, starches) and their functions, methods, classification, standards. Equipment: Cleaning, operation, processes, quality checks, preservation (conventional and evolving preservatives), regulations. Baking processes, quality of baked products

Safety Measures & Regulations: Food safety rules and regulations for bakery and confectionary products-Layout, hygienic conditions required for bakery plant, operation and maintenance of bakery equipment

Identifications and composition of various ingredients for snacks, bakery and confectionery products 2. Preparation and quality assessment of pizza base 3. Preparation and quality assessment of bread 4. Preparation and quality assessment of different types of cakes. 5. Preparation and quality assessment of cookies and biscuits 6. Preparation of selected varieties of chocolates and toffees 7. Preparation, and quality assessment of selected snack items 8. Preparation of selected varieties of macaronis. 9. Visit to a baking industry and preparation of report

Reference Books

- 1 Bakery technology - packaging, nutrition, product development, quality assurance, Samuel A. Matz, 1st - 1989, Chapman - Hall.
- 2 Textbook of Bakery and Confectioner, Yogambal Ashokkumar, 3rd - 2023, Prentice Hall India Learning Private Limited.
- 3 Bakery products: science and technology, Weibiao Zhou, Y. H. Hui, I. De Leyn, M. A. Pagani, C. M. Rosell, J. D. Selman, N. Therdthai, 2nd - 2014, Wiley.
- 4 Complete Confectioner, Glasse, Hannah, 1st - 2018, Gale Ecco Print Editions.
- 5 Textbook of Bakery and Confectionary, Sivalingam, Yogambal, 3rd - 2023, Prentice Hall India Learning Private Limited.

22FT32C2R - FOOD PACKAGING TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
22FT32C2R	FOOD PACKAGING TECHNOLOGY	FPT	R	1	0	0	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand designing and development of safe food packaging material.	2	PO1, PO7
CO2	Apply packaging requirement for food products and different types of food packaging systems.	3	PO1, PO7
CO3	Apply various packaging materials and equipment used in packaging industry.	3	PO1, PO7
CO4	Apply suitable packaging for a given food product.	3	PO1, PO7
CO5	Apply the learning toward establishing marketable food products.	3	PO1, PO7

Syllabus

Outline of Food packaging: Need, Role of packaging in extending shelf life of foods, designing packaging materials, testing of packaging materials, package performance tests, Principles of developing safe and protective packing, Safety assessment of food packaging materials.

Food packaging systems: Product characteristics and package requirements, Introduction of food packaging system, Different forms of packaging, Rigid, semi-rigid, flexible forms of packaging, Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods.

Packaging materials. Types, characteristics, uses. Paper (Pulping, Fibrillation, Beating, Types of papers, testing methods). Glass (Composition, Properties, Types, Methods of bottle making. Metals (Tinplate, Types of cans, Aluminum containers, Lacquers). Plastics (Types, films, laminated and co-extruded plastic materials).

Package accessories and advances in Packaging technology. Introduction, Active packaging, MAP, Aseptic packaging, Packages for convenience, Biodegradable plastics, Coatings. Packaging equipment and machinery (Vacuum packaging, CA & MA packaging, Sealing, shrink packaging, FFS, Aseptic packaging, Retort, Bottling, Carton making, Printing).

Packaging technology to preserve perishable foods. Select perishable foods. Identify their preservation requirements to achieve a longer shelf-life. Design a suitable packaging for the select foods by conducting the necessary testing.

Reference Books

- 1 A Handbook of Food Packaging , P. John Jacob , 2010, Daya Publishing House .
- 2 Handbook of Food Packaging Technology , EIRI Board , 2015, EIRI Board .
- 3 Fundamentals of Packaging Technology , Walter Soroka , 2009, IOPP.
- 4 FOOD PACKAGING: PRINCIPLES AND PRACTICE , ROBERTSON L. GORDON , 2016, CRC Press.

23ACCAPM - PERFORMANCE MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACCAPM	PERFORMANCE MANAGEMENT	PM	R	3	2	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and acquire decision making techniques under limiting factors.	2	PO11, PSO2
CO2	Develop skills in dealing with decision-making processes under short-term, risk and uncertainty.	3	PO11, PSO2
CO3	Apply and acquire skills in dealing with budgetary systems and Standard costing.	3	PO11, PSO2
CO4	Apply knowledge and skills to analyze and manage financial performance through budgeting and control techniques.	3	PO11, PSO2

Syllabus

Specialist cost and management accounting techniques - Activity based costing, Target costing, Life-cycle costing, Throughput accounting, and Environmental accounting. Decision-making techniques - Relevant cost analysis- Explain the nature of CVP analysis, Calculate and interpret the break-even point and margin of safety, Calculate the contribution to sales ratio, in single and multi-product situations, and demonstrate an understanding of its use, Calculate target profit or revenue in single and multi-product situations, and demonstrate an understanding of its use, Prepare break even charts and profit volume charts and interpret the information contained within each, including multi-product situations, Discuss the limitations of CVP analysis for planning and decision making. Decision-making techniques - Limiting factors - Identify limiting factors in a scarce resource situation and select an appropriate technique, Determine the optimal production plan where an organisation is restricted by a single limiting factor, including within the context of make or buy decisions, Formulate and solve multiple scarce resource problem both graphically and using simultaneous equations as appropriate, Explain and calculate shadow prices and discuss their implications on decision-making and performance management, Calculate slack and explain the implications of the existence of slack for decision-making and performance manage -Pricing decisions - Explain the factors that influence the pricing of a product or service, explain the price elasticity of demand, Derive and manipulate a straight line demand equation. Calculate the optimum selling price and quantity for an organisation, equating marginal cost and marginal revenue, Evaluate a decision to increase production and sales levels, considering incremental costs, incremental revenues and other factors, Determine prices and output levels for profit maximization using the demand based approach to pricing , Explain different price strategies, Calculate a price from a given strategy using cost-plus and relevant cost.

Decision making techniques Make or buy and other short term decisions Explain the issues surrounding make vs. buy and outsourcing decisions, Calculate and compare make costs with buyin costs, Compare in-house costs and outsource costs of completing tasks and consider other issues surrounding this decision, Apply relevant costing principles in situations involving shut down, one-off contracts and the further processing of joint products. Decision making techniques Dealing with risk and uncertainty in decision making Suggest research techniques to reduce uncertainty e.g. Focus groups, market research, Explain the use of simulation, expected values and sensitivity, Apply expected values and sensitivity to decision making problems. Apply the techniques of maximax, maximin, and minimax regret to decision making problems including the production of profit tables, Draw a decision tree and use it to solve a multi-stage decision problem, Calculate the value of perfect and imperfect information.

Budgeting and Control Budgetary systems and types of budget Explain how budgetary systems fit within the . performance hierarchy, Select and explain appropriate budgetary systems for an organisation, including topdown, bottom-up, rolling, zero-base, activitybase, incremental and feed-forward control, Describe the information used in budget systems and the sources of the information needed, Indicate the usefulness and problems with different budget types including fixed, flexible, zero-based, activity- based, incremental, rolling, top-down, bottom up, master, functional, Prepare rolling budgets and activity based budgets Explain the beyond budgeting model, including the benefits and problems that may be faced if it is adopted in an organisation,Budgeting and Control Quantitative analysis in budgeting Apply the learning curve to a budgetary problem.

Budgeting and Control - variances-Budgeting and Control - Performance analysis - Analyse and evaluate past performance using the results of variance analysis, Use variance analysis to assess how future performance of an organisation or business can be improved,Identify the factors which influence behaviour, Describe the dysfunctional nature of some variances in the modern environment of JIT and TQM, Discuss the behavioural problems resulting from using standard costs in changing environment.

Reference Books

- 1 Performance Management, BPP Learning Media, 6th, 2013, BPP Learning Media.
- 2 Performance Management, Kaplan Publishing, 5th 2012, Kaplan Publishing.
- 3 Performance Management, Becker Professional Education, 8th,2010, Becker Professional Education.
- 4 Performance Management, London School of Business and Finance, 5th,2010, London School of Business and Finance.
- 5 Performance Management, Emile Woolf International, 9th,2015, Emile Woolf International.

23ACCATX - TAXATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ACCATX	TAXATION	TXT	R	3	2	0	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Basic Concepts of Direct Taxes topics covered includes Basic Concepts of Fiscal Policies & Definitions, assessment year, previous year, person, assessee, Income, charges on income, gross total income, capital and revenue receipts, residential status etc.,	2	PO1
CO2	Apply Computation of Total Income and Tax Liability comprises of topics like ncome from salaries, Income from house property, Profits and Gains from business or Profession, Capital Gains and Income from other sources, Aggregation of income, Carry forward and set off of losses, Gross Total Income, Deductions under Chapter VI A, Total Income	3	PO1
CO3	Develop Corporate Tax Planning covering the topics Computation of total income and tax liability of corporate entities with Minimum Alternate Tax, Corporate Dividend Tax, Exemptions available to companies in SEZ, Tax holidays, Tax implications of Corporate Restructuring	3	PO3
CO4	Apply Tax Authorities, Assessment Procedure and Rules topics covering Income Tax authorities and functions, Deduction and collection of tax a source, advance tax and interest, return of income and assessment procedure, Refunds, penalties and prosecution, appeals and revision, Settlement of cases etc.,	3	PO5

Syllabus

Basic Concepts of Fiscal Policies & Definitions, assessment year, previous year, person, assessee, Income, charges on income, gross total income, capital and revenue receipts, residential status, receipt and accrual of income, connotation of income deemed to accrue or arise in India, Tax Planning, Tax Evasion and Tax Management.

Income from salaries, Income from house property, Profits and Gains from business or Profession, Capital Gains and Income from other sources, Aggregation of income, Carry forward and set off of losses, Gross Total Income, Deductions under Chapter VI A, Total Income , Computation of Tax liability of individual assesses, Preparation of Income tax returns of Individual assesses, E - filing of returns.

Computation of total income and tax liability of corporate entities with Minimum Alternate Tax, Corporate Dividend Tax, Exemptions available to companies in SEZ, Tax holidays, Tax implications of Corporate Restructuring, Double Taxation Avoidance Agreements (DTAA), Transfer pricing and General Anti Avoidance Rule (GAAR)

Income Tax authorities and functions, Deduction and collection of tax a source, advance tax and interest, return of income and assessment procedure, Refunds, penalties and prosecution, appeals and revision, Settlement of cases. Introduction to Indirect Taxes: Difference between direct and indirect taxes, Law relating to Central Excise, Customs, Service Tax, VAT and related rules, Introduction to GST.

Reference Books

- 1 Singhania, M., & Singhania, V. K. Students Guide to Income Tax, Singhania, M., & Singhania, V. K. (n.d.), 2023, New Delhi:Taxmann Publications.
- 2 Corporate Tax Planning & Business TaxProcedures with Case Studies., Singhania, M., & Singhania, V. K. (n.d.), 2023, New Delhi:Taxmann Publications.
- 3 Systematic Approach to Tax Laws &Practice, Ahuja, G., & Gupta, R. , 2023, Bharat Law House Pvt. Ltd. .
- 4 Direct Tax Laws, Manoharan, T. N., & Hari, G. R. , 2023, Mumbai Snowwhite Publications Pvt Ltd.

23AD01HF - MACHINE LEARNING FOR HEALTHCARE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD01HF	MACHINE LEARNING FOR HEALTHCARE	MLH	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand fundamental machine learning concepts and their applications in healthcare.	2	PO1, PO2, PSO1
CO2	Apply data preprocessing techniques on healthcare data.	3	PO2, PO3, PO4, PSO1
CO3	Build supervised, unsupervised and deep learning models in healthcare context.	3	PO2, PO3, PO4, PSO1
CO4	Examine the challenges and ethical consideration in deploying machine learning models in healthcare.	4	PO3, PO4, PSO1
CO5	Evaluate various Machine Learning Techniques in health care domain using python language	5	PO2, PO3, PO4, PSO1

Syllabus

Introduction to Machine Learning in Healthcare: Overview of machine learning concepts: supervised learning, unsupervised learning, and deep learning. Introduction to healthcare applications of machine learning: predictive modeling, image analysis, natural language processing. Challenges and opportunities in applying machine learning to healthcare data.

Data Preprocessing Techniques for Healthcare Data: Data preprocessing for healthcare data - Handling missing values and outliers, Normalization and standardization techniques, Feature selection and dimensionality reduction. Techniques for dealing with imbalanced datasets in healthcare.

Machine Learning Algorithms for Healthcare: Supervised Learning Models - Linear Regression and Logistic Regression for disease prediction and outcome modeling, Support Vector Machines (SVMs) for medical image classification and diagnostic decision support, Decision Trees and Random Forests for hospital readmission prediction and personalized medicine. Unsupervised Learning Models - K-Means and hierarchical clustering for patient stratification and cohort discovery, Principal Component Analysis (PCA) and t-SNE for dimensionality reduction and visualization of healthcare data. Deep Learning Models - Convolutional Neural Networks (CNNs) for medical image analysis (e.g., radiology, pathology), Recurrent Neural Networks (RNNs) and LSTM networks for time series analysis in healthcare monitoring.

Challenges and Ethical Considerations in Deploying ML Models in Healthcare: Regulatory frameworks and compliance issues in healthcare data management - HIPAA, GDPR, Privacy and security challenges in handling sensitive patient data, Bias and fairness considerations in machine learning models - mitigating healthcare disparities, Ethical implications of AI and machine learning in clinical decision-making and patient care.

Reference Books

- 1 Machine Learning in Healthcare Informatics, Chee-Yee Chong, Sumeet Dua, 2014, CRC Press.
- 2 Machine Learning and Healthcare Analytics, Natarajan Meghanathan, Subarna Chatterjee, Hari Kalva, 2019, Springer.
- 3 Machine Learning for Healthcare: Technologies, Algorithms, and Applications, Carol Friedman, et al., 2020, O'Reilly Media.
- 4 Machine Learning for Healthcare: Case Studies and Algorithms for Working with Data, Manuel Amunategui, Adam Perer, 2021, O'Reilly Media.

23AD02HF - DATA ENGINEERING AND ARCHITECTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD02HF	DATA ENGINEERING AND ARCHITECTURE	DEA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Comprehend the foundational concepts and components of data infrastructure, including databases, data warehouses, data lakes, and streaming platforms.	2	PO1, PO5, PSO2
CO2	Design and implement efficient data models for storage and processing, focusing on scalability, performance, and data integrity.	3	PO1, PSO1
CO3	Utilize various data storage technologies and data modeling techniques to manage and organize data effectively	3	PO1, PO5, PSO2
CO4	Familiar with the foundational concepts of data engineering and architecture to design and implement robust data systems.	2	PO2, PSO1
CO5	Implement data governance and security measures to ensure data integrity and compliance with regulations	3	PO2, PO5

Syllabus

Introduction to Data Engineering and Architecture: Overview of Data Engineering and Architecture, Key concepts, Data Lifecycle Management, Introduction to Data Modeling, Data Engineering Tools and Technologies

Data Storage Technologies: Relational Databases and SQL, NoSQL Databases: MongoDB, Cassandra, Data Warehousing and OLAP, Distributed File Systems: HDFS, AWS S3, In-Memory Databases: Redis, Memcached

Data Processing and Transformation: Batch Processing with Apache Hadoop, Stream Processing with Apache Kafka, Data Transformation with Apache Spark, Workflow Management: Apache Airflow, Real-time Data Processing: Apache Flink

Data Integration and ETL: Extract, Transform, Load (ETL) Processes, Data Integration Patterns and Architectures, Data Quality and Cleansing Techniques, Change Data Capture (CDC) Methods, ETL Automation and Orchestration

Data Governance and Security: Introduction to Data Governance, Data Privacy Regulations and Compliance, Data Security Best Practices, Auditing and Monitoring Data Systems, Role-based Access Control (RBAC) and Encryption Techniques

Reference Books

- 1 Tapping into Unstructured Data: Integrating Unstructured Data and Textual Analytics into Business Intelligence, Bill Inmon, Anthony Nesavich, 2007, IBM Press.
- 2 Hadoop: The Definitive Guide, Tom White, 2009, O'Reilly Media.
- 3 Learning Spark: Lightning-Fast Big Data Analysis, Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, 2015, O'Reilly Media.
- 4 The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Ralph Kimball, Margy Ross, 2013, Wiley.

23AD03HF - REINFORCEMENT LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD03HF	REINFORCEMENT LEARNING	RIL	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Discuss basic and advanced reinforcement learning techniques.	2	PO1, PO4, PO5, PSO1
CO2	Demonstrate suitable learning tasks to which these learning techniques can be applied.	3	PO2, PO4, PO5, PSO1
CO3	Analyze some of the current limitations of reinforcement learning techniques.	4	PO2, PO4, PO5, PSO2
CO4	Formulate decision problems, set up and run computational experiments, evaluation of results from experiments.	5	PO2, PO4, PO5, PSO2
CO5	Design experiments to evaluate the performance of different reinforcement learning algorithms on various environments.	5	PO2, PO4, PO5, PSO2

Syllabus

Reinforcement learning framework, Bandit problems, Advanced Bandit Algorithms, action selection, Policy Gradient Methods

Dynamic programming, Markov Decision Processes (MDPs), Monte Carlo methods, Monte Carlo Control, Temporal-difference learning, Temporal-Difference Control

Planning in RL, Model-Based Planning Methods, Function approximation for generalization, Advanced Function Approximation Techniques, Actor-critic and gradient-based optimization

Multi-agent reinforcement learning, Multi-Agent Learning Paradigms, Value-Based Methods in MARL, Environments with partial observability, Value-Based Methods for POMDPs

Reference Books

- 1 Reinforcement Learning: An Introduction, Richard S. Sutton and Andrew G. Barto, Second Edition, 2018, The MIT Press.
- 2 Algorithms for Reinforcement Learning, Csaba Szepesvári, First Edition, 2010, Morgan & Claypool Publishers.
- 3 Reinforcement Learning and Optimal Control, Dimitri P. Bertsekas and John N. Tsitsiklis, Second Edition, 2019., Athena Scientific.
- 4 Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo (Editors), First Edition, 2012, Springer.

23AD04HF - EXPLAINABLE AI (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD04HF	EXPLAINABLE AI	EAI	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the knowledge about AI basics and its diverse applications in various domains.	2	PO1, PO2, PSO1
CO2	Analyze the effects of AI technologies on society and consider ethical implications in their development and deployment.	4	PO1, PO2, PSO1
CO3	Explore the methods to interpret and explain AI models, focusing on their transparency and interpretability.	4	PO1, PO2, PSO1
CO4	Analyze different techniques to make AI models interpretable and understandable, ensuring transparency in their functioning.	4	PO1, PO2, PSO1
CO5	Design AI systems with built-in explainability features, ensuring they are suitable for real-world deployment and addressing societal concerns.	5	PO1, PO2, PSO1

Syllabus

Introduction to Explainable AI: Introduction to AI and its subfields Importance of explainability in AI systems; Ethical considerations in AI development Case studies on the societal impact of AI technologies; Interpretable machine learning techniques Model-agnostic explanation methods

Explainability Techniques and Methods: Local and global explanation methods, Perturbation-based explanation techniques, Incorporating explainability into AI development lifecycle, Case studies and projects on building explainable AI systems

Evaluation and Validation of Explainable AI Systems: Evaluate the effectiveness and limitations of explainable AI techniques: Metrics for evaluating explanation quality, Challenges and trade-offs in designing explainable AI systems; Validate the reliability and trustworthiness of explainable AI models: Verification and validation techniques for explainable AI, Ethical considerations in deploying explainable AI systems.

Advanced Topics in Explainable AI: Explore advanced topics and emerging trends in explainable AI: Adversarial attacks and defenses in explainable AI, Incorporating domain knowledge into explanation generation; Engage in research and innovation to enhance the explainability of AI systems: Research papers and current developments in explainable AI, Project work on advancing the state-of-the-art in explainable AI.

Reference Books

- 1 Interpretable Machine Learning: A Guide for Making Black Box Models Explainable, Christoph Molnar, First Edition, Leanpub.
- 2 Explainable AI: Interpreting, Explaining and Visualizing Deep Learning, Monika Wolinska and Wojciech Samek, First Edition, Springer.
- 3 Explainable AI: A Guide for Understanding, Visualizing, and Interpreting Deep Learning, Martin Wattenberg, Been Kim, and Fernanda Viegas, First Edition, CRC Press.
- 4 Interpretable AI: Machine Learning Insights for Practitioners, Dennis Rothman and Alexander Hentschel, First Edition, O'Reilly Media.
- 5 Evaluating Machine Learning Models: A Beginner, Christoph Molnar, First Edition, Leanpub.
- 6 Building Explainable AI Models: A Hands-On Guide for Data Scientists and AI Practitioners, Hima Patel and Hanlin Tang, First Edition, Packt Publishing.

- 7 Explainable AI: Understanding, Visualizing, and Interpreting Deep Learning Models, Przemyslaw Biecek and Tomasz Burzykowski, First Edition, Apress.
- 8 Interpretable Machine Learning with Python: Explaining Black Box Models with LIME, SHAP, and XAI, Serg Masis and Patrick Hall, First Edition, O'Reilly Media.

23AD2103R - SYSTEM DESIGN & INTRODUCTION TO CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD2103R	SYSTEM DESIGN & INTRODUCTION TO CLOUD	SDC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the functionalities and types of operating systems, their support for computer architecture, and concepts such as process virtualization, CPU scheduling, segmentation, paging, TLB, swapping, demand paging, thrashing, and page replacement algorithms	2	PO1, PO2, PO3, PSO2
CO2	Applying deadlock management strategies such as prevention, detection, and avoidance, alongside concurrency concepts including threads and common problems, while comparing network types, topologies, and reference models	3	PO1, PO2, PO4, PSO2
CO3	Understanding the network layer design issues, including store and forward packet switching, the services provided to the transport layer, and the implementation of connectionless and connection-oriented services	2	PO1, PO3, PO4, PSO2
CO4	Analyzing the fundamentals of cloud computing, including its history, characteristics, advantages and disadvantages, deployment models, cloud services (IAAS, PAAS, SAAS), virtualization, containers and pricing models	4	PO1, PO2, PO3, PSO2
CO5	Applying Operating System Concepts, HTTP Clients, HTTP Servers and Computer Networking concepts. Analyzing Cloud Service Providers - AWS EC2	3	PO1, PO2, PO3, PSO2

Syllabus

Operating System Functionalities, Types of Operating Systems, Computer Architecture support to Operating Systems, Process Virtualization: Processes, Process API code, Direct Execution, CPU Scheduling, Segmentation, Introduction to Paging, Translation Look Aside Buffer, Swapping, Demand Paging, Thrashing, Page replacement algorithms

Deadlock: Prevention, Detection and Avoidance Persistence, Concurrency: Concurrency and Threads code, Thread API, Common concurrency problems. Network Types, LAN, MAN, WAN, Network Topologies Reference models- The OSI Reference Model- the TCP/IP Reference Model - A Comparison of the OSI and TCP/IP Reference Models, OSI Vs TCP/IP, Physical layer, Datalink layer

The Network Layer Design Issues - store and forward packet switching - Services provided to the transport layer - Implementation of Connectionless Service and Connection orientation service - Comparison of Virtual Circuit and Datagram Networks, Transport layer, Application layer

Fundamentals of Cloud computing : Cloud Computing Basics - History of Cloud Computing, Characteristics of Cloud Computing, Advantages and Disadvantages of Cloud computing,. Cloud deployment models, Introduction to Cloud services-IAAS,PAAS, SAAS, Overview, Virtualization, Container, Pricing models, SLA, VPC.

Reference Books

- 1 Principles of Operating System, Cesar Herrera, Flor Narciso , Darrell W Hajek, 2020, Independently published.
- 2 Operating system concepts essentials, Silberschatz, A., Galvin, P.B. and Gagne, G., 2018, John Wiley & Sons, Inc..
- 3 Cloud Computing A Complete Guide, Gerardus Blokdyk , 2020, Pearson.
- 4 Computer Networks: A Systems Approach, Larry L. Peterson, Bruce S. Davie , 2021, Morgan Kaufmann .

23AD2205R - DEEP LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD2205R	DEEP LEARNING	DL	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and apply optimization algorithms to solve neural networks, enhancing model performance through weight adjustment. Develop the ability to select and implement appropriate optimization techniques for various neural network architectures and problems	3	PO1, PO2, PSO1
CO2	Apply CNN models and their variants to real-time data, including LeNet, AlexNet, ZF-Net, and VGGNet. Gain proficiency in implementing and optimizing these models for various real-time data scenarios.	3	PO1, PO2, PSO1
CO3	Apply RNN, Long Short Term Memory (LSTM), and autoencoders to relevant data tasks. Acquire the ability to design, train, and optimize these models for various sequential and feature extraction problems.	3	PO1, PO2, PSO1
CO4	Apply variational autoencoders and generative neural models for data generation tasks. Develop skills in constructing, training, and optimizing these models to create high-quality synthetic data.	3	PO2, PO3, PSO2
CO5	Apply and implement basic neural networks, various types of autoencoders, batch normalization, and convolutional neural networks. Gain proficiency in constructing, training, and optimizing these models for diverse applications. Develop the ability to enhance model performance using advanced techniques.	3	PO2, PO3, PSO2
CO6	Construct , Design and develop various types of neural network models, autoencoders, batch normalization, and convolutional neural networks. Gain expertise in building, training, and optimizing these models for different tasks. Enhance your ability to implement advanced techniques to improve model performance.	5	PO2, PO3, PSO2

Syllabus

Introduction to Deep learning, History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron\\ , Introduction to Deep learning, History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron\\ Bias Variance Tradeoff, L2 regularization, Early stopping, . Batch Normalization, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Dropout,

Greedy Layer wise Pre-training, etter activation functions, better weight initialization methods, Learning Vectorial Representations of Words Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Loss Functions in RNNs, Sequence Prediction, Gated Recurrent Units (GRUs), Long Short TermMemory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs , Encoder Decoder Models:Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders.

Attention Mechanism, Attention over images, Deep Belief networks, Markov Networks. Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Variational autoencoders, Autoregressive Models:NADE, MADE, PixelRNN , Generative Adversarial Networks (GANs) Cycle GAN ,Super resolution and Conditional GAN models, Deep Reinforcement learning

Reference Books

- 1 Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courvill, 2016, MIT Press.

- 2 Grokking Deep Learning, Andrew Trask, 2019, Manning publications.
- 3 Deep Learning with Python,, Francois Chollet,, 2018, Manning publications,.
- 4 Deep Learning: A Practitioner's Approach, Adam Gibson and Josh Patterson, 2023, O'Reilly Media.

23AD4108 - ETHICS FOR ARTIFICIAL INTELLIGENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23AD4108	ETHICS FOR ARTIFICIAL INTELLIGENCE	EAI	R	1	0	0	0	1

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Ethical Principles underlying AI development and deployment, including transparency, fairness, accountability, and privacy.	2	PO1, PO2, PSO1
CO2	Analyze Ethical Dilemmas arising in AI design, development, and deployment, considering multiple perspectives and potential consequences.	4	PO1, PO2, PSO1
CO3	Apply Ethical Frameworks and guidelines to evaluate the ethical implications of AI technologies across various domains such as healthcare, employment, and social justice.	3	PO1, PO2, PSO1
CO4	Critically Evaluate AI Systems for biases, fairness, and ethical considerations, employing analytical tools and methods to assess the ethical soundness of these systems.	5	PO1, PO2, PSO1

Syllabus

Introduction to Ethics and AI: Overview of ethical theories, Introduction to AI and its ethical implications, Ethical frameworks for AI development Ethical Principles in AI: Ethical principles: transparency, fairness, accountability, and privacy, Case studies on ethical principles in AI applications Bias and Fairness: Understanding bias in AI systems, Fairness in algorithmic decision-making, Strategies for mitigating bias in AI

Privacy and Data Ethics: Privacy issues in AI, Data ethics and responsible data use, GDPR and other regulatory frameworks Autonomous Systems and Responsibility: Moral agency in AI, Responsibility and liability in autonomous systems, Case studies on ethical decision-making by autonomous systems Ethical Design and Development: Ethical considerations in AI design, Participatory design and stakeholder engagement, Ethical guidelines and best practices

AI and Employment: Impact of AI on employment and the workforce, Ethical considerations in AI-driven automation, Policies and interventions to address job displacement AI and Healthcare: Ethical issues in AI-enabled healthcare, Bias in medical AI algorithms, Patient privacy and consent in AI-driven healthcare systems AI and Social Justice, AI ethics and social justice, Ethical implications of AI in criminal justice, education, and other domains, Addressing bias and promoting equity in AI applications

Ethical Governance and Regulation: Regulatory challenges in AI, International efforts for AI governance, Ethical considerations in AI policy-making Ethical Decision-Making in AI: Ethical decision-making frameworks, Case studies on ethical dilemmas in AI, Ethical impact assessments Future Directions and Emerging Ethical Challenges: Emerging ethical challenges in AI: Ethical considerations in advanced AI technologies (e.g., AGI): Ethical leadership in AI development and deployment

Reference Books

- 1 Philosophy and Theory of Artificial Intelligence, Vincent C. Müller, 2017, Springer.
- 2 Robot Ethics: The Ethical and Social Implications of Robotics (Intelligent Robotics and Autonomous Agents series), George A. Bekey, Keith Abney, Patrick Lin, 2014, The MIT Press, Cambridge, London.
- 3 Artificial Intelligence: A Guide for Thinking Humans, Melanie Mitchell, 2019, Farrar, Straus and Giroux.
- 4 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING, Dr G.Revathy, Dr S.Selvi, Dr N.S.Kavitha, 2023, MJP Publishers.

23BT1101 - CELL BIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT1101	CELL BIOLOGY	CB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the structural organization of cell and apply the knowledge of genomic organization in designing primers	3	PO1
CO2	Apply the knowledge on cell cycle in identifying drug targets involved in various disease condition	3	PO1
CO3	Apply the knowledge of receptor signalling and list the therapeutic molecules which can interfere with receptor signalling pathways and inhibit cancer cell growth	3	PO4
CO4	Apply the knowledge of cell membrane organization and cellular transport mechanism in liposome assisted drug delivery	3	PO1, PO4

Syllabus

Structure and function of Prokaryotic and Eukaryotic cell bacterial cell, plant cell, animal cell, Cyanobacterial cell. Cell organelles

Cell division and cell cycle-Cell Division: Mitosis and Meiosis. Steps in cell cycle, G₀-G₁ transition, cell cycle checkpoints, Chromosome movements, regulation of cell division. Cell differentiation: cortical Differentiation, nuclear differentiation and cell death

Tissues & Receptors Meristems, Simple, complex and special tissues. Growth patterns, Cell growth and mechanisms. Embryonic development, Organogenesis, metamorphosis, Cell signaling Membrane receptors, Cell Cell interactions

Membrane Structure and Transport The structural and functional organization of cell membrane, the extra cellular matrix of eukaryotes cell wall. Transport across cell membrane passive and active transport, NaK pump, Ca²⁺ ATPase pumps, Lysosomal and Vacuolar membrane ATP dependent proton pumps, Co-transport into prokaryotic cells, endocytosis, exocytosis, pinocytosis and phagocytosis

Reference Books

- 1 Cell biology, Genetic, Molecular Biology, Evolution and Ecology, P.S. Verma and V.K. Agarwal,, 2004 , S. Chand and Company Ltd..
- 2 Schaum's Outline of Biology, George H fried,, 2013 , McGraw Hill..
- 3 Cell Biology & Molecular Biology, EDP Roberties & EMF Roberties, 2017, Wolters Kluwer Publishers.
- 4 Textbook of Biochemistry and Human biology, G P Talwar and L.M. Srivatsava, 2002, PHI Learning.

23BT2103R - BIOCHEMISTRY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT2103R	BIOCHEMISTRY	BCM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Relate the importance of biological buffers and its preparation, explain cellular thermodynamics, structure, function and metabolism of carbohydrates; the association between structure and function of carbohydrate at a chemical level with a biological perspective with a hands-on approach on laboratory techniques	2	PO1, PO2, PO4, PSO1
CO2	Make use of the information about the folding, conformation, dynamics and intrinsic properties of proteins and apply the knowledge to learn about abnormalities related with protein dysfunction and their clinical importance	3	PO1, PO2, PO4, PSO1
CO3	Apply the structural and biological roles that nucleic acids and lipids play in cellular physiology, and application of that knowledge in biotechniques to identify these biomolecules and discuss about disorders related with nucleotide metabolism	3	PO1, PO2, PO4, PSO1
CO4	Categorize enzymes, catalysis, kinetics, applications; immobilized enzymes and their catalytic mechanisms	4	PO1, PO2, PO4, PSO1
CO5	Analyze the biomolecules from various sources by employing experimental techniques and laboratory studies	4	PO1, PO2, PO4, PSO1

Syllabus

Types of the chemical bonds in biomolecules, Principles of biophysical chemistry pH, buffer, Henderson-Hasselbalch equation, colligative properties of solution. Composition, structure, and function of carbohydrates: monosaccharides, disaccharides and polysaccharides (homopolysaccharides and heteropolysaccharides). Ring structure and mutarotation, stereo isomers and optical isomers, disorder of carbohydrate metabolism. Principle of bioenergetics and introduction to cellular thermodynamics, Gibbs free energy, Enthalpy, Entropy, Concept of free energy, and standard free energy change, Biological oxidation-reduction reactions, Glycolysis & oxidation of Pyruvate, Krebs (TCA) cycle, its function in energy generation, Role of vitamin and Inhibitors of TCA cycle, Pentose phosphate pathway, Gluconeogenesis, electron transport and Oxidative phosphorylation, Inhibitors of ETC cycle.

Amino acids and Metabolism: Classification and Characteristics, Zwitter ion, isoelectric pH of amino acids, Amino acid biosynthetic pathway; Amino acid biodegradation: Deamination, transamination, Urea Cycle, Blood urea clinical importance, Amino acid as neurotransmitter. Peptide & Protein: peptide bond and pI values of peptides, solid-phase peptide synthesis, Ramachandran plot, structural organization of proteins, protein stability and folding, native structure of protein (Myoglobin, Hemoglobin and collagen), conjugated proteins, Abnormalities associated with Hemoglobin.

Lipids: Fats and lipids Introduction, Essential fatty acids. Fatty acid synthesis. beta oxidation of fatty acids. Nucleic acids Synthesis of Purines, Pyrimidines. Catabolism of purine and pyrimidine nucleotides.

Enzymes: nomenclature and classification of enzymes, enzyme kinetics (Michaelis-Menten and Lineweaver-Burk plot), influencing elements for enzyme activity, cofactor, coenzymes and allosteric modulators, enzyme inhibition and types, Immobilization of enzymes.

employing experimental techniques and laboratory studies

Reference Books

- 1 Harper's Illustrated Biochemistry, Murray RK, Granner DK, Mayes PA, Rodwell VW, 2022, McGraw-Hill Publishers.
- 2 Lehninger Principles of Biochemistry, Nelson DL, Cox MM, Hoskins AA, 2021, Macmillan Publishing.
- 3 Biochemistry, Satyanarayana U, Chakrapani U, 2020, Elsevier Publishing.

- 4 Essentials of Biochemistry, Naik P , 2022, Jaypee Brothers Medical Publishers.

23BT2104 - MICROBIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT2104	MICROBIOLOGY	MBG	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the history of Microbiology, taxonomy, working principles, and the importance of various microscopes in the analysis of physicochemical properties of microorganisms.	2	PO1
CO2	Understand the structure and biology of microorganisms and apply the staining techniques to visualize the structures.	3	PO1
CO3	Analyze and determine the growth, in vitro culturing, physicochemical properties, and controlling of microorganisms, and the various means to control the microorganisms and enumerate them.	3	PO1
CO4	Analyze the various diseases caused by bacteria, Fungi, and Viruses. Design, conduct experiments, and interpret the data pertaining to the biochemical and metabolic potential of microorganisms.	3	PO1
CO5	Formulate various sterilization, isolation, culturing techniques for microbes	3	PO1

Syllabus

Major contributors in the field of Microbiology - Antony van Leeuwenhoek; Robert Koch- Germ theory of disease and Koch postulates; Louis Pasteur, Edward Jenner; Joseph Lister; Winogradsky and Beijerinck. Discovery of microorganisms; Taxonomy-Major characteristics used in taxonomy, types of taxonomy (Phylogenetic, phenetic, numerical), Microbial taxonomy and diversity: Classification of microorganisms, Bacteria, and their broad classification., Bergey's Manual of bacteriology, Light microscopy-Bright field and dark field microscopy; simple compound, fluorescence, and electron microscopy.

MORPHOLOGY AND CELL STRUCTURE OF MICROORGANISMS Ultrastructure of bacteria cell wall, external appendages, endospore, and cell inclusions. Identification based on shape, simple, differential, capsule, Endospore, Acid-fast staining, Yeasts and Molds, Classification of Fungi, morphology, life cycle. Morphology and classification replication of viruses, lytic and lysogenic cycles.

Nutritional classification of bacteria, Essential Macronutrients, Micronutrients, and Growth factors. Microbial growth, Growth curve and factors affecting the growth. Culture media, synthetic and complex media, solidifying agents, types of media. Synchronous growth and diauxic growth, Isolation of pure cultures, spread, pour, and streak plate methods. Maintenance and Preservation of microorganisms, Methods of growth estimation. Classification of Archaeobacteria, thermophiles, psychrophiles, halophiles, and methanogens. Sterilization and disinfection, Antibiotics, classification, mode of action, and resistance.

Normal microbial flora, Respiratory infections caused by bacteria and viruses, Influenza, Tuberculosis, Hepatitis, Disease transmitted by animals, rabies and insects malaria, Food and water-borne diseases, Typhoid, pathogenic fungi, Viroids, Virusoids and Prions

Reference Books

- 1 Microbiology , Pelczar MJ, Chan ECS & Krieg NR , 5, 2023, Tata McGraw Hill .
- 2 General Microbiology , Prescott & Dunn , 11, 2019, McGraw Hill publishers .
- 3 Textbook of Microbiology , Arora, 5, 2017, CBS Publishers and Distributors .
- 4 Medical Microbiology , Ananthanarayan and Panikar , 12, 2022, Orient Blackswan .

23BT2105R - IMMUNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT2105R	IMMUNOLOGY	IMM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the role and components of immune system	3	PO2, PO3, PSO2
CO2	Apply the mechanism of immune system in Healthcare Biotechnology	3	PO2, PO3, PSO2
CO3	Apply the role of T Cells and B Cells in Immunity and to Apply the concepts of immune system to disease/disorders	3	PO3, PO6
CO4	Apply the concept of immunology to diagnostics	3	PO6, PO7
CO5	Conduct experiments based on concepts of immunity	3	PO6, PO7

Syllabus

Types of Immunity, Innate, acquired, Humoral & cell mediated; Organs of the immune system: Primary lymphoid organs Bursa of fabraceous, Bone marrow, thymus; Secondary lymphoid organs Spleen, lymph node. Cells of immunity, Lymphoid & Myeloid lineage

Antigens Types, Chemical nature of antigens, characteristics of Antigen, Hapten and Cytokines; Types, receptors and functions, B Cell Ontogeny, B-Cell biology, BCR

Immune Response, Primary, Secondary, and Tertiary Responses, Theories of Immune Response, Immunoglobulins Structure, Types, Subtypes, and Role, T Cell Ontogeny, T Cell Biology, TCR, Types of T Cells, TH, TC, and TS Cells, T Cell Effector Mechanism, Structure of MHC I and II, Mechanism of Antigen Processing, Antigen Presentation, Professional Antigen Presenting Cells, Clinical Immunology

Complement System-Classical, alternative, and MB Lectin Pathway & Regulation, Hypersensitivity: IgE Mediated, Antibody Dependent Cell Cytotoxicity, Immune Complex mediated reactions and delayed type of hypersensitivity, Autoimmunity-systemic & organ specific, Transplantation immunity-MLR and MCA, Tumor Immunity, Tumor Antigens, Vaccination-Basic Concept and Types

ODD Assay (Ag-Ab Pattern), ODD Assay (Ab Titre), Immunoelectrophoresis, Counter current immunoelectrophoresis, Radial Immunodiffusion, Rocket Immunoelectrophoresis, Dot ELISA, Antigen capture ELISA, Western Blot, Purification of IgY, Antibody capture ELISA, Antibody capture ELISA, Antibody HRP conjugation.

Reference Books

- 1 Kuby Immunology, Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen, 2018, WH Freeman .
- 2 Elements of Immunology, Fahim Halim Khan , 2009, Pearson .
- 3 Roitts Essential Immunology, Ivan Roitt, 2001, Wiley.
- 4 Practical Immunology, Frank C. Hay, Olwyn M. R. Westwood, 2002, AP.

23BT2206 - MOLECULAR BIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT2206	MOLECULAR BIOLOGY	MBY	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the DNA structure and genome organization	2	PO1
CO2	Understand the DNA replication in prokaryotes and eukaryotes along with DNA damage and its repair mechanisms	2	PO1
CO3	Understand the mechanism of transcription and translation and apply the post-transcriptional and post-translational modifications along with cracking of genetic code	3	PO1
CO4	Applications of gene expression in prokaryotes and eukaryotes	3	PO1

Syllabus

Nucleic acid as genetic material, Genome of prokaryotes and eukaryotes, C Value Paradox, repetitive DNA, pseudogenes, split genes. Watson and Crick model, Forms of DNA. Transposons

Semi conservative replication apparatus, bidirectional and rolling circle replication. DNA damage, Mutations, Types of Mutations, Effect of UV, Deamination, Alkylation. Repair Mechanisms, Direct Repair, Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair.

Mechanism of transcription and translation in Prokaryotes and Eukaryotes, Structure of Promoters, RNA Polymerases of Prokaryotic and Eukaryotic Organisms, Post Transcriptional Processes of Eukaryotic RNA, Translation in prokaryotic and Eukaryotes, Genetic code, Posttranslational modifications and protein synthesis. Gene Silencing.

Regulation of gene expression Regulation of Gene expression in Bacteria, Operon concept, inducible and repressible operons, positive and negative regulations, Inducer molecules, repressor molecules, co repressor molecules, Induction and catabolic repression of lac Operon in E.Coli, Repression and attenuation of trp operon in E.Coli, Absolute control by Antisense RNAs. Regulation in eukaryotes, Control by promoter, enhancer and silencers. Cis trans elements.

Reference Books

- 1 Molecular Biology, D Freifelder, 2015, Narosa Publications.
- 2 Molecular Biology of the Cell, Bruce Alberts, 2014, Garland Science .
- 3 Principles of Molecular Regulation, PM Conn, AR Means, 2011, Humana Publishers.
- 4 Cell And Molecular Biology , De Robertis, 2017, Walters Kluver.

23BT2215 - PROCESS ENGINEERING PRINCIPLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT2215	PROCESS ENGINEERING PRINCIPLES	PEP	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the various methods for estimation of chemical composition of different microbial cultures	3	PO1, PO2, PSO1
CO2	Apply various techniques for determination of volatile components in the microbial cultures	3	PO1, PO2, PSO1
CO3	Apply the principles of material balance for designing of Bioreactors	3	PO1, PO2, PSO1
CO4	Apply various principles of Energy balance for designing of Stirred tank reactors.	3	PO1, PO2, PSO1
CO5	Apply the various processes to produce value added biological products from different sources.	3	PO1, PO2, PSO1

Syllabus

Introduction to Engineering Calculations: Physical variables; dimensions and Units; Measurement conventions: Density, specific gravity; specific volume, mole, chemical composition, vapour pressures, concentration, composition of mixtures and solutions: molarity, molality, normality, weight fractions, mole fractions,

Ideal gas law, differences between ideal and real gases, application of ideal gas law, Daltons law of additive pressures, amagat law of additive volumes, volume changes with change in composition

Material balances: Introduction to system and process; difference between steady state and equilibrium, Law of conservation of mass: Types of material balances, Procedure for material balance calculations with and without chemical reactions, Material balances in cell culture: Material balance for continuous filtration, batch mixing, material balances with recycle, by pass and purge streams

Energy balances: Basic Energy concepts: law of conservation of energy, standard heat of formation, latent heat of vaporization and condensation, specific heat, Energy balance worked examples without reaction: cooling in downstream processing, continuous water heater, and fermentation energy balance.

Reference Books

- 1 Bioprocess Engineering Principles, Pauline M.Doran,, 1995, ELSEVIER publications.
- 2 Introduction to Biochemical Engineering, D G Rao, 2005, Mc Graw Hill publications.
- 3 Bioprocess Engineering, Basic Concepts, Michael L.Shuler Fikret Kargi, 2001, Pearson Education India.
- 4 Introduction to Process calculations (Stoichiometry), K.A Gavhane, 2016, Nirali Publication.

23BT3214 - BIOINFORMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23BT3214	BIOINFORMATICS	BI	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Acquire the theoretical basis of bioinformatics and understand the access and analyze the biological information from databases.	3	PO1, PSO1
CO2	Choose the DNA/Protein sequences using standalone PC programs and with the help of the worldwide web.	3	PO1, PO5, PSO1
CO3	Apply multiple sequence alignment tools on gene and protein sequences to find homologs, construct and interpret the evolutionary trees.	3	PO1, PSO1
CO4	Apply structural bioinformatics to understand the secondary and tertiary structures of proteins from primary sequence.	3	PO1, PO5, PSO1
CO5	Choose the sequences from the databases and apply sequence alignment, tree construction tools to infer their relations.	3	PO1, PO5, PSO1

Syllabus

Biological Information on the web. Introduction to Biological databases Primary Databases: NCBL, EMBL, DDBJ. Secondary Databases: SwissProt, PIR. Specialized data bases KEGG and BRENDA. Information retrieval from Databases. Concepts of Data mining, Basics of Sequencing Technologies, Genome projects human genome project.

SEQUENCE COMPARISONS AND ALIGNMENTS: String similarity Local, Global alignment; pair wise alignments Dot plots, Dynamic Programming Methods, Heuristic methods FASTA and BLAST; Amino acid substitution matrices- PAM and BLOSUM.

MULTIPLE SEQUENCE ALIGNMENT: Methods for Multiple sequence alignments- local and global multiple sequence alignment; Significance and applications of MSA, PHYLOGENETIC ANALYSIS: Origins of Molecular Phylogenetics; Methods of Phylogenetic analysis- Maximum Parsimony Maximum Likelihood and Distance based methods.

STRUCTURAL BIOINFORMATICS: Protein Structure Basics; Peptide Formation; Dihedral Angles; Hierarchy Secondary Structures, Tertiary Structures, Primary structural analysis and prediction, Secondary structural analysis and prediction. PERL programming basics.

Reference Books

- 1 Essential Bioinformatics , Jin Xiong , 2012, Cambridge University Press .
- 2 BIOINFORMATICS: METHODS AND APPLICATIONS GENOMICS, PROTEOMICS AND DRUG DISCOVERY , RASTOGI, S.C., RASTOGI, PARAG, MENDIRATTA, NAMITA , 2022, PHI Learning Pvt. Ltd .
- 3 BIOINFORMATICS , Vinay Sharma, Ashok Munjal, Ashish Shanker , 2019, Rastogi Publications .
- 4 Bioinformatics: Sequence, Structure, and Databanks: A Practical Approach, Des Higgins, Willie Taylor, 2000, Oxford University Press.

23CE2102R - FLUID MECHANICS & HYDRAULICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CE2102R	FLUID MECHANICS & HYDRAULICS	FMH	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Application of Properties of Fluid	3	PO1, PO2, PO7, PSO1
CO2	Determination of losses through pipe flow	3	PO1, PO2, PO7, PSO1
CO3	Analysis of flow in open channel	4	PO1, PO2, PO7, PSO1
CO4	Analysis of specific energy curve in open channel flow	4	PO1, PO2, PO7, PSO1
CO5	Illustrate the experimental procedure and interpretation of results obtained	4	PO1, PO2, PO7, PSO1

Syllabus

Fluid properties and conservation laws: Properties of Fluid, Flow Classification; Fluid pressure and its measurement for simple manometer and differential manometer; Hydrostatic forces for vertical, horizontal, and inclined plane; buoyancy and floatation: buoyancy, centre of buoyancy, meta-centre, meta-centric height, equilibrium condition of floating and sub-merged bodies; Types of fluid flow; Conservation Laws: Conservation of Mass, Conservation of Momentum, Energy Conservation; Application of Conservation Laws.

Flow through pipes: Losses of energy in pipes, Major head loss, Minor head losses, hydraulic gradient and total energy line, flow through pipes in series, Equivalent pipe, flow through parallel pipes, water hammer in pipes, pipe network, Concept of boundary layer and its growth, Concept of lift and drag.

Uniform flow in open channel and most efficient section Steady and Unsteady Flows, Uniform and Nonuniform flows, Laminar and Turbulent Flows, Subcritical, Supercritical, and Critical Flows; Chezy's Equation, Manning Equation in Uniform Flow, Computation of Normal Depth in Uniform Flow;

Specific Energy, Energy-depth Relationships, Unit Discharge, and Specific Force for Rectangular and Non-rectangular Channel; Application of Critical Flow; Location of Critical Flow; Computation of Critical Depth; Hydraulic Jump: Ratio of Sequent Depths, Length of Jump, Jump types, Energy loss. Gradually Varied Flow Governing Equation, Classification of Water-Surface Profiles, Sketching of Water-Surface Profiles; Dimensional analysis and hydraulic similitude.

Reference Books

- 1 Fluid Mechanics, Frank M. White, 3rd Edition, McGraw-Hill Education.
- 2 Hydraulics & Fluid Mechanics, P.N. Modi and S.M. Seth, 2nd Edition, Standard Book House.
- 3 Fluid Mechanics and Hydraulic Machines, R. K. Bansal, 1st Edition, Laxmi Publication.
- 4 Fluid Mechanics and Machinery, Manish Kumar Goyal, 1st Edition, PHI Publishers.

23CE2103R - SURVEYING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CE2103R	SURVEYING	SVY	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the knowledge of plane surveying, geodetic surveying for computation of bearings in a traverse.	2	PO2, PO4, PSO1
CO2	Apply and Calculate the difference in elevation by using differential levelling techniques and prepare a contour plan.	3	PO2, PO4, PSO1
CO3	Compute the area of the field and volume of earthwork	3	PO2, PO4, PSO1
CO4	Understand about the different types of curves and uses of GPS & GIS	2	PO2, PO4, PSO1
CO5	Evaluate Conceptualize the project by applying surveying techniques such as chain, compass, traverse.	4	PO2, PO4, PSO1
CO6	Calculate the height of building by using theodolite and tacheometric survey, and total station surveying	3	PO2, PO4, PSO1

Syllabus

Introduction to surveying, Overview of plane surveying (chain, compass and plane table), Objectives, Principles and classifications. Distances and Direction - Distance measurement conventions and methods; use of chain and tape, Electronic distance measurements, Meridians, Azimuths and Bearings, declination, computation of angle. Global and regional sustainability guidelines and regulations. Case studies of successful construction projects

Concept and Terminology, adjustments- method of levelling. Characteristics and Uses of contours- methods of conducting contour surveys and their plotting. Area from field notes, computation of areas along irregular boundaries and area consisting of regular boundaries. Embankments and cutting for a level section and two level sections with and without transverse slopes, determination of the capacity of reservoir, volume of barrow pits.

Theodolite, description, uses and adjustments, measurement of horizontal and vertical angles. Principles of Electronic Theodolite, Trigonometrical levelling, Traversing. Stadia and tangential methods of Tacheometry. Distance and Elevation formulae for Staff vertical position.

Types of curves, design and setting out of simple curves. Introduction, Accessories with description, Features of total station, Onboard software electronic data reading, Summary of total stations characteristics, Field procedure of total stations in topographic survey, Global positioning system, Introduction to Geographic information system (GIS).

Measurement of horizontal and vertical angles using theodolite, Determination of a given area using total station. Calculation of volume of earthwork using total station, staking out the points in an area using total station, Measurement of height of the tower/building using total station, Measuring and plotting using Auto cad of a given area of land by total station.

Reference Books

- 1 Elementary Surveying: An Introduction to Geomatics, Charles Ghislaine , 15, Pearson.
- 2 Surveying Vol-I, Arora K. R., 10, Rajsons Publications Pvt. Ltd.
- 3 Surveying: Principles and Applications, Barry F. Kavanagh and Tom B. Mastin, 9, Pearson.
- 4 Surveying: Volume 1, B.C. Punmia, Ashok Kumar Jain, and Arun Kumar Jain, 14, Laxmi Publications.

23CE2206 - STRUCTURAL ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CE2206	STRUCTURAL ANALYSIS	STA	R	3	1	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Mastery of Structural Analysis Methods	3	PO1, PO5, PSO1
CO2	Ability to Analyze Complex Structures:	3	PO1, PO5, PSO1
CO3	Proficiency in Structural Modeling and Software Tools	3	PO1, PO5, PSO1
CO4	Understanding of Structural Behavior and Design Implications	3	PO1, PO5, PSO1
CO5	Evaluate the dynamic response of structures subjected to external forces and vibrations, including natural frequencies and mode shapes.	4	PO1, PO5, PSO1
CO6	Apply knowledge of structural analysis principles to solve practical engineering problems and design structural elements that meet safety and performance criteria.	5	PO1, PO5, PSO1
CO7	Demonstrate proficiency in using structural analysis software and computational tools to analyze and design structures efficiently and accurately.	3	PO1, PO5, PSO1

Syllabus

Introduction to Structural Analysis and Loads

Analysis of Determinate Structures

Analysis of Indeterminate Structures

Matrix Structural Analysis and Computer Applications

Dynamic Analysis of Structures ,Fundamentals of structural dynamics Free and forced vibration analysis of single and multi-degree-of-freedom systems

Plastic Analysis of Structures ,Plastic behavior of materials and structural elements Plastic analysis of beams, frames, and portal structures

Influence Lines and Moving Loads Construction and use of influence lines for determinate and indeterminate structures

Special Topics in Advanced Structural Analysis Nonlinear analysis of structures Stability analysis of structures

Reference Books

- 1 Structural Analysis, Aslam Kassimali, 2014, Cengage Learning.
- 2 Structural Analysis, R.C. Hibbeler, 2022, Pearson.
- 3 Structural Analysis, Russell C. Hibbeler, 2014, Pearson.
- 4 Matrix Analysis of Structures, Aslam Kassimali, 2011, Cengage Learning.

23CE2207 - CONCRETE TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CE2207	CONCRETE TECHNOLOGY	CT	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand about the constituent and properties of cement	2	PO1
CO2	Understand about the fresh, hardened and durability of concrete.	2	PO1
CO3	Understand about special concretes and concreting techniques.	2	PO4
CO4	To apply concrete mix design in the field.	2	PO3, PSO1
CO5	Demonstrate and apply knowledge experiments in the project-based laboratory	3	PO6
CO6	Understand the production and placement of concrete	2	
CO7	Develop solutions for enhancing concrete performance	6	

Syllabus

Basics: Historical background, composition of concrete, general note on strength mechanism, recent practice and future trends. Constituent of Concrete : 1. Cement , Chemical composition, hydration, heat of hydration, hydrated structure, various types of cement, testing of cement as per Indian standard. 2. Aggregates , Utility in concrete, classification, effect of geometry & texture, strength, mechanical properties, moisture content, water absorption, bulking of sand, deleterious substances, sieve analysis, various grading and grading requirements, sampling & testing as per Indian Standards. 3. Water , General Requirements & limiting values of impurities. 4. Admixtures , Additives and admixtures, types, necessity and benefit Mineral admixture , Fly ash, silica fume, blast furnace slag, and other pozzolanic materials. Chemical admixtures , Accelerator, retarder, water reducing elements, plasticizer and super-plasticizer, their functions and dosage.

Fresh concrete , Methods of mixing, transporting and placing of concrete. Workability , Definition and requirement, factors affecting workability, various tests as per IS and ASTM. Segregation and bleeding, stiffening, retempering. Curing, necessity and various methods, micro-cracking. Hardened concrete, Compressive and tensile strength and their relationship, various tests as per IS and ASTM. Factors affecting strength, water cement ratio, gel space ratio, aggregate cement ratio, properties of ingredients, effect of age, maturity, aggregate cement-paste inter-face, various finishes of concrete. Introduction to aspects of elasticity, shrinkage and creep. Tests for strength of concrete: Destructive, semi destructive and non destructive tests with their limitations, test methods as per IS and ASTM. Durability and permeability of concrete, Definitions, causes, carbonation, cracking

Concrete in aggressive environment: Alkali aggregate reaction, sulphate attack, chloride attack, acid attack, effect of sea water, special coating for water proofing, sulphate chloride and acid attack, concrete for hot liquids. Special Concrete: Review of behavior and characteristics of high strength concrete, high performance concrete, fiber reinforced concrete, mass concrete, light weight and heavy weight concrete, Precast concrete Special concreting techniques: Pumped concrete, concrete, underwater concrete, pre-placed concrete, vacuum dewatered concrete, hot and cold weather concreting, Ready mixed concrete.

Concrete mix design: Principles of mix proportioning, probabilistic parameters, factors governing selection of mix. Road note 4, DOE, ACI and IS method of concrete mix design, Variability of test results, acceptance criteria, various IS code provisions.

Testing of Concrete: Fresh Concrete Testing Slump test, flow test, Vebe test, compaction factor test. Hardened Concrete Testing: Compressive strength test, split tensile test, flexural strength test. Non-destructive testing methods: Rebound hammer, ultrasonic pulse velocity

Durability of Concrete: Chemical Attack on Concrete Sulfate attack, chloride attack, alkali-aggregate reaction
Reinforcement Corrosion Mechanism of corrosion Factors affecting corrosion Prevention methods: Coatings, cathodic protection Environmental Impact Freeze-thaw cycles, carbonation, and abrasion resistance

Enhancing Concrete Performance: Use of Admixtures Water reducers, superplasticizers, accelerators, retarders
Supplementary Cementitious Materials Fly ash, slag, silica fume, and their effects on concrete properties Advanced Curing Techniques Steam curing, membrane curing, and self-curing concrete

Production and Placement of Concrete: Batching and Mixing Batching methods: Weight batching, volume batching Types of mixers: Drum mixers, pan mixers, truck mixers Transportation and Placement Methods of transportation: Pumps, conveyors, cranes Placement techniques: Compaction, vibration, and finishing Curing of Concrete Importance of curing Methods of curing: Water curing, membrane curing, curing compounds

Reference Books

- 1 "Concrete Technology, A.M. Neville, 5th, Pearson.
- 2 Concrete Technology, M.S. Shetty , 7th, S. Chand & Company Ltd;.
- 3 Concrete: Microstructure, Properties, and Materials, P. Kumar Mehta and Paulo J.M. Monteiro, 4, McGraw-Hill Education.
- 4 Concrete Technology, A.R. Santhakumar, 1, Oxford University Press.

23CI2203 - MANAGEMENT INFORMATION SYSTEM - ERP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CI2203	MANAGEMENT INFORMATION SYSTEM - ERP	MIS	R	2	0	0	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Remember the basic concepts and technologies used in the field of management information systems from technical, socio-ethical and business perspective and as well for assessing the relationship between the digital firm, electronic commerce, electronic business and internet technology.	2	PO1, PO5, PSO2
CO2	To apply various knowledge representation methods with different technology infrastructure and business intelligence as strategic weapons to counter the risks associated with business and for making business more competitive	3	PO2, PO6, PSO1
CO3	Analyze and interpret information systems role played by the major types of information systems in organizations and their relationship in supporting the major functional areas of the business between organizations, information systems and business processes, including the processes for customer relationship management and supply chain management in creating efficiencies for businesses.	4	PO1, PO5, PSO1
CO4	Analyze and distinguish the relationships between concepts of information systems, organization, management and strategy for better decision making in supporting various levels of business strategy with information systems	4	PO1, PO5, PSO2

Syllabus

Information Systems in Global Business Today Information Systems Analysis & Design Fundamentals of Data Systems Analytics, Visualization & Engineering, perspectives of information Systems, EBusiness: How Businesses Use Information Systems

Information Technology Infrastructure Enterprise Resource Planning, Business Systems Modelling & Design, Infrastructure components Contemporary Hardware and Software Platform Trends, Foundations of Business Intelligence: Databases and Information management, Telecommunications, the Internet, and Wireless Technology

Achieving Operational Excellence and Customer Intimacy Enterprise Applications, Customer Relation Management Systems Enterprise Applications, E-Commerce: Digital Markets, Digital Goods, Types of Electronic Commerce, M-Commerce Electronic Commerce Payment System

Building and Managing Systems, Managing Projects, importance of project, selecting project, Managing Global Systems The growth of international information systems Organizing International Information Systems, Information Security Governance & Risk Management. Management solution

Reference Books

- 1 "Management Information Systems: Managing the Digital Firm", Kenneth C. Laudon and Jane P. Laudon, 16th Edition, 2020, Pearson.
- 2 "Management Information Systems for the Information Age", Stephen Haag, 10th Edition, 2021, McGraw-Hill Education.
- 3 Information Systems Today: Managing in the Digital World, Joseph Valacich and Christoph Schneider, 8th Edition, 2021, Pearson.
- 4 "Essentials of MIS", Kenneth C. Laudon and Jane P. Laudon, 14th Edition, 2022, pearson.
- 5 "Business Driven Information Systems", Paige Baltzan and Amy Phillips, 6th Edition, 2023, McGraw-Hill Education.
- 6 "Using MIS", David Kroenke and Randall Boyle, 12th Edition, 2022, pearson.

23CS03HF - ADVANCED ALGORITHMS & DATA STRUCTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS03HF	ADVANCED ALGORITHMS & DATA STRUCTURES	AADS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate a comprehensive understanding of advanced data structures such as balanced trees, hash tables, and graphs	2	PO1, PO3, PO6, PSO1
CO2	Develop proficiency in designing, analyzing, and optimizing complex algorithms	2	PO1, PO2, PO3, PSO1
CO3	Effectively apply advanced graph algorithms to solve real-world problems.	3	PO1, PO2, PO3, PSO1
CO4	Apply dynamic programming and backtracking techniques to solve combinatorial and optimization problems	3	PO1, PO3, PO6, PSO1
CO5	Analyze various advanced algorithms and data structures	3	PO1, PO3, PO6, PSO1

Syllabus

Introduction to Advanced Data Structures ,Review of basic data structures (arrays, linked lists, stacks, queues),AVL trees: Properties, insertion, deletion,Red-Black trees: Properties, rotation operations,B-Trees: Structure, insertion, deletion, searching,Hash tables: Collision resolution techniques (chaining, open addressing).

Algorithm Design Techniques,Divide and Conquer: Principles, merge sort, quicksort, closest pair,Greedy Algorithms: Strategies, minimum spanning trees, shortest paths, Huffman coding,Dynamic Programming: Principles, matrix chain multiplication, longest common subsequence, knapsack problem.

Graph Algorithm, Depth-First Search (DFS) and Breadth-First Search (BFS), Single Source Shortest Paths (Dijkstra's Algorithm),All-Pairs Shortest Paths (Floyd-Warshall Algorithm),Minimum Spanning Trees (Prim's and Kruskal's Algorithms)

Advanced Topics in Algorithms Network Flow Algorithms: Ford-Fulkerson method, Edmonds-Karp algorithm, max-flow min-cut theorem,String Matching Algorithms: Knuth-Morris-Pratt algorithm, Rabin-Karp algorithm, Boyer-Moore algorithm,Approximation Algorithms: Greedy algorithms for NP-hard problems, approximation ratio, analysis

Reference Books

- 1 Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein., 3rd, 2009, The MIT Press.
- 2 Algorithm Design Manual, Steven S. Skiena., 2nd, 2008, Springer.
- 3 Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser., 2nd, 2013, Wiley.
- 4 The Art of Computer Programming, Donald E. Knuth, 3rd, 1997, Addison-Wesley Professional.

23CS04HF - HIGH PERFORMANCE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS04HF	HIGH PERFORMANCE COMPUTING	HPC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the basis concept of processors, optimization and parallel computers, shared memory, parallel programming with MPI.	3	PO2, PO3, PO4, PSO1
CO2	Apply knowledge of FPGA based supercomputers, rearchitecting, and core optimization.	4	PO2, PO3, PO4, PSO1
CO3	Analyze openMp, MPI and their hybridization principles.	4	PO2, PO3, PO4, PSO1
CO4	"Analyze the working principle of GPU, CUDA, threads, performance, openCL."	4	PO2, PO3, PO4, PSO1
CO5	Analyze the parallel programming concepts, openMP, MPI, CUDA, and other significant features of HPC.	4	PO2, PO3, PO4, PSO1

Syllabus

Evolution of Processors and Modern Processor, Basic optimization techniques for serial code, Data access optimization, Parallel computers, Basics of parallelization, Shared-memory parallel programming with OpenMP.

FPGA based super computer for statistical physics, Weird Case of Janus, High speed torus interconnect using FPGAs, Rearchitecting memory resources for clusters, Various kinds of models, Core optimization.

Efficient openMP programming, Local optimization on ccNuma architecture, Distributed memory parallel programming with MPI, Efficient MPI programming, Hybrid parallelization with MPI and Open MP.

History of GPU computing, GPU memory Hierarchy, Introduction to CUDA, CUDA threads, CUDA performance consideration, Introduction to Open CL, Hybrid- Core Architecture, Low cost High performance reconfigurable computing.

Reference Books

- 1 HPC @ Green IT, Green High Performance Computing Methods, Ralf Gruber, Vincent Keller, 2010, Springer.
- 2 High-Performance Computing Using FPGAs, Christian de Schryver, Norbert Wehn, 2013, Springer.
- 3 Using OpenMP: Portable Shared Memory Parallel Programming (Scientific and Engineering Computation), Barbara Chapman (Author), David J. Kuck (Foreword) (Author), Gabriele Jost (Author), 2007, Paperback.
- 4 Parallel and High Performance Computing, Robert Robey, Yuliana Zamora, 2021, Manning.

23CS05EF - PYTHON FULL STACK DEVELOPMENT WITH DJANGO (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS05EF	PYTHON FULL STACK DEVELOPMENT WITH DJANGO	PFSD	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the fundamental concepts like Flow control and conditions, File handling, OOPs, and Python modules	3	PO2, PO3, PSO1
CO2	Apply Python and Django framework to develop web applications using Template System, URLs	3	PO1, PO3, PSO1
CO3	Apply Python and Django framework to develop web applications using models, views, forms and data bases	3	PO2, PO3, PSO1
CO4	Apply Django framework to develop web applications using model, views, templates, URLs, forms, and databases to develop the project	3	PO3, PSO1

Syllabus

Introduction to Python programming language - Setting up development environment - Basic programming concepts - Data Types, Functions, File Handling, Modules, Exception Handling- . Python Libraries and Packages - Working with popular Python libraries such as NumPy, Pandas, and Matplotlib - Installing, managing, and publishing Python packages using pip - Using Python virtual environments effectively.

Object-oriented Programming in Python - Introduction to object-oriented programming - Classes, methods, and properties in Python - Inheritance, polymorphism, and encapsulation.

Introduction to Django - Overview of Django framework - Setting up a Django project - Creating apps in Django - Django Web Development - Building web applications in Django - Django views and URL mapping - Django templates and rendering - Handling forms and user input

Middleware-Session handling-Enabling sessions-Using and Configuring Sessions-Saving Session Data-Testing Middleware-Import and Export File - CSV, PDF Request and Response Objects -HttpRequest object- UploadedFile object-QueryDict object-HttpResponseobject.Restful API-Concept of REST - HTTP Principles- Installing and Configuring Django REST Framework-SerializersURL and DRF Routers-Custom Properties- Configuring API Endpoint-Testing API's.

Reference Books

- 1 Django for Beginners, William S. Vincent, 3rd, 2022, Welcome to Code.
- 2 Web Development with Django, Ben Shaw, Saurabh Badhwar, Chris Guest, Bharath Chandra K S, 2nd, 2023, Packt Publishing.
- 3 Mastering Django:Core, Nigel George, 2nd, 2016, Lean publishing.
- 4 Pro Django (Expert's Voice in Web Development), Marty Alchin, 2nd, 2013, APress.

23CS06EF - MERN STACK WEB DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS06EF	MERN STACK WEB DEVELOPMENT	MSWD	E	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design and develop a responsive front-end application using ReactJS libraries, Material-UI, and Bootstrap.	3	PO5, PO9, PSO1
CO2	Create and manage a MongoDB database, and implement CRUD operations and queries.	3	PO5, PO9, PSO1
CO3	Develop an Express server within a Node.js environment, implementing RESTful APIs.	3	PO5, PO9, PSO1
CO4	Develop full stack web applications using the MongoDB, Express.js, React, and Node.js (MERN) framework.	3	PO5, PO9, PSO1

Syllabus

Fundamentals of Web Applications: Overview of HTML, CSS, Single Page Application (SPA), JavaScript, and ES6. Full-Stack Web Development. Introduction to React JS: class, functions, arrays, DOM methods, Components, and Multiple components JSX, Passing data to components-props. De structuring, Page re-rendering, Stateful component, State Vs Props, State management, Event handling: Event handler as a function, passing state to child components, Refactoring the components, Rendering Collections, Key-attribute, Map Controlled component Filtering Displayed Elements, Axios, promises. Form handling, State and Effect hooks, React-Router, Material UI Components: Inputs, Feedback, Data Display, Surface, Navigation, Layout, Utils, MUI X. Rendering MaterialUI using RESTful API, Error handling, error handling into middleware.

Working with MongoDB: Installation of MongoDB Compass, working with Mongo Shell, Atlas account, MongoDB, Schema, CRUD operations on objects from the database, other data operations, queries, connectivity with compass and other applications.

Working with Server using Node JS and Express: Simple Web server, About Node JS, modules, routes, Streaming, Files, Express, Web and express, nodemon, REST, Fetching and deleting resources, Postman, receiving data, HTTP Request types, same origin policy, and CORS, authentication and authorization, Token based authentication.

GraphQL, Apollo Server, Apollo Studio Explorer, Parameters resolver, Mutations, other queries. REDUX: Flux-architecture and Redux, communicating with a server in a redux application, Asynchronous actions, and redux-thunk, connect function in Redux, Redux, the component state. TESTING: Validation, debugging and ESLint, Project Structure, Testing React apps, Testing backend applications, async / await. Type Scripting, react with typescript. React Native basics, communicating with the server, Testing, and extending. Introduction to CI/CD, Container. Getting started with GitHub Actions, Deployment of both client-server apps in Heroku.

Reference Books

- 1 The Full-Stack Developer , Chris Northwood , 1st ed. 20224, APRESS Book.
- 2 Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, Node.js App , Greg Lim Book , 1st ed. 2023, Greg Lim Book .
- 3 Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node , Vasan Subramanian , 2nd ed.2023, Apress.
- 4 Node.js Design Patterns, Mario Casciaro, Luciano Mammino., 2nd ed. 2023, Packt Publishing.
- 5 Learning Node.js Development, Andrew Mead, 1st ed. 2024, Packt Publishing.
- 6 Practical Node.js: Building Real-World Scalable Web Apps, Azat Mardan, 1st ed. 2024, Apress.

23CS2103R - ADVANCED OBJECT ORIENTED PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2103R	ADVANCED OBJECT ORIENTED PROGRAMMING	AOOP	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply software development practices for designing reusable solutions (design patterns), writing clean and maintainable code (clean coding techniques), and ensuring code quality through tests (Test Driven Development).	3	PO1, PO5, PSO2
CO2	Analyze the advanced Java programming concepts for working with typed collections (generics & collections framework) and exploring advanced data structures like trees and graphs.	4	PO1, PO5, PSO2
CO3	Apply the techniques for running multiple tasks concurrently in Java, including thread creation, synchronization, and advanced concepts like parallel programming.	3	PO2, PO5, PSO2
CO4	Develop the applications that connect databases with JDBC and building web applications using servlets and JSP for dynamic content.	3	PO2, PO5, PSO2
CO5	Experiment with different design patterns (creational, structural, and behavioral) to structure your code effectively, while solidifying your understanding of key OOP principles like encapsulation, inheritance, and polymorphism to create reusable, maintainable, and adaptable object-oriented applications.	3	PO1, PO2, PO5, PSO2
CO6	Dissect real-world challenges by applying object-oriented design patterns and principles in open-source projects to craft reusable solutions.	4	PO2, PO5, PO9, PSO2

Syllabus

Design Patterns: Introduction to design patterns, Creational Design Pattern (Singleton, Factory, Abstract Factory), Structural Design Patterns (Adapter, Bridge, Decorator, Facade), & Behavioural Design Patterns (Chain of Responsibility, State, Iterator, Command, Observer), Dependency injection. Clean Coding Techniques: Introduction to code smells - bloaters, Object-oriented abusers, change preventers, dispensables and couplers. Refactoring techniques to remove the code smells. Test Driven Development (TDD): Introduction to TDD, Introduction to Unit Testing & JUnit.

Generics & Collections Framework: Introduction to Generics, Generics with interfaces. Stacks, Queues & Priority Queue, Comparator & Comparable Interface, Cloneable & Iterator interfaces. Introduction to Sets and Maps and their Java API. Nested Classes, Lambda expression and Stream API. Graphs & Trees - Graph based algorithms, Graph Visualization, Graph Traversal - DFS, BFS, Binary Tree, Binary Search Tree (BST), AVL trees. Case studies related to trees and graphs.

Multi-threading & Parallel programming: Introduction to Multithreading and Parallel Programming, Thread Concepts & its States, Creating Tasks & Threads, Thread Classes, Thread Pools, Thread Synchronization & Locks, Cooperation among Threads, Case Study: Producer/Consumer, Blocking Queues, Semaphores, Deadlock Avoidance, Synchronized Collections & Parallel Programming.

Java I/O and its Limitations, JDBC: API, Components, Architecture (2 Tier & 3 Tier), Drivers & Its Types, Packages for JDBC Connection, Steps to connect to Databases (PostgreSQL). Servlets: Overview, Life Cycle of Servlet, Attributes in Servlets, Interaction between Client & Servlet, Servlet demo Application development with Sessions, JSP: JSP & Advantages over servlets, Features, syntax, Life Cycle of JSP, Interaction between client, JSP & server, JSP demo Application Development.

Reference Books

- 1 Head First Design Patterns, Eric Freeman, Elisabeth Robson, Bert Bates, Kathy Sierra, Oct-04, O'Reilly Media, Inc.
- 2 Introduction to Java Programming, Y Daniel Lian, 2018, Pearson Education.
- 3 Step by Step Database Programming, Siahaan, V., Sianipar, R.H., 2019, SPARTA Publishing.

- 4 Head First Servlets and JSP, Kathy Sierra, Bryan Basham, Bert Bates, 25 March 2008, O'Reilly Media, Inc.
- 5 Java EE 7 Essentials, Arun Gupta and Debrahlee Charatan, August-2013, O'Reilly Media, Inc.

23CS2205R - DESIGN AND ANALYSIS OF ALGORITHMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23CS2205R	DESIGN AND ANALYSIS OF ALGORITHMS	DAA	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply concepts of mathematics to find space complexity, time complexities of various algorithms	3	PO1, PSO1
CO2	Analyze the problems that can be solved by using Divide and Conquer and Greedy Method	4	PO2, PO3, PO5, PSO1
CO3	Analyze the problems that can be solved by using Dynamic Programming and Backtracking	4	PO2, PO3, PO5, PSO1
CO4	Analyze the problems that can be solved by using Branch and Bound, NP-Hard Graph problems and Approximation Algorithms	4	PO2, PO3, PO5, PSO1
CO5	Solve and Analyze the complex and realtime problems by various design strategies	4	PO1, PO2, PO3, PO5, PSO2
CO6	Analyze the various design techniques to solve any real-world problems	4	PO1, PO2, PO3, PO5, PSO2

Syllabus

Introduction, Definition of an Algorithm Algorithm Specification Analysis of Algorithm PRAM Algorithms Merging Sorting. String Algorithms The Naive String Matching Algorithm, Robin Karp Algorithm.

Divide and Conquer, Merge Sort, Quick Sort, Strassen's Matrix Multiplication, Convex Hull. Greedy Method, The General Method Job Sequencing with Deadlines, Knapsack Problem, Minimum Cost Spanning Trees, Huffman Codes, Single Source Shortest Path Method.

Dynamic Programming, The General Method Optimal Binary Search Tree, 0/1 Knapsack, Traveling Sales Person Problem, Ford Fulkerson. Backtracking The Eight Queens Problem, Graph Coloring, Knapsack Problem.

Branch and Bound 0/1 Knapsack Problem, Traveling Sales Person Problem. NP Hard and NP Complete Problems, Basic Concepts Cook's Theorem, NP Hard Graph Problems, CDP, NCDP, AOG

KMP Algorithm, Sum Of Subset Problem, Approximation Algorithms Introduction, Planar Graph Coloring, Maximum Programs stored problem, NP-Hard Absolute approximation

Reference Books

- 1 Fundamentals of Computer Algorithms¹, Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, 2nd Edition, 2008, University Press.
- 2 Introduction to algorithms, Cormen, Leiserson & Rivest, 3rd Edition, 2002, Prentice-Hall.
- 3 Algorithm Design, Jon Kleinberg and Eva Tardos, 4th edition, 2006, Pearson Education.
- 4 Algorithms, Robert Sedgewick and Kevin Wayne, 4th edition, 2011, Addison Wesley Prof., .
- 5 Introduction to Design and Analysis of Algorithms, Anny Levitin, 2nd Edition, 2007, Person Education Press. .

23EC01HF - VLSI PHYSICAL DESIGN AUTOMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC01HF	VLSI PHYSICAL DESIGN AUTOMATION	VPDA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Formulate the graphs for the physical design problems and estimate the complexity of physical design algorithms	3	PO1, PO2, PSO1
CO2	Apply the group migration algorithm for the successive circuit partitioning	3	PO2, PO3, PSO1
CO3	Modify the floorplans in an abstract manner and apply computer algorithms to make large and optimized floorplans	3	PO1, PO3, PSO1
CO4	Apply quadratic and Euclidean distance approaches for the wire length estimation of the full custom / semi custom placement problem	3	PO2, PO4, PSO1
CO5	Apply the CAD design problems using algorithmic methods	3	PO3, PO4, PO5, PSO1

Syllabus

The physical design cycle in VLSI involves a top-down flow that encompasses stages from system specification to layout. In graph theory, key types include complete graphs, connected graphs, subgraphs, isomorphisms, bipartite graphs, and trees. Shortest path algorithms like Dijkstra's and spanning tree algorithms like Kruskal's and Prim's are fundamental. Additionally, Depth-First Search (DFS) and Breadth-First Search (BFS) are essential traversal methods. The computational complexity of these algorithms is often analyzed using Big O notation. Problems are classified into complexity classes such as P (solvable in polynomial time), NP (verifiable in polynomial time), NP-hard (at least as hard as the hardest problems in NP), and NP-complete (both NP and NP-hard).

Partitioning in VLSI design involves dividing a circuit into smaller, manageable sections to optimize performance and reduce complexity. The objective is to minimize interconnections between partitions while balancing size and computational load. Common goals include improving signal integrity, reducing delay, and enhancing manufacturability. Partitioning algorithms can be classified into different types such as group migration algorithms and iterative improvement algorithms. The Kernighan-Lin Algorithm is a well-known group migration algorithm, with extensions developed to handle larger and more complex systems. Simulated annealing is another method that uses probabilistic techniques to find a near-optimal solution by escaping local minima. Multilevel partitioning involves hierarchically dividing the design, coarsening the graph, partitioning at a coarse level, and then refining it, which helps in efficiently handling very large designs.

Floorplanning in VLSI design involves determining the placement of various functional blocks within a chip to optimize performance, area, and power consumption. The optimization goals are to minimize area, reduce interconnect lengths, and improve timing and power efficiency. Floorplan representations translate the physical layout into abstract models, such as converting a floorplan to a constraint-graph pair, which captures spatial relationships and constraints between blocks. Another representation is the sequence pair, which provides a compact and efficient way to describe the relative positions of modules. Converting a sequence pair back into a floorplan involves decoding these positional relationships into a physical layout. Floorplanning algorithms include floorplan sizing, which adjusts the dimensions of blocks to fit optimally within the chip area; cluster growth, which incrementally places blocks by grouping them based on connectivity; and integrated floorplanning algorithms, which combine floorplanning with other design stages for holistic optimization. Pin assignment involves determining the optimal locations for input/output pins on the blocks to minimize routing complexity and signal delay.

In VLSI design, placement involves positioning the various circuit components on the chip to optimize performance and minimize wire length. Wire length estimation models, such as the half-perimeter wire length and Rent's rule, are essential for effective placement. Quadratic placement techniques use mathematical optimization to minimize wire length by solving quadratic equations, while the sequence pair technique ensures relative positioning of blocks to reduce overlap and congestion.

Simulation and logic synthesis are critical processes in VLSI design, encompassing gate-level and switch-level modeling and simulation. Gate-level simulation focuses on the behavior of digital circuits at the level of logic gates, while switch-level simulation models the transistors and their interconnections, offering more detailed analysis.

Reference Books

- 1 VLSI Physical Design Automation .Theory and Practice, H. Yosuff and S.M. Sait, 2010, Cambridge.
- 2 Practical Problems in VLSI Physical Design Automation, Sung Kyu Lim, 2011, Springer.
- 3 Algorithms for VLSI Physical Design Automation, Naveed A. Sherwani, 1999, Kluwer Academic Publishers.
- 4 VLSI Physical Design: From Graph Partitioning to Timing Closure, Andrew B. Kahng, Jens Lienig, Igor L. Markov, JinHu, 2011, Springer.

23EC02HF - SENSORS AND TRANSDUCERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC02HF	SENSORS AND TRANSDUCERS	SAT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply concepts of mechanical, electromechanical, and inductive sensors, including their operating principles, types, materials, and performance characteristics.	3	PO1, PO2, PSO1
CO2	Identify concepts of capacitive and piezoelectric sensors, covering their fundamental operating principles, various design configurations, sensitivity calculations, and applications in areas like microphones, force sensors, and ultrasonic	3	PO1, PO2, PSO1
CO3	Apply thermal sensors, including their operating principles, material selection, performance characteristics (accuracy, range) for different types like material expansion, resistance change (RTD, thermistor), thermoelectric (thermocouple, IC, PTAT), and radiation sensors (pyroelectric etc.).	3	PO1, PO2, PSO1
CO4	Analyze magnetic and radiation sensors, exploring principles like Villari, Wiedemann, Thomson, and Hall effects, along with their applications in force, torque, proximity sensing, and radiation detection using LDRs, photovoltaics, photodiodes, Geiger counters, and scintillation detectors.	4	PO1, PO2, PSO1
CO5	Examine interfacing sensors and devices using analog and digital methods, communication protocols (I2C, SPI), and data acquisition systems, including sampling and conversion techniques.	4	PO1, PO2, PO5, PSO1

Syllabus

Mechanical and Electromechanical sensor Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity. Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes. Inductive sensor: common types- Reluctance change type, Mutual inductance change type, transformer action type, Magnetostrictive type, brief discussion with respect to material, construction and input output variable, Ferromagnetic plunger type, short analysis. LVDT: Construction, material, output input relationship, I/O curve, discussion. Proximity sensor.

Capacitive sensors: variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics. Piezoelectric element: piezoelectric effect, charge and voltage co-efficient, crystal model, materials, natural & synthetic type, their comparison, force & stress sensing, ultrasonic sensors.

Thermal sensors: Material expansion type: solid, liquid, gas & vapor Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermister material, shape, ranges and accuracy specification. Thermoemf sensor: types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type. Radiation sensors: types, characteristics and comparison. Pyroelectric type

Magnetic sensors: Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics. Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell-types, materials, construction, response. Geiger counters, Scintillation detectors.

Interfacing Methods Analog and digital interfaces Communication protocols (e.g., I2C, SPI) Data Acquisition Systems Sampling and conversion techniques

Reference Books

- 1 Sensor & transducers, D. Patranabis, 2003, PHI .

- 2 Instrument transducers, H.K.P. Neubert, 1999, Oxford University press.
- 3 Measurement systems: application & design, E.A.Doebelin, 1990, Mc Graw Hill..
- 4 A Textbook of Medical Instruments , S. Ananthi , 2005, New Age International Private Limited .

23EC2209R - ELECTROMAGNETIC WAVES & TRANSMISSION LINES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2209R	ELECTROMAGNETIC WAVES & TRANSMISSION LINES	EMWTL	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply vector calculus to interpret the behavior of Electrostatics in different media.	3	PO1, PSO1
CO2	Apply the principles of magnetostatics to estimate and evaluate the behavior of the field in different media.	3	PO1, PSO1
CO3	Apply the concepts of Maxwell equations to characterize the uniform plane wave Propagation in lossless and lossy media.	3	PO1, PSO1
CO4	Analyze the propagation characteristics of transmission lines at various frequencies.	4	PO2, PSO1

Syllabus

Static Electric Fields: Coordinate systems, Charge distributions, Coulombs Law, Electric field intensity, electric flux density, Gauss Law and applications, Divergence, Divergence theorem, Potential and Potential difference, Potential gradient. Boundary conditions on E and D. Electric current, current densities, equation of continuity.

Static Magnetic Fields: Biot Savart Law and applications, Ampere circuital law, differential form of Ampere circuital law, Curl, Stoke theorem, Lorentz force equation, force on a current element in magnetic field, Boundary conditions on B and H.

Electromagnetic Waves: Faraday law of Induction, Maxwell Equations in Differential and integral forms. Wave equation for free space, Uniform plane wave general solution and propagation. Wave equations for conducting medium. Wave equations in phasor form, wave propagation in loss less medium, Poynting vector.

Transmission lines: General Solution, input impedance, infinite line, wavelength, velocity, Reflection Coefficient, Open and short circuited lines, lossless line, standing wave ratio, input impedance, open and short circuited lossless lines, Impedance matching.

Reference Books

- 1 Engineering Electromagnetics , W H.Hayt and J A Buck , 2007 , TATA McGraw-Hill.
- 2 EM waves and Radiating Systems , EC.Jordan , 2011, PHI.
- 3 Netwotk Lines and fields, John D Ryder , 2005, PHI.
- 4 Elements of Electromagnetics, Mathew no Sadiku, 2003, Oxford University Press.
- 5 Field and Wave Electromagnetics , David K.Cheng, 2004, Pearson Edition.

23EC2211R - VLSI DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EC2211R	VLSI DESIGN	VLSID	R	3	0	2	2	4.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Realize MOS device with transient and DC characteristics	3	PO1, PO2
CO2	Understand the characteristics of CMOS inverter	3	PO1
CO3	Analyze the static and dynamic characteristics of CMOS circuits	4	PO2, PO3
CO4	Analyze the performance of CMOS circuits	4	PO1, PO2
CO5	Design and analyze the combinational and sequential circuits using Cadence VLSI Design Full Suite	4	PO1, PO4, PO5, PSO1, PSO2
CO6	Design and analysis of VLSI circuits for real time applications.	4	PO2, PO3, PO5, PSO1, PSO2

Syllabus

MOS Transistor Theory: Introduction to the metal oxide semiconductor (MOS) structure, Long-channel I-V characteristics, C-V characteristics, non-linear I-V effects, and DC transfer characteristics. CMOS Process Technology: Fabrication process flow- basic steps, the CMOS n-Well process, layout design rules, stick diagram, full-custom mask. Circuit Characterization and Performance Estimation: Introduction, Delay Estimation, Logical effort and transistor sizing, power dissipation, interconnect, design margin, reliability, scaling. MOS Inverters: Resistive load, depletion load, enhancement load, CMOS inverter, Static and Dynamic characteristics.

Combinational CMOS Logic Circuits: MOS logic circuits with depletion nMOS loads, MOS Inverter - Static Characteristics, Switching Characteristics, and Interconnects effects, CMOS logic circuits, complex logic circuits, CMOS transmission gates (pass gates), ratioed, dynamic and pass transistor logic circuits.

Sequential MOS logic circuits: Behavior of bi-stable elements, SR latch circuits, clocked latch and flip-flop circuits, CMOS D-latch, and edge-triggered flip-flop. Timing path, Setup time and hold time static, an example of setup and hold time static, setup and hold slack, clock skew and jitter, Clock, reset, and power distributions. Memory Design, SRAM, DRAM structure, and implementations.

Reference Books

- 1 Principles of CMOS VLSI Design: A System Perspective electrical Circuit Theory and Technology, N. H. E. Weste and C. Harris, 2007, Pearson.
- 2 Digital Integrated Circuits: A Design Perspective, J. Rabaey, A. Chandrakasan and B. Nikolic, 2004, Prentice Hall.
- 3 Basic VLSI design, Pucknell, Douglas A., and Kamran Eshraghian, 1994, Prentice Hall.
- 4 CMOS digital integrated circuits, Kang, Sung Mo, and Yusuf Leblebici, Kang, Sung Mo, and Yusuf Leblebici, MacGrawhill.

23EE01HF - RESTRUCTURED POWER SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE01HF	RESTRUCTURED POWER SYSTEMS	RPS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of deregulated market structures and reforms in Indian Power Sector	2	PO1
CO2	Apply different techniques for finding available transfer capacity for congestion management	3	PO5
CO3	Analyze transmission pricing methods and effect of congestion on LMPs	4	PO5
CO4	Understand ancillary services and system security in deregulation	2	PO5
CO6	Analyze the problems in restructured power systems using simulation tools	4	PO5

Syllabus

Need and conditions for deregulation: Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Different forms of Ownership and management. Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model, Reforms in Indian power sector, Availability based tariff

Congestion management: Review of Concepts original cost of generation, Short-run and Long-run cost, Various costs of production, least-cost operation, incremental cost of generation, Definition of congestion, Reasons for transfer capability limitation, Calculation of ATC , ATC calculation using PTDF and LODF based on DC model

Pricing: Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices. effect of congestion on LMPs Transmission network and market power, Power wheeling transactions and marginal costing, transmission costing, transmission loss ,financial transmission rights

Ancillary Services and System Security in Deregulation: Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry. Load-generation balancing related services, Frequency regulation, Load following, Spinning reserve services.

Reference Books

- 1 Operation of restructured power systems, K Bhattacharya, M.H.J. Bollen and J.E. Daalder , 2001, Kluwers Power Electronics and Power Systems Series..
- 2 Market Operations in Electric Power Systems, M. Shahidehpour, H. Yamin and Z. Li,, 2002, John Wiley and Sons..
- 3 Power Generation Operation and Control, A.J.Wood and B.F.Wollenberg, 1996, John Wiley and sons, New York, .
- 4 Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry, N. S. Rau, 2003, Wiley IEEE Press,.
- 5 Power System Economics: Designing markets for electricity, StevenStoft,, 2002, IEEE Computer Society Press.

23EE2101 - ELECTRICAL CIRCUITS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE2101	ELECTRICAL CIRCUITS	ELC	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand two-port network parameters (Z, Y, H, ABCD) and their interrelations for circuit design.	2	PO1, PO5, PSO1
CO2	Apply transient responses of resistors, capacitors, and inductors under AC and DC conditions.	3	PO1, PO5, PSO1
CO3	Apply network topology techniques (node and mesh analysis) to solve circuit problems.	3	PO1, PO5, PSO1
CO4	Apply Kirchhoff's laws to calculate power in three-phase circuits, both balanced and unbalanced. This involves understanding voltage, current distributions, and power factor calculations.	3	PO1, PO5, PSO1
CO6	Analyze network theorems like Thevenin's and Norton's, three-phase power flows, and circuit transients. This comprehensive analysis is key to solving complex electrical engineering problems.	4	PO1, PO5, PSO1

Syllabus

Two port Networks: One port and two port networks, two port network parameters: Z, Y, Transmission and Hybrid parameters and their relationships.

Transients: Response of R-L, R-C, R-L-C (Series and parallel combinations) for impulse, step, ramp excitations. Transient response of R-L, R-C, R-L-C circuits (Series and parallel combinations) for D.C and sinusoidal excitations, initial conditions, time domain and Laplace transform methods of solutions.

Network Topology - definitions, graph, tree, basic cut-set and basic tie set matrices for planar network, Loop and Nodal methods of analysis of networks, duality and dual networks.

Three Phase Circuits: Three phase circuits-phase sequence, star and delta connection, Relation between line and phase voltages and currents in balanced systems, Analysis of balanced and unbalanced 3 phase circuits.

Magnetic circuits: concept of mutual inductance, dot convention, coefficient of coupling, Magnetic Circuits, Analysis of series and parallel magnetic circuits.

Reference Books

- 1 Network Analysis , M. E. Van Valkenberg , 1998, Prentice-Hall of India Pvt. Ltd. .
- 2 Engineering circuit analysis , William Hayt and Jack E. Kemmerly , 2007, Tata Mc Graw-Hill Companies .
- 3 Fundamentals of Electric Circuits , Charles K Alexander, Mathew N O Sadiku , 2007, Tata McGraw Hill Education Pvt. Ltd. .
- 4 Introductory Circuit Analysis, Robert L. Boylestad, 2015, Pearson.
- 5 Engineering Circuit Analysis, William H. Hayt Jr., Jack E. Kemmerly, Steven M. Durbin, 2018, McGraw-Hill Education.
- 6 Circuit Analysis: Theory and Practice, Allan H. Robbins, Wilhelm C. Miller, 2012, Cengage Learning.

23EE2102R - ELECTRICAL MACHINES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE2102R	ELECTRICAL MACHINES	ELM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the performance of single-phase and three-phase Transformers.	4	PO1
CO2	Apply the basic principles of electromechanical energy conversion and DC Generators.	3	PO1
CO3	Apply the basic principles of electromechanical energy conversion to DC Machines and induction machines.	3	PO2
CO4	Apply the basic principles of electromechanical energy conversion to Synchronous Machines.	3	PO2
CO5	Test the performance of Electrical Machines: single-phase and three-phase Transformers, DC Machines, induction machines and Synchronous Machines.	4	PO1, PO5

Syllabus

Transformers: Single-phase transformer: equivalent circuit, phasor diagram, EMF equation, direct load test. open circuit and short circuit tests, regulation, and efficiency; Three-phase transformers: connections, parallel operation; Auto-transformer.

Electromechanical Energy Conversion: Basic principles of Energy, Lorentz force equation, the general expression of stored magnetic energy and Co energy. Force and Torque equations of single and multiple excited systems. DC Generators: Working principle and construction of DC machines, methods of excitation. EMF equation. Circuit models, Armature reaction, commutation process, Compensating winding, Characteristics of various types of generators.

DC. Motors: Working Principle, Torque equation, and types of DC motors. Performance of DC Machines- Testing- Direct, and indirect methods of DC machines. Induction Motor: Constructional features, Rotating magnetic Field, phasor diagram, equivalent circuit, production of torque, torque-slip characteristics.

Synchronous Machines: Alternators-Constructional features. Cylindrical rotor machine- Synchronous Generator- Generated e.m.f., circuit model and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Direct Load Test. Synchronous Motor, principle, starting, hunting, damper windings

Performance of Electrical Machines: Transformers-DC Machines-Induction Motors-Synchronous Machines.

Reference Books

- 1 Electric Machinery Fundamentals, Stephen J Chapman, Fourth Edition-2005, McGraw Hill, Singapore .
- 2 Electric Machinery, A.E.Fitzgerald, C Kingsley and S Umans, 7th Edition-2013., McGraw Hill.
- 3 Theory of Alternating Current Machinery, Alexander S Langsdorf, 2nd ed-2001., Tata Mc Graw-Hill.
- 4 Electrical Machines, I.J Nagrath& D.P Kothari, 3rd edition-2009., Tata Mc Graw-Hill.
- 5 Electrical Machines, P.S. Bimbra, 7th Edition-2007, Khanna Publishers.

23EE2204R - ELECTRICAL POWER GENERATION, TRANSMISSION & DISTRIBUTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE2204R	ELECTRICAL POWER GENERATION, TRANSMISSION & DISTRIBUTION	EPGTD	R	2	1	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the working of various generating stations and the economic aspects of generation.	2	PO1, PO3
CO2	Apply field concepts to calculate the over-head transmission line and underground cable electrical parameters.	3	PO1, PO2
CO3	Analyse the performance of overhead transmission lines and AC/DC distribution.	4	PO1, PO3
CO4	Analyse mechanical sag, corona, Insulators, and substation layouts.	4	PO1, PO3

Syllabus

Generating stations: Organization of power sector in India, Layout & Operation of Thermal, Hydro, Nuclear and combined cycle power stations. Overview of Solar, Wind Power Plant and Fuel Cells. Economics of generation, load curves, Demand Factor, load factor, diversity factor, Plant Capacity Factor, Plant Use Factor & Utilization Factor, Characteristics of Tariff, Types of Tariffs.

Transmission line parameters: Types of conductors - calculation of resistance for solid conductors - Calculation of inductance for single phase and three phase, single and double circuit lines, concept of GMR & GMD, Calculation of capacitance for 2 wire and 3 wire systems, effect of ground on capacitance, capacitance calculations for symmetrical and asymmetrical single and three phase, single and double circuit lines. Underground cable Types of cables, grading concepts, Capacitance of three core belted type cable. Cable sizing.

Transmission line theory: Introduction, short transmission line, medium transmission line, evaluation of A, B, C, D Constants, Surge Impedance Loading of Long Lines, Ferranti effect, elementary concepts of AC and DC distribution.

Corona- factors affecting corona, critical voltages, and power loss; Radio interference due to Corona. Insulators: Types of Insulators, String efficiency and Methods for improvement, calculation of string efficiency, Capacitance grading and Static Shielding. Mechanical sag. Substation practice: Classification of substations, layout, and bus bar arrangements.

Reference Books

- 1 A Course in Power Systems, J B Gupta, 1987, S. K. Kataria & sons.
- 2 Electrical Power Systems , C. L. Wadhwa, 1983, New Age International (P) Limited Publishers .
- 3 Power System Engineering , J. Nagarath and D.P Kothari , 1994, Tata Mc Graw-Hill .
- 4 A Course in Electric Power , Soni, Gupta and Bhatnagar , 1984, Dhanpat Rai & Sons. .
- 5 Electric Power Generation, Transmission & Distribution , S. N. Singh , 2003, Prentice Hall India. .

23EE3106R - POWER SYSTEM ANALYSIS & STABILITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE3106R	POWER SYSTEM ANALYSIS & STABILITY	PSAS	R	2	1	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of network matrices for solution of power flow problems	3	PO1
CO2	Apply the reactance diagrams for Symmetrical short circuit faults in power system	3	PO5
CO3	Analyze symmetrical components for unsymmetrical fault analysis in a power system	4	PO5
CO4	Analyze rotor angle stability	3	PO1

Syllabus

Power Flow Solutions: Network model formulation, Formation of YBUS by Direct Inspection Method, Formation of ZBUS, Power flow problem formulation, GS method, NR Method (Polar Coordinate Approach), FDLF.

Symmetrical Fault Analysis: Representation of Power Systems Components, Per Unit System, Reactance diagrams, change of base values, Short circuit of synchronous machine unloaded, Calculation of symmetrical short circuit currents for simple systems.

"Unsymmetrical Fault Analysis: Symmetrical components transformation, Sequence Impedance and Networks of Power System Components, Unsymmetrical Faults on an Unloaded Generator and Power Systems. "

Power System Stability: Dynamics of a synchronous machine, Swing equation, power angle equation, Single machine connected to infinite bus, two machine system, steady state stability, Transient stability analysis using Equal Area Criterion, critical clearing angle

Reference Books

- 1 Power System Analysis , John J Grainger, William D Stevenson , 2008 , Tata McGraw Hill,.
- 2 Computer Methods in Power System Analysis , Stagg & el-Abiad, 1980, McGraw-Hill .
- 3 Modern Power System Analysis , I.J. Nagrath, D.P. Kothari, 2008, Tata McGraw Hill,.
- 4 Electrical Power Systems , C.L.Wadhwa , 2008, New Age International (P) Limited,.
- 5 Power System Analysis and Design, B.R. Gupta, 2003, wheeler publishers.

23EE3208R - POWER SYSTEM PROTECTION & CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23EE3208R	POWER SYSTEM PROTECTION & CONTROL	PSPC	R	2	0	2	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principle of protective relays & circuit breakers	2	PO1, PO5, PSO1
CO2	Apply overcurrent, distance and differential schemes for the protection of power system equipment	3	PO1, PO5, PSO1
CO3	Analyze over voltage protection and economic operation of power system	4	PO1, PO5, PSO1
CO4	Understand automatic generation control and voltage regulators	2	PO1, PO5, PSO1
CO5	Test the characteristics of power system protective relays and Operation of power systems through programming/simulation	4	PO1, PO5, PSO1
CO6	Build the protection system for electrical distribution system	4	PO1, PO5, PSO1

Syllabus

Power System Protection: Introduction, need for protective systems, nature and causes of faults, essential qualities of protection, zones of protection, primary and backup protection, Classification of protective relays & Schemes- over current, differential and distance protection, Arc voltage, Arc interruption, re-striking and recovery voltage, resistance switching, current chopping, Classification of circuit breakers and their ratings.

Protection against Over Voltages: Causes of over voltages, ground wires, lightning arresters, Neutral Grounding: Necessity of earthing, step voltage, Types of neutral grounding.

Economic Dispatch: Optimal operation of generators on a Bus Bar, optimum generation scheduling with and without constraints.

Automatic Generation Control & Automatic Voltage Regulator: Load frequency control single area (Single area case), Load frequency control and economic dispatch control, Automatic voltage control, AVR block diagram.

Reference Books

- 1 Modern Power System Analysis, D. P. Kothari, I. J Nagrath, 2003, Tata Mc-Graw Hill Publications.
- 2 Power System Protection and Switchgear, Badri Ram, D N Vishwakarma, 1995, ata Mc-Graw Hill .
- 3 Power System Analysis, 1. Jhon J Grainger, William D Stevenson Jr, 1994, Tata Mc-Graw Hill Publications.
- 4 Switch Gear Protections, Sunil S Rao,, 2008, Khanna Publications.

23ME1002 - ENGINEERING GRAPHICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME1002	ENGINEERING GRAPHICS	EG	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Enumerating engineering curves, Listing various geometries and descriptions on multiple scales.	2	PO1, PO5, PSO1
CO2	Apply the concept of first-angle and third-angle projection,	3	PO1, PO5, PSO1
CO3	Demonstrate sectional view and sketching in modern tools.	3	PO1, PO5, PSO1
CO4	Apply the engineering design process to real world problems	3	PO1, PO5, PSO1

Syllabus

Introduction to Engineering Drawing Principles of Engineering Graphics and their significance Drawing Instruments and their Use Conventions in Drawing Lettering Conic Sections Ellipse Parabola Hyperbola and Rectangular Hyperbola oblong concentric method Special Curves Cycloid Epicycloids Hypocycloid and Involute Scales Plain and Vernier scales

Projection of Lines points and Projections of Planes First and Third Angle Projections of Points and Lines inclined to planes True lengths, traces Constructions Projections of regular planes inclined to both planes

Projections of Solids and Developments of surfaces Projections of Regular solids inclined to one plane Sections and Sectional Views Right Regular Solids Prism Cylinder Pyramid Cone Surface development of right regular solids Prisms Cylinder Pyramid cone and their parts Understand the fundamentals of modelling and design for manufacturing

Orthographic Projection in First Angle Projection and Isometric Projections Principles of Orthographic Projections conventions Principles of Isometric Projection Isometric Scale Isometric view conventions Isometric View of Lines Plane Figures and simple problems Transformation of Projections Conversion of Isometric Views to Orthographic Views Conventions Analyse manufacturing processes and their impact on product design. Utilize Fusion 360 software for computer aided design (CAD) modeling and visualization

Reference Books

- 1 Engineering Drawing , N.D.Bhat/ Charotar , 3rd Edition 2011, Pearson Education .
- 2 Engineering Graphics, , Agrawal B. & Agrawal C. M , 2012, TMH Publication. .
- 3 Fundamentals of Engineering Drawing , .W.J. Luzadder and J.M. Duff , 11th edition 2015, PHI learning .
- 4 Visualization, Modeling, and Graphics for Engineering Design , D.K. Lieu and S.A. Sorby , 2nd Edition 2016, Cengage Learning .

23ME1004 - WORKSHOP PRACTICES FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME1004	WORKSHOP PRACTICES FOR ENGINEERS	WPE	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Prepare carpentry joints, fitting trade fits, tin-smithy components, and house wiring.	3	PO1, PO3, PSO1
CO2	Prepare mould cavities, perform lathe, drill, grinding operations, create welding joints, and CNC programs.	3	PO1, PO3, PSO1

Syllabus

Carpentry, including simple exercises in woodworking, pattern making, fitting operations, and power tools, along with electrical wiring and sheet metal working

Welding (arc welding), moulding, and casting alongside manufacturing methods such as drilling, turning, milling, surface grinding, and code preparation for CNC machining

Reference Books

- 1 Elements of Workshop Technology , Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K. , 3rd Edition , Media promoters and publishers private limited, Mumbai. .
- 2 Production drawing , K.L.Narayana and P.Kannaiah , 2nd Edition , New Age International .
- 3 Processes and Materials of Manufacture , Roy A. Lindberg , 4th edition , Prentice Hall India .
- 4 Manufacturing Engineering and Technology, Kalpakjian S. And Steven S. Schmid, 4th edition, Pearson Education India Edition.

23ME2107R - THERMODYNAMICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME2107R	THERMODYNAMICS	TD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Examine the basic terminology used in thermodynamics	2	PO1, PSO1
CO2	Apply first law of thermodynamics to various flow and non-flow processes.	3	PO1, PSO2
CO3	Apply second law of thermodynamics and principle of entropy to Engineering Devices	3	PO1, PSO2
CO4	Apply thermodynamic principles to estimate the performance of different air standard cycles and different psychrometric processes	3	PO2, PSO2

Syllabus

Fundamental Concepts and Definitions: Thermodynamic system and control volume, macroscopic and microscopic points of view, thermodynamic properties, processes, state, path, cycle, thermodynamic equilibrium and quasi-static process. Reversible and irreversible processes

zeroth law, concept of temperature. Work and Heat: Definition of work, units, work done at the moving boundary of system, work done in various non-flow processes, definition of heat, units, comparison of heat and work. First Law of Thermodynamics for Non-Flow Systems: First law of thermodynamics for a closed system undergoing a cycle and for a change of state; energy - a property of system, internal energy and enthalpy. Specific heat at constant volume and constant pressure. First Law of Thermodynamics for Flow Systems: Control mass, control volume, first law of thermodynamics for a control volume, steady flow energy equation and applications to engineering equipment and PMM-1

Second Law of Thermodynamics: Thermal reservoirs, Kelvin-Planck and Clausius statements of second law of thermodynamics; Equivalence of Kelvin-Planck and Clausius statements, PMM-2; Carnot cycle, Carnot engine, corollary of Carnot's theorem, absolute thermodynamic temperature scale. Entropy: Definition of entropy, Clausius theorem, entropy change in reversible process temperature-entropy plot, inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy, applications of entropy principle, entropy change of an ideal gas; availability and irreversibility. Air standard cycles: Performance analysis of Otto, Diesel, Dual, and Brayton cycles.

Psychrometric: Psychrometric properties, psychrometric chart and air-conditioning process -Sensible heating and cooling Humidification and dehumidification, Mixing of air streams Adiabatic saturation process Psychrometric process equations Basic components of air conditioning systems Types of air conditioning systems

Reference Books

- 1 Thermodynamics, an Engineering Approach, Yunus A. Cengel & Michael Boles, 2, 1990, Tata McGraw Hill, New Delhi.
- 2 Engineering Thermodynamics, P. K. Nag, 4, 1995, Tata McGraw Hill, New Delhi.
- 3 Engineering Thermodynamics, Cohen and Rogers, 1, 1995, Pearson Education India limited.
- 4 Thermodynamics, E Rathakrishnan, 2, 2005, Eastern economy edition.

23ME2209R - KINEMATICS & DYNAMICS OF MACHINES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME2209R	KINEMATICS & DYNAMICS OF MACHINES	KDOM	R	3	1	2	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic principles and concepts of kinematics and mobility of the mechanisms.	3	PO1, PO5
CO2	Analyze and kinematic design of mechanisms and machines using velocity and? acceleration analysis.	4	PO1, PO5
CO3	Apply principles of cams to draw cam profiles and understand gear systems and gear trains for various applications.	3	PO1, PO5
CO4	Understand the principles of balancing and vibrations and analyze gyroscopic effect on naval ships and automobiles.	4	PO1, PO5
CO5	Apply and analyze the concepts learned in theory to perform experiments related to mechanisms and machines using the ADAMS simulation software for data analysis.	4	PO1

Syllabus

Introduction to Kinematics and Dynamics of Machines: Basic concepts and definitions, Types of motion, Degrees of freedom, Kinematics of Mechanisms: Linkages and mechanisms.

Velocity and acceleration analysis of Mechanisms by IC and relative velocity method.

Cams: classification, knife-edge, roller followers; Gears: terminology, fundamental law, contact lengths, interference, gear trains: simple, compound, reverted, epicyclic.

Balancing by static and dynamic methods, force transfer between planes, balancing reciprocating masses, and gyroscope effects on vehicles. Machine vibrations, free/forced vibrations, critical speeds, and isolation.

Reference Books

- 1 Theory of Machines, S S Ratan, 2017, Tata McGraw-Hill Education.
- 2 THEORY OF MECHANISMS AND MACHINES, Amitabha Ghosh, Asok Kumar Mallik, 1998, Affiliated East-West Press Pvt. Ltd..
- 3 Kinematics and Dynamics of Machines, George H. Martin, 2002, McGraw-Hill.
- 4 Theory of Machines and Mechanisms, John J. Uicker Jr., Gordon R. Pennock, Joseph E. Shigley, 2014, Oxford University Press.
- 5 The Theory of Machines through Solved Problems, J.S. Rao, 1996, New Age International.

23ME3110R - HEAT TRANSFER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME3110R	HEAT TRANSFER	HT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Fourier law of conduction and combined conduction convection concepts to 1-D heat transfer problems	3	PO1, PO2, PSO1
CO2	Analyze heat transfer through extended surfaces and apply unsteady state heat transfer to various systems	4	PO1, PO2, PSO1
CO3	Apply the empirical correlations for solving convection heat transfer and heat transfer through during phase change problems	3	PO1, PO2, PSO1
CO4	Analyze various types of heat exchangers by applying the principles of conduction, convection, radiation	4	PO1, PO2, PSO1
CO5	Analyze various parameters of heat transfer in different thermal systems physically/numerically	4	PO1, PO2, PSO1

Syllabus

Introduction to fundamental processes of heat transfer and their governing laws. 1-D steady state heat conduction in single and multi-layered plane walls, cylinders and spheres along with concepts of thermal contact resistance and critical thickness of insulation. One dimensional heat conduction with internal heat generation

Fins-applications and performance analysis; Transient conduction-lumped capacitance, semi-infinite body and application of Heisler and Grober charts

Elementary convection including laminar and turbulent boundary layers in external flows and internal flows of forced convection, natural convection. Heat transfer in boiling and condensation

Basic concepts of heat exchangers; Thermal radiation-Stefan-Boltzmann law, small object in a large enclosure, parallel plates and shape factor

Reference Books

- 1 Introduction to Heat Transfer , Incropera, F. P. and Dewitt, D. P , 2th edition, 1994, John Wiley and Sons. .
- 2 Heat transfer A practical approach , Yunus A. Cengel , 4th edition, 2003, Tata McGraw Hill.
- 3 Heat Transfer - A Conceptual Approach , P. K. Sarma and K. Ramakrishn, 4th edition, 2006, 2006 .
- 4 Heat and Mass Transfer, R. K. Rajput,, 2th edition 2008, S. Chand & Company Limited .
- 5 Heat and Mass Transfer Data Book, C. P. Kothandaraman, 8th edition 2017, NEW AGE INTERNATIONAL PUBLISHERS.

23ME3111R - MECHANICAL ENGINEERING DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME3111R	MECHANICAL ENGINEERING DESIGN	MED	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply engineering design phases and general considerations to design any machine component	3	PO2, PSO2
CO2	Apply the mechanical behavior of engineering materials concept to solve any material failure problem	3	PO2, PSO2
CO3	Analyse the machine components for static strength	4	PO2
CO4	Analyse the machine components for fatigue strength	4	PO2

Syllabus

Design Philosophy, Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design. General considerations and procedure in machine design, Codes & Standards, Reliability, Preferred numbers

Selection of Materials and Shapes: Mechanical behavior of engineering materials, Selection of Materials, Selection of Shapes. Fundamentals of mechanical behavior of materials, as well as design with materials: elasticity, plasticity, fatigue, fracture, and creep

Design for Static Strength: Simple Stresses - Combined stresses - Torsional and Bending stresses - Factor of safety and theories of failure

Design for Fatigue Strength: Stress concentration, Methods of reducing stress concentration, design for fluctuating stresses, Endurance limit, Estimation of Endurance strength, Notch sensitivity, Goodman line and Soderberg line, Combined fluctuating stresses

Reference Books

- 1 Design of machine elements , V. B. Bhandari , 5th;2020, McGraw-Hill International .
- 2 Machine Design , Robert L. Norton , 5th;2018, Pearson.
- 3 Shigley's Mechanical Engineering Design , Richard G Budynas; J Keith Nisbett , 11th;2020, McGraw-Hill International .
- 4 Materials selection in Mechanical Design , Michael F. Ashby , 5th;2019, Elsevier Butterworth-Heinemann .

23ME3113R - MANUFACTURING TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
23ME3113R	MANUFACTURING TECHNOLOGY	MT	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize the concept of metal cutting processes	3	PO2, PSO1
CO2	Select appropriate machine tool to prepare desired objects	3	PO1, PSO2
CO3	Make use of non-traditional machining processes	3	PO1, PSO2
CO4	Construct the automation of production lines	3	PO4, PSO1
CO5	Apply the concepts of modern manufacturing processes	3	PO5, PSO2

Syllabus

Overview of metal cutting, single and multi-point cutting tools, orthogonal and oblique cutting, force components, Merchant's force circle diagram, chip formation, tool wear and life, cutting tool materials, and cutting fluids.

Machine Tools, Introduction to Lathe, milling, drilling, boring, shaper, slotter, planer. Mechanics and operations, principles of work holding, jigs and fixtures

Nontraditional machining processes, Introduction to Abrasive Jet Machining, Water Jet Machining, Ultrasonic Machining, Electrical Discharge Machining and Electro chemical machining, principle and process parameters, MRR

Automation and CNC, Reasons and strategies of Automation, Basic Components of NC, CNC, DNC. Economics and comparison, Absolute and Incremental Positioning, CNC Programming for Turning, Milling and Drilling operations

Reference Books

- 1 Processes and Materials of Manufacture, Lindberg, Revised edition, Prentice hall India (p) Ltd.
- 2 Manufacturing Engineering and Technology, Serope Kalpakjian, 4rth Edition, Prentice Hall .
- 3 Mechanical Metallurgy, Dieter, Revised edition , Mc Graw.
- 4 Advanced Machining Processes, Vijay K Jain , Revised Edition, Allied Publishers Pvt Limited.

Our Campuses


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Guntur District, A.P., India, Pincode : 522 302.


Aziznagar, Moinabad Road,
Near TS Police Academy, Hyderabad, Telangana,
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Gajularamaram, Hyderabad, Telangana,
India, Pincode : 500 043

 
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