



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

Y25: B.Tech. - Mechanical Engineering

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: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
P02	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
P03	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
P04	Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
P05	Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
P06	The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)
P07	Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
P08	Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
P09	Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
P010	Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to ones own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
P011	Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)
PSO1	Apply principles of mechanics, thermal sciences, and manufacturing to develop innovative, efficient, and sustainable engineering solutions that address industrial and societal challenges.
PSO2	Design, analyze and manufacture mechanical systems and products that meet technological, economic and environmental needs.

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 and achieve the prescribed CGPA/SGPA, and fulfill the defined outcomes and targets outlined in the degree requirements.
- **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 and achieve the prescribed CGPA/SGPA, and fulfill the defined outcomes and targets outlined in the degree requirements.

- **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 and achieve the prescribed CGPA/SGPA, and fulfill the defined outcomes and targets outlined in the degree requirements.
- **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 and achieve the prescribed CGPA/SGPA, and fulfill the defined outcomes and targets outlined in the degree requirements.

Note: For the above-mentioned major flexibilities, if a student fails to meet the prescribed CGPA/SGPA requirements along with the specific outcome/targets outlined for the respective degree, at any point after registration, then they will lose their eligibility for the honors degree. In such cases, the student will be awarded only the regular B.Tech. Degree. However, a separate grade sheets will be issued, listing the additional courses successfully completed by the student.

Program Add-ons:

- **Specialization:** Specialization degree can be awarded if student completes five professional electives in the same track of his/her interest in addition to fulfilling all other degree requirements.
- **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. Students opting for an Honors degree are additionally required to complete one more global certification or value-added course in their chosen discipline.

- **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.
- **Peer Learning Mode:** Encourages collaborative learning, where students actively learn from and with each other through discussions, group projects, study circles, or mentoring activities. Credits are based on participation, contributions, and reflective documentation. This mode is suitable for students who thrive in interactive environments and value shared learning experiences.

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

- **Academic Excellence**
 - 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.
 - Students availing this option must demonstrate regular progress in their chosen work or activity, which will be periodically reviewed.
 - Students using the attendance waiver must participate in all assessments and evaluation components without being marked ineligible due to attendance-based regulations.

- **Sports Representation**

- Students officially representing the University at State, National, or International level sports events, shall be exempted from mandatory attendance requirements for the duration of their preparation and participation in recognized competitions.
- Student athletes must submit prior intimation, along with proof of participation and endorsement by the Director of Sports, for verification and academic coordination.

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 $\geq \text{mean} + 1.50\sigma$
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.
- In cases where there is a clash between 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.

- 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.

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 fulfills 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 fulfills 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: 204

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	0.0	20.0	0	5	
12	HEC	HEC-CORE	20.0	20.0	5	5	
13	SDC	SDP-1	2.0	2.0	1	1	
14	SDC	SDP-2	2.0	2.0	1	1	
15	SDC	SDP-3	2.0	2.0	1	1	
16	SDC	SDP-4	2.0	2.0	1	1	
17	PEC	PE-1	4.0	4.0	1	1	
18	PEC	PE-2	3.0	3.0	1	1	
19	PEC	PE-3	3.5	3.5	1	1	
20	PEC	PE-4	3.0	3.0	1	1	
21	PEC	PE-5	3.0	3.0	1	1	
22	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
23	OEC	OE-1	3.0	3.0	1	1	
24	OEC	OE-2	3.0	3.0	1	1	
25	OEC	OE-3	3.0	3.0	1	1	
26	VAC	VAC-SPORTS	0.0	0.0	1	1	
27	VAC	VAC-CERT	0.0	0.0	4	4	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
28	AUC	AUC-CORE	0.0	0.0	4	4	
29	AUC	AUC-CAREER	0.0	0.0	1	1	
30	MIN	MIN-CORE	16.0	16.0	4	4	MINOR
31	MSDC	MIN-SDP	4.0	4.0	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum One Scopus Journal Publication.
- Minimum One Design Patent.
- Two Consultancy Projects.
- Additional 20 Credits must be from chosen minor degree.
- Must take up Capstone Project-1 and Capstone Project-2.

2. Honors through Experiential Learning with Double Major

a) Credit Requirement

Total Credit Required: 224

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	0.0	20.0	0	5	
12	HEC	HEC-CORE	20.0	20.0	5	5	
13	SDC	SDP-1	2.0	2.0	1	1	
14	SDC	SDP-2	2.0	2.0	1	1	
15	SDC	SDP-3	2.0	2.0	1	1	
16	SDC	SDP-4	2.0	2.0	1	1	
17	PEC	PE-1	4.0	6.0	1	1	
18	PEC	PE-2	3.0	3.0	1	1	
19	PEC	PE-3	3.5	5.5	1	1	
20	PEC	PE-4	3.0	3.0	1	1	
21	PEC	PE-5	3.0	3.0	1	1	
22	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
23	OEC	OE-1	3.0	3.0	1	1	
24	OEC	OE-2	3.0	3.0	1	1	
25	OEC	OE-3	3.0	3.0	1	1	
26	VAC	VAC-SPORTS	0.0	0.0	1	1	
27	VAC	VAC-CERT	0.0	0.0	4	4	
28	AUC	AUC-CORE	0.0	0.0	4	4	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CAREER	0.0	0.0	1	1	
30	SMFC	SMFC-CORE	36.0	36.0	9	9	DOUBLE MAJOR
31	SMFC	SMFC-SDP	4.0	4.0	1	1	DOUBLE MAJOR

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum One Scopus Journal Publication.
- Minimum One Design Patent.
- Two Consultancy Projects.
- Additional 40 Credits must be from selected second major degree.
- Must take up Capstone Project-1 and Capstone Project-2.

3. Honors through Experiential Learning with Specialization

a) Credit Requirement

Total Credit Required: 184

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	0.0	20.0	0	5	
12	HEC	HEC-CORE	20.0	20.0	5	5	
13	SDC	SDP-1	2.0	2.0	1	1	
14	SDC	SDP-2	2.0	2.0	1	1	
15	SDC	SDP-3	2.0	2.0	1	1	
16	SDC	SDP-4	2.0	2.0	1	1	
17	PEC	PE-1	4.0	6.0	1	1	SPECIALIZATION
18	PEC	PE-2	3.0	3.0	1	1	SPECIALIZATION
19	PEC	PE-3	3.5	5.5	1	1	SPECIALIZATION
20	PEC	PE-4	3.0	3.0	1	1	SPECIALIZATION
21	PEC	PE-5	3.0	3.0	1	1	SPECIALIZATION
22	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
23	OEC	OE-1	3.0	3.0	1	1	
24	OEC	OE-2	3.0	3.0	1	1	
25	OEC	OE-3	3.0	3.0	1	1	
26	VAC	VAC-SPORTS	0.0	0.0	1	1	
27	VAC	VAC-CERT	0.0	0.0	4	4	
28	AUC	AUC-CORE	0.0	0.0	4	4	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum One Scopus Journal Publication.
- Minimum One Design Patents.
- Two Consultancy Projects.
- All professional elective credits must be from same chosen specialization.
- Must take up Capstone Project-1 and Capstone Project-2.

4. Honors through Experiential Learning with No Add-on

a) Credit Requirement

Total Credit Required: 184

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	0.0	20.0	0	5	
12	HEC	HEC-CORE	20.0	20.0	5	5	
13	SDC	SDP-1	2.0	2.0	1	1	
14	SDC	SDP-2	2.0	2.0	1	1	
15	SDC	SDP-3	2.0	2.0	1	1	
16	SDC	SDP-4	2.0	2.0	1	1	
17	PEC	PE-1	4.0	4.0	1	1	
18	PEC	PE-2	3.0	3.0	1	1	
19	PEC	PE-3	3.5	3.5	1	1	
20	PEC	PE-4	3.0	3.0	1	1	
21	PEC	PE-5	3.0	3.0	1	1	
22	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
23	OEC	OE-1	3.0	3.0	1	1	
24	OEC	OE-2	3.0	3.0	1	1	
25	OEC	OE-3	3.0	3.0	1	1	
26	VAC	VAC-SPORTS	0.0	0.0	1	1	
27	VAC	VAC-CERT	0.0	0.0	4	4	
28	AUC	AUC-CORE	0.0	0.0	4	4	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum One Scopus Journal Publication.
- Minimum One Design Patent.
- Two Consultancy Projects.
- Must take up Capstone Project-1 and Capstone Project-2.

5. Honors through Innovation with Minor

a) Credit Requirement

Total Credit Required: 204

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	8.0	20.0	2	5	
12	HRC	HRC-CORE	0.0	0.0	0	0	
13	HIC	HIC-CORE	12.0	12.0	4	4	
14	HEC	HEC-CORE	0.0	20.0	0	5	
15	SDC	SDP-1	2.0	2.0	1	1	
16	SDC	SDP-2	2.0	2.0	1	1	
17	SDC	SDP-3	2.0	2.0	1	1	
18	SDC	SDP-4	2.0	2.0	1	1	
19	PEC	PE-1	4.0	4.0	1	1	
20	PEC	PE-2	3.0	3.0	1	1	
21	PEC	PE-3	3.5	3.5	1	1	
22	PEC	PE-4	3.0	3.0	1	1	
23	PEC	PE-5	3.0	3.0	1	1	
24	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
25	OEC	OE-1	3.0	3.0	1	1	
26	OEC	OE-2	3.0	3.0	1	1	
27	OEC	OE-3	3.0	3.0	1	1	
28	VAC	VAC-SPORTS	0.0	0.0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0.0	0.0	4	4	
30	AUC	AUC-CORE	0.0	0.0	4	4	
31	AUC	AUC-CAREER	0.0	0.0	1	1	
32	MIN	MIN-CORE	16.0	16.0	4	4	MINOR
33	MSDC	MIN-SDP	4.0	4.0	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum One Web of Science Journal Publications.
- Minimum Two Design Patents & One Utility Patent.
- LLP Establishment.
- Additional 20 credits must be from same chosen minor degree.
- Must take up Innovation Project-1 and Innovation Project-2.

6. Honors through Innovation with Double Major

a) Credit Requirement

Total Credit Required: 224

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	8.0	20.0	2	5	
12	HIC	HIC-CORE	12.0	12.0	4	4	
13	HEC	HEC-CORE	0.0	20.0	0	5	
14	SDC	SDP-1	2.0	2.0	1	1	
15	SDC	SDP-2	2.0	2.0	1	1	
16	SDC	SDP-3	2.0	2.0	1	1	
17	SDC	SDP-4	2.0	2.0	1	1	
18	PEC	PE-1	4.0	6.0	1	1	
19	PEC	PE-2	3.0	3.0	1	1	
20	PEC	PE-3	3.5	5.5	1	1	
21	PEC	PE-4	3.0	3.0	1	1	
22	PEC	PE-5	3.0	3.0	1	1	
23	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
24	OEC	OE-1	3.0	3.0	1	1	
25	OEC	OE-2	3.0	3.0	1	1	
26	OEC	OE-3	3.0	3.0	1	1	
27	VAC	VAC-SPORTS	0.0	0.0	1	1	
28	VAC	VAC-CERT	0.0	0.0	4	4	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CORE	0.0	0.0	4	4	
30	AUC	AUC-CAREER	0.0	0.0	1	1	
31	SMFC	SMFC-CORE	36.0	36.0	9	9	DOUBLE MAJOR
32	SMFC	SMFC-SDP	4.0	4.0	1	1	DOUBLE MAJOR

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum One Web of Science Journal Publications.
- Minimum Two Design Patents & One Utility Patent.
- LLP Establishment.
- Additional 40 Credits must be from selected second major degree.
- Must take up Innovation Project-1 and Innovation Project-2.

7. Honors through Innovation with Specialization

a) Credit Requirement

Total Credit Required: 184

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	8.0	20.0	2	5	
12	HRC	HRC-CORE	0.0	0.0	0	0	
13	HIC	HIC-CORE	12.0	12.0	4	4	
14	HEC	HEC-CORE	0.0	20.0	0	5	
15	SDC	SDP-1	2.0	2.0	1	1	
16	SDC	SDP-2	2.0	2.0	1	1	
17	SDC	SDP-3	2.0	2.0	1	1	
18	SDC	SDP-4	2.0	2.0	1	1	
19	PEC	PE-1	4.0	6.0	1	1	SPECIALIZATION
20	PEC	PE-2	3.0	3.0	1	1	SPECIALIZATION
21	PEC	PE-3	3.5	5.5	1	1	SPECIALIZATION
22	PEC	PE-4	3.0	3.0	1	1	SPECIALIZATION
23	PEC	PE-5	3.0	3.0	1	1	SPECIALIZATION
24	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
25	OEC	OE-1	3.0	3.0	1	1	
26	OEC	OE-2	3.0	3.0	1	1	
27	OEC	OE-3	3.0	3.0	1	1	
28	VAC	VAC-SPORTS	0.0	0.0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0.0	0.0	3	3	
30	AUC	AUC-CORE	0.0	0.0	4	4	
31	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- 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 professional elective credits must be from same chosen specialization.
- Must take up Innovation Project-1 and Innovation Project-2.

8. Honors through Innovation with No Add-on**a) Credit Requirement****Total Credit Required: 184**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	8.0	20.0	2	5	
12	HRC	HRC-CORE	0.0	0.0	0	0	
13	HIC	HIC-CORE	12.0	12.0	4	4	
14	HEC	HEC-CORE	0.0	20.0	0	5	
15	SDC	SDP-1	2.0	2.0	1	1	
16	SDC	SDP-2	2.0	2.0	1	1	
17	SDC	SDP-3	2.0	2.0	1	1	
18	SDC	SDP-4	2.0	2.0	1	1	
19	PEC	PE-1	4.0	4.0	1	1	
20	PEC	PE-2	3.0	3.0	1	1	
21	PEC	PE-3	3.5	3.5	1	1	
22	PEC	PE-4	3.0	3.0	1	1	
23	PEC	PE-5	3.0	3.0	1	1	
24	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
25	OEC	OE-1	3.0	3.0	1	1	
26	OEC	OE-2	3.0	3.0	1	1	
27	OEC	OE-3	3.0	3.0	1	1	
28	VAC	VAC-SPORTS	0.0	0.0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0.0	0.0	4	4	
30	AUC	AUC-CORE	0.0	0.0	4	4	
31	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- 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 take up Innovation Project-1 and Innovation Project-2.

9. Honors through Research with Minor

a) Credit Requirement

Total Credit Required: 204

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	8.0	20.0	2	5	
12	HRC	HRC-CORE	12.0	12.0	4	4	
13	HIC	HIC-CORE	0.0	0.0	0	0	
14	HEC	HEC-CORE	0.0	20.0	0	5	
15	SDC	SDP-1	2.0	2.0	1	1	
16	SDC	SDP-2	2.0	2.0	1	1	
17	SDC	SDP-3	2.0	2.0	1	1	
18	SDC	SDP-4	2.0	2.0	1	1	
19	PEC	PE-1	4.0	4.0	1	1	
20	PEC	PE-2	3.0	3.0	1	1	
21	PEC	PE-3	3.5	3.5	1	1	
22	PEC	PE-4	3.0	3.0	1	1	
23	PEC	PE-5	3.0	3.0	1	1	
24	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
25	OEC	OE-1	3.0	3.0	1	1	
26	OEC	OE-2	3.0	3.0	1	1	
27	OEC	OE-3	3.0	3.0	1	1	
28	VAC	VAC-SPORTS	0.0	0.0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0.0	0.0	4	4	
30	AUC	AUC-CORE	0.0	0.0	4	4	
31	AUC	AUC-CAREER	0.0	0.0	1	1	
32	MIN	MIN-CORE	16.0	16.0	4	4	MINOR
33	MSDC	MIN-SDP	4.0	4.0	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum Three Web of Science Journal Publications.
- Minimum One Design Patent.
- Additional 20 credits must be from same chosen minor degree.
- Must take up Research Seminar, Term paper, Research Project-1 and Research Project-2.

10. Honors through Research with Double Major

a) Credit Requirement

Total Credit Required: 224

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	8.0	20.0	2	5	
12	HRC	HRC-CORE	12.0	12.0	4	4	
13	HIC	HIC-CORE	0.0	0.0	0	0	
14	HEC	HEC-CORE	0.0	20.0	0	5	
15	SDC	SDP-1	2.0	2.0	1	1	
16	SDC	SDP-2	2.0	2.0	1	1	
17	SDC	SDP-3	2.0	2.0	1	1	
18	SDC	SDP-4	2.0	2.0	1	1	
19	PEC	PE-1	4.0	6.0	1	1	
20	PEC	PE-2	3.0	3.0	1	1	
21	PEC	PE-3	3.5	5.5	1	1	
22	PEC	PE-4	3.0	3.0	1	1	
23	PEC	PE-5	3.0	3.0	1	1	
24	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
25	OEC	OE-1	3.0	3.0	1	1	
26	OEC	OE-2	3.0	3.0	1	1	
27	OEC	OE-3	3.0	3.0	1	1	
28	VAC	VAC-SPORTS	0.0	0.0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0.0	0.0	4	4	
30	AUC	AUC-CORE	0.0	0.0	4	4	
31	AUC	AUC-CAREER	0.0	0.0	1	1	
32	SMFC	SMFC-CORE	36.0	36.0	9	9	DOUBLE MAJOR
33	SMFC	SMFC-SDP	4.0	4.0	1	1	DOUBLE MAJOR

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum Three Web of Science Journal Publications.
- Minimum One Design Patent.
- Additional 40 Credits must be from selected second major degree.
- Must take up Research Seminar, Term Paper, Research Project-1 and Research Project-2.

11. Honors through Research with Specialization

a) Credit Requirement

Total Credit Required: 184

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	8.0	20.0	2	5	
12	HRC	HRC-CORE	12.0	12.0	4	4	
13	HEC	HEC-CORE	0.0	20.0	0	5	
14	SDC	SDP-1	2.0	2.0	1	1	
15	SDC	SDP-2	2.0	2.0	1	1	
16	SDC	SDP-3	2.0	2.0	1	1	
17	SDC	SDP-4	2.0	2.0	1	1	
18	PEC	PE-1	4.0	6.0	1	1	SPECIALIZATION
19	PEC	PE-2	3.0	3.0	1	1	SPECIALIZATION
20	PEC	PE-3	3.5	5.5	1	1	SPECIALIZATION
21	PEC	PE-4	3.0	3.0	1	1	SPECIALIZATION
22	PEC	PE-5	3.0	3.0	1	1	SPECIALIZATION
23	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
24	OEC	OE-1	3.0	3.0	1	1	
25	OEC	OE-2	3.0	3.0	1	1	
26	OEC	OE-3	3.0	3.0	1	1	
27	VAC	VAC-SPORTS	0.0	0.0	1	1	
28	VAC	VAC-CERT	0.0	0.0	3	3	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	AUC	AUC-CORE	0.0	0.0	4	4	
30	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum Three Web of Science Journal Publications.
- Minimum One Design Patent.
- All professional elective credits must be from same chosen specialization.
- Must take up Research Seminar, Term Paper, Research Project-1 and Research Project-2.

12. Honors through Research with No Add-on**a) Credit Requirement****Total Credit Required: 184**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	8.0	20.0	2	5	
12	HRC	HRC-CORE	12.0	12.0	4	4	
13	HIC	HIC-CORE	0.0	0.0	0	0	
14	HEC	HEC-CORE	0.0	20.0	0	5	
15	SDC	SDP-1	2.0	2.0	1	1	
16	SDC	SDP-2	2.0	2.0	1	1	
17	SDC	SDP-3	2.0	2.0	1	1	
18	SDC	SDP-4	2.0	2.0	1	1	
19	PEC	PE-1	4.0	4.0	1	1	
20	PEC	PE-2	3.0	3.0	1	1	
21	PEC	PE-3	3.5	3.5	1	1	
22	PEC	PE-4	3.0	3.0	1	1	
23	PEC	PE-5	3.0	3.0	1	1	
24	PRI	PRI-CORE	16.0	16.0	4	4	PROJECT
25	OEC	OE-1	3.0	3.0	1	1	
26	OEC	OE-2	3.0	3.0	1	1	
27	OEC	OE-3	3.0	3.0	1	1	
28	VAC	VAC-SPORTS	0.0	0.0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0.0	0.0	4	4	
30	AUC	AUC-CORE	0.0	0.0	4	4	
31	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum Three Web of Science Journal Publications.
- Minimum One Design Patent.
- Must take up Research Seminar, Term Paper, Research Project-1 and Research Project-2.

13. Honors with Minor**a) Credit Requirement****Total Credit Required: 204**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	20.0	20.0	5	5	
12	HRC	HRC-CORE	0.0	0.0	0	0	
13	HIC	HIC-CORE	0.0	0.0	0	0	
14	HEC	HEC-CORE	0.0	0.0	0	0	
15	SDC	SDP-1	2.0	2.0	1	1	
16	SDC	SDP-2	2.0	2.0	1	1	
17	SDC	SDP-3	2.0	2.0	1	1	
18	SDC	SDP-4	2.0	2.0	1	1	
19	PEC	PE-1	4.0	4.0	1	1	
20	PEC	PE-2	3.0	3.0	1	1	
21	PEC	PE-3	3.5	3.5	1	1	
22	PEC	PE-4	3.0	3.0	1	1	
23	PEC	PE-5	3.0	3.0	1	1	
24	PRI	PRI-CORE	16.0	16.0	4	4	
25	OEC	OE-1	3.0	3.0	1	1	
26	OEC	OE-2	3.0	3.0	1	1	
27	OEC	OE-3	3.0	3.0	1	1	
28	VAC	VAC-SPORTS	0.0	0.0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0.0	0.0	4	4	
30	AUC	AUC-CORE	0.0	0.0	4	4	
31	AUC	AUC-CAREER	0.0	0.0	1	1	
32	MIN	MIN-CORE	16.0	16.0	4	4	MINOR
33	MSDC	MIN-SDP	4.0	6.0	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum one Scopus Journal Publication.
- Additional 20 credits must be from same chosen minor degree.

14. Honors with Double Major**a) Credit Requirement****Total Credit Required: 224**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	20.0	20.0	5	5	
12	HRC	HRC-CORE	0.0	0.0	0	0	
13	HIC	HIC-CORE	0.0	0.0	0	0	
14	HEC	HEC-CORE	0.0	0.0	0	0	
15	SDC	SDP-1	2.0	2.0	1	1	
16	SDC	SDP-2	2.0	2.0	1	1	
17	SDC	SDP-3	2.0	2.0	1	1	
18	SDC	SDP-4	2.0	2.0	1	1	
19	PEC	PE-1	4.0	6.0	1	1	
20	PEC	PE-2	3.0	3.0	1	1	
21	PEC	PE-3	3.5	5.5	1	1	
22	PEC	PE-4	3.0	3.0	1	1	
23	PEC	PE-5	3.0	3.0	1	1	
24	PRI	PRI-CORE	16.0	16.0	4	4	
25	OEC	OE-1	3.0	3.0	1	1	
26	OEC	OE-2	3.0	3.0	1	1	
27	OEC	OE-3	3.0	3.0	1	1	
28	VAC	VAC-SPORTS	0.0	0.0	1	1	

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	VAC	VAC-CERT	0.0	0.0	4	4	
30	AUC	AUC-CORE	0.0	0.0	4	4	
31	AUC	AUC-CAREER	0.0	0.0	1	1	
32	SMFC	SMFC-CORE	36.0	36.0	9	9	DOUBLE MAJOR
33	SMFC	SMFC-SDP	4.0	4.0	1	1	DOUBLE MAJOR

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum one Scopus Journal Publication.
- Additional 40 Credits must be from selected second major degree.

15. Honors with Specialization

a) Credit Requirement

Total Credit Required: 184

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	20.0	20.0	5	5	
12	SDC	SDP-1	2.0	2.0	1	1	
13	SDC	SDP-2	2.0	2.0	1	1	
14	SDC	SDP-3	2.0	2.0	1	1	
15	SDC	SDP-4	2.0	2.0	1	1	
16	PEC	PE-1	4.0	6.0	1	1	SPECIALIZATION
17	PEC	PE-2	3.0	3.0	1	1	SPECIALIZATION
18	PEC	PE-3	3.5	5.5	1	1	SPECIALIZATION
19	PEC	PE-4	3.0	3.0	1	1	SPECIALIZATION
20	PEC	PE-5	3.0	3.0	1	1	SPECIALIZATION
21	PRI	PRI-CORE	16.0	16.0	4	4	
22	OEC	OE-1	3.0	3.0	1	1	
23	OEC	OE-2	3.0	3.0	1	1	
24	OEC	OE-3	3.0	3.0	1	1	
25	VAC	VAC-SPORTS	0.0	0.0	1	1	
26	VAC	VAC-CERT	0.0	0.0	3	3	
27	AUC	AUC-CORE	0.0	0.0	4	4	
28	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum one Scopus Journal Publication.
- All professional elective credits must be from same chosen specialization.

16. Honors with No Add-on**a) Credit Requirement****Total Credit Required: 184**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	HFC	HFC-CORE	20.0	20.0	5	5	
12	SDC	SDP-1	2.0	2.0	1	1	
13	SDC	SDP-2	2.0	2.0	1	1	
14	SDC	SDP-3	2.0	2.0	1	1	
15	SDC	SDP-4	2.0	2.0	1	1	
16	PEC	PE-1	4.0	4.0	1	1	
17	PEC	PE-2	3.0	3.0	1	1	
18	PEC	PE-3	3.5	3.5	1	1	
19	PEC	PE-4	3.0	3.0	1	1	
20	PEC	PE-5	3.0	3.0	1	1	
21	PRI	PRI-CORE	16.0	16.0	4	4	
22	OEC	OE-1	3.0	3.0	1	1	
23	OEC	OE-2	3.0	3.0	1	1	
24	OEC	OE-3	3.0	3.0	1	1	
25	VAC	VAC-SPORTS	0.0	0.0	1	1	
26	VAC	VAC-CERT	0.0	0.0	3	3	
27	AUC	AUC-CORE	0.0	0.0	4	4	
28	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 8.25.
- Additional 20 credits through extra courses from the Honors category, courses in advanced or experiential mode, or a combination of both.
- No History of Backlogs.
- No History of Betterment.
- Minimum one Scopus Journal Publication.

17. No Flexibility with Minor**a) Credit Requirement****Total Credit Required: 184**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	SDC	SDP-1	2.0	2.0	1	1	
12	SDC	SDP-2	2.0	2.0	1	1	
13	SDC	SDP-3	2.0	2.0	1	1	
14	SDC	SDP-4	2.0	2.0	1	1	
15	PEC	PE-1	4.0	4.0	1	1	
16	PEC	PE-2	3.0	3.0	1	1	
17	PEC	PE-3	3.5	3.5	1	1	
18	PEC	PE-4	3.0	3.0	1	1	
19	PEC	PE-5	3.0	3.0	1	1	
20	PRI	PRI-CORE	16.0	16.0	4	4	
21	OEC	OE-1	3.0	3.0	1	1	
22	OEC	OE-2	3.0	3.0	1	1	
23	OEC	OE-3	3.0	3.0	1	1	
24	VAC	VAC-SPORTS	0.0	0.0	1	1	
25	VAC	VAC-CERT	0.0	0.0	3	3	
26	AUC	AUC-CORE	0.0	0.0	4	4	
27	AUC	AUC-CAREER	0.0	0.0	1	1	
28	MIN	MIN-CORE	16.0	16.0	4	4	MINOR

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	MSDC	MIN-SDP	4.0	4.0	1	1	MINOR

b) Outcome Requirement

- Minimum CGPA 6.75.
- Additional 20 credits must be from same chosen minor degree.

18. No Flexibility with Double Major**a) Credit Requirement****Total Credit Required: 204**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	SDC	SDP-1	2.0	2.0	1	1	
12	SDC	SDP-2	2.0	2.0	1	1	
13	SDC	SDP-3	2.0	2.0	1	1	
14	SDC	SDP-4	2.0	2.0	1	1	
15	PEC	PE-1	4.0	4.0	1	1	
16	PEC	PE-2	3.0	3.0	1	1	
17	PEC	PE-3	3.5	3.5	1	1	
18	PEC	PE-4	3.0	3.0	1	1	
19	PEC	PE-5	3.0	3.0	1	1	
20	PRI	PRI-CORE	16.0	16.0	4	4	
21	OEC	OE-1	3.0	3.0	1	1	
22	OEC	OE-2	3.0	3.0	1	1	
23	OEC	OE-3	3.0	3.0	1	1	
24	VAC	VAC-SPORTS	0.0	0.0	1	1	
25	VAC	VAC-CERT	0.0	0.0	3	3	
26	AUC	AUC-CORE	0.0	0.0	4	4	
27	AUC	AUC-CAREER	0.0	0.0	1	1	
28	SMFC	SMFC-CORE	36.0	36.0	9	9	DOUBLE MAJOR

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
29	SMFC	SMFC-SDP	4.0	4.0	1	1	DOUBLE MAJOR

b) Outcome Requirement

- Minimum CGPA 7.75.
- Additional 40 Credits must be from selected second major degree.

19. No Flexibility with Specialization**a) Credit Requirement****Total Credit Required: 164**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	SDC	SDP-1	2.0	2.0	1	1	
12	SDC	SDP-2	2.0	2.0	1	1	
13	SDC	SDP-3	2.0	2.0	1	1	
14	SDC	SDP-4	2.0	2.0	1	1	
15	PEC	PE-1	4.0	4.0	1	1	SPECIALIZATION
16	PEC	PE-2	3.0	3.0	1	1	SPECIALIZATION
17	PEC	PE-3	3.5	3.5	1	1	SPECIALIZATION
18	PEC	PE-4	3.0	3.0	1	1	SPECIALIZATION
19	PEC	PE-5	3.0	3.0	1	1	SPECIALIZATION
20	PRI	PRI-CORE	16.0	16.0	4	4	
21	OEC	OE-1	3.0	3.0	1	1	
22	OEC	OE-2	3.0	3.0	1	1	
23	OEC	OE-3	3.0	3.0	1	1	
24	VAC	VAC-SPORTS	0.0	0.0	1	1	
25	VAC	VAC-CERT	0.0	0.0	3	3	
26	AUC	AUC-CORE	0.0	0.0	4	4	
27	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 6.75.
- All professional elective credits must be from same chosen specialization.

20. No Flexibility with No Add-on**a) Credit Requirement****Total Credit Required: 164**

S#	Category	Sub-Category	Min-Credit	Max-Credit	Min-Courses	Max-Courses	Grouping
1	HAS	HAS-CORE	10.0	10.0	6	6	
2	HAS	HAS-FLE	3.0	3.0	1	1	
3	HAS	HAS-MGE	3.0	3.0	1	1	
4	BSC	BSC-CORE	16.0	16.0	4	4	
5	BSC	BSC-SE-1	4.0	8.0	1	1	
6	BSC	BSC-SE-2	4.0	8.0	1	1	
7	ESC	ESC-CORE	30.0	30.0	9	9	
8	PCC	PCC-CORE	38.5	38.5	9	9	
9	FCC	FC-1	3.0	3.0	1	1	
10	FCC	FC-2	3.0	3.0	1	1	
11	SDC	SDP-1	2.0	2.0	1	1	
12	SDC	SDP-2	2.0	2.0	1	1	
13	SDC	SDP-3	2.0	2.0	1	1	
14	SDC	SDP-4	2.0	2.0	1	1	
15	PEC	PE-1	4.0	4.0	1	1	
16	PEC	PE-2	3.0	3.0	1	1	
17	PEC	PE-3	3.5	3.5	1	1	
18	PEC	PE-4	3.0	3.0	1	1	
19	PEC	PE-5	3.0	3.0	1	1	
20	PRI	PRI-CORE	16.0	16.0	4	4	
21	OEC	OE-1	3.0	3.0	1	1	
22	OEC	OE-2	3.0	3.0	1	1	
23	OEC	OE-3	3.0	3.0	1	1	
24	VAC	VAC-SPORTS	0.0	0.0	1	1	
25	VAC	VAC-CERT	0.0	0.0	3	3	
26	AUC	AUC-CORE	0.0	0.0	4	4	
27	AUC	AUC-CAREER	0.0	0.0	1	1	

b) Outcome Requirement

- Minimum CGPA 5.25.

Program Structure

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	HAS	HAS-CORE	25UC1203	DESIGN THINKING FOR INNOVATION	R	DTI	0	0	4	0	2	4	
2	HAS	HAS-CORE	25UC1102	LANGUAGE SKILLS FOR ENGINEERS	R	LSE	0	0	4	0	2	4	
3	HAS	HAS-CORE	25UC1204	COMMUNICATION SKILLS FOR ENGINEERS	R	CSE	0	0	4	0	2	4	
4	HAS	HAS-CORE	25UC0026	HUMAN VALUES, GENDER EQUALITY AND PROFESSIONAL ETHICS	R	UHV	2	0	0	0	2	2	
5	HAS	HAS-CORE	25UC0021	SOCIAL IMMERSIVE LEARNING	R	SIL-1	0	0	2	0	1	2	
6	HAS	HAS-CORE	25UC0022	SOCIAL IMMERSIVE LEARNING	R	SIL-2	0	0	2	0	1	2	
7	HAS	HAS-FLE	25FL3054	FRENCH LANGUAGE	R	FLG	3	0	0	0	3	3	
8	HAS	HAS-FLE	25FL3055	GERMAN LANGUAGE	R	GLG	3	0	0	0	3	3	
9	HAS	HAS-FLE	25FL3058	JAPANESE LANGUAGE	R	JLG	3	0	0	0	3	3	
10	HAS	HAS-FLE	25FL3064	KOREAN LANGUAGE	R	KLG	3	0	0	0	3	3	
11	HAS	HAS-MGE	25MB4068	FINANCIAL MANAGEMENT FOR ENGINEERS	R	FMFE	3	0	0	0	3	3	
12	HAS	HAS-MGE	25MB4053	MANAGING PERSONAL FINANCE	R	MPF	3	0	0	0	3	3	
13	HAS	HAS-MGE	25MB4055	ORGANIZATION MANAGEMENT	R	OMG	3	0	0	0	3	3	
14	HAS	HAS-MGE	25MB4231	DIGITAL MARKETING	R	DMK	3	0	0	0	3	3	
15	HAS	HAS-MGE	25MB4054	BASICS OF MARKETING FOR ENGINEERS	R	BME	3	0	0	0	3	3	
16	HAS	HAS-MGE	25MB4056	PARADIGMS IN MANAGEMENT THOUGHT	R	PMT	3	0	0	0	3	3	
17	HAS	HAS-MGE	25MB4058	SIX SIGMA YELLOW BELT	R	SSYB	3	0	0	0	3	3	
18	HAS	HAS-MGE	25MB4060	FINTECH:FINANCE INDUSTRY TRANSFORMATION AND REGULATION	R	FINT	3	0	0	0	3	3	
19	HAS	HAS-MGE	25MB4070	SUSTAINABILITY LEADERSHIP AND STRATEGIC IMPACT	R	SLSI	3	0	0	0	3	3	
20	HAS	HAS-MGE	25MB4071	RESOURCE SAFETY AND QUALITY MANAGEMENT	R	RSQM	3	0	0	0	3	3	
21	HAS	HAS-MGE	25MB4072	INVESTEMENT, PORTFOLIO THEORY AND BEHAVIOURAL FINANCE	R	IPTBF	3	0	2	0	4	5	
22	HAS	HAS-MGE	25MB4067	INDUSTRIAL MANAGEMENT & PRODUCTION PLANNING	R	IMPP	3	0	0	0	3	3	
23	HAS	HAS-MGE	25MB4073	INNOVATION MANAGEMENT	R	IM	3	0	0	0	3	3	
24	BSC	BSC-CORE	25MT2003	MATHEMATICAL MODELLING & NUMERICAL METHODS	R	MNMM	2	2	0	0	4	4	
25	BSC	BSC-CORE	25MT1001	LINEAR ALGEBRA AND CALCULUS FOR ENGINEERS	R	LCE	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-CORE	25MT2019	PROBABILITY AND STATISTICS	R	PNS	2	2	0	0	4	4	
27	BSC	BSC-CORE	25MT2004	MATHEMATICAL OPTMIZATION	R	MTO	2	2	0	0	4	4	
28	BSC	BSC-SE-1	25CY1001	ENGINEERING CHEMISTRY	R	SCE2	3	0	2	0	4	5	
29	BSC	BSC-SE-2	25ME2105	MATERIAL SCIENCE & METALLURGY	R	MMS	3	0	2	0	4	5	
30	ESC	ESC-CORE	25ME2109	THERMODYNAMICS	R	TD	3	1	0	0	4	4	
31	ESC	ESC-CORE	25ME1004	WORKSHOP PRACTICES FOR ENGINEERS	R	WPE	0	0	4	0	2	4	
32	ESC	ESC-CORE	25ME1002	ENGINEERING GRAPHICS	R	EG	0	0	4	0	2	4	
33	ESC	ESC-CORE	25ME1001	ENGINEERING MECHANICS	R	EM	3	0	0	0	3	3	
34	ESC	ESC-CORE	25ME1103	DESIGN TOOLS WORKSHOP	R	DTW	0	0	4	0	2	4	
35	ESC	ESC-CORE	25SC1203	DATA STRUCTURES	R	DST	3	0	2	4	5	9	
36	ESC	ESC-CORE	25SC2007	PYTHON PROGRAMMING	R	PP	2	0	2	0	3	4	
37	ESC	ESC-CORE	25SC1101	PROBLEM SOLVING THROUGH C	R	PSTC	3	0	2	4	5	9	
38	ESC	ESC-CORE	25EC1101	BASIC ELECTRICAL AND ELECTRONIC CIRCUITS	R	BEEC	3	0	2	0	4	5	
39	PCC	PCC-CORE	25AD2001	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	R	AIML	3	0	2	0	4	5	
40	PCC	PCC-CORE	25ME2107	MECHANICS OF SOLIDS	R	MOS	3	0	2	0	4	5	
41	PCC	PCC-CORE	25ME2108	MANUFACTURING PROCESS & TECHNOLOGY	R	MPT	3	0	2	0	4	5	
42	PCC	PCC-CORE	25ME2106	FLUID MECHANICS & HYDRAULIC MACHINES	R	FMHM	3	0	2	0	4	5	
43	PCC	PCC-CORE	25ME3214	DESIGN OF THERMAL SYSTEMS	R	DTS	3	1	0	4	5	8	
44	PCC	PCC-CORE	25ME3212	MACHINE DESIGN	R	MD	3	1	0	2	4.5	6	
45	PCC	PCC-CORE	25ME3112	HEAT TRANSFER	R	HT	3	0	2	0	4	5	
46	PCC	PCC-CORE	25ME2211	KINEMATICS & DYNAMICS OF MACHINES	R	KDOM	3	1	2	0	5	6	
47	PCC	PCC-CORE	25ME2210	AUTOMATED MANUFACTURING	R	AMT	3	0	2	0	4	5	
48	FCC	FC-1	25ME2221F	MODERN VEHICLE TECHNOLOGY	F	MVT	2	0	2	0	3	4	
49	FCC	FC-1	25ME2225F	MATERIAL SCIENCE	R	MS	2	0	2	0	3	4	
50	FCC	FC-1	25ME1001F	ENGINEERING MECHANICS	R	EM	2	1	0	0	3	3	
51	FCC	FC-1	25ME2109F	THERMODYNAMICS	R	TD	2	1	0	0	3	3	
52	FCC	FC-2	25ME3122F	ROBOTICS & MECHATRONICS	F	R&M	2	0	2	0	3	4	
53	HFC	HFC-CORE	25ME01HF	RENEWABLE ENERGY SYSTEMS	R	RES	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
54	HFC	HFC-CORE	25ME02HF	ROBOTICS AND CONTROL : THEORY AND PRACTICE	R	RCTP	3	0	2	0	4	5	
55	HFC	HFC-CORE	25ME03HF	ADVANCED MANUFACTURING TECHNOLOGIES	R	AMT	3	0	2	0	4	5	
56	HFC	HFC-CORE	25ME04HF	ADVANCED FINITE ELEMENT ANALYSIS	R	AFEA	3	0	2	0	4	5	
57	HFC	HFC-CORE	25ME05HF	MULTIDISCIPLINARY DESIGN OPTIMIZATION	R	MDO	3	0	2	0	4	5	
58	HRC	HRC-CORE	25IE01RF	INDEPENDENT STUDY & RESEARCH	R	ISR	2	0	2	0	3	4	
59	HRC	HRC-CORE	25IE02RF	RESEARCH METHODOLOGY, ETHICS & SCIENTIFIC WRITING	R	RMESW	2	0	2	0	3	4	
60	HRC	HRC-CORE	25IE03RF	RESEARCH SEMINAR	R	RS	2	0	2	0	3	4	
61	HRC	HRC-CORE	25IE04RF	TERM PAPER	R	TP	2	0	2	0	3	4	
62	HIC	HIC-CORE	25DT01IF	ENTREPRENEURIAL TECHNOLOGY DEVELOPMENT AND PROTOTYPING	E	ETDP	2	0	2	0	3	4	
63	HIC	HIC-CORE	25DT02IF	PROBLEM DEFINITION AND VALIDATION	E	PDV	2	0	2	0	3	4	
64	HIC	HIC-CORE	25DT03IF	PRODUCT DESIGN AND PROTOTYPE VALIDATION	E	PDPV	2	0	2	0	3	4	
65	HIC	HIC-CORE	25DT04IF	SCALABLE SOLUTION DEVELOPMENT	E	SSD	2	0	2	0	3	4	
66	HEC	HEC-CORE	25ME01EF	ENERGY STORAGE SYSTEMS AND TECHNOLOGIES	R	ESST	3	0	2	0	4	5	
67	HEC	HEC-CORE	25ME02EF	MECHANICAL SYSTEMS DESIGN	R	MSD	3	0	2	0	4	5	
68	HEC	HEC-CORE	25ME03EF	ADVANCED MANUFACTURING PROCESSES	R	AMP	3	0	2	0	4	5	
69	HEC	HEC-CORE	25ME04EF	MECHATRONICS AND ROBOTICS	R	MTR	3	0	2	0	4	5	
70	HEC	HEC-CORE	25ME05EF	TECHNOLOGIES FOR CLEAN AND RENEWABLE ENERGY PRODUCTION	R	TCREP	3	0	2	0	4	5	
71	SDC	SDP-1	25SDME01	FINITE ELEMENT ANALYSIS	R	FEA	1	0	0	4	2	5	
72	SDC	SDP-2	25SDME02	COMPUTER INTEGRATED MANUFACTURING	R	CIM	1	0	0	4	2	5	
73	SDC	SDP-3	25SDME03	APPLIED MECHANICAL DESIGN PRACTICE	R	AMDP	1	0	0	4	2	5	
74	SDC	SDP-4	25SDME04A	ANALYSIS OF ENERGY SYSTEMS	A	AES	2	0	2	4	4	8	
75	SDC	SDP-4	25SDME04	ANALYSIS OF ENERGY SYSTEMS	R	AES	1	0	0	4	2	5	
76	PEC	PE-1	25MBT3101A	STEM CELL TECHNOLOGY	A	SCT	4	1	2	0	6	7	
77	PEC	PE-1	25MBT3101E	STEM CELL TECHNOLOGY	E	SCT	4	1	2	0	6	7	
78	PEC	PE-1	25MBT3101	STEM CELL TECHNOLOGY	R	SCT	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
79	PEC	PE-1	25SMF3101A	AI AND IOT IN MANUFACTURING	A	AIM	4	1	2	0	6	7	
80	PEC	PE-1	25SMF3101E	AI AND IOT IN MANUFACTURING	E	AIM	4	1	2	0	6	7	
81	PEC	PE-1	25SMF3101	AI AND IOT IN MANUFACTURING	R	AIM	3	0	2	0	4	5	
82	PEC	PE-1	25IBT3101A	PHARMACEUTICAL BIOTECHNOLOGY	A	PBT	4	1	2	0	6	7	
83	PEC	PE-1	25IBT3101E	PHARMACEUTICAL BIOTECHNOLOGY	E	PBT	4	1	2	0	6	7	
84	PEC	PE-1	25IBT3101	PHARMACEUTICAL BIOTECHNOLOGY	R	PBT	3	0	2	0	4	5	
85	PEC	PE-1	25NTO3102A	NANOSCALE ENGINEERING FOR CLEAN ENERGY	A	NEC	4	1	2	0	6	7	
86	PEC	PE-1	25NTO3102E	NANOSCALE ENGINEERING FOR CLEAN ENERGY	E	NEC	4	1	2	0	6	7	
87	PEC	PE-1	25NTO3102	NANOSCALE ENGINEERING FOR CLEAN ENERGY	R	NEC	3	0	2	0	4	5	
88	PEC	PE-1	25NTO3101A	THIN FILM TECHNOLOGIES FOR NANOELECTRONICS	A	TTN	4	1	2	0	6	7	
89	PEC	PE-1	25NTO3101E	THIN FILM TECHNOLOGIES FOR NANOELECTRONICS	E	TTN	4	1	2	0	6	7	
90	PEC	PE-1	25NTO3101	THIN FILM TECHNOLOGIES FOR NANOELECTRONICS	R	TTN	3	0	2	0	4	5	
91	PEC	PE-1	25IOT3101A	INDUSTRIAL INTERNET OF THINGS	A	IIOT	4	1	2	0	6	7	
92	PEC	PE-1	25IOT3101E	INDUSTRIAL INTERNET OF THINGS	E	IIOT	4	1	2	0	6	7	
93	PEC	PE-1	25IOT3101	INDUSTRIAL INTERNET OF THINGS	R	IIOT	3	0	2	0	4	5	
94	PEC	PE-1	25BMI3101A	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	A	BSIP	4	1	2	0	6	7	
95	PEC	PE-1	25BMI3101E	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	E	BSIP	4	1	2	0	6	7	
96	PEC	PE-1	25BMI3101	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	R	BSIP	3	0	2	0	4	5	
97	PEC	PE-1	25GAM3101A	NATURAL LANGUAGE PROCESSING AND APPLICATIONS	A	NLPA	4	1	2	0	6	7	
98	PEC	PE-1	25GAM3101E	NATURAL LANGUAGE PROCESSING AND APPLICATIONS	E	NLPA	4	1	2	0	6	7	
99	PEC	PE-1	25GAM3101	NATURAL LANGUAGE PROCESSING AND APPLICATIONS	R	NLPA	3	0	2	0	4	5	
100	PEC	PE-1	25RFM3101A	MICROWAVE ENGINEERING	A	ME	4	1	2	0	6	7	
101	PEC	PE-1	25RFM3101E	MICROWAVE ENGINEERING	E	ME	4	1	2	0	6	7	
102	PEC	PE-1	25RFM3101	MICROWAVE ENGINEERING	R	ME	3	0	2	0	4	5	
103	PEC	PE-1	25QCS3101A	QUANTUM HARDWARE AND CONTROL SYSTEMS	A	QHCS	4	1	2	0	6	7	

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104	PEC	PE-1	25QCS3101E	QUANTUM HARDWARE AND CONTROL SYSTEMS	E	QHCS	4	1	2	0	6	7	
105	PEC	PE-1	25QCS3101	QUANTUM HARDWARE AND CONTROL SYSTEMS	R	QHCS	3	0	2	0	4	5	
106	PEC	PE-1	25AVI3102A	AI DRIVEN VIDEO PROCESSING	A	AIDVP	4	1	2	0	6	7	
107	PEC	PE-1	25AVI3102E	AI DRIVEN VIDEO PROCESSING	E	AIDVP	4	1	2	0	6	7	
108	PEC	PE-1	25AVI3102	AI DRIVEN VIDEO PROCESSING	R	AIDVP	3	0	2	0	4	5	
109	PEC	PE-1	25QTS3101A	QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE	A	QCCAFT	4	1	2	0	6	7	
110	PEC	PE-1	25QTS3101E	QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE	E	QCCAFT	4	1	2	0	6	7	
111	PEC	PE-1	25QTS3101	QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE	R	QCCAFT	3	0	2	0	4	5	
112	PEC	PE-1	25SDM3101A	SENTIMENT ANALYSIS	A	SA	4	1	2	0	6	7	
113	PEC	PE-1	25SDM3101E	SENTIMENT ANALYSIS	E	SA	4	1	2	0	6	7	
114	PEC	PE-1	25SDM3101	SENTIMENT ANALYSIS	R	SA	3	0	2	0	4	5	
115	PEC	PE-1	25GMI3101A	PRINCIPLES OF DEEP NEURAL COMPUTATION	A	PDNC	4	1	2	0	6	7	
116	PEC	PE-1	25GMI3101E	PRINCIPLES OF DEEP NEURAL COMPUTATION	E	PDNC	4	1	2	0	6	7	
117	PEC	PE-1	25GMI3101	PRINCIPLES OF DEEP NEURAL COMPUTATION	R	PDNC	3	0	2	0	4	5	
118	PEC	PE-1	25SCI3101A	SPATIAL DATA VISUALIZATION	A	SDV	4	1	2	0	6	7	
119	PEC	PE-1	25SCI3101E	SPATIAL DATA VISUALIZATION	E	SDV	4	1	2	0	6	7	
120	PEC	PE-1	25SCI3101	SPATIAL DATA VISUALIZATION	R	SDV	3	0	2	0	4	5	
121	PEC	PE-1	25DSE3101A	DATA ANALYTICS & VISUALIZATION	A	DAV	4	1	2	0	6	7	
122	PEC	PE-1	25DSE3101E	DATA ANALYTICS & VISUALIZATION	E	DAV	4	1	2	0	6	7	
123	PEC	PE-1	25DSE3101	DATA ANALYTICS & VISUALIZATION	R	DAV	3	0	2	0	4	5	
124	PEC	PE-1	25DLS3101A	STREAMING DATA ARCHITECTURES & FRAMEWORKS	A	SDAF	4	1	2	0	6	7	
125	PEC	PE-1	25DLS3101E	STREAMING DATA ARCHITECTURES & FRAMEWORKS	E	SDAF	4	1	2	0	6	7	
126	PEC	PE-1	25DLS3101	STREAMING DATA ARCHITECTURES & FRAMEWORKS	R	SDAF	3	0	2	0	4	5	
127	PEC	PE-1	25AAS3101A	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	A	ADAS	4	1	2	0	6	7	

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128	PEC	PE-1	25AAS3101E	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	E	ADAS	4	1	2	0	6	7	
129	PEC	PE-1	25AAS3101	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	R	ADAS	3	0	2	0	4	5	
130	PEC	PE-1	25ACI3101A	GENERATIVE ADVERSARIAL NETWORKS	A	GANWS	4	1	2	0	6	7	
131	PEC	PE-1	25ACI3101E	GENERATIVE ADVERSARIAL NETWORKS	E	GANWS	4	1	2	0	6	7	
132	PEC	PE-1	25ACI3101	GENERATIVE ADVERSARIAL NETWORKS	R	GANWS	3	0	2	0	4	5	
133	PEC	PE-1	25AVI3101A	DEEP LEARNING	A	DL	4	1	2	0	6	7	
134	PEC	PE-1	25AVI3101E	DEEP LEARNING	E	DL	4	1	2	0	6	7	
135	PEC	PE-1	25AVI3101	DEEP LEARNING	R	DL	3	0	2	0	4	5	
136	PEC	PE-1	25ADE3101A	EDGE COMPUTING FUNDAMENTALS	A	ECF	4	1	2	0	6	7	
137	PEC	PE-1	25ADE3101E	EDGE COMPUTING FUNDAMENTALS	E	ECF	4	1	2	0	6	7	
138	PEC	PE-1	25ADE3101	EDGE COMPUTING FUNDAMENTALS	R	ECF	3	0	2	0	4	5	
139	PEC	PE-1	25ALT3101A	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	A	AMLFTA	4	1	2	0	6	7	
140	PEC	PE-1	25ALT3101E	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	E	AMLFTA	4	1	2	0	6	7	
141	PEC	PE-1	25ALT3101	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	R	AMLFTA	3	0	2	0	4	5	
142	PEC	PE-1	25HDA3101A	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	A	ISDPDD	4	1	2	0	6	7	
143	PEC	PE-1	25HDA3101E	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	E	ISDPDD	4	1	2	0	6	7	
144	PEC	PE-1	25HDA3101	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	R	ISDPDD	3	0	2	0	4	5	
145	PEC	PE-1	25AEC3101A	EDGE AI HARDWARE ARCHITECTURES & ACCELERATION	A	EHA	4	1	2	0	6	7	
146	PEC	PE-1	25AEC3101E	EDGE AI HARDWARE ARCHITECTURES & ACCELERATION	E	EHA	4	1	2	0	6	7	
147	PEC	PE-1	25AEC3101	EDGE AI HARDWARE ARCHITECTURES & ACCELERATION	R	EHA	3	0	2	0	4	5	
148	PEC	PE-1	25CEC3101	CLOUD INFRASTRUCTURE AND SERVICES	R	CIS	3	0	2	0	4	5	
149	PEC	PE-1	25GDU3101A	PROGRAMMING FOR GAME DEVELOPMENT	A	PGD	4	1	2	0	6	7	
150	PEC	PE-1	25GDU3101E	PROGRAMMING FOR GAME DEVELOPMENT	E	PGD	4	1	2	0	6	7	
151	PEC	PE-1	25GDU3101	PROGRAMMING FOR GAME DEVELOPMENT	R	PGD	3	0	2	0	4	5	

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152	PEC	PE-1	25CNE3101A	FOUNDATIONS OF CLOUD NATIVE COMPUTING	A	FCNC	4	1	2	0	6	7	
153	PEC	PE-1	25CNE3101E	FOUNDATIONS OF CLOUD NATIVE COMPUTING	E	FCNC	4	1	2	0	6	7	
154	PEC	PE-1	25CNE3101	FOUNDATIONS OF CLOUD NATIVE COMPUTING	R	FCNC	3	0	2	0	4	5	
155	PEC	PE-1	25CNS3101A	INTRODUCTION TO CLOUD NATIVE COMPUTING	A	ITCNC	4	1	2	0	6	7	
156	PEC	PE-1	25CNS3101E	INTRODUCTION TO CLOUD NATIVE COMPUTING	E	ITCNC	4	1	2	0	6	7	
157	PEC	PE-1	25CNS3101	INTRODUCTION TO CLOUD NATIVE COMPUTING	R	ITCNC	3	0	2	0	4	5	
158	PEC	PE-1	25CSC3101A	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	A	FCS	4	1	2	0	6	7	
159	PEC	PE-1	25CSC3101E	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	E	FCS	4	1	2	0	6	7	
160	PEC	PE-1	25CSC3101	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	R	FCS	3	0	2	0	4	5	
161	PEC	PE-1	25BEW3101A	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	A	IBCTCCT	4	1	2	0	6	7	
162	PEC	PE-1	25BEW3101E	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	E	IBCTCCT	4	1	2	0	6	7	
163	PEC	PE-1	25BEW3101	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	R	IBCTCCT	3	0	2	0	4	5	
164	PEC	PE-1	25CID3101A	CLOUD INFRASTRUCTURE ENGINEERING	A	CIE	4	1	2	0	6	7	
165	PEC	PE-1	25CID3101E	CLOUD INFRASTRUCTURE ENGINEERING	E	CIE	4	1	2	0	6	7	
166	PEC	PE-1	25CID3101	CLOUD INFRASTRUCTURE ENGINEERING	R	CIE	3	0	2	0	4	5	
167	PEC	PE-1	25CPD3101A	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	A	FMAD	4	1	2	0	6	7	
168	PEC	PE-1	25CPD3101E	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	E	FMAD	4	1	2	0	6	7	
169	PEC	PE-1	25CPD3101	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	R	FMAD	3	0	2	0	4	5	
170	PEC	PE-1	25CSB3101A	CRYPT ANALYSIS & CYBER DEFENSE	A	CACD	4	1	2	0	6	7	
171	PEC	PE-1	25CSB3101E	CRYPT ANALYSIS & CYBER DEFENSE	E	CACD	4	1	2	0	6	7	
172	PEC	PE-1	25CSB3101	CRYPT ANALYSIS & CYBER DEFENSE	R	CACD	3	0	2	0	4	5	
173	PEC	PE-1	25DEA3101A	FUNDAMENTALS OF DATA ENGINEERING	A	FDE	4	1	2	0	6	7	

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174	PEC	PE-1	25DEA3101E	FUNDAMENTALS OF DATA ENGINEERING	E	FDE	4	1	2	0	6	7	
175	PEC	PE-1	25DEA3101	FUNDAMENTALS OF DATA ENGINEERING	R	FDE	3	0	2	0	4	5	
176	PEC	PE-1	25DSB3101A	DATA ANALYTICS AND VISUALIZATION	A	DAV	4	1	2	0	6	7	
177	PEC	PE-1	25DSB3101E	DATA ANALYTICS AND VISUALIZATION	E	DAV	4	1	2	0	6	7	
178	PEC	PE-1	25DSB3101	DATA ANALYTICS AND VISUALIZATION	R	DAV	3	0	2	0	4	5	
179	PEC	PE-1	25DLA3101A	BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS	A	SNTSA	4	1	2	0	6	7	
180	PEC	PE-1	25DLA3101E	BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS	E	SNTSA	4	1	2	0	6	7	
181	PEC	PE-1	25DLA3101	BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS	R	SNTSA	3	0	2	0	4	5	
182	PEC	PE-1	25HSS3101A	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	A	ITHSCD	4	1	2	0	6	7	
183	PEC	PE-1	25HSS3101E	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	E	ITHSCD	4	1	2	0	6	7	
184	PEC	PE-1	25HSS3101	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	R	ITHSCD	3	0	2	0	4	5	
185	PEC	PE-1	25SMD3101A	SOFTWARE VERIFICATION & VALIDATION	A	SVV	4	1	2	0	6	7	
186	PEC	PE-1	25SMD3101E	SOFTWARE VERIFICATION & VALIDATION	E	SVV	4	1	2	0	6	7	
187	PEC	PE-1	25SMD3101	SOFTWARE VERIFICATION & VALIDATION	R	SVV	3	0	2	0	4	5	
188	PEC	PE-1	25AAS3102A	AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT	A	AICFT	4	1	2	0	6	7	
189	PEC	PE-1	25AAS3102E	AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT	E	AICFT	4	1	2	0	6	7	
190	PEC	PE-1	25AAS3102	AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT	R	AICFT	3	0	2	0	4	5	
191	PEC	PE-1	25AAS3112A	ECU DESIGN FOR AUTONOMOUS SYSTEMS	A	EDAS	4	1	2	0	6	7	
192	PEC	PE-1	25AAS3112E	ECU DESIGN FOR AUTONOMOUS SYSTEMS	E	EDAS	4	1	2	0	6	7	
193	PEC	PE-1	25AAS3112	ECU DESIGN FOR AUTONOMOUS SYSTEMS	R	EDAS	3	0	2	0	4	5	
194	PEC	PE-1	25IGD3101A	GAME DEVELOPMENT WITH UNREAL ENGINE (C++)	A	GDUE	4	1	2	0	6	7	

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195	PEC	PE-1	25IGD3101E	GAME DEVELOPMENT WITH UNREAL ENGINE (C++)	E	GDUE	4	1	2	0	6	7	
196	PEC	PE-1	25IGD3101	GAME DEVELOPMENT WITH UNREAL ENGINE (C++)	R	GDUE	3	0	2	0	4	5	
197	PEC	PE-1	25IGD3102A	GAME DEVELOPMENT WITH UNITY ENGINE (C#)	A	GDUN	4	1	2	0	6	7	
198	PEC	PE-1	25IGD3102E	GAME DEVELOPMENT WITH UNITY ENGINE (C#)	E	GDUN	4	1	2	0	6	7	
199	PEC	PE-1	25IGD3102	GAME DEVELOPMENT WITH UNITY ENGINE (C#)	R	GDUN	3	0	2	0	4	5	
200	PEC	PE-1	25CND3101A	CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION	A	CNAD	4	1	2	0	6	7	
201	PEC	PE-1	25CND3101E	CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION	E	CNAD	4	1	2	0	6	7	
202	PEC	PE-1	25CND3101	CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION	R	CNAD	3	0	2	0	4	5	
203	PEC	PE-1	25GSD3101A	GREEN SOFTWARE ENGINEERING	A	GSE	4	1	2	0	6	7	
204	PEC	PE-1	25GSD3101E	GREEN SOFTWARE ENGINEERING	E	GSE	4	1	2	0	6	7	
205	PEC	PE-1	25GSD3101	GREEN SOFTWARE ENGINEERING	R	GSE	3	0	2	0	4	5	
206	PEC	PE-1	25HCA3101A	MULTI-MODAL INFORMATION PROCESSING	A	MMIP	4	1	2	0	6	7	
207	PEC	PE-1	25HCA3101E	MULTI-MODAL INFORMATION PROCESSING	E	MMIP	4	1	2	0	6	7	
208	PEC	PE-1	25HCA3101	MULTI-MODAL INFORMATION PROCESSING	R	MMIP	3	0	2	0	4	5	
209	PEC	PE-1	25CTI3101A	DIGITAL FORENSICS & INCIDENT RESPONSE	A	DFIR	4	1	2	0	6	7	
210	PEC	PE-1	25CTI3101E	DIGITAL FORENSICS & INCIDENT RESPONSE	E	DFIR	4	1	2	0	6	7	
211	PEC	PE-1	25CTI3101	DIGITAL FORENSICS & INCIDENT RESPONSE	R	DFIR	3	0	2	0	4	5	
212	PEC	PE-1	25CTI3102A	MALWARE ANALYSIS & REVERSE ENGINEERING	A	MARE	4	1	2	0	6	7	
213	PEC	PE-1	25CTI3102E	MALWARE ANALYSIS & REVERSE ENGINEERING	E	MARE	4	1	2	0	6	7	
214	PEC	PE-1	25CTI3102	MALWARE ANALYSIS & REVERSE ENGINEERING	R	MARE	3	0	2	0	4	5	
215	PEC	PE-1	25CAC3101A	GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC	A	GPAH	4	1	2	0	6	7	
216	PEC	PE-1	25CAC3101E	GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC	E	GPAH	4	1	2	0	6	7	

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217	PEC	PE-1	25CAC3101	GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC	R	GPAH	3	0	2	0	4	5	
218	PEC	PE-1	25ABT3101A	BIOSENSORS AND BIOELECTRONICS	A	BSBE	4	1	2	0	6	7	
219	PEC	PE-1	25ABT3101E	BIOSENSORS AND BIOELECTRONICS	E	BSBE	4	1	2	0	6	7	
220	PEC	PE-1	25ABT3101	BIOSENSORS AND BIOELECTRONICS	R	BSBE	3	0	2	0	4	5	
221	PEC	PE-1	25AEA3101A	AUTOMOTIVE SENSOR AND APPLICATIONS	A	ASA	4	1	2	0	6	7	
222	PEC	PE-1	25AEA3101E	AUTOMOTIVE SENSOR AND APPLICATIONS	E	ASA	4	1	2	0	6	7	
223	PEC	PE-1	25AEA3101	AUTOMOTIVE SENSOR AND APPLICATIONS	R	ASA	3	0	2	0	4	5	
224	PEC	PE-1	25WLT3101A	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	A	4GW	4	1	2	0	6	7	
225	PEC	PE-1	25WLT3101E	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	E	4GW	4	1	2	0	6	7	
226	PEC	PE-1	25WLT3101	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	R	4GW	3	0	2	0	4	5	
227	PEC	PE-1	25AEE3101A	AUTOMOBILE ENGINEERING	A	AEG	4	1	2	0	6	7	
228	PEC	PE-1	25AEE3101E	AUTOMOBILE ENGINEERING	E	AEG	4	1	2	0	6	7	
229	PEC	PE-1	25AEE3101	AUTOMOBILE ENGINEERING	R	AEG	3	0	2	0	4	5	
230	PEC	PE-1	25WRE3101A	ADVANCED FOUNDATION ENGINEERING	A	AFE	4	1	2	0	6	7	
231	PEC	PE-1	25WRE3101E	ADVANCED FOUNDATION ENGINEERING	E	AFE	4	1	2	0	6	7	
232	PEC	PE-1	25WRE3101	ADVANCED FOUNDATION ENGINEERING	R	AFE	3	0	2	0	4	5	
233	PEC	PE-1	25BIS3101A	MOLECULAR MODELLING AND DRUG DESIGN	A	MMDD	4	1	2	0	6	7	
234	PEC	PE-1	25BIS3101E	MOLECULAR MODELLING AND DRUG DESIGN	E	MMDD	4	1	2	0	6	7	
235	PEC	PE-1	25BIS3101	MOLECULAR MODELLING AND DRUG DESIGN	R	MMDD	3	0	2	0	4	5	
236	PEC	PE-1	25VLS3101A	ANALOG VLSI DESIGN	A	AVD	4	1	2	0	6	7	
237	PEC	PE-1	25VLS3101E	ANALOG VLSI DESIGN	E	AVD	4	1	2	0	6	7	
238	PEC	PE-1	25VLS3101	ANALOG VLSI DESIGN	R	AVD	3	0	2	0	4	5	
239	PEC	PE-1	25STE3101A	ADVANCED CONCRETE TECHNOLOGY	A	ACT	4	1	2	0	6	7	
240	PEC	PE-1	25STE3101E	ADVANCED CONCRETE TECHNOLOGY	E	ACT	4	1	2	0	6	7	
241	PEC	PE-1	25STE3101	ADVANCED CONCRETE TECHNOLOGY	R	ACT	3	0	2	0	4	5	

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242	PEC	PE-1	25CPS3101A	IOT SENSING AND ACTUATING DEVICES	A	ISAD	4	1	2	0	6	7	
243	PEC	PE-1	25CPS3101E	IOT SENSING AND ACTUATING DEVICES	E	ISAD	4	1	2	0	6	7	
244	PEC	PE-1	25CPS3101	IOT SENSING AND ACTUATING DEVICES	R	ISAD	3	0	2	0	4	5	
245	PEC	PE-1	25SGT3101A	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	A	DERSG	3	1	2	0	5	6	
246	PEC	PE-1	25SGT3101E	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	E	DERSG	4	1	2	0	6	7	
247	PEC	PE-1	25SGT3101	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	R	DERSG	3	0	2	0	4	5	
248	PEC	PE-1	25RAN3102A	ADVANCED ROBOTICS	A	AR	4	1	2	0	6	7	
249	PEC	PE-1	25RAN3102E	ADVANCED ROBOTICS	E	AR	4	1	2	0	6	7	
250	PEC	PE-1	25RAN3102	ADVANCED ROBOTICS	R	AR	3	0	2	0	4	5	
251	PEC	PE-1	25RAN3101A	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	A	RMPDC	4	1	2	0	6	7	
252	PEC	PE-1	25RAN3101E	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	E	RMPDC	4	1	2	0	6	7	
253	PEC	PE-1	25RAN3101	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	R	RMPDC	3	0	2	0	4	5	
254	PEC	PE-1	25DCM3101A	TCP/IP AND OTHER PROTOCOL SUITE	A	TCP	4	1	2	0	6	7	
255	PEC	PE-1	25DCM3101E	TCP/IP AND OTHER PROTOCOL SUITE	E	TCP	4	1	2	0	6	7	
256	PEC	PE-1	25DCM3101	TCP/IP AND OTHER PROTOCOL SUITE	R	TCP	3	0	2	0	4	5	
257	PEC	PE-1	25EDS3101A	ADVANCED EMBEDDED SYSTEMS	A	AES	4	1	2	0	6	7	
258	PEC	PE-1	25EDS3101E	ADVANCED EMBEDDED SYSTEMS	E	AES	4	1	2	0	6	7	
259	PEC	PE-1	25EDS3101	ADVANCED EMBEDDED SYSTEMS	R	AES	3	0	2	0	4	5	
260	PEC	PE-1	25EME3101A	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	A	PTDEV	4	1	2	0	6	7	
261	PEC	PE-1	25EME3101E	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	E	PTDEV	4	1	2	0	6	7	
262	PEC	PE-1	25EME3101	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	R	PTDEV	3	0	2	0	4	5	
263	PEC	PE-1	25GET3101A	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	A	SPMET	4	1	2	0	6	7	
264	PEC	PE-1	25GET3101E	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	E	SPMET	4	1	2	0	6	7	
265	PEC	PE-1	25GET3101	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	R	SPMET	3	0	2	0	4	5	

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266	PEC	PE-1	25ILA3101A	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	A	IIIoT	4	1	2	0	6	7	
267	PEC	PE-1	25ILA3101E	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	E	IIIoT	4	1	2	0	6	7	
268	PEC	PE-1	25ILA3101	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	R	IIIoT	3	0	2	0	4	5	
269	PEC	PE-1	25EGD3101A	ADVANCED STRENGTH OF MATERIALS	A	ASM	4	1	2	0	6	7	
270	PEC	PE-1	25EGD3101E	ADVANCED STRENGTH OF MATERIALS	E	ASM	4	1	2	0	6	7	
271	PEC	PE-1	25EGD3101	ADVANCED STRENGTH OF MATERIALS	R	ASM	3	0	2	0	4	5	
272	PEC	PE-2	25ILA3202	INDUSTRIAL AUTOMATION AND ROBOTICS	R	IAR	3	0	0	0	3	3	
273	PEC	PE-2	25ILA3203	EDGE COMPUTING FOR INDUSTRY 4.0	R	ECI	3	0	0	0	3	3	
274	PEC	PE-2	25GET3202	WIND AND ENERGY STORAGE TECHNOLOGIES	R	WEST	3	0	0	0	3	3	
275	PEC	PE-2	25GET3203	ENERGY ECONOMICS AND POLICY	R	EEP	3	0	0	0	3	3	
276	PEC	PE-2	25RAN3203	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	R	RMWR	3	0	0	0	3	3	
277	PEC	PE-2	25RAN3202	AUTONOMOUS VEHICLES AND AUTOMOTIVE ELECTRONICS	R	AVAE	3	0	0	0	3	3	
278	PEC	PE-2	25EGD3202	CREEP, FATIGUE AND FRACTURE MECHANICS	R	CFFM	3	0	0	0	3	3	
279	PEC	PE-2	25EGD3203	THEORY OF ELASTICITY AND PLASTICITY	R	KDARS	3	0	0	0	3	3	
280	PEC	PE-2	25EME3202	COMMUNICATION PROTOCOLS AND TESTING OF ELECTRIC VEHICLE	R	CPTEV	3	0	0	0	3	3	
281	PEC	PE-2	25EME3203	AUTONOMOUS VEHICLES AND AUTOMOTIVE ELECTRONICS	R	AVAE	3	0	0	0	3	3	
282	PEC	PE-2	25EDS3202	EMBEDDED SYSTEMS FOR IOT	R	ESIOT	3	0	0	0	3	3	
283	PEC	PE-2	25DCM3202	CLOUD COMPUTING AND NETWORKS SECURITY	R	CCNS	3	0	0	0	3	3	
284	PEC	PE-2	25STE3202	ADVANCED STRUCTURAL ANALYSIS	R	ASA	3	0	0	0	3	3	
285	PEC	PE-2	25SGT3203	MICROGRID DYNAMICS AND CONTROL	R	MDC	3	0	0	0	3	3	
286	PEC	PE-2	25SGT3202	DISTRIBUTION SYSTEM PRACTICES	R	DSP	3	0	0	0	3	3	
287	PEC	PE-2	25CPS3202	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	R	IOTAP	3	0	0	0	3	3	
288	PEC	PE-2	25BIS3203	PYTHON AND R PROGRAMMING	R	P&RP	3	0	0	0	3	3	
289	PEC	PE-2	25VLS3202	TESTING AND VERIFICATION OF VLSI CIRCUITS	R	TVVC	3	0	0	0	3	3	

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290	PEC	PE-2	25BIS3202	BIOMEDICAL INFORMATICS	R	BMI	3	0	0	0	3	3	
291	PEC	PE-2	25WRE3202	INTELLIGENT TRANSPORTATION SYSTEMS	R	ITS	3	0	0	0	3	3	
292	PEC	PE-2	25AAS3202	INTRODUCTION TO INTELLIGENT DRONES	R	IID	3	0	0	0	3	3	
293	PEC	PE-2	25AEE3202	AUTOTRONICS AND SAFETY	R	AESS	3	0	0	0	3	3	
294	PEC	PE-2	25AEA3202	AUTOTRONICS	R	AT	3	0	0	0	3	3	
295	PEC	PE-2	25WLT3202	MODERN SATELLITE COMMUNICATION SYSTEMS	R	MSCS	3	0	0	0	3	3	
296	PEC	PE-2	25AEA3203	AUTOMOTIVE POLLUTION AND ITS CONTROL	R	APC	3	0	0	0	3	3	
297	PEC	PE-2	25ABT3202	IOT APPLICATIONS IN PRECISION AGRICULTURE	R	IOTAPA	3	0	0	0	3	3	
298	PEC	PE-2	25ABT3203	MACHINE LEARNING FOR PRECISION AGRICULTURE	R	MLPA	3	0	0	0	3	3	
299	PEC	PE-2	25AEC3202	SECURE & SCALABLE EDGE AI NETWORKING	R	SEAN	3	0	0	0	3	3	
300	PEC	PE-2	25CTI3203	ETHICAL HACKING & OFFENSIVE SECURITY	R	EHOS	3	0	0	0	3	3	
301	PEC	PE-2	25CTI3204	VULNERABILITY ASSESSMENT & PENETRATION TESTING	R	VAPT	3	0	0	0	3	3	
302	PEC	PE-2	25CAC3202	PARALLEL & FUNCTIONAL PROGRAMMING FOR SCIENTIFIC APPLICATIONS	R	PFPS	3	0	0	0	3	3	
303	PEC	PE-2	25HCA3202	NATURAL LANGUAGE PROCESSING	R	NLP	3	0	0	0	3	3	
304	PEC	PE-2	25HCA3203	COMPUTER VISION & OBJECT DETECTION	R	CVOD	3	0	0	0	3	3	
305	PEC	PE-2	25HCA3204	COMPUTATIONAL PARALINGUISTICS	R	CPL	3	0	0	0	3	3	
306	PEC	PE-2	25GSD3202	GREEN ALGORITHMS AND SUSTAINABLE APP DESIGN	R	GAD	3	0	0	0	3	3	
307	PEC	PE-2	25CND3202	CLOUD-NATIVE ARCHITECTURE & INFRASTRUCTURE AS CODE	R	CNAI	3	0	0	0	3	3	
308	PEC	PE-2	25IGD3203	MULTIPLAYER GAME DEVELOPMENT AND NETWORKING	R	MGDN	3	0	0	0	3	3	
309	PEC	PE-2	25IGD3204	GAME DEVOPS AND CLOUD DEPLOYMENT	R	GDCD	3	0	0	0	3	3	
310	PEC	PE-2	25AAS3203	AI AND IOT FOR AUTONOMOUS VEHICLE	R	AIAV	3	0	0	0	3	3	
311	PEC	PE-2	25AAS3205	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	R	AVECUD	3	0	0	0	3	3	
312	PEC	PE-2	25AAS3213	PERCEPTION ENGINEERING FOR AUTONOMY	R	PEA	3	0	0	0	3	3	
313	PEC	PE-2	25SDM3203	META SOCIAL MEDIA ANALYTICS	R	MSMA	3	0	0	0	3	3	

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314	PEC	PE-2	25HDA3204	PYTHON FOR GENOMIC DATA SCIENCE	R	PFGDS	3	0	0	0	3	3	
315	PEC	PE-2	25HSS3202	FUNDAMENTALS OF COMPUTER SECURITY	R	FOCS	3	0	0	0	3	3	
316	PEC	PE-2	25SMD3202	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	R	DPCT	3	0	0	2	3.5	5	
317	PEC	PE-2	25DLA3202	MACHINE LEARNING FOR FINANCIAL RISK & BEHAVIORAL INTELLIGENCE	R	MLFRBI	3	0	0	0	3	3	
318	PEC	PE-2	25DLA3203	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	R	BTDT	3	0	0	0	3	3	
319	PEC	PE-2	25DSB3202	DATA WAREHOUSING AND MINING	R	DWHM	3	0	0	0	3	3	
320	PEC	PE-2	25DEA3202	DATA EXPLORATION AND PREPARATION	R	DEP	3	0	0	0	3	3	
321	PEC	PE-2	25CSB3202	NETWORK AND INFRASTRUCTURE SECURITY	R	NS	3	0	0	0	3	3	
322	PEC	PE-2	25CSB3203	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	R	IBCC	3	0	0	0	3	3	
323	PEC	PE-2	25CPD3202	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	R	RNA	3	0	0	0	3	3	
324	PEC	PE-2	25CPD3203	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	R	FBCPD	3	0	0	0	3	3	
325	PEC	PE-2	25CID3202	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	R	ECT	3	0	0	0	3	3	
326	PEC	PE-2	25CID3203	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	R	AHASCE	3	0	0	0	3	3	
327	PEC	PE-2	25CEC3202	ADVANCED OPERATING SYSTEMS	R	AOS	3	0	0	0	3	3	
328	PEC	PE-2	25CEC3203	FUNCTIONAL AND CONCURRENT PROGRAMMING	R	FCP	3	0	0	0	3	3	
329	PEC	PE-2	25CEC3204	CLOUD DEVOPS	R	CD	3	0	0	0	3	3	
330	PEC	PE-2	25BEW3202	SMART CONTRACTS	R	SC	3	0	0	0	3	3	
331	PEC	PE-2	25ALT3202	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	R	DLFNL	3	0	0	0	3	3	
332	PEC	PE-2	25CSC3202	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	R	DSA	3	0	0	0	3	3	
333	PEC	PE-2	25CSC3203	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	R	DSCC	3	0	0	0	3	3	
334	PEC	PE-2	25CNS3202	FUNDAMENTALS OF CLOUD SECURITY	R	FOCS	2	0	2	0	3	4	
335	PEC	PE-2	25CNE3202	CLOUD NATIVE APPLICATION DEVELOPMENT	R	CNAD	3	0	0	0	3	3	

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336	PEC	PE-2	25CNE3203	CLOUD NATIVE DESIGN PROCESS	R	CNDP	3	0	0	0	3	3	
337	PEC	PE-2	25GDU3202	UX DESIGN	R	UXD	3	0	0	0	3	3	
338	PEC	PE-2	25ADE3202	AI AT THE EDGE	R	AIAE	3	0	0	0	3	3	
339	PEC	PE-2	25ACI3202	EXPLAINABLE AI AND COMMUNICATIONS	R	EAIC	3	0	0	0	3	3	
340	PEC	PE-2	25DLS3202	DESIGNING REAL-TIME DATA PIPELINES	R	RTDP	3	0	0	0	3	3	
341	PEC	PE-2	25DSE3202	DATA EXPLORATION & PREPARATION	R	DEP	3	0	0	0	3	3	
342	PEC	PE-2	25DSE3203	DATA WAREHOUSING& BUSINESS INTELLIGENCE	R	DWBI	3	0	0	0	3	3	
343	PEC	PE-2	25SCI3202	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	R	SCMG	3	0	0	0	3	3	
344	PEC	PE-2	25GMI3202	ENGINEERING LARGE LANGUAGE MODEL SYSTEMS	R	ELLS	3	0	0	0	3	3	
345	PEC	PE-2	25SDM3202	OPINION MINING AND RECOMMENDER SYSTEMS	R	OMRS	3	0	0	0	3	3	
346	PEC	PE-2	25BEW3110	SMART CONTRACT DEVELOPMENT & TESTING	R	SCDT	3	0	0	0	3	3	
347	PEC	PE-2	25QTS3202	QUANTUM CRYPTOGRAPHY & QUANTUM COMMUNICATION	R	QCQC	3	0	0	0	3	3	
348	PEC	PE-2	25AVI3203	COMPUTER VISION	R	CV	3	0	0	0	3	3	
349	PEC	PE-2	25BEW3211	BLOCKCHAIN NETWORK ARCHITECTURE & CONSENSUS MECHANISMS	R	BNAC	3	0	0	0	3	3	
350	PEC	PE-2	25QCS3202	QUANTUM OPTICS	R	QO	3	0	0	0	3	3	
351	PEC	PE-2	25RFM3202	ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS	R	AADW	3	0	0	0	3	3	
352	PEC	PE-2	25GAM3202	DEEP LEARNING FOR COMPUTER VISION APPLICATIONS	R	DLCVA	3	0	0	0	3	3	
353	PEC	PE-2	25AEE3203	REFRIGERATION & AIR CONDITIONING	R	RAC	3	0	0	0	3	3	
354	PEC	PE-2	25BMI3202	ADVANCED BIOMEDICAL SIGNAL PROCESSING	R	ABSP	3	0	0	0	3	3	
355	PEC	PE-2	25HDA3202	BIO MEDICAL INFORMATICS	R	BMI	3	0	0	0	3	3	
356	PEC	PE-2	25HDA3203	GENETIC PROGRAMMING	R	GP	3	0	0	0	3	3	
357	PEC	PE-2	25IBT3202	PHARMACOVIGILANCE AND SAFETY	R	PCS	3	0	0	0	3	3	
358	PEC	PE-2	25NTO3204	NANOPHOTONICS AND BIOPHOTONICS	R	NAB	3	0	0	0	3	3	
359	PEC	PE-2	25IBT3203	BIOPROCESS ECONOMICS AND PLANT DESIGN	R	BEPD	3	0	0	0	3	3	

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360	PEC	PE-2	25NTO3203	NANOTECHNOLOGY AND NANOSENSORS	R	NAN	3	0	0	0	3	3	
361	PEC	PE-2	25SMF3202	FLEXIBLE MANUFACTURING SYSTEMS	R	FMS	3	0	0	0	3	3	
362	PEC	PE-2	25SMF3203	PRECISION AND MICRO MANUFACTURING	R	PMM	3	0	0	0	3	3	
363	PEC	PE-2	25IOT3202	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
364	PEC	PE-2	25IOT3203	PRECISION AGRICULTURE	R	PA	3	0	0	0	3	3	
365	PEC	PE-2	25IOT3204	SMART FARMING	R	SF	3	0	0	0	3	3	
366	PEC	PE-2	25MBT3203	NANOBIOTECHNOLOGY	R	TE	3	0	0	0	3	3	
367	PEC	PE-2	25MBT3202	VIROLOGY	R	VR	3	0	0	0	3	3	
368	PEC	PE-3	25SMF3304A	ADDITIVE AND HYBRID MANUFACTURING	A	AHM	4	1	0	2	5.5	7	
369	PEC	PE-3	25SMF3304E	ADDITIVE AND HYBRID MANUFACTURING	E	AHM	4	1	0	2	5.5	7	
370	PEC	PE-3	25SMF3304	ADDITIVE AND HYBRID MANUFACTURING	R	AHM	3	0	0	2	3.5	5	
371	PEC	PE-3	25IBT3304A	ENZYME ENGINEERING	A	EE	4	1	0	2	5.5	7	
372	PEC	PE-3	25IBT3304E	ENZYME ENGINEERING	E	EE	4	1	0	2	5.5	7	
373	PEC	PE-3	25IBT3304	ENZYME ENGINEERING	R	EE	3	0	0	2	3.5	5	
374	PEC	PE-3	25NTO3306A	NANOROBOTICS FOR ADVANCED APPLICATIONS	A	NAA	4	1	0	2	5.5	7	
375	PEC	PE-3	25NTO3306E	NANOROBOTICS FOR ADVANCED APPLICATIONS	E	NAA	4	1	0	2	5.5	7	
376	PEC	PE-3	25NTO3306	NANOROBOTICS FOR ADVANCED APPLICATIONS	R	NAA	3	0	0	2	3.5	5	
377	PEC	PE-3	25MBT3304A	HEALTHCARE BIOTECHNOLOGY	A	HBT	4	1	0	2	5.5	7	
378	PEC	PE-3	25MBT3304E	HEALTHCARE BIOTECHNOLOGY	E	HBT	4	1	0	2	5.5	7	
379	PEC	PE-3	25MBT3304	HEALTHCARE BIOTECHNOLOGY	R	HBT	3	0	0	2	3.5	5	
380	PEC	PE-3	25NTO3305A	NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS	A	NBA	4	1	0	2	5.5	7	
381	PEC	PE-3	25NTO3305E	NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS	E	NBA	4	1	0	2	5.5	7	
382	PEC	PE-3	25NTO3305	NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS	R	NBA	3	0	0	2	3.5	5	
383	PEC	PE-3	25BMI3303A	MATERIALS FOR BIO-MEDICAL APPLICATIONS	A	MBMA	4	1	0	2	5.5	7	
384	PEC	PE-3	25BMI3303E	MATERIALS FOR BIO-MEDICAL APPLICATIONS	E	MBMA	4	1	0	2	5.5	7	

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385	PEC	PE-3	25BMI3303	MATERIALS FOR BIO-MEDICAL APPLICATIONS	R	MBMA	3	0	0	2	3.5	5	
386	PEC	PE-3	25GAM3303A	GENERATIVE AI ARCHITECTURES	A	GAA	4	1	0	2	5.5	7	
387	PEC	PE-3	25GAM3303E	GENERATIVE AI ARCHITECTURES	E	GAA	4	1	0	2	5.5	7	
388	PEC	PE-3	25GAM3303	GENERATIVE AI ARCHITECTURES	R	GAA	3	0	0	2	3.5	5	
389	PEC	PE-3	25RFM3303A	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	A	MRSN	4	1	0	2	5.5	7	
390	PEC	PE-3	25RFM3303E	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	E	MRSN	4	1	0	2	5.5	7	
391	PEC	PE-3	25RFM3303	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	R	MRSN	3	0	0	2	3.5	5	
392	PEC	PE-3	25QCS3303A	QUANTUM SENSING	A	QS	4	1	0	2	5.5	7	
393	PEC	PE-3	25QCS3303E	QUANTUM SENSING	E	QS	4	1	0	2	5.5	7	
394	PEC	PE-3	25QCS3303	QUANTUM SENSING	R	QS	3	0	0	2	3.5	5	
395	PEC	PE-3	25BEW3312A	WEB3 APPLICATION DEVELOPMENT & INTEGRATION	A	WADI	4	1	0	2	5.5	7	
396	PEC	PE-3	25BEW3312E	WEB3 APPLICATION DEVELOPMENT & INTEGRATION	E	WADI	4	1	0	2	5.5	7	
397	PEC	PE-3	25BEW3312	WEB3 APPLICATION DEVELOPMENT & INTEGRATION	R	WADI	3	0	0	2	3.5	5	
398	PEC	PE-3	25AVI3304A	OBJECT DETECTION	A	OD	4	1	0	2	5.5	7	
399	PEC	PE-3	25AVI3304E	OBJECT DETECTION	E	OD	4	1	0	2	5.5	7	
400	PEC	PE-3	25AVI3304	OBJECT DETECTION	R	OD	3	0	0	2	3.5	5	
401	PEC	PE-3	25QTS3303A	QUANTUM SENSING & METROLOGY	A	QSM	4	1	0	2	5.5	7	
402	PEC	PE-3	25QTS3303E	QUANTUM SENSING & METROLOGY	E	QSM	4	1	0	2	5.5	7	
403	PEC	PE-3	25QTS3303	QUANTUM SENSING & METROLOGY	R	QSM	3	0	0	2	3.5	5	
404	PEC	PE-3	25GMI3303A	REINFORCEMENT LEARNING	A	RL	4	1	0	2	5.5	7	
405	PEC	PE-3	25GMI3303E	REINFORCEMENT LEARNING	E	RL	4	1	0	2	5.5	7	
406	PEC	PE-3	25GMI3303	REINFORCEMENT LEARNING	R	RL	3	0	0	2	3.5	5	
407	PEC	PE-3	25CEC3305A	CLOUD AND SERVERLESS COMPUTING	A	CSC	4	1	0	2	5.5	7	
408	PEC	PE-3	25CEC3305E	CLOUD AND SERVERLESS COMPUTING	E	CSC	4	1	0	2	5.5	7	
409	PEC	PE-3	25CEC3305	CLOUD AND SERVERLESS COMPUTING	R	CSC	3	0	0	2	3.5	5	
410	PEC	PE-3	25SCI3303A	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	A	SCPD	4	1	0	2	5.5	7	

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411	PEC	PE-3	25SCI3303E	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	E	SCPD	4	1	0	2	5.5	7	
412	PEC	PE-3	25SCI3303	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	R	SCPD	3	0	0	2	3.5	5	
413	PEC	PE-3	25DSE3304A	BIG DATA ENGINEERING	A	BDE	4	1	0	2	5.5	7	
414	PEC	PE-3	25DSE3304E	BIG DATA ENGINEERING	E	BDE	4	1	0	2	5.5	7	
415	PEC	PE-3	25DSE3304	BIG DATA ENGINEERING	R	BDE	3	0	0	2	3.5	5	
416	PEC	PE-3	25DSE3305A	BUSINESS ANALYTICS	A	BA	4	1	0	2	5.5	7	
417	PEC	PE-3	25DSE3305E	BUSINESS ANALYTICS	E	BA	4	1	0	2	5.5	7	
418	PEC	PE-3	25DSE3305	BUSINESS ANALYTICS	R	BA	3	0	0	2	3.5	5	
419	PEC	PE-3	25DLS3303A	DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS	A	DLSS	4	1	0	2	5.5	7	
420	PEC	PE-3	25DLS3303E	DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS	E	DLSS	4	1	0	2	5.5	7	
421	PEC	PE-3	25DLS3303	DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS	R	DLSS	3	0	0	2	3.5	5	
422	PEC	PE-3	25ACI3303A	FUZZY LOGIC WITH SET THEORY	A	FLST	4	1	0	2	5.5	7	
423	PEC	PE-3	25ACI3303E	FUZZY LOGIC WITH SET THEORY	E	FLST	4	1	0	2	5.5	7	
424	PEC	PE-3	25ACI3303	FUZZY LOGIC WITH SET THEORY	R	FLST	3	0	0	2	3.5	5	
425	PEC	PE-3	25ADE3303A	EDGE AI ARCHITECTURES AND APPLICATIONS	A	EAIAA	4	1	0	2	5.5	7	
426	PEC	PE-3	25ADE3303E	EDGE AI ARCHITECTURES AND APPLICATIONS	E	EAIAA	4	1	0	2	5.5	7	
427	PEC	PE-3	25ADE3303	EDGE AI ARCHITECTURES AND APPLICATIONS	R	EAIAA	3	0	0	2	3.5	5	
428	PEC	PE-3	25AEC3303A	SERVICE MESH & OBSERVABILITY FOR EDGE AI	A	SMOA	4	1	0	2	5.5	7	
429	PEC	PE-3	25AEC3303E	SERVICE MESH & OBSERVABILITY FOR EDGE AI	E	SMOA	4	1	0	2	5.5	7	
430	PEC	PE-3	25AEC3303	SERVICE MESH & OBSERVABILITY FOR EDGE AI	R	SMOA	3	0	0	2	3.5	5	
431	PEC	PE-3	25GDU3303A	AR AND VR APPLICATION DEVELOPMENT	A	AR&VR	4	1	0	2	5.5	7	
432	PEC	PE-3	25GDU3303E	AR AND VR APPLICATION DEVELOPMENT	E	AR&VR	4	1	0	2	5.5	7	
433	PEC	PE-3	25GDU3303	AR AND VR APPLICATION DEVELOPMENT	R	AR&VR	3	0	0	2	3.5	5	
434	PEC	PE-3	25CNE3304A	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	A	SEC	4	1	0	2	5.5	7	
435	PEC	PE-3	25CNE3304E	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	E	SEC	4	1	0	2	5.5	7	

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436	PEC	PE-3	25CNE3304	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	R	SEC	3	0	0	2	3.5	5	
437	PEC	PE-3	25CNS3303A	CONTAINER SECURITY	A	CTSY	4	1	0	2	5.5	7	
438	PEC	PE-3	25CNS3303E	CONTAINER SECURITY	E	CTSY	4	1	0	2	5.5	7	
439	PEC	PE-3	25CNS3303	CONTAINER SECURITY	R	CTSY	3	0	0	2	3.5	5	
440	PEC	PE-3	25CSC3304A	CLOUD BASED HIGH PERFORMANCE COMPUTING	A	CHC	4	1	0	2	5.5	7	
441	PEC	PE-3	25CSC3304E	CLOUD BASED HIGH PERFORMANCE COMPUTING	E	CHC	4	1	0	2	5.5	7	
442	PEC	PE-3	25CSC3304	CLOUD BASED HIGH PERFORMANCE COMPUTING	R	CHC	3	0	0	2	3.5	5	
443	PEC	PE-3	25ALT3303A	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	A	CAICBD	4	1	0	2	5.5	7	
444	PEC	PE-3	25ALT3303E	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	E	CAICBD	4	1	0	2	5.5	7	
445	PEC	PE-3	25ALT3303	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	R	CAICBD	3	0	0	2	3.5	5	
446	PEC	PE-3	25BEW3303A	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	A	DADW	4	1	0	2	5.5	7	
447	PEC	PE-3	25BEW3303E	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	E	DADW	4	1	0	2	5.5	7	
448	PEC	PE-3	25BEW3303	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	R	DADW	3	0	0	2	3.5	5	
449	PEC	PE-3	25CID3304A	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	A	CIA	4	1	0	2	5.5	7	
450	PEC	PE-3	25CID3304E	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	E	CIA	4	1	0	2	5.5	7	
451	PEC	PE-3	25CID3304	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	R	CIA	3	0	0	2	3.5	5	
452	PEC	PE-3	25CPD3304A	SECURE MOBILE APPLICATION DEVELOPMENT	A	SMAD	4	1	0	2	5.5	7	
453	PEC	PE-3	25CPD3304E	SECURE MOBILE APPLICATION DEVELOPMENT	E	SMAD	4	1	0	2	5.5	7	
454	PEC	PE-3	25CPD3304	SECURE MOBILE APPLICATION DEVELOPMENT	R	SMAD	3	0	0	2	3.5	5	
455	PEC	PE-3	25CSB3304A	DIGITAL FORENSICS	A	DF	4	1	0	2	5.5	7	
456	PEC	PE-3	25CSB3304E	DIGITAL FORENSICS	E	DF	4	1	0	2	5.5	7	
457	PEC	PE-3	25CSB3304	DIGITAL FORENSICS	R	DF	3	0	0	2	3.5	5	
458	PEC	PE-3	25DEA3303A	BIG DATA TECHNOLOGIES	A	BDT	4	1	0	2	5.5	7	
459	PEC	PE-3	25DEA3303E	BIG DATA TECHNOLOGIES	E	BDT	4	1	0	2	5.5	7	
460	PEC	PE-3	25DEA3303	BIG DATA TECHNOLOGIES	R	BDT	3	0	0	2	3.5	5	

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461	PEC	PE-3	25DSB3303A	BIG DATA ANALYTICS	A	BDA	4	1	0	2	5.5	7	
462	PEC	PE-3	25DSB3303E	BIG DATA ANALYTICS	E	BDA	4	1	0	2	5.5	7	
463	PEC	PE-3	25DSB3303	BIG DATA ANALYTICS	R	BDA	3	0	0	2	3.5	5	
464	PEC	PE-3	25DLA3304A	MULTI AGENT SYSTEMS	A	MAS	4	1	0	2	5.5	7	
465	PEC	PE-3	25DLA3304E	MULTI AGENT SYSTEMS	E	MAS	4	1	0	2	5.5	7	
466	PEC	PE-3	25DLA3304	MULTI AGENT SYSTEMS	R	MAS	3	0	0	2	3.5	5	
467	PEC	PE-3	25SMD3303A	CONTINUOUS DELIVERY & DEVOPS	A	CDD	4	1	0	2	5.5	7	
468	PEC	PE-3	25SMD3303E	CONTINUOUS DELIVERY & DEVOPS	E	CDD	4	1	0	2	5.5	7	
469	PEC	PE-3	25SMD3303	CONTINUOUS DELIVERY & DEVOPS	R	CDD	3	0	0	2	3.5	5	
470	PEC	PE-3	25HSS3303A	HARDWARE SECURITY MECHANISMS	A	HSM	4	1	0	2	5.5	7	
471	PEC	PE-3	25HSS3303E	HARDWARE SECURITY MECHANISMS	E	HSM	4	1	0	2	5.5	7	
472	PEC	PE-3	25HSS3303	HARDWARE SECURITY MECHANISMS	R	HSM	3	0	0	2	3.5	5	
473	PEC	PE-3	25IOT3305A	DEEP LEARNING	A	DL	4	1	0	2	5.5	7	
474	PEC	PE-3	25IOT3305E	DEEP LEARNING	E	DL	4	1	0	2	5.5	7	
475	PEC	PE-3	25IOT3305	DEEP LEARNING	R	DL	3	0	0	2	3.5	5	
476	PEC	PE-3	25HDA3305A	COMPUTATIONAL NEUROSCIENCE	A	CNSE	4	1	0	2	5.5	7	
477	PEC	PE-3	25HDA3305E	COMPUTATIONAL NEUROSCIENCE	E	CNSE	4	1	0	2	5.5	7	
478	PEC	PE-3	25HDA3305	COMPUTATIONAL NEUROSCIENCE	R	CNSE	3	0	0	2	3.5	5	
479	PEC	PE-3	25SDM3304A	SOCIAL MEDIA MARKETING ANALYTICS	A	SMMA	4	1	0	2	5.5	7	
480	PEC	PE-3	25SDM3304E	SOCIAL MEDIA MARKETING ANALYTICS	E	SMMA	4	1	0	2	5.5	7	
481	PEC	PE-3	25SDM3304	SOCIAL MEDIA MARKETING ANALYTICS	R	SMMA	3	0	0	2	3.5	5	
482	PEC	PE-3	25AAS3304A	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	A	ADLAS	4	1	0	2	5.5	7	
483	PEC	PE-3	25AAS3304E	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	E	ADLAS	4	1	0	2	5.5	7	
484	PEC	PE-3	25AAS3304	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	R	ADLAS	3	0	0	2	3.5	5	
485	PEC	PE-3	25AAS3309A	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	A	AAAV	4	1	0	2	5.5	7	
486	PEC	PE-3	25AAS3309E	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	E	AAAV	4	1	0	2	5.5	7	
487	PEC	PE-3	25AAS3309	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	R	AAAV	3	0	0	2	3.5	5	

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488	PEC	PE-3	25AAS3314A	AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE	A	ANCE	4	1	0	2	5.5	7	
489	PEC	PE-3	25AAS3314E	AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE	E	ANCE	4	1	0	2	5.5	7	
490	PEC	PE-3	25AAS3314	AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE	R	ANCE	3	0	0	2	3.5	5	
491	PEC	PE-3	25IGD3305A	3D GAME PROGRAMMING AND PHYSICS SIMULATION	A	3DPS	4	1	0	2	5.5	7	
492	PEC	PE-3	25IGD3305E	3D GAME PROGRAMMING AND PHYSICS SIMULATION	E	3DPS	4	1	0	2	5.5	7	
493	PEC	PE-3	25IGD3305	3D GAME PROGRAMMING AND PHYSICS SIMULATION	R	3DPS	3	0	0	2	3.5	5	
494	PEC	PE-3	25IGD3306A	PROCEDURAL WORLD BUILDING	A	PWB	4	1	0	2	5.5	7	
495	PEC	PE-3	25IGD3306E	PROCEDURAL WORLD BUILDING	E	PWB	4	1	0	2	5.5	7	
496	PEC	PE-3	25IGD3306	PROCEDURAL WORLD BUILDING	R	PWB	3	0	0	2	3.5	5	
497	PEC	PE-3	25CND3303A	ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING	A	DORS	4	1	0	2	5.5	7	
498	PEC	PE-3	25CND3303E	ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING	E	DORS	4	1	0	2	5.5	7	
499	PEC	PE-3	25CND3303	ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING	R	DORS	3	0	0	2	3.5	5	
500	PEC	PE-3	25GSD3303A	SUSTAINABLE CLOUD AND EDGE COMPUTING	A	SCE	4	1	0	2	5.5	7	
501	PEC	PE-3	25GSD3303E	SUSTAINABLE CLOUD AND EDGE COMPUTING	E	SCE	4	1	0	2	5.5	7	
502	PEC	PE-3	25GSD3303	SUSTAINABLE CLOUD AND EDGE COMPUTING	R	SCE	3	0	0	2	3.5	5	
503	PEC	PE-3	25HCA3305A	LARGE LANGUAGE MODELS & CONVERSATIONAL AI	A	LLMC	4	1	0	2	5.5	7	
504	PEC	PE-3	25HCA3305E	LARGE LANGUAGE MODELS & CONVERSATIONAL AI	E	LLMC	4	1	0	2	5.5	7	
505	PEC	PE-3	25HCA3305	LARGE LANGUAGE MODELS & CONVERSATIONAL AI	R	LLMC	3	0	0	2	3.5	5	
506	PEC	PE-3	25DLA3303A	SMART CONTRACTS & WEB3 APPLICATION ENGINEERING	A	SCW3	4	1	0	2	5.5	7	
507	PEC	PE-3	25DLA3303E	SMART CONTRACTS & WEB3 APPLICATION ENGINEERING	E	SCW3	4	1	0	2	5.5	7	
508	PEC	PE-3	25DLA3303	SMART CONTRACTS & WEB3 APPLICATION ENGINEERING	R	SCW3	3	0	0	2	3.5	5	
509	PEC	PE-3	25HCA3306A	IMAGE PROCESSING & SCENE UNDERSTANDING	A	IPSU	4	1	0	2	5.5	7	

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510	PEC	PE-3	25HCA3306E	IMAGE PROCESSING & SCENE UNDERSTANDING	E	IPSU	4	1	0	2	5.5	7	
511	PEC	PE-3	25HCA3306	IMAGE PROCESSING & SCENE UNDERSTANDING	R	IPSU	3	0	0	2	3.5	5	
512	PEC	PE-3	25CAC3303A	ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION	A	ACHA	4	1	0	2	5.5	7	
513	PEC	PE-3	25CAC3303E	ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION	E	ACHA	4	1	0	2	5.5	7	
514	PEC	PE-3	25CAC3303	ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION	R	ACHA	3	0	0	2	3.5	5	
515	PEC	PE-3	25HCA3307A	SPEECH PROCESSING	A	SP	4	1	0	2	5.5	7	
516	PEC	PE-3	25HCA3307E	SPEECH PROCESSING	E	SP	4	1	0	2	5.5	7	
517	PEC	PE-3	25HCA3307	SPEECH PROCESSING	R	SP	3	0	0	2	3.5	5	
518	PEC	PE-3	25CAC3304A	QUANTUM PROGRAMMING FUNDAMENTALS	A	QPF	4	1	0	2	5.5	7	
519	PEC	PE-3	25CAC3304E	QUANTUM PROGRAMMING FUNDAMENTALS	E	QPF	4	1	0	2	5.5	7	
520	PEC	PE-3	25CAC3304	QUANTUM PROGRAMMING FUNDAMENTALS	R	QPF	3	0	0	2	3.5	5	
521	PEC	PE-3	25CTI3305A	BLUE TEAM OPERATIONS & SIEM	A	BTOS	4	1	0	2	5.5	7	
522	PEC	PE-3	25CTI3305E	BLUE TEAM OPERATIONS & SIEM	E	BTOS	4	1	0	2	5.5	7	
523	PEC	PE-3	25CTI3305	BLUE TEAM OPERATIONS & SIEM	R	BTOS	3	0	0	2	3.5	5	
524	PEC	PE-3	25CTI3306A	SOC MANAGEMENT	A	SOC	4	1	0	2	5.5	7	
525	PEC	PE-3	25CTI3306E	SOC MANAGEMENT	E	SOC	4	1	0	2	5.5	7	
526	PEC	PE-3	25CTI3306	SOC MANAGEMENT	R	SOC	3	0	0	2	3.5	5	
527	PEC	PE-3	25ABT3304A	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	A	IPAA	4	1	0	2	5.5	7	
528	PEC	PE-3	25ABT3304E	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	E	IPAA	4	1	0	2	5.5	7	
529	PEC	PE-3	25ABT3304	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	R	IPAA	3	0	0	2	3.5	5	
530	PEC	PE-3	25WLT3303A	5G NR-WIRELESS TECHNOLOGIES	A	5GWT	4	1	0	2	5.5	7	
531	PEC	PE-3	25WLT3303E	5G NR-WIRELESS TECHNOLOGIES	E	5GWT	4	1	0	2	5.5	7	
532	PEC	PE-3	25WLT3303	5G NR-WIRELESS TECHNOLOGIES	R	5GWT	3	0	0	2	3.5	5	
533	PEC	PE-3	25AEA3304A	ALTERNATE DRIVES, TRACTION AND CONTROLS	A	ADTC	4	1	0	2	5.5	7	

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534	PEC	PE-3	25AEA3304E	ALTERNATE DRIVES, TRACTION AND CONTROLS	E	ADTC	4	1	0	2	5.5	7	
535	PEC	PE-3	25AEA3304	ALTERNATE DRIVES, TRACTION AND CONTROLS	R	ADTC	3	0	0	2	3.5	5	
536	PEC	PE-3	25WRE3303A	GROUND IMPROVEMENT TECHNIQUES	A	GIT	4	1	0	2	5.5	7	
537	PEC	PE-3	25WRE3303E	GROUND IMPROVEMENT TECHNIQUES	E	GIT	4	1	0	2	5.5	7	
538	PEC	PE-3	25WRE3303	GROUND IMPROVEMENT TECHNIQUES	R	GIT	3	0	0	2	3.5	5	
539	PEC	PE-3	25VLS3303A	VLSI PHYSICAL DESIGN AUTOMATION	A	VPDA	4	1	0	2	5.5	7	
540	PEC	PE-3	25VLS3303E	VLSI PHYSICAL DESIGN AUTOMATION	E	VPDA	4	1	0	2	5.5	7	
541	PEC	PE-3	25VLS3303	VLSI PHYSICAL DESIGN AUTOMATION	R	VPDA	3	0	0	2	3.5	5	
542	PEC	PE-3	25AEE3304A	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	A	TMEES	4	1	0	2	5.5	7	
543	PEC	PE-3	25AEE3304E	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	E	TMEES	4	1	0	2	5.5	7	
544	PEC	PE-3	25AEE3304	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	R	TMEES	3	0	0	2	3.5	5	
545	PEC	PE-3	25BIS3304A	STRUCTURAL BIOLOGY	A	SB	4	1	0	2	5.5	7	
546	PEC	PE-3	25BIS3304E	STRUCTURAL BIOLOGY	E	SB	4	1	0	2	5.5	7	
547	PEC	PE-3	25BIS3304	STRUCTURAL BIOLOGY	R	SB	3	0	0	2	3.5	5	
548	PEC	PE-3	25STE3303A	PRESTRESSED CONCRETE	A	PSC	4	1	0	2	5.5	7	
549	PEC	PE-3	25STE3303E	PRESTRESSED CONCRETE	E	PSC	4	1	0	2	5.5	7	
550	PEC	PE-3	25STE3303	PRESTRESSED CONCRETE	R	PSC	3	0	0	2	3.5	5	
551	PEC	PE-3	25CPS3303A	CYBER PHYSICAL SYSTEMS	A	CPS	4	1	0	2	5.5	7	
552	PEC	PE-3	25CPS3303E	CYBER PHYSICAL SYSTEMS	E	CPS	4	1	0	2	5.5	7	
553	PEC	PE-3	25CPS3303	CYBER PHYSICAL SYSTEMS	R	CPS	3	0	0	2	3.5	5	
554	PEC	PE-3	25SGT3304A	ENERGY MANAGEMENT SYSTEMS AND SCADA	A	EMS&SCADA	4	1	0	2	5.5	7	
555	PEC	PE-3	25SGT3304E	ENERGY MANAGEMENT SYSTEMS AND SCADA	E	EMS&SCADA	4	1	0	2	5.5	7	
556	PEC	PE-3	25SGT3304	ENERGY MANAGEMENT SYSTEMS AND SCADA	R	EMS&SCADA	3	0	0	2	3.5	5	
557	PEC	PE-3	25RAN3304A	AUTONOMOUS MOBILE ROBOT SYSTEMS	A	AMRS	4	1	0	2	5.5	7	

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558	PEC	PE-3	25RAN3304E	AUTONOMOUS MOBILE ROBOT SYSTEMS	E	AMRS	4	1	0	2	5.5	7	
559	PEC	PE-3	25RAN3304	AUTONOMOUS MOBILE ROBOT SYSTEMS	R	AMRS	3	0	0	2	3.5	5	
560	PEC	PE-3	25DCM3303A	VOIP AND BROADBAND NETWORKS	A	VOIP	4	1	0	2	5.5	7	
561	PEC	PE-3	25DCM3303E	VOIP AND BROADBAND NETWORKS	E	VOIP	4	1	0	2	5.5	7	
562	PEC	PE-3	25DCM3303	VOIP AND BROADBAND NETWORKS	R	VOIP	3	0	0	2	3.5	5	
563	PEC	PE-3	25EDS3303A	EMBEDDED AND REAL-TIME SYSTEMS	A	ERTS	4	1	0	2	5.5	7	
564	PEC	PE-3	25EDS3303E	EMBEDDED AND REAL-TIME SYSTEMS	E	ERTS	4	1	0	2	5.5	7	
565	PEC	PE-3	25EDS3303	EMBEDDED AND REAL-TIME SYSTEMS	R	ERTS	3	0	0	2	3.5	5	
566	PEC	PE-3	25EME3304A	CHARGING STATIONS FOR ELECTRIC VEHICLES	A	CSEV	4	1	0	2	5.5	7	
567	PEC	PE-3	25EME3304E	CHARGING STATIONS FOR ELECTRIC VEHICLES	E	CSEV	4	1	0	2	5.5	7	
568	PEC	PE-3	25EME3304	CHARGING STATIONS FOR ELECTRIC VEHICLES	R	CSEV	3	0	0	2	3.5	5	
569	PEC	PE-3	25EGD3304A	MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS	A	MADRS	4	1	0	2	5.5	7	
570	PEC	PE-3	25EGD3304E	MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS	E	MADRS	4	1	0	2	5.5	7	
571	PEC	PE-3	25EGD3304	MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS	R	MADRS	3	0	0	2	3.5	5	
572	PEC	PE-3	25GET3304A	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	A	GIRES	4	1	0	2	5.5	7	
573	PEC	PE-3	25GET3304E	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	E	GIRES	4	1	0	2	5.5	7	
574	PEC	PE-3	25GET3304	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	R	GIRES	3	0	0	2	3.5	5	
575	PEC	PE-3	25ILA3304A	INDUSTRIAL DRIVES AND CONTROL	A	ID&C	4	1	0	2	5.5	7	
576	PEC	PE-3	25ILA3304E	INDUSTRIAL DRIVES AND CONTROL	E	ID&C	4	1	0	2	5.5	7	
577	PEC	PE-3	25ILA3304	INDUSTRIAL DRIVES AND CONTROL	R	ID&C	3	0	0	2	3.5	5	
578	PEC	PE-4	25ILA3405	INDUSTRIAL COMMUNICATION PROTOCOLS AND CYBER SECURITY	R	ICPCS	3	0	0	0	3	3	
579	PEC	PE-4	25ILA3406	DIGITAL MANUFACTURING AND DESIGN	R	DMD	3	0	0	0	3	3	
580	PEC	PE-4	25GET3405	ENERGY MANAGEMENT AND GREEN BUILDING	R	EMGB	3	0	0	0	3	3	
581	PEC	PE-4	25GET3406	HYDROGEN FUEL CELL TECHNOLOGY	R	HFCT	3	0	0	0	3	3	

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582	PEC	PE-4	25EGD3405	SUSTAINABLE DESIGN AND SOCIAL INNOVATION IN ENGINEERING DESIGN	R	SDSIED	3	0	0	0	3	3	
583	PEC	PE-4	25EGD3406	ADVANCED VIBRATIONS	R	AV	3	0	0	0	3	3	
584	PEC	PE-4	25EME3405	INTRODUCTION TO BATTERY-MANAGEMENT SYSTEMS	R	IBMS	3	0	0	0	3	3	
585	PEC	PE-4	25EME3406	BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE	R	BSAEV	3	0	0	0	3	3	
586	PEC	PE-4	25EDS3404	CLOUD ARCHITECTURE IN IOT	R	CAIOT	3	0	0	0	3	3	
587	PEC	PE-4	25DCM3404	5G MOBILE AND IEEE STANDARDS	R	5GMI	3	0	0	0	3	3	
588	PEC	PE-4	25RAN3406	HUMAN MACHINE INTERFACE AND BRAIN MACHINE INTERFACE	R	HMIBMI	3	0	0	0	3	3	
589	PEC	PE-4	25RAN3405	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	R	AIR	3	0	0	0	3	3	
590	PEC	PE-4	25SGT3406	SMART METERS AND SMART CITIES	R	SMSC	3	0	0	0	3	3	
591	PEC	PE-4	25CPS3404	FOUNDATIONS OF HYBRID AND EMBEDDED SYSTEMS	R	DVP	3	0	0	0	3	3	
592	PEC	PE-4	25VLS3404	MIXED SIGNAL IC DESIGN	R	MSID	3	0	0	0	3	3	
593	PEC	PE-4	25STE3404	SUSTAINABLE CONSTRUCTION TECHNOLOGY	R	SCT	3	0	0	0	3	3	
594	PEC	PE-4	25BIS3405	APPLIED BIOINFORMATICS	R	ABI	3	0	0	0	3	3	
595	PEC	PE-4	25BIS3406	NGS SEQUENCING AND DATA ANALYSIS	R	NGSDA	3	0	0	0	3	3	
596	PEC	PE-4	25AEE3405	SPECIAL PURPOSE VEHICLES	R	SPV	3	0	0	0	3	3	
597	PEC	PE-4	25AEE3406	VEHICLE DYNAMICS	R	VDS	3	0	0	0	3	3	
598	PEC	PE-4	25WRE3404	RIVER ENGINEERING	R	REG	3	0	0	0	3	3	
599	PEC	PE-4	25AEA3405	VEHICLE CONTROL SYSTEMS	R	VCS	3	0	0	0	3	3	
600	PEC	PE-4	25AEA3406	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	R	AEES	3	0	0	0	3	3	
601	PEC	PE-4	25ABT3405	BIOINSTRUMENTATION	R	BIIS	3	0	0	0	3	3	
602	PEC	PE-4	25ABT3406	DATA ACQUISITION AND COMMUNICATION SYSTEMS FOR AGRICULTURE	R	DACSA	3	0	0	0	3	3	
603	PEC	PE-4	25CTI3407	CLOUD SECURITY	R	CS	3	0	0	0	3	3	
604	PEC	PE-4	25CTI3408	DEVSECOPS & INFRASTRUCTURE SECURITY	R	DSI	3	0	0	0	3	3	
605	PEC	PE-4	25IOT3406	DATA VISUALIZATION TECHNIQUES	R	DVT	3	0	0	0	3	3	

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606	PEC	PE-4	25CAC3405	CLOUD ARCHITECTURES FOR HPC & AI WORKLOADS	R	CHAW	3	0	0	0	3	3	
607	PEC	PE-4	25CAC3406	QUANTUM ALGORITHMS FOR AI & OPTIMIZATION	R	QAAO	3	0	0	0	3	3	
608	PEC	PE-4	25AAS3410	CYBERSECURITY IN AUTONOMOUS VEHICLE	R	CAV	3	0	0	0	3	3	
609	PEC	PE-4	25HCA3408	VISION TRANSFORMERS & GENERATIVE MODELS FOR VISION	R	VTGM	3	0	0	0	3	3	
610	PEC	PE-4	25DLA3404	TOKENOMICS, DIGITAL ASSETS & CRYPTO INFRASTRUCTURE	R	TDCI	3	0	0	0	3	3	
611	PEC	PE-4	25HDA3407	INTRODUCTION TO GENOMIC TECHNOLOGIES	R	IGT	3	0	0	0	3	3	
612	PEC	PE-4	25GMI3404	GENERATIVE AI, AGENTIC AI & RETRIEVAL AUGMENTED GENERATION	R	GAAR	3	0	0	0	3	3	
613	PEC	PE-4	25GSD3404	HARDWARE FOR SUSTAINABLE DIGITAL INFRASTRUCTURE	R	HSDI	3	0	0	0	3	3	
614	PEC	PE-4	25CND3404	CLOUD-NATIVE MLOPS & A1-DRIVEN APPLICATION DEPLOYMENT	R	CNMA	3	0	0	0	3	3	
615	PEC	PE-4	25IGD3407	IMMERSIVE GAME DEVELOPMENT	R	IGD	3	0	0	0	3	3	
616	PEC	PE-4	25IGD3408	SPATIAL COMPUTING FOR INTERACTIVE SYSTEMS	R	SCIS	3	0	0	0	3	3	
617	PEC	PE-4	25AAS3405	EXPERT SYSTEMS	R	ES	3	0	0	0	3	3	
618	PEC	PE-4	25AAS3406	SELF-DRIVING CARS	R	SDC	3	0	0	0	3	3	
619	PEC	PE-4	25AAS3415	REAL-TIME NETWORKS, COMMUNICATION & SECURITY FOR AUTONOMOUS SYSTEMS	R	RTNCSAS	3	0	0	0	3	3	
620	PEC	PE-4	25HDA3406	NGS SEQUENCING AND DATA ANALYSIS	R	NGSDA	3	0	0	0	3	3	
621	PEC	PE-4	25SMD3404	SOFTWARE PROJECT MANAGEMENT	R	SPM	3	0	0	0	3	3	
622	PEC	PE-4	25SMD3405	SOFTWARE ARCHITECTURE & DESIGN	R	SAD	3	0	0	0	3	3	
623	PEC	PE-4	25HSS3404	SOFTWARE SECURITY PRINCIPLES	R	SSP	3	0	0	0	3	3	
624	PEC	PE-4	25SDM3406	ETHICAL SOCIAL MEDIA	R	ESM	3	0	0	0	3	3	
625	PEC	PE-4	25HSS3405	SECURE CO-DESIGN METHODOLOGIES	R	SCDM	3	0	0	0	3	3	
626	PEC	PE-4	25HSS3406	HARDWARE TROJAN DETECTION AND PREVENTION	R	HTDAP	3	0	0	0	3	3	
627	PEC	PE-4	25DSB3404	BIG DATA OPTIMIZATION	R	BDO	3	0	0	0	3	3	
628	PEC	PE-4	25DSB3407	DATA ANALYTICS ON CLOUD	R	DAC	3	0	0	0	3	3	
629	PEC	PE-4	25DSB3408	DIGITAL MEDIA ANALYTICS	R	DMA	3	0	0	0	3	3	

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630	PEC	PE-4	25DLA3405	BLOCKCHAIN ANALYTICS	R	BCA	3	0	0	0	3	3	
631	PEC	PE-4	25DLA3406	CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGY	R	CBT	3	0	0	0	3	3	
632	PEC	PE-4	25DEA3404	DATA WAREHOUSING AND BUSINESS INTELLIGENCE	R	DWBI	3	0	0	0	3	3	
633	PEC	PE-4	25CSB3405	DATABASE SYSTEM AND SECURITY	R	DSS	3	0	0	0	3	3	
634	PEC	PE-4	25CSB3406	PROGRAMMING FOR SMART CONTRACTS	R	PSC	3	0	0	0	3	3	
635	PEC	PE-4	25CSB3407	CLOUD SECURITY	R	CS	3	0	0	0	3	3	
636	PEC	PE-4	25CPD3406	META REACT NATIVE SPECIALIZATION	R	MRNS	3	0	0	0	3	3	
637	PEC	PE-4	25CPD3405	UX DESIGN	R	UXD	3	0	0	0	3	3	
638	PEC	PE-4	25CID3405	RELIABLE CLOUD INFRASTRUCTURE: DESIGN AND PROCESS	R	RID	3	0	0	0	3	3	
639	PEC	PE-4	25CID3406	HYBRID CLOUD INTEGRATION AND MANAGEMENT	R	HCIM	3	0	0	0	3	3	
640	PEC	PE-4	25CEC3406	ADVANCED COMPUTER ARCHITECTURE	R	ACA	3	0	0	0	3	3	
641	PEC	PE-4	25CEC3407	PARALLEL ALGORITHMS	R	PA	3	0	0	0	3	3	
642	PEC	PE-4	25CEC3408	CLOUD SECURITY	R	CS	3	0	0	0	3	3	
643	PEC	PE-4	25CEC3409	ARCHITECTING CLOUD SOLUTIONS*	R	ACS	3	0	0	0	3	3	
644	PEC	PE-4	25BEW3404	BLOCKCHAIN PLATFORMS AND PROTOCOLS	R	BCPPF	3	0	0	0	3	3	
645	PEC	PE-4	25BEW3405	BLOCKCHAIN SECURITY	R	BCF	3	0	0	0	3	3	
646	PEC	PE-4	25BEW3406	ORACLES AND DATA FEEDS	R	ODF	3	0	0	0	3	3	
647	PEC	PE-4	25ALT3404	TEXT UNDERSTANDING	R	TUS	3	0	0	0	3	3	
648	PEC	PE-4	25ALT3405	NATURAL LANGUAGE PROCESSING	R	NLP	3	0	0	0	3	3	
649	PEC	PE-4	25ALT3506	LANGUAGE UNDERSTANDING WITH PRE-TRAINED MODELS	R	LUWPTM	3	0	0	0	3	3	
650	PEC	PE-4	25CSC3405	CLOUD-BASED GRID COMPUTING	R	CGC	3	0	0	0	3	3	
651	PEC	PE-4	25CSC3406	CLOUD COMPUTING FOR SCIENTIFIC DISCOVERY	R	CCFSD	3	0	0	0	3	3	
652	PEC	PE-4	25CNS3404	MICROSERVICES SECURITY	R	MSS	3	0	0	0	3	3	
653	PEC	PE-4	25CNS3405	INFRASTRUCTURE AS CODE SECURITY	R	ISACS	3	0	0	0	3	3	
654	PEC	PE-4	25CNS3406	IDENTITY AND ACCESS MANAGEMENT IN CLOUD NATIVE ENVIRONMENTS	R	IAMCNE	3	0	0	0	3	3	

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655	PEC	PE-4	25CNS3407	NETWORK SECURITY IN CLOUD NATIVE ARCHITECTURES	R	NSCNA	3	0	0	0	3	3	
656	PEC	PE-4	25CNE3405	SERVERLESS COMPUTING AND EVENT-DRIVEN ARCHITECTURES	R	SCEDA	3	0	0	0	3	3	
657	PEC	PE-4	25CNE3406	CLOUD NATIVE SOFTWARE ARCHITECTURES	R	CNSA	3	0	0	0	3	3	
658	PEC	PE-4	25GDU3404	COMPUTER GRAPHICS	R	CG	3	0	0	0	3	3	
659	PEC	PE-4	25GDU3405	3D MODELLING & ANIMATION	R	3DMA	3	0	0	0	3	3	
660	PEC	PE-4	25AEC3404	SERVERLESS & COST-OPTIMIZED AI AT THE EDGE	R	SCAE	3	0	0	0	3	3	
661	PEC	PE-4	25AVI3405	VISUAL RECOGNITION AND SCENE UNDERSTANDING	R	VRSU	3	0	0	0	3	3	
662	PEC	PE-4	25ADE3404	EDGE AI AND 5G	R	EAI5G	3	0	0	0	3	3	
663	PEC	PE-4	25ADE3405	EDGE AI SECURITY AND PROTECTION	R	EAISP	3	0	0	0	3	3	
664	PEC	PE-4	25ACI3404	HEURISTIC ALGORITHMS	R	HA	3	0	0	0	3	3	
665	PEC	PE-4	25ACI3405	SWARM INTELLIGENCE APPROACHES	R	SIA	3	0	0	0	3	3	
666	PEC	PE-4	25DLS3404	REAL-TIME ANALYTICS & COMPLEX EVENT PROCESSING	R	RTAC	3	0	0	0	3	3	
667	PEC	PE-4	25DSE3406	AI-DRIVEN DATA ENGINEERING	R	AIDE	3	0	0	0	3	3	
668	PEC	PE-4	25DSE3407	DATA GOVERNANCE ON CLOUD	R	DGC	3	0	0	0	3	3	
669	PEC	PE-4	25SCI3404	SPATIAL AND SOCIAL IMPLICATIONS OF IMMERSIVE TECHNOLOGIES	R	SSIIT	3	0	0	0	3	3	
670	PEC	PE-4	25SCI3405	SPATIAL AUDIO DESIGN FOR GAMES	R	SADG	3	0	0	0	3	3	
671	PEC	PE-4	25QTS3404	QUANTUM MATERIALS & TOPOLOGICAL MATTER	R	QMTM	3	0	0	0	3	3	
672	PEC	PE-4	25SDM3405	DIGITAL MEDIA ANALYTICS	R	DMA	3	0	0	0	3	3	
673	PEC	PE-4	25AVI3406	DEEP REINFORCEMENT LEARNING FOR VISION	R	DRLV	3	0	0	0	3	3	
674	PEC	PE-4	25BEW3413	DECENTRALIZED FINANCE (DEFI) SYSTEMS ENGINEERING	R	DFSE	3	0	0	0	3	3	
675	PEC	PE-4	25BEW3414	POST-QUANTUM CRYPTOGRAPHY FOR BLOCKCHAIN	R	PQCB	3	0	0	0	3	3	
676	PEC	PE-4	25QCS3404	QUANTUM RADAR	R	QR	3	0	0	0	3	3	
677	PEC	PE-4	25RFM3404	RF AND MILLIMETER-WAVE CIRCUIT DESIGN	R	RMWCD	3	0	0	0	3	3	
678	PEC	PE-4	25GAM3404	DESIGN OF LARGE LANGUAGE MODELS	R	DLLM	3	0	0	0	3	3	
679	PEC	PE-4	25BMI3404	NANOTECHNOLOGY AND NANOSENSORS	R	NTN	3	0	0	0	3	3	

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680	PEC	PE-4	25IBT3406	FOOD TECHNOLOGY	R	FT	3	0	0	0	3	3	
681	PEC	PE-4	25SGT3405	SMART GRID COMMUNICATION AND CYBERSECURITY	R	SGCCS	3	0	0	0	3	3	
682	PEC	PE-4	25NT03407	COMPUTATIONAL DATA SCIENCE FOR NANOTECHNOLOGY	R	CDN	3	0	0	0	3	3	
683	PEC	PE-4	25NT03408	INDUSTRIAL NANOTECHNOLOGY	R	INT	3	0	0	0	3	3	
684	PEC	PE-4	25IBT3405	BIOPROCESS VALIDATION AND CGMP	R	BVCGMP	3	0	2	0	4	5	
685	PEC	PE-4	25SMF3405	DIGITAL MANUFACTURING	R	DM	3	0	0	0	3	3	
686	PEC	PE-4	25SMF3406	PRECISION INNOVATION & ENTREPRENEURSHIP	R	PIE	3	0	0	0	3	3	
687	PEC	PE-4	25IOT3407	APPLIED MACHINE LEARNING FOR AGRICULTURE	R	AMLA	3	0	0	0	3	3	
688	PEC	PE-4	25MBT3406	NEUROBIOLOGY	R	NB	3	0	0	0	3	3	
689	PEC	PE-4	25MBT3405	CANCER BIOLOGY	R	CB	3	0	0	0	3	3	
690	PEC	PE-5	25SMF3507	SUSTAINABLE MANUFACTURING	R	SM	3	0	0	0	3	3	
691	PEC	PE-5	25SMF3508	MACHINE TO MACHINE COMMUNICATION	R	MMC	3	0	0	0	3	3	
692	PEC	PE-5	25ILA3508	PLC PROGRAMMING AND CONTROL	R	PLCPC	3	0	0	0	3	3	
693	PEC	PE-5	25IBT3507	MICROBIAL TECHNOLOGY	R	MBT	3	0	0	0	3	3	
694	PEC	PE-5	25IBT3508	METABOLIC ENGINEERING	R	MBE	3	0	0	0	3	3	
695	PEC	PE-5	25MBT3508	TISSUE ENGINEERING	R	NBT	3	0	0	0	3	3	
696	PEC	PE-5	25MBT3507	BIOELECTRONICS AND BIOSENSORS	R	BB	3	0	0	0	3	3	
697	PEC	PE-5	25GAM3505	AI PRODUCT DEVELOPMENT AND MANAGEMENT	R	APDM	3	0	0	0	3	3	
698	PEC	PE-5	25RFM3505	SATELLITE DESIGN	R	SD	3	0	0	0	3	3	
699	PEC	PE-5	25QCS3506	QUANTUM INFORMATION THEORY	R	QIT	3	0	0	0	3	3	
700	PEC	PE-5	25QCS3505	QUANTUM SATELLITE COMMUNICATIONS	R	QSC	3	0	0	0	3	3	
701	PEC	PE-5	25BEW3515	DECENTRALIZED STORAGE, IDENTITY & MIDDLEWARE SYSTEMS	R	DSIM	3	0	0	0	3	3	
702	PEC	PE-5	25BEW3516	QUANTUM ALGORITHMS FOR BLOCKCHAIN DATA ANALYSIS	R	QABA	3	0	0	0	3	3	
703	PEC	PE-5	25AVI3509	ADVANCED IMAGE PROCESSING AND ANALYSIS	R	AIPA	3	0	0	0	3	3	
704	PEC	PE-5	25SDM3507	INTELLIGENT SOCIAL MEDIA MONITORING SYSTEMS	R	ISMMS	3	0	0	0	3	3	
705	PEC	PE-5	25QTS3505	QUANTUM AI & MACHINE LEARNING	R	QAIML	3	0	0	0	3	3	

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706	PEC	PE-5	25SCI3506	SPATIAL USER INTERFACE DESIGN	R	SUID	3	0	0	0	3	3	
707	PEC	PE-5	25SCI3507	INTRODUCTION TO SPATIAL COMPUTING	R	ITSC	3	0	0	0	3	3	
708	PEC	PE-5	25DSE3508	DATA ANALYTICS ON CLOUD	R	DAC	3	0	0	0	3	3	
709	PEC	PE-5	25DSE3509	GRAPH & WEB ANALYTICS	R	GWA	3	0	0	0	3	3	
710	PEC	PE-5	25DLS3505	STREAMING ANALYTICS FOR IOT AND EDGE ENVIRONMENTS	R	SAIE	3	0	0	0	3	3	
711	PEC	PE-5	25ACI3506	DATA MANIPULATION	R	DM	3	0	0	0	3	3	
712	PEC	PE-5	25ACI3507	REINFORCEMENT LEARNING	R	RIL	3	0	0	0	3	3	
713	PEC	PE-5	25ACI3508	EVOLUTIONARY COMPUTATION	R	ECP	3	0	0	0	3	3	
714	PEC	PE-5	25ADE3506	EDGE AI DEVELOPMENT FRAMEWORKS AND TOOLS	R	EAIDFT	3	0	0	0	3	3	
715	PEC	PE-5	25ADE3507	EDGE AI ANALYTICS AND DATA MANAGEMENT	R	EAIADM	3	0	0	0	3	3	
716	PEC	PE-5	25ADE3508	EDGE AI AND SUSTAINABILITY	R	EAIAS	3	0	0	0	3	3	
717	PEC	PE-5	25AVI3507	HUMAN COMPUTER INTERACTION	R	HCI	3	0	0	0	3	3	
718	PEC	PE-5	25AVI3508	OBJECT LOCALIZATION	R	OL	3	0	0	0	3	3	
719	PEC	PE-5	25AEC3505	EDGE AI ORCHESTRATION & LIFECYCLE MANAGEMENT	R	EAOM	3	0	0	0	3	3	
720	PEC	PE-5	25GDU3506	PRINCIPLES OF GAME DESIGN	R	PRGD	3	0	0	0	3	3	
721	PEC	PE-5	25GDU3507	BUSINESS OF GAMES & ENTREPRENEURSHIP	R	BGE	3	0	0	0	3	3	
722	PEC	PE-5	25CNE3507	CLOUD NATIVE NETWORKING AND STORAGE SYSTEMS	R	CNNSS	3	0	0	0	3	3	
723	PEC	PE-5	25CNE3508	CLOUD INFRASTRUCTURE AND VIRTUALIZATION	R	CIAV	3	0	0	0	3	3	
724	PEC	PE-5	25CNS3508	MONITORING AND LOGGING FOR CLOUD NATIVE SECURITY	R	MLCNS	3	0	0	0	3	3	
725	PEC	PE-5	25CNS3509	COMPLIANCE AND GOVERNANCE IN CLOUD NATIVE ENVIRONMENTS	R	CGCNE	3	0	0	0	3	3	
726	PEC	PE-5	25CNS3510	SERVERLESS SECURITY	R	SLSY	3	0	0	0	3	3	
727	PEC	PE-5	25CNS3512	FUTURE TRENDS IN CLOUD NATIVE SECURITY	R	FTCNS	3	0	0	0	3	3	
728	PEC	PE-5	25CSC3507	CLOUD-BASED SCALABLE COMPUTING AND BIG DATA ANALYTICS	R	CSCBD	3	0	0	0	3	3	
729	PEC	PE-5	25CSC3508	PARALLEL COMPUTING FOR SCIENTISTS USING CLOUD PLATFORMS	R	PCSCP	3	0	0	0	3	3	

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730	PEC	PE-5	25ALT3507	LARGE LANGUAGE MODEL FOR SPEECH PROCESSING	R	LLMFSP	3	0	0	0	3	3	
731	PEC	PE-5	25BEW3507	BLOCKCHAIN SCALABILITY AND LAYER 2 SOLUTIONS	R	BCSALS	3	0	0	0	3	3	
732	PEC	PE-5	25BEW3508	REGULATORY LANDSCAPE AND COMPLIANCE	R	RLAC	3	0	0	0	3	3	
733	PEC	PE-5	25BEW3509	FUTURE TRENDS IN BLOCKCHAIN AND WEB3	R	FTBCAW	3	0	0	0	3	3	
734	PEC	PE-5	25CEC3510	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
735	PEC	PE-5	25CEC3511	HIGH PERFORMANCE COMPUTING	R	HPC	3	0	0	0	3	3	
736	PEC	PE-5	25CEC3512	DESIGN OF DISTRIBUTED APPLICATIONS ON CLOUD (DDA)	R	DDAC	3	0	0	0	3	3	
737	PEC	PE-5	25CEC3513	CLOUD NETWORKING	R	CN	3	0	0	0	3	3	
738	PEC	PE-5	25CID3507	CLOUD ENGINEERING	R	CE	3	0	0	0	3	3	
739	PEC	PE-5	25CID3508	CLOUD DATA MANAGEMENT AND STORAGE SOLUTIONS	R	CDMSS	3	0	0	0	3	3	
740	PEC	PE-5	25CPD3507	ADVANCED MOBILE APPLICATION DEVELOPMENT	R	AMAD	3	0	0	0	3	3	
741	PEC	PE-5	25CPD3508	CROSS PLATFORM USER INTERFACE DESIGN	R	CPED	3	0	0	0	3	3	
742	PEC	PE-5	25CPS3507	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
743	PEC	PE-5	25CSB3508	SECURE SOFTWARE ENGINEERING	R	SSE	3	0	0	0	3	3	
744	PEC	PE-5	25CSB3509	WEB SECURITY	R	WS	3	0	0	0	3	3	
745	PEC	PE-5	25CSB3510	SECURITY GOVERNANCE & MANAGEMENT	R	SGM	3	0	0	0	3	3	
746	PEC	PE-5	25DEA3505	MACHINE LEARNING ENGINEERING FOR BIG DATA	R	MLEBD	3	0	0	0	3	3	
747	PEC	PE-5	25SMD3506	SOFTWARE RELIABILITY	R	SR	3	0	0	0	3	3	
748	PEC	PE-5	25SMD3507	CROSS-PLATFORM USER INTERFACE DESIGN	R	CPUIF	3	0	0	0	3	3	
749	PEC	PE-5	25DLA3507	DISTRIBUTED LEDGER ARCHITECTURE FOR AUTOMATION	R	DLAA	3	0	0	0	3	3	
750	PEC	PE-5	25DSB3509	ADVANCED DATABASES	R	AD	3	0	0	0	3	3	
751	PEC	PE-5	25DSB3510	BUSINESS ANALYTICS	R	BA	3	0	0	0	3	3	
752	PEC	PE-5	25DLA3508	PERMISSIONED DISTRIBUTED LEDGER	R	PDL	3	0	0	0	3	3	
753	PEC	PE-5	25DSB3511	GRAPH & WEB ANALYTICS	R	GWA	3	0	0	0	3	3	
754	PEC	PE-5	25DSB3512	DATA GOVERNANCE ON CLOUD	R	DGC	3	0	0	0	3	3	
755	PEC	PE-5	25SDM3508	SEARCH ENGINE OPTIMIZATION	R	SEO	3	0	0	0	3	3	

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756	PEC	PE-5	25HDA3511	EPI GENETIC CONTROL FOR GENE EXPRESSION	R	ECBI	3	0	0	0	3	3	
757	PEC	PE-5	25HDA3510	GENOMIC DATASCIENCE AND CLUSTERING	R	GDSC	3	0	0	0	3	3	
758	PEC	PE-5	25HSS3507	SIDE-CHANNEL ATTACKS AND COUNTER MEASURES	R	SCACM	3	0	0	0	3	3	
759	PEC	PE-5	25HSS3508	FORMAL METHODS FOR HARDWARE-SOFTWARE SECURITY	R	FMHSS	3	0	0	0	3	3	
760	PEC	PE-5	25HSS3509	TRUSTED PLATFORM MODULES AND SECURE ELEMENTS	R	TPMASE	3	0	0	0	3	3	
761	PEC	PE-5	25HSS3511	HARDWARE-SOFTWARE CO-DESIGN	R	HSCCS	3	0	0	0	3	3	
762	PEC	PE-5	25HSS3512	FUTURE TRENDS IN HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY	R	FTHSCS	3	0	0	0	3	3	
763	PEC	PE-5	25IOT3508	BIG DATA ANALYTICS	R	BDA	3	0	0	0	3	3	
764	PEC	PE-5	25AAS3507	LOCALIZATION & PROGRAMMING REAL-TIME AUTONOMOUS SYSTEMS	R	LPRAS	3	0	0	0	3	3	
765	PEC	PE-5	25AAS3508	REINFORCEMENT LEARNING FOR AUTONOMOUS SYSTEM	R	RLA	3	0	0	0	3	3	
766	PEC	PE-5	25AAS3511	AI DRIVEN ECU DESIGN FOR AUTONOMOUS VEHICLES	R	AEDATT	3	0	0	0	3	3	
767	PEC	PE-5	25AAS3516	CYBER-PHYSICAL SECURITY IN AUTONOMOUS PLATFORMS	R	CPSAP	3	0	0	0	3	3	
768	PEC	PE-5	25IGD3509	GAME AI AND AUTONOMOUS AGENTS	R	GAIA	3	0	0	0	3	3	
769	PEC	PE-5	25IGD3510	GENERATIVE AI IN GAME DESIGN	R	GAID	3	0	0	0	3	3	
770	PEC	PE-5	25CND3505	HIGH-PERFORMANCE & SECURE CLOUD-NATIVE SYSTEMS	R	HPCS	3	0	0	0	3	3	
771	PEC	PE-5	25GSD3505	SMART INFRASTRUCTURE FOR GREEN DATA CENTERS	R	SIGD	3	0	0	0	3	3	
772	PEC	PE-5	25GMI3505	MULTI-MODAL INTELLIGENCE	R	MMI	3	0	0	0	3	3	
773	PEC	PE-5	25HDA3509	MOLECULAR MODELLING AND DRUG DESIGN	R	MMOD	3	0	0	0	3	3	
774	PEC	PE-5	25DLA3505	PRIVACY, COMPLIANCE & DECENTRALIZED SECURITY ENGINEERING	R	PCDS	3	0	0	0	3	3	
775	PEC	PE-5	25HCA3509	AI ETHICS, FAIRNESS & RESPONSIBLE DEPLOYMENT	R	AIFD	3	0	0	0	3	3	
776	PEC	PE-5	25HCA3510	HUMAN-AI INTERACTION & USER-CENTERED DESIGN	R	HAI	3	0	0	0	3	3	
777	PEC	PE-5	25CAC3508	HYBRID QUANTUM-CLASSICAL CLOUD SYSTEMS	R	HQCC	3	0	0	0	3	3	
778	PEC	PE-5	25CAC3507	MLOPS & SCIENTIFIC WORKFLOW AUTOMATION IN CLOUD	R	MSWC	3	0	0	0	3	3	

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779	PEC	PE-5	25CTI3509	QUANTUM CRYPTOGRAPHY & POST-QUANTUM SECURITY	R	QCPS	3	0	0	0	3	3	
780	PEC	PE-5	25CTI3510	APPLIED CRYPTOGRAPHY FOR CYBERSECURITY	R	ACC	3	0	0	0	3	3	
781	PEC	PE-5	25ABT3507	MICROFLUIDICS FOR AGRICULTURAL APPLICATIONS	R	MAP	3	0	0	0	3	3	
782	PEC	PE-5	25ABT3508	BIOINFORMATICS FOR AGRICULTURE	R	BIA	3	0	0	0	3	3	
783	PEC	PE-5	25WLT3505	MACHINE LEARNING FOR WIRELESS COMMUNICATION	R	MLWC	3	0	0	0	3	3	
784	PEC	PE-5	25AEA3507	SOFT COMPUTING TECHNIQUES FOR AUTOMOTIVE APPLICATIONS	R	SCTAA	3	0	0	0	3	3	
785	PEC	PE-5	25AEA3508	AUTOMOTIVE NETWORKING AND PROTOCOLS	R	ANP	3	0	0	0	3	3	
786	PEC	PE-5	25WRE3505	ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSIS	R	EIALCA	3	0	0	0	3	3	
787	PEC	PE-5	25WLT3404	OPTICAL WIRELESS COMMUNICATIONS	R	OWC	3	0	0	0	3	3	
788	PEC	PE-5	25AEE3507	AUTONOMOUS VEHICLES	R	AVS	3	0	0	0	3	3	
789	PEC	PE-5	25VLS3505	SYSTEM-ON-CHIP	R	SOC	3	0	0	0	3	3	
790	PEC	PE-5	25AEE3508	ALTERNATE ENERGY SOURCES FOR AUTOMOBILES	R	AESA	3	0	0	0	3	3	
791	PEC	PE-5	25BIS3507	SYSTEMS BIOLOGY	R	SSB	3	0	0	0	3	3	
792	PEC	PE-5	25BIS3508	DATA BASE MANAGEMENT SYSTEM FOR BIOLOGIST	R	DBMS	3	0	0	0	3	3	
793	PEC	PE-5	25BMI3505	BIOSENSING AND BIOELECTRONICS	R	BSBE	3	0	0	0	3	3	
794	PEC	PE-5	25STE3505	CONSTRUCTION PLANNING AND SCHEDULING	R	CPS	3	0	0	0	3	3	
795	PEC	PE-5	25CPS3505	CLOUD COMPUTING FOR IOT ENGINEERS	R	CCIOTE	3	0	0	0	3	3	
796	PEC	PE-5	25CPS3506	WIRELESS SENSOR NETWORKS	R	WSN	3	0	0	0	3	3	
797	PEC	PE-5	25SGT3508	SMART GRID PROTECTION	R	SGP	3	0	0	0	3	3	
798	PEC	PE-5	25SGT3507	INTERNET OF THINGS AND SMART GRID ANALYTICS	R	IOT&SGA	3	0	0	0	3	3	
799	PEC	PE-5	25RAN3507	COMPUTER VISION AND APPLICATIONS	R	CVA	3	0	0	0	3	3	
800	PEC	PE-5	25DCM3505	IP MULTIMEDIA SUB-SYSTEM AND EMERGING TECHNOLOGIES	R	IMSET	3	0	0	0	3	3	
801	PEC	PE-5	25EDS3505	EDGE COMPUTING AND DATA ANALYTICS IN IOT	R	ECDAI	3	0	0	0	3	3	
802	PEC	PE-5	25EME3507	AI AND IOT FOR ELECTRIC VEHICLE	R	AIEV	3	0	0	0	3	3	

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803	PEC	PE-5	25EME3508	EV SYSTEM AND WIRING DESIGN	R	ESWS	3	0	0	0	3	3	
804	PEC	PE-5	25EGD3507	MECHANICS OF COMPOSITE MATERIALS	R	MOCM	3	0	0	0	3	3	
805	PEC	PE-5	25GET3507	AI AND IOT FOR GREEN ENERGY INTEGRATION	R	AIGEI	3	0	0	0	3	3	
806	PEC	PE-5	25GET3508	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	R	PERES	3	0	0	0	3	3	
807	PEC	PE-5	25NTO3509	BIOSENSING AND BIOELECTRONICS	R	BAB	3	0	0	0	3	3	
808	PEC	PE-5	25ILA3507	SMART SENSORS AND SENSOR NETWORKING	R	SSSN	3	0	0	0	3	3	
809	PEC	PE-5	25EGD3508	HYBRID AND ELECTRIC VEHICLE DESIGN	R	HEVD	3	0	0	0	3	3	
810	PEC	PE-5	25NTO3510	MICRO/NANO FLUIDIC SYSTEMS FOR SENSORS	R	MFS	3	0	0	0	3	3	
811	PRI	PRI-CORE	25IE4053	ENGINEERING CAPSTONE PROJECT - 1	R	ECP-1	0	0	8	16	8	12	
812	PRI	PRI-CORE	25IE4048	ENGINEERING PROJECT	R	EPJ	0	0	8	16	8	12	
813	PRI	PRI-CORE	25IE4054	ENGINEERING CAPSTONE PROJECT - 2	R	ECP-2	0	0	8	16	8	12	
814	PRI	PRI-CORE	25IE4051	INTERNSHIP-1	R	INT-1	0	0	8	16	8	12	
815	PRI	PRI-CORE	25IE4052	INTERNSHIP-2	R	INT-2	0	0	8	16	8	12	
816	PRI	PRI-CORE	25IE4042	INTERNSHIP	R	INT	0	0	8	16	8	12	
817	PRI	PRI-CORE	25IE4055	INNOVATION PROJECT-1	R	IP-1	0	0	8	16	8	12	
818	PRI	PRI-CORE	25IE4056	INNOVATION PROJECT-2	R	IP-2	0	0	8	16	8	12	
819	PRI	PRI-CORE	25IE4057	RESEARCH PROJECT-1	R	RP-1	0	0	8	16	8	12	
820	PRI	PRI-CORE	25IE4058	RESEARCH PROJECT-2	R	RP-2	0	0	8	16	8	12	
821	PRI	PRI-CORE	25IE3041	TECHNICAL INTERNSHIP	R	TIP	0	0	0	4	0	4	
822	PRI	PRI-CORE	25IE2040	SOCIAL INTERNSHIP	R	SIP	0	0	0	4	0	4	
823	OEC	OE-1	OEEC1001	IMAGE PROCESSING	R	IP	3	0	0	0	3	3	
824	OEC	OE-1	OEEC1002	ML FOR ENGINEERING AND SCIENTIFIC APPLICATIONS	R	MLESA	3	0	0	0	3	3	
825	OEC	OE-1	OEEC1003	DATA SCIENCE: DL AND NN	R	DSDLNN	3	0	0	0	3	3	
826	OEC	OE-1	OEEE1001	RENEWABLE ENERGY RESOURCES	R	RER	3	0	0	0	3	3	
827	OEC	OE-1	OEEA1001	ART & IDEAS	R	AI	3	0	0	0	3	3	
828	OEC	OE-1	OEEE1002M	SELF-DRIVING CARS	R	SDC	3	0	0	0	3	3	
829	OEC	OE-1	OEGN1002	NATIONAL SERVICE SCHEME - 1	R	NSS-1	2	0	4	0	4	6	

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830	OEC	OE-1	OEAR1001	ARCHITECTURAL JOURNALISM	R	AJ	3	0	0	0	3	3	
831	OEC	OE-1	OEBA1001	INTERNATIONAL RELATIONS	R	IR	3	0	0	0	3	3	
832	OEC	OE-1	OEBB1001	FINANCE FOR ENGINEERS	R	FE	3	0	0	0	3	3	
833	OEC	OE-1	OEBB1002M	FINANCIAL MATHEMATICS & RISK ANALYTICS	R	FMRA	3	0	2	0	4	5	
834	OEC	OE-1	OEBT1001	IPR AND PATENT LAWS	R	IPRPL	3	0	0	0	3	3	
835	OEC	OE-1	OEBT1002	ENVIRONMENTAL BIOTECHNOLOGY	R	EB	3	0	0	0	3	3	
836	OEC	OE-1	OECE1001	SOLID AND HAZARDOUS WASTE MANAGEMENT	R	SHWM	3	0	0	0	3	3	
837	OEC	OE-1	OECE1002	ENVIRONMENTAL POLLUTION CONTROL METHODS	R	EPCM	3	0	0	0	3	3	
838	OEC	OE-1	OECE1003	INDUSTRIAL WASTE WATER TREATMENT	R	IWWT	3	0	0	0	3	3	
839	OEC	OE-1	OECM1001	ACCOUNTING FOR ENGINEERS	R	AE	3	0	0	0	3	3	
840	OEC	OE-1	OECs1001	FUNDAMENTALS OF DBMS	R	FDBMS	3	0	0	0	3	3	
841	OEC	OE-1	OECs1002	SUSTAINABILITY AND ENVIRONMENTAL AWARENESS IN THE DIGITAL ERA	R	SEADE	3	0	0	0	3	3	
842	OEC	OE-1	OECI1001	FUNDAMENTALS OF SOFTWARE ENGINEERING	R	FSE	3	0	0	0	3	3	
843	OEC	OE-1	OEAG1001	AGRICULTURE CROP PRODUCTION	R	ACP	3	0	0	0	3	3	
844	OEC	OE-1	OEAD1001	FUNDAMENTALS OF BIG DATA	R	FBD	3	0	0	0	3	3	
845	OEC	OE-1	OEPY1001	ADVANCED ORGANIC CHEMISTRY	R	AOC	3	0	0	0	3	3	
846	OEC	OE-1	OEGN1001	NATIONAL CADET CORPS - 1	R	NCC-1	2	0	4	0	4	6	
847	OEC	OE-2	OEAG2006	INTRODUCTION TO HORTICULTURE	R	ITH	3	0	0	0	3	3	
848	OEC	OE-2	OEPY2006	REGULATORY AFFAIRS	R	RA	3	0	0	0	3	3	
849	OEC	OE-2	OEAD2006	DATA SCIENCE AND VISUALIZATION	R	DSV	3	0	0	0	3	3	
850	OEC	OE-2	OECI2006	FOUNDATIONS OF INFORMATION SYSTEMS	R	FIS	3	0	0	0	3	3	
851	OEC	OE-2	OECs2007	DESIGNING RESILIENT AND SUSTAINABLE URBAN SYSTEMS	R	DRSUS	3	0	0	0	3	3	
852	OEC	OE-2	OECs2006	FUNDAMENTALS OF CYBER SECURITY AND CLOUD COMPUTING	R	FCSCC	3	0	0	0	3	3	
853	OEC	OE-2	OECM2006	COST ACCOUNTING	R	CA	3	0	0	0	3	3	
854	OEC	OE-2	OECE2006	REMOTE SENSING & GIS	R	RSGIS	3	0	0	0	3	3	
855	OEC	OE-2	OECE2007	DISASTER MANAGEMENT	R	DM	3	0	0	0	3	3	

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856	OEC	OE-2	OECE2008	WATER MANAGEMENT	R	WM	3	0	0	0	3	3	
857	OEC	OE-2	OECE2009	TRANSPORTATION SYSTEM MANAGEMENT	R	TSM	3	0	0	0	3	3	
858	OEC	OE-2	OEBT2006	COMPUTER AIDED DRUG DESIGN	R	CADD	3	0	0	0	3	3	
859	OEC	OE-2	OEBT2007	BIOMATERIALS	R	BM	3	0	0	0	3	3	
860	OEC	OE-2	OEBB2007M	FOUNDATIONS OF FINANCIAL SYSTEMS & MARKETS	R	FFSM	3	0	2	0	4	5	
861	OEC	OE-2	OEBB2006	MARKETING FOR ENGINEERS	R	ME	3	0	0	0	3	3	
862	OEC	OE-2	OEBA2006	INTERNAL SECURITY	R	IS	3	0	0	0	3	3	
863	OEC	OE-2	OEGN2007	NATIONAL SERVICE SCHEME - 2	R	NSS-2	2	0	4	0	4	6	
864	OEC	OE-2	OEEE2007M	ENERGY PRODUCTION, DISTRIBUTION & SAFETY	R	EPDS	3	0	0	0	3	3	
865	OEC	OE-2	OEFA2006	PHOTOGRAPHY TECHNIQUES	R	PT	3	0	0	0	3	3	
866	OEC	OE-2	OEGN2006	NATIONAL CADET CORPS - 2	R	NCC-2	2	0	4	0	4	6	
867	OEC	OE-2	OEEE2006	ENERGY ESTIMATION & AUDIT	R	EEA	3	0	0	0	3	3	
868	OEC	OE-2	OEEC2006	NANO ELECTRONICS	R	NE	3	0	0	0	3	3	
869	OEC	OE-2	OEEC2007	SATELLITE SUB-SYSTEMS	R	SSS	3	0	0	0	3	3	
870	OEC	OE-2	OEEC2008	INTRODUCTION TO MEMS	R	IM	3	0	0	0	3	3	
871	OEC	OE-2	OEEC2009	ENERGY HARVESTING TECHNOLOGIES FOR IOT	R	EHTIOT	3	0	0	0	3	3	
872	OEC	OE-3	OEEC3011	WIRELESS AD-HOC NETWORKS	R	WAHN	3	0	0	0	3	3	
873	OEC	OE-3	OEEC3012	SWAM ROBOTICS CONTROL SYSTEMS	R	SRCS	3	0	0	0	3	3	
874	OEC	OE-3	OEEC3013	ELECTRONIC WARFARE, EMI &	R	EWEMIEMC	3	0	0	0	3	3	
875	OEC	OE-3	OEGN3011	NATIONAL CADET CORPS - 3	R	NCC-3	2	0	4	0	4	6	
876	OEC	OE-3	OEEE3011	ELECTRICAL POWER ENGINEERING	R	EPE	3	0	0	0	3	3	
877	OEC	OE-3	OEGN3012	NATIONAL SERVICE SCHEME - 3	R	NSS-3	2	0	4	0	4	6	
878	OEC	OE-3	OEBA3011	INTRODUCTION TO PUBLIC ADMINISTRATION	R	IPA	3	0	0	0	3	3	
879	OEC	OE-3	OEBB3011M	ACCOUNTING, COMPLIANCE & FINANCIAL STATEMENT ANALYSIS	R	ACFSA	3	0	2	0	4	5	
880	OEC	OE-3	OEBT3011	BIOLOGY FOR ENGINEERS	R	BE	3	0	0	0	3	3	
881	OEC	OE-3	OECE3011	CONSTRUCTION MANAGEMENT	R	CM	3	0	0	0	3	3	
882	OEC	OE-3	OECE3012	GREEN BUILDING	R	GB	3	0	0	0	3	3	
883	OEC	OE-3	OECE3013	BUILDING MATERIALS	R	BM	3	0	0	0	3	3	

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884	OEC	OE-3	OECE3014	TRAFFIC AND ROAD SAFETY	R	TRS	3	0	0	0	3	3	
885	OEC	OE-3	OECE3015	EXPLORING OUR RESPONSES TO CLIMATE CHANGE	R	ERCC	3	0	0	0	3	3	
886	OEC	OE-3	OECE3016	GEOGRAPHIC INFORMATION SYSTEMS	R	GIS	3	0	0	0	3	3	
887	OEC	OE-3	OECS3011	FUNDAMENTALS OF INFORMATION TECHNOLOGY	R	FIT	3	0	0	0	3	3	
888	OEC	OE-3	OECS3012	ENVIRONMENTAL IMPACTS OF THE DIGITAL LIFESTYLE	R	EIDL	3	0	0	0	3	3	
889	OEC	OE-3	OECI3011	FUNDAMENTALS OF SOFTWARE TESTING METHODOLOGIES	R	FSTM	3	0	0	0	3	3	
890	OEC	OE-3	OEAD3011	MEDICAL DATA ANALYTICS	R	MDA	3	0	0	0	3	3	
891	VAC	VAC-	25SP2101	ATHLETICS	R	ATH	0	0	0	2	0	2	
892	VAC	VAC-	25SP2103	BADMINTON	R	BMT	0	0	0	2	0	2	
893	VAC	VAC-	25SP2116	YOGA	R	YOG	0	0	0	2	0	2	
894	VAC	VAC-	25SP2102	BASKETBALL	R	BKB	0	0	0	2	0	2	
895	VAC	VAC-	25SP2114	VOLLEYBALL	R	VOB	0	0	0	2	0	2	
896	VAC	VAC-	25SP2105	CHESS	R	CHS	0	0	0	2	0	2	
897	VAC	VAC-	25SP2113	THROW BALL	R	THB	0	0	0	2	0	2	
898	VAC	VAC-	25SP2110	TENNIS	R	TNS	0	0	0	2	0	2	
899	VAC	VAC-	25SP2111	TABLE TENNIS	R	TTS	0	0	0	2	0	2	
900	VAC	VAC-	25SP2108	KABADDI	R	KBD	0	0	0	2	0	2	
901	VAC	VAC-	25SP2109	KHO-KHO	R	KHO	0	0	0	2	0	2	
902	VAC	VAC-	25SP2104	CRICKET	R	CRKT	0	0	0	2	0	2	
903	VAC	VAC-CERT	25CC3008	AUTOCAD	R	ACAD	0	0	0	8	0	8	
904	VAC	VAC-CERT	25CC3001	3D MODELLING USING CATIA	R	3MUC	0	0	0	8	0	8	
905	VAC	VAC-CERT	25CC3009	AUTODESK FUSION 360	R	ADF	0	0	0	8	0	8	
906	VAC	VAC-CERT	25CC3071	PROGRAMMING USING PYTHON	R	PUP	0	0	0	8	0	8	
907	VAC	VAC-CERT	25CC3084	STATIC ANALYSIS USING ANSYS	R	SAUA	0	0	0	8	0	8	
908	VAC	VAC-CERT	25CC3085	STATIC AND DYNAMIC ANALYSIS USING ALTAIR HYPERWORKS	R	SDAAH	0	0	0	8	0	8	
909	VAC	VAC-CERT	25CC3114	STATIC AND FLOW ANALYSIS USING ANSYS CFD	R	SFAUCFD	0	0	0	8	0	8	
910	VAC	VAC-CERT	25CC3115	ANSYS THERMAL MODELLING PROGRAMME	R	ATMP	0	0	0	8	0	8	

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911	AUC	AUC-CORE	25UC0008	INDIAN CONSTITUTION	R	CON	2	0	0	0	0	2	
912	AUC	AUC-CORE	25UC0017	INDIAN ANCIENT KNOWLEDGE SYSTEMS : VEDIC MATHEMATICS	R	IAKS-VM	2	0	0	0	0	2	
913	AUC	AUC-CORE	25UC0032	INSIGHTS TO SUSTAINABLE DEVELOPMENT GOALS	R	SDG	2	0	0	0	0	2	
914	AUC	AUC-CORE	25UC0009	ECOLOGY AND ENVIRONMENT	R	ENE	2	0	0	0	0	2	
915	AUC	AUC-CAREER	CRTCODL2V2	CAMPUS RECRUITMENT: CODING SKILLS TRAINING - DATA STRUCTURES	R	CRT: CST-DS	0	0	0	8	0	8	
916	AUC	AUC-CAREER	CRTCODL3V3	CAMPUS RECRUITMENT: CODING SKILLS TRAINING - ALGORITHMS	R	CRT: CST-	0	0	0	8	0	8	
917	AUC	AUC-CAREER	CRTVQRL1V1	CAMPUS RECRUITMENT: VERBAL APTITUDE TRAINING	R	CRT: VAT	0	0	0	8	0	8	
918	AUC	AUC-CAREER	CRTVQRL2V2	CAMPUS RECRUITMENT: QUANTITATIVE APTITUDE TRAINING	R	CRT: QAT	0	0	0	8	0	8	
919	AUC	AUC-CAREER	CRTVQRL3V3	CAMPUS RECRUITMENT: REASONING APTITUDE TRAINING	R	CRT: RAT	0	0	0	8	0	8	
920	AUC	AUC-CAREER	CRTCSSL1V1	CAMPUS RECRUITMENT: COMMUNICATION SKILLS TRAINING	R	CRT: CST	0	0	0	8	0	8	
921	AUC	AUC-CAREER	CRTCSSL2V2	CAMPUS RECRUITMENT: SOFT SKILLS TRAINING	R	CRT: SST	0	0	0	8	0	8	
922	AUC	AUC-CAREER	CRTTOLL1V1	CAMPUS RECRUITMENT: TOOL BASED TRAINING	R	CRT: TBT	0	0	0	8	0	8	
923	AUC	AUC-CAREER	CRTTOLL2V2	CAMPUS RECRUITMENT: TOOL BASED TRAINING	R	CRT: TBT	0	0	0	8	0	8	
924	AUC	AUC-CAREER	CRTINDL1V1	CAMPUS RECRUITMENT: INDUSTRY-SPECIFIC TRAINING	R	CRT: IST	0	0	0	8	0	8	
925	AUC	AUC-CAREER	CRTINDL2V2	CAMPUS RECRUITMENT: INDUSTRY-SPECIFIC TRAINING	R	CRT: IST	0	0	0	8	0	8	
926	AUC	AUC-CAREER	CADCORL1V1	CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN	R	CAD: TICD	0	0	0	8	0	8	
927	AUC	AUC-CAREER	CADCORL2V2	CAREER ADVANCEMENT: TRAINING IN CORE DOMAIN	R	CAD: TICD	0	0	0	8	0	8	
928	AUC	AUC-CAREER	CADUPSL1V1	CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING	R	CAD: UPSC	0	0	0	8	0	8	
929	AUC	AUC-CAREER	CADUPSL2V2	CAREER ADVANCEMENT: UPSC-CIVIL SERVICES EXAM TRAINING	R	CAD: UPSC	0	0	0	8	0	8	
930	AUC	AUC-CAREER	CADGATL1V1	CAREER ADVANCEMENT: GATE TRAINING	R	CAD: GATE	0	0	0	8	0	8	
931	AUC	AUC-CAREER	CADGREL1V1	CAREER ADVANCEMENT: GRE, TOEFL & IELTS TRAINING	R	CAD: GRE-	0	0	0	8	0	8	
932	AUC	AUC-CAREER	CADCATL1V1	CAREER ADVANCEMENT: CAT, GMAT TRAINING	R	CAD: CAT-	0	0	0	8	0	8	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
933	AUC	AUC-CAREER	CADENTL1V1	CAREER ADVANCEMENT: ENTREPRENEURIAL CAREER PATHWAY TRAINING	R	CAD: ECPT	0	0	0	8	0	8	
934	AUC	AUC-CAREER	CRTCODL1V1	CAMPUS RECRUITMENT: LOGIC BUILDING SKILLS TRAINING	R	CRT: LBST	0	0	0	8	0	8	
935	MIN	MIN-CORE	25MRPA01	FUNDAMENTALS OF AGRONOMY	R	FOA	3	0	2	0	4	5	
936	MIN	MIN-CORE	25MRPA02	INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE	R	IACC	3	0	2	0	4	5	
937	MIN	MIN-CORE	25MRPA03	GEOINFORMATICS AND NANOTECHNOLOGY FOR PRECISION FARMING	R	GNPF	3	0	2	0	4	5	
938	MIN	MIN-CORE	25MRPA04	PROTECTED CULTIVATION AND POST-HARVEST TECHNOLOGIES	R	PCPHT	3	0	2	0	4	5	
939	MIN	MIN-CORE	25MRWS02	SOIL AND WATER CONSERVATION ENGINEERING	R	SWCE	3	0	2	0	4	5	
940	MIN	MIN-CORE	25MRWS04	RAINFED AGRICULTURE AND WATERSHED MANAGEMENT	R	RAWM	3	0	2	0	4	5	
941	MIN	MIN-CORE	25MRID01	INTRODUCTION TO INTERIOR DESIGN	R	IID	3	0	2	0	4	5	
942	MIN	MIN-CORE	25MRID02	SPACE PLANNING AND LAYOUT	R	SPL	3	0	2	0	4	5	
943	MIN	MIN-CORE	25MRID03	INTERIOR MATERIAL AND FINISHES	R	IMF	3	0	2	0	4	5	
944	MIN	MIN-CORE	25MRID04	FURNITURE AND ACCESSORIES DESIGN	R	FAD	3	0	2	0	4	5	
945	MIN	MIN-CORE	25MRAP01M	INTRODUCTION TO ANTHROPOLOGY	M	ITA	4	0	0	0	4	4	
946	MIN	MIN-CORE	25MRAP02M	CULTURAL EVOLUTION	M	CET	4	0	0	0	4	4	
947	MIN	MIN-CORE	25MRAP03M	HUMAN ECOLOGY AND ECOLOGICAL ANTHROPOLOGY	M	HEEA	4	0	0	0	4	4	
948	MIN	MIN-CORE	25MRAP04M	FUNDAMENTALS IN ARCHEOLOGICAL ANTHROPOLOGY CHRONOLOGY	M	FAAC	4	0	0	0	4	4	
949	MIN	MIN-CORE	25MRAR01	FUNDAMENTALS OF MACRO-ECONOMICS	R	FME	4	0	0	0	4	4	
950	MIN	MIN-CORE	25MRAR02	BASICS OF ECONOMETRICS	R	BOE	4	0	0	0	4	4	
951	MIN	MIN-CORE	25MRAR03	INTERNATIONAL RELATIONS: THEORIES AND CONCEPTS	R	IRTC	4	0	0	0	4	4	
952	MIN	MIN-CORE	25MRAR04	BEHAVIOURAL ECONOMICS AND POLICY	R	BEP	4	0	0	0	4	4	
953	MIN	MIN-CORE	25MRFT01	INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY	R	IFST	3	0	2	0	4	5	
954	MIN	MIN-CORE	25MRFT02	FOOD ANALYSIS AND QUALITY ASSURANCE	R	FAQA	3	0	2	0	4	5	

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955	MIN	MIN-CORE	25MRFT03	FOOD SAFETY AND REGULATIONS	R	FSR	3	1	0	0	4	4	
956	MIN	MIN-CORE	25MRFT04	FOOD ENGINEERING	R	FEG	3	0	2	0	4	5	
957	MIN	MIN-CORE	25MRBA01M	ORGANIZATIONAL BEHAVIOUR	M	OBR	4	0	0	0	4	4	
958	MIN	MIN-CORE	25MRBA02M	MARKETING MANAGEMENT	M	MMG	4	0	0	0	4	4	
959	MIN	MIN-CORE	25MRBA03M	FINANCIAL MANAGEMENT	M	FMG	4	0	0	0	4	4	
960	MIN	MIN-CORE	25MRBA04M	HUMAN RESOURCE MANAGEMENT	M	HRM	4	0	0	0	4	4	
961	MIN	MIN-CORE	25MRAC01M	AI FOR BUSINESS STRATEGY	M	ABS	4	0	0	0	4	4	
962	MIN	MIN-CORE	25MRAC02M	AI STRATEGY AND GOVERNANCE	M	ASG	4	0	0	0	4	4	
963	MIN	MIN-CORE	25MRAC03M	SUCCESSFUL AI STRATEGIES : A CEO'S PERSPECTIVES	M	SAI	4	0	0	0	4	4	
964	MIN	MIN-CORE	25MRAC04M	CRAFTING A COMPETITIVE ADVANTAGE	M	CCA	4	0	0	0	4	4	
965	MIN	MIN-CORE	25MRDM01M	FUNDAMENTALS OF DIGITAL MARKETING	M	FDM	4	0	0	0	4	4	
966	MIN	MIN-CORE	25MRDM02M	SOCIAL MEDIA MARKETING	M	SMM	4	0	0	0	4	4	
967	MIN	MIN-CORE	25MRDM03M	SERACH ENGINE OPTIMIZATION	M	SEO	4	0	0	0	4	4	
968	MIN	MIN-CORE	25MRDM04M	ARTIFICIAL INTELLIGENCE IN MARKETING	M	AIM	4	0	0	0	4	4	
969	MIN	MIN-CORE	25MRFA01M	FOUNDATIONS AND APPLICATIONS OF FINANCIAL TECHNOLOGY	M	AFT	4	0	0	0	4	4	
970	MIN	MIN-CORE	25MRFA02M	DECENTRALISED FINANCE: THE FUTURE OF FINANCE	M	DFFF	4	0	0	0	4	4	
971	MIN	MIN-CORE	25MRFA03M	FINTECH INNOVATIONS	M	FIV	4	0	0	0	4	4	
972	MIN	MIN-CORE	25MRFA04M	USING MACHINE LEARNING IN TRADING AND FINANCE	M	ML	4	0	0	0	4	4	
973	MIN	MIN-CORE	25MRIB01M	INTERNATIONAL BUSINESS ESSENTIALS	M	IBET	4	0	0	0	4	4	
974	MIN	MIN-CORE	25MRIB02M	INTERNATIONAL BUSINESS ENVIRONMENT	M	IBEV	4	0	0	0	4	4	
975	MIN	MIN-CORE	25MRIB03M	INTERNATIONAL BUSINESS OPERATIONS	M	IBO	4	0	0	0	4	4	
976	MIN	MIN-CORE	25MRIB04M	INTERNATIONAL BUSINESS MODELS	M	IBM	4	0	0	0	4	4	
977	MIN	MIN-CORE	25MROB01M	ORGANIZATIONAL BEHAVIOUR	M	POM	4	0	0	0	4	4	
978	MIN	MIN-CORE	25MROB02M	ORGANIZATIONAL BEHAVIOUR MODELS	M	OBM	4	0	0	0	4	4	
979	MIN	MIN-CORE	25MROB03M	ORGANIZATIONAL CHANGE AND DEVELOPMENT	M	OCD	4	0	0	0	4	4	
980	MIN	MIN-CORE	25MROB04M	LEADERSHIP IN ORGANIZATION	M	LIO	4	0	0	0	4	4	

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981	MIN	MIN-CORE	25MRIM01	APPLIED DESIGN THINKING	R	ADT	3	0	2	0	4	5	
982	MIN	MIN-CORE	25MRIM02	BUSINESS MODEL INNOVATION	R	BMI	3	0	2	0	4	5	
983	MIN	MIN-CORE	25MRIM03	VENTURE MANAGEMENT	R	VMT	3	0	2	0	4	5	
984	MIN	MIN-CORE	25MRIM04	BUSINESS AND LEADERSHIP	R	BL	3	0	2	0	4	5	
985	MIN	MIN-CORE	25MRTP01	INTRODUCTION TO TECHNOLOGICAL ENTREPRENEURSHIP	R	ITEP	3	0	2	0	4	5	
986	MIN	MIN-CORE	25MRTP02	LEAN STARTUP LAUNCHPAD	R	LSLP	3	0	2	0	4	5	
987	MIN	MIN-CORE	25MRTP03	ENTREPRENEURSHIP AND VENTURE CAPITAL	R	EVC	3	0	2	0	4	5	
988	MIN	MIN-CORE	25MRTP04	BUILDING AND SUSTAINING A SUCCESSFUL ENTERPRISE	R	BSSE	3	0	2	0	4	5	
989	MIN	MIN-CORE	25MRCL01	PRINCIPLES OF COMPANIES ACT AND CORPORATE GOVERNANCE	R	PCACG	3	0	2	0	4	5	
990	MIN	MIN-CORE	25MRCL02	MERGERS, ACQUISITIONS AND PRIVATE EQUITY	R	MAPE	3	0	2	0	4	5	
991	MIN	MIN-CORE	25MRCL03	INSOLVENCY AND BANKRUPTCY LAW	R	IBL	3	0	2	0	4	5	
992	MIN	MIN-CORE	25MRCL04	COMPETITION LAW AND PRACTICE	R	CLP	3	0	2	0	4	5	
993	MIN	MIN-CORE	25MRIP01	EMERGENCE AND DEVELOPMENT OF IPR	R	EDIPR	3	0	2	0	4	5	
994	MIN	MIN-CORE	25MRIP02	LAW OF COPYRIGHT	R	LOCR	3	0	2	0	4	5	
995	MIN	MIN-CORE	25MRIP03	LAW OF PATENTS	R	LOPS	3	0	2	0	4	5	
996	MIN	MIN-CORE	25MRIP04	LAW OF TRADEMARK	R	LOTM	3	0	2	0	4	5	
997	MIN	MIN-CORE	25MRCY01	INTRODUCTION TO CYBERLAW AND CYBERSPACE	R	ITCLCS	4	0	0	0	4	4	
998	MIN	MIN-CORE	25MRCY02	CYBERLAW AND E-COMMERCE IMPLICATIONS	R	CLECI	4	0	0	0	4	4	
999	MIN	MIN-CORE	25MRCY03	CYBERCRIMES IN INDIA	R	CCII	4	0	0	0	4	4	
1000	MIN	MIN-CORE	25MRCY04	INTRODUCTION TO CYBERSECURITY, INCIDENTAL RESPONSE AND DIGITAL FORENSIC	R	ITCIRDF	4	0	0	0	4	4	
1001	MIN	MIN-CORE	25MRME01M	MICROECONOMICS - THE POWER OF MARKETS	M	MEPM	4	0	0	0	4	4	
1002	MIN	MIN-CORE	25MRME02M	FUNDAMENTALS OF ACCOUNTING	M	FOA	4	0	0	0	4	4	
1003	MIN	MIN-CORE	25MRME03M	FINANCIAL MANAGEMENT	M	FM	4	0	0	0	4	4	
1004	MIN	MIN-CORE	25MRME04M	FINANCIAL MARKETS	M	FM	4	0	0	0	4	4	
1005	MIN	MIN-CORE	25MRPS01M	INTRODUCTION TO PSYCHOLOGY	M	ITP	4	0	0	0	4	4	

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1006	MIN	MIN-CORE	25MRPS02M	PSYCHOLOGY OF EVERYDAY	M	POE	4	0	0	0	4	4	
1007	MIN	MIN-CORE	25MRPS03M	SOCIAL COGNITION	M	SC	4	0	0	0	4	4	
1008	MIN	MIN-CORE	25MRPS04M	THE SCIENCE OF WELL-BEING FOR TEENS	M	TSOWBFT	4	0	0	0	4	4	
1009	MIN	MIN-CORE	25MRCM01	LINEAR ALGEBRA	R	LAG	2	2	0	0	4	4	
1010	MIN	MIN-CORE	25MRCM02	ADVANCED NUMERICAL ANALYSIS	R	ANA	2	2	0	0	4	4	
1011	MIN	MIN-CORE	25MRCM03	MATHEMATICAL MODELLING	R	MML	3	0	2	0	4	5	
1012	MIN	MIN-CORE	25MRCM04	STOCHASTIC PROCESSES & OPTIMIZATION	R	SPO	2	2	0	0	4	4	
1013	MIN	MIN-CORE	25MRCM05	FUZZY MATHEMATICS AND ITS APPLICATIONS	R	FMAA	2	2	0	0	4	4	
1014	MIN	MIN-CORE	25MRPY01	BASICS OF PHARMACOLOGY	R	BOP	3	0	2	0	4	5	
1015	MIN	MIN-CORE	25MRPY02	ADVANCED PHARMACOLOGY - I	R	AP-I	3	0	2	0	4	5	
1016	MIN	MIN-CORE	25MRPY03	EXPERIMENTAL PHARMACOLOGY	R	EPC	3	0	2	0	4	5	
1017	MIN	MIN-CORE	25MRPY04	ADVANCED PHARMACOLOGY - II	R	AP-II	3	0	2	0	4	5	
1018	MIN	MIN-CORE	25MRCA01	INTRODUCTION TO CREATIVE ARTS	R	ICA	0	0	6	4	4	10	
1019	MIN	MIN-CORE	25MRCA02	DRAWING AND SKETCHING	R	DAS	0	0	6	4	4	10	
1020	MIN	MIN-CORE	25MRCA03	PAINTING	R	PNT	0	0	6	4	4	10	
1021	MIN	MIN-CORE	25MRCA04	CREATIVE WRITING	R	CWT	0	0	6	4	4	10	
1022	MIN	MIN-CORE	25MRFM01	FILM AESTHETICS	R	FAS	0	0	6	4	4	10	
1023	MIN	MIN-CORE	25MRFM02	SCREEN WRITING	R	SWT	0	0	6	4	4	10	
1024	MIN	MIN-CORE	25MRFM03	CINEMATIC LIGHTING	R	CML	0	0	6	4	4	10	
1025	MIN	MIN-CORE	25MRFM04	SOUND DESIGN	R	SDS	0	0	6	4	4	10	
1026	MIN	MIN-CORE	25MRGD01	INTRODUCTION TO GRAPHIC DESIGN	R	IGD	0	0	6	4	4	10	
1027	MIN	MIN-CORE	25MRGD02	TYPOGRAPHY	R	TPY	0	0	6	4	4	10	
1028	MIN	MIN-CORE	25MRGD03	VISUAL IDENTITY AND BRANDING	R	VIB	0	0	6	4	4	10	
1029	MIN	MIN-CORE	25MRGD04	PRINT DESIGN	R	PRDG	0	0	6	4	4	10	
1030	MIN	MIN-CORE	25MRAG01	INTRODUCTION TO GAME MATH	R	IGM	0	0	6	4	4	10	
1031	MIN	MIN-CORE	25MRAG02	DRAWING BASICS	R	DBS	0	0	6	4	4	10	
1032	MIN	MIN-CORE	25MRAG03	GRAPHIC DESIGN	R	GDS	0	0	6	4	4	10	
1033	MIN	MIN-CORE	25MRAG04	CONCEPTS OF 3D	R	C3D	0	0	6	4	4	10	
1034	MIN	MIN-CORE	25MRWS03	IRRIGATION WATER MANAGEMENT	R	IWM	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1035	MIN	MIN-CORE	25MRBN01M	INTRODUCTION TO BUSINESS ANALYTICS	M	IBA	4	0	0	0	4	4	
1036	MIN	MIN-CORE	25MRBN02M	FOUNDATIONS OF BUSINESS INTELLIGENCE	M	FBI	4	0	0	0	4	4	
1037	MIN	MIN-CORE	25MRBN03M	POWER BI FOR DATA SCIENCE AND ANALYTICS	M	PBDSA	4	0	0	0	4	4	
1038	MIN	MIN-CORE	25MRBN04M	BUSINESS ANALYTICS WITH EXCEL: ELEMENTARY TO ADVANCE	M	BAWEEA	4	0	0	0	4	4	
1039	MSDC	MIN-SDP	25MRBN05M	ADVANCED BUSINESS ANALYTICS	M	ABA	4	0	0	0	4	4	
1040	MSDC	MIN-SDP	25MRAG05	DIGITAL ART	R	DTA	0	0	6	4	4	10	
1041	MSDC	MIN-SDP	25MRBA05M	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	M	LSCM	0	0	6	4	4	10	
1042	MSDC	MIN-SDP	25MRGD05	PUBLICATION DESIGN	R	PUDG	0	0	6	4	4	10	
1043	MSDC	MIN-SDP	25MRFM05	DIGITAL PHOTOGRAPHY	R	DPG	0	0	6	4	4	10	
1044	MSDC	MIN-SDP	25MRCA05	SCULPTURE	R	SCP	0	0	6	4	4	10	
1045	MSDC	MIN-SDP	25MRPY05	PRACTICAL PHARMACOLOGY	R	PRI	0	0	6	4	4	10	
1046	MSDC	MIN-SDP	25MRCM06	TRANSFORM TECHNIQUES FOR ENGINEERING	R	TTE	2	0	2	4	4	8	
1047	MSDC	MIN-SDP	25MRCM07	STATISTICS WITH R PROGRAMMING	R	SWRP	2	0	2	4	4	8	
1048	MSDC	MIN-SDP	25MRCM08	MATRIX COMPUTATION	R	MCT	2	0	2	4	4	8	
1049	MSDC	MIN-SDP	25MRPS05M	POSITIVE PSYCHOLOGY: RESILIENCE SKILLS	M	PPRS	4	0	0	0	4	4	
1050	MSDC	MIN-SDP	25MRME05M	HOW TO FINANCE YOUR VENTURE	M	HTFYV	4	0	0	0	4	4	
1051	MSDC	MIN-SDP	25MRCY05	CYBER SECURITY: TOOLS, TECHNIQUES & COUNTERMEASURES	M	CSTTCM	4	0	0	0	4	4	
1052	MSDC	MIN-SDP	25MRIP05	LAW OF DESIGNS, GEOGRAPHICAL INDICATIONS AND PLANT VARIETIES	R	LODGP	0	0	6	4	4	10	
1053	MSDC	MIN-SDP	25MRCL05	COMMERCIAL CONTRACT DRAFTING	R	CCD	0	0	6	4	4	10	
1054	MSDC	MIN-SDP	25MRTP05	TECH INNOVATION PROJECT FOR ENTREPRENEURS	R	TIPFE	0	0	6	4	4	10	
1055	MSDC	MIN-SDP	25MRIM05	PROJECT INNOVATE: STRATEGIES FOR ENTREPRENEURIAL GROWTH	R	PISEG	0	0	6	4	4	10	
1056	MSDC	MIN-SDP	25MROB05M	TEAM BUILDING AND COLLABORATION SKILLS FOR MANAGERS	M	TBCM	0	0	6	4	4	10	
1057	MSDC	MIN-SDP	25MRIB05M	PROFESSIONAL SKILLS FOR INTERNATIONAL BUSINESS	M	PIB	0	0	6	4	4	10	
1058	MSDC	MIN-SDP	25MRFA05M	TRADING ALGORITHMS	M	TA	0	0	6	4	4	10	
1059	MSDC	MIN-SDP	25MRDM05M	CONTENT MARKETING	M	CM	0	0	6	4	4	10	

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1060	MSDC	MIN-SDP	25MRAC05M	AI APPLICATIONS FOR BUSINESS SUCCESS	M	AIA	0	0	6	4	4	10	
1061	MSDC	MIN-SDP	25MRFT05	FOOD PACKAGING TECHNOLOGY	R	FPT	2	0	2	4	4	8	
1062	MSDC	MIN-SDP	25MRAR05	SOCIAL GEOGRAPHY AND CARTOGRAPHY	R	SGC	0	0	6	4	4	10	
1063	MSDC	MIN-SDP	25MRAP05M	SOCIAL CULTURE ANTHROPOLOGY	M	SCA	0	0	6	4	4	10	
1064	MSDC	MIN-SDP	25MRID05	DESIGN PRESENTATION AND COMMUNICATION	R	DPC	0	0	6	4	4	10	
1065	MSDC	MIN-SDP	25MRPA05	MODERN FARMING TECHNIQUES AND INNOVATIONS	R	AELP	0	0	6	4	4	10	
1066	BRIDGE	BRIDGE-	25UC0018	FUNDAMENTALS OF MATHEMATICS	R	FOM	3	0	0	0	0	3	

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	MINOR	PSYCHOLOGY
24	MINOR	MANAGERIAL ECONOMICS AND FINANCE
25	MINOR	BUSINESS ANALYTICS
26	MINOR	CYBER SECURITY LAW
27	SPECIALIZATION	AGRI-BIOTECHNOLOGY
28	SPECIALIZATION	AI & AUTONOMOUS SYSTEMS
29	SPECIALIZATION	AI FOR COMPUTATIONAL INTELLIGENCE

S#	Category	Group Name
30	SPECIALIZATION	AI SYSTEMS FOR VISUAL INTELLIGENCE
31	SPECIALIZATION	AI-DRIVEN EDGE ARCHITECTURES & APPLICATIONS
32	SPECIALIZATION	AI-DRIVEN LANGUAGE TECHNOLOGIES
33	SPECIALIZATION	AUTOMOTIVE ELECTRONICS & AUTOSAR
34	SPECIALIZATION	AUTOMOTIVE ENERGY ENGINEERING
35	SPECIALIZATION	BIOINFORMATICS
36	SPECIALIZATION	BLOCKCHAIN ENGINEERING FOR WEB3
37	SPECIALIZATION	CLOUD & EDGE COMPUTING
38	SPECIALIZATION	CLOUD INFRASTRUCTURE DESIGN & ENGINEERING
39	SPECIALIZATION	CLOUD NATIVE SECURITY
40	SPECIALIZATION	CLOUD NATIVE SOFTWARE ENGINEERING
41	SPECIALIZATION	CLOUD-BASED SCIENTIFIC COMPUTING
42	SPECIALIZATION	CROSS PLATFORM DEVELOPMENT FRAMEWORKS
43	SPECIALIZATION	CYBER PHYSICAL SYSTEMS & IOT
44	SPECIALIZATION	CYBER SECURITY & BLOCKCHAIN TECHNOLOGY
45	SPECIALIZATION	DATA COMMUNICATIONS
46	SPECIALIZATION	DATA ENGINEERING FOR AI
47	SPECIALIZATION	DATA SCIENCE & BIG DATA ANALYTICS
48	SPECIALIZATION	DISTRIBUTED LEDGER ANALYTICS
49	SPECIALIZATION	EMBEDDED SYSTEMS
50	SPECIALIZATION	E-MOBILITY ENGINEERING
51	SPECIALIZATION	ENGINEERING DESIGN
52	SPECIALIZATION	GAME DEVELOPMENT & UX DESIGN
53	SPECIALIZATION	GREEN ENERGY TECHNOLOGIES
54	SPECIALIZATION	GENERATIVE AI & MACHINE LEARNING
55	SPECIALIZATION	HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY
56	SPECIALIZATION	HEALTHCARE DATA ANALYTICS
57	SPECIALIZATION	INDUSTRIAL AUTOMATION
58	SPECIALIZATION	INDUSTRIAL BIOTECHNOLOGY
59	SPECIALIZATION	IOT ANALYTICS

S#	Category	Group Name
60	SPECIALIZATION	MEDICAL BIOTECHNOLOGY
61	SPECIALIZATION	NANO TECHNOLOGY & OPTOELECTRONICS
62	SPECIALIZATION	ROBOTICS & AUTOMATION
63	SPECIALIZATION	SMART GRID TECHNOLOGIES
64	SPECIALIZATION	SMART MANUFACTURING
65	SPECIALIZATION	SOCIAL & DIGITAL MEDIA ANALYTICS
66	SPECIALIZATION	SOFTWARE MODELLING & DEVOPS
67	SPECIALIZATION	SPATIAL COMPUTING & IMMERSIVE TECHNOLOGIES
68	SPECIALIZATION	STRUCTURAL ENGINEERING
69	SPECIALIZATION	VLSI
70	SPECIALIZATION	INFRASTRUCTURE & ENVIRONMENTAL ENGINEERING
71	SPECIALIZATION	5G - 6G WIRELESS TECHNOLOGIES
72	SPECIALIZATION	GENRATIVE AI FOR AGENTIC AND MULTI-MODAL INTELLIGENCE
73	SPECIALIZATION	HUMAN-CENTRIC AI SYSTEMS
74	SPECIALIZATION	DATA SCIENCE & ENGINEERING FOR AI
75	SPECIALIZATION	DATA LAKE SYSTEMS & STREAMING ANALYTICS
76	SPECIALIZATION	CLOUD NATIVE APPLICATION ENGINEERING & DEVOPS
77	SPECIALIZATION	AI DRIVEN EDGE COMPUTING
78	SPECIALIZATION	CLOUD AI & ACCELERATED COMPUTING
79	SPECIALIZATION	CYBER THREAT INTELLIGENCE AND SECURITY OPERATIONS
80	SPECIALIZATION	INTELLIGENT GAME DEVELOPMENT & IMMERSIVE TECHNOLOGIES
81	SPECIALIZATION	GREEN & SUSTAINABLE DIGITAL SYSTEMS
82	SPECIALIZATION	BIO-MEDICAL INSTRUMENTATION
83	SPECIALIZATION	RF & MICROWAVE
84	SPECIALIZATION	QUANTUM COMMUNICATIONS
85	SPECIALIZATION	QUANTUM TECHNOLOGIES
86	PROJECT	RESEARCH PROJECT
87	PROJECT	INNOVATION PROJECT
88	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	25MRAC01M	AI FOR BUSINESS STRATEGY	M	ABS	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRAC02M	AI STRATEGY AND GOVERNANCE	M	ASG	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRAC03M	SUCCESSFUL AI STRATEGIES : A CEO'S PERSPECTIVES	M	SAI	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRAC04M	CRAFTING A COMPETITIVE ADVANTAGE	M	CCA	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRAC05M	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	25MRAG02	DRAWING BASICS	R	DBS	0	0	6	4	4	10	
2	MIN	MIN-CORE	25MRAG03	GRAPHIC DESIGN	R	GDS	0	0	6	4	4	10	
3	MIN	MIN-CORE	25MRAG04	CONCEPTS OF 3D	R	C3D	0	0	6	4	4	10	
4	MSDC	MIN-SDP	25MRAG05	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	25MRAP01M	INTRODUCTION TO ANTHROPOLOGY	M	ITA	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRAP02M	CULTURAL EVOLUTION	M	CET	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRAP03M	HUMAN ECOLOGY AND ECOLOGICAL ANTHROPOLOGY	M	HEEA	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRAP04M	FUNDAMENTALS IN ARCHEOLOGICAL ANTHROPOLOGY CHRONOLOGY	M	FAAC	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRAP05M	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	25MRAR01	FUNDAMENTALS OF MACRO-ECONOMICS	R	FME	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRAR02	BASICS OF ECONOMETRICS	R	BOE	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRAR03	INTERNATIONAL RELATIONS: THEORIES AND CONCEPTS	R	IRTC	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRAR04	BEHAVIOURAL ECONOMICS AND POLICY	R	BEP	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRAR05	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	25MRBA01M	ORGANIZATIONAL BEHAVIOUR	M	OBR	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRBA02M	MARKETING MANAGEMENT	M	MMG	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRBA03M	FINANCIAL MANAGEMENT	M	FMG	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRBA04M	HUMAN RESOURCE MANAGEMENT	M	HRM	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRBA05M	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	25MRCM01	LINEAR ALGEBRA	R	LAG	2	2	0	0	4	4	
2	MIN	MIN-CORE	25MRCM02	ADVANCED NUMERICAL ANALYSIS	R	ANA	2	2	0	0	4	4	
3	MIN	MIN-CORE	25MRCM03	MATHEMATICAL MODELLING	R	MML	3	0	2	0	4	5	
4	MIN	MIN-CORE	25MRCM04	STOCHASTIC PROCESSES & OPTIMIZATION	R	SPO	2	2	0	0	4	4	
5	MIN	MIN-CORE	25MRCM05	FUZZY MATHEMATICS AND ITS APPLICATIONS	R	FMAA	2	2	0	0	4	4	
6	MSDC	MIN-SDP	25MRCM06	TRANSFORM TECHNIQUES FOR ENGINEERING	R	TTE	2	0	2	4	4	8	
7	MSDC	MIN-SDP	25MRCM07	STATISTICS WITH R PROGRAMMING	R	SWRP	2	0	2	4	4	8	
8	MSDC	MIN-SDP	25MRCM08	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	25MRCL01	PRINCIPLES OF COMPANIES ACT AND CORPORATE GOVERNANCE	R	PCACG	3	0	2	0	4	5	
2	MIN	MIN-CORE	25MRCL02	MERGERS, ACQUISITIONS AND PRIVATE EQUITY	R	MAPE	3	0	2	0	4	5	
3	MIN	MIN-CORE	25MRCL03	INSOLVENCY AND BANKRUPTCY LAW	R	IBL	3	0	2	0	4	5	
4	MIN	MIN-CORE	25MRCL04	COMPETITION LAW AND PRACTICE	R	CLP	3	0	2	0	4	5	
5	MSDC	MIN-SDP	25MRCL05	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	25MRCA01	INTRODUCTION TO CREATIVE ARTS	R	ICA	0	0	6	4	4	10	
2	MIN	MIN-CORE	25MRCA02	DRAWING AND SKETCHING	R	DAS	0	0	6	4	4	10	
3	MIN	MIN-CORE	25MRCA03	PAINTING	R	PNT	0	0	6	4	4	10	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
4	MIN	MIN-CORE	25MRCA04	CREATIVE WRITING	R	CWT	0	0	6	4	4	10	
5	MSDC	MIN-SDP	25MRCA05	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	25MRDM01M	FUNDAMENTALS OF DIGITAL MARKETING	M	FDM	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRDM02M	SOCIAL MEDIA MARKETING	M	SMM	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRDM03M	SERACH ENGINE OPTIMIZATION	M	SEO	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRDM04M	ARTIFICIAL INTELLIGENCE IN MARKETING	M	AIM	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRDM05M	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	25MRFM01	FILM AESTHETICS	R	FAS	0	0	6	4	4	10	
2	MIN	MIN-CORE	25MRFM02	SCREEN WRITING	R	SWT	0	0	6	4	4	10	
3	MIN	MIN-CORE	25MRFM03	CINEMATIC LIGHTING	R	CML	0	0	6	4	4	10	
4	MIN	MIN-CORE	25MRFM04	SOUND DESIGN	R	SDS	0	0	6	4	4	10	
5	MSDC	MIN-SDP	25MRFM05	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	25MRFA01M	FOUNDATIONS AND APPLICATIONS OF FINANCIAL TECHNOLOGY	M	AFT	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRFA02M	DECENTRALISED FINANCE: THE FUTURE OF FINANCE	M	DFFF	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRFA03M	FINTECH INNOVATIONS	M	FIV	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRFA04M	USING MACHINE LEARNING IN TRADING AND FINANCE	M	ML	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRFA05M	TRADING ALGORITHMNS	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	25MRFT01	INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY	R	IFST	3	0	2	0	4	5	
2	MIN	MIN-CORE	25MRFT02	FOOD ANALYSIS AND QUALITY ASSURANCE	R	FAQA	3	0	2	0	4	5	
3	MIN	MIN-CORE	25MRFT03	FOOD SAFETY AND REGULATIONS	R	FSR	3	1	0	0	4	4	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
4	MIN	MIN-CORE	25MRFT04	FOOD ENGINEERING	R	FEG	3	0	2	0	4	5	
5	MSDC	MIN-SDP	25MRFT05	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	25MRGD01	INTRODUCTION TO GRAPHIC DESIGN	R	IGD	0	0	6	4	4	10	
2	MIN	MIN-CORE	25MRGD02	TYPOGRAPHY	R	TPY	0	0	6	4	4	10	
3	MIN	MIN-CORE	25MRGD03	VISUAL IDENTITY AND BRANDING	R	VIB	0	0	6	4	4	10	
4	MIN	MIN-CORE	25MRGD04	PRINT DESIGN	R	PRDG	0	0	6	4	4	10	
5	MSDC	MIN-SDP	25MRGD05	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	25MRIM01	APPLIED DESIGN THINKING	R	ADT	3	0	2	0	4	5	
2	MIN	MIN-CORE	25MRIM02	BUSINESS MODEL INNOVATION	R	BMI	3	0	2	0	4	5	
3	MIN	MIN-CORE	25MRIM03	VENTURE MANAGEMENT	R	VMT	3	0	2	0	4	5	
4	MIN	MIN-CORE	25MRIM04	BUSINESS AND LEADERSHIP	R	BL	3	0	2	0	4	5	
5	MSDC	MIN-SDP	25MRIM05	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	25MRIP01	EMERGENCE AND DEVELOPMENT OF IPR	R	EDIPR	3	0	2	0	4	5	
2	MIN	MIN-CORE	25MRIP02	LAW OF COPYRIGHT	R	LOCR	3	0	2	0	4	5	
3	MIN	MIN-CORE	25MRIP03	LAW OF PATENTS	R	LOPS	3	0	2	0	4	5	
4	MIN	MIN-CORE	25MRIP04	LAW OF TRADEMARK	R	LOTM	3	0	2	0	4	5	
5	MSDC	MIN-SDP	25MRIP05	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	25MRID01	INTRODUCTION TO INTERIOR DESIGN	R	IID	3	0	2	0	4	5	
2	MIN	MIN-CORE	25MRID02	SPACE PLANNING AND LAYOUT	R	SPL	3	0	2	0	4	5	
3	MIN	MIN-CORE	25MRID03	INTERIOR MATERIAL AND FINISHES	R	IMF	3	0	2	0	4	5	
4	MIN	MIN-CORE	25MRID04	FURNITURE AND ACCESSORIES DESIGN	R	FAD	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	MSDC	MIN-SDP	25MRID05	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	25MRIB01M	INTERNATIONAL BUSINESS ESSENTIALS	M	IBET	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRIB02M	INTERNATIONAL BUSINESS ENVIRONMENT	M	IBEV	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRIB03M	INTERNATIONAL BUSINESS OPERATIONS	M	IBO	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRIB04M	INTERNATIONAL BUSINESS MODELS	M	IBM	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRIB05M	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	25MROB01M	ORGANIZATIONAL BEHAVIOUR	M	POM	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MROB02M	ORGANIZATIONAL BEHAVIOUR MODELS	M	OBM	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MROB03M	ORGANIZATIONAL CHANGE AND DEVELOPMENT	M	OCD	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MROB04M	LEADERSHIP IN ORGANIZATION	M	LIO	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MROB05M	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	25MRPY01	BASICS OF PHARMACOLOGY	R	BOP	3	0	2	0	4	5	
2	MIN	MIN-CORE	25MRPY02	ADVANCED PHARMACOLOGY - I	R	AP-I	3	0	2	0	4	5	
3	MIN	MIN-CORE	25MRPY03	EXPERIMENTAL PHARMACOLOGY	R	EPC	3	0	2	0	4	5	
4	MIN	MIN-CORE	25MRPY04	ADVANCED PHARMACOLOGY - II	R	AP-II	3	0	2	0	4	5	
5	MSDC	MIN-SDP	25MRPY05	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	25MRPA01	FUNDAMENTALS OF AGRONOMY	R	FOA	3	0	2	0	4	5	
2	MIN	MIN-CORE	25MRPA02	INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE	R	IACC	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	25MRPA03	GEOINFORMATICS AND NANOTECHNOLOGY FOR PRECISION FARMING	R	GNPF	3	0	2	0	4	5	
4	MIN	MIN-CORE	25MRPA04	PROTECTED CULTIVATION AND POST-HARVEST TECHNOLOGIES	R	PCPHT	3	0	2	0	4	5	
5	MSDC	MIN-SDP	25MRPA05	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	25MRTP01	INTRODUCTION TO TECHNOLOGICAL ENTREPRENEURSHIP	R	ITEP	3	0	2	0	4	5	
2	MIN	MIN-CORE	25MRTP02	LEAN STARTUP LAUNCHPAD	R	LSLP	3	0	2	0	4	5	
3	MIN	MIN-CORE	25MRTP03	ENTREPRENEURSHIP AND VENTURE CAPITAL	R	EVC	3	0	2	0	4	5	
4	MIN	MIN-CORE	25MRTP04	BUILDING AND SUSTAINING A SUCCESSFUL ENTERPRISE	R	BSSE	3	0	2	0	4	5	
5	MSDC	MIN-SDP	25MRTP05	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	25MRPA01	FUNDAMENTALS OF AGRONOMY	R	FOA	3	0	2	0	4	5	
2	MIN	MIN-CORE	25MRWS02	SOIL AND WATER CONSERVATION ENGINEERING	R	SWCE	3	0	2	0	4	5	
3	MIN	MIN-CORE	25MRWS04	RAINFED AGRICULTURE AND WATERSHED MANAGEMENT	R	RAWM	3	0	2	0	4	5	
4	MIN	MIN-CORE	25MRWS03	IRRIGATION WATER MANAGEMENT	R	IWM	3	0	2	0	4	5	
5	MSDC	MIN-SDP	25MRPA05	MODERN FARMING TECHNIQUES AND INNOVATIONS	R	AELP	0	0	6	4	4	10	

23. MINOR: PSYCHOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	25MRPS01M	INTRODUCTION TO PSYCHOLOGY	M	ITP	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRPS02M	PSYCHOLOGY OF EVERYDAY	M	POE	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRPS03M	SOCIAL COGNITION	M	SC	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRPS04M	THE SCIENCE OF WELL-BEING FOR TEENS	M	TSOWBFT	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRPS05M	POSITIVE PSYCHOLOGY: RESILIENCE SKILLS	M	PPRS	4	0	0	0	4	4	

24. MINOR: MANAGERIAL ECONOMICS AND FINANCE

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	25MRME01M	MICROECONOMICS - THE POWER OF MARKETS	M	MEPM	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRME02M	FUNDAMENTALS OF ACCOUNTING	M	FOA	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRME03M	FINANCIAL MANAGEMENT	M	FM	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRME04M	FINANCIAL MARKETS	M	FM	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRME05M	HOW TO FINANCE YOUR VENTURE	M	HTFYV	4	0	0	0	4	4	

25. MINOR: BUSINESS ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	25MRBN01M	INTRODUCTION TO BUSINESS ANALYTICS	M	IBA	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRBN02M	FOUNDATIONS OF BUSINESS INTELLIGENCE	M	FBI	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRBN03M	POWER BI FOR DATA SCIENCE AND ANALYTICS	M	PBDSA	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRBN04M	BUSINESS ANALYTICS WITH EXCEL: ELEMENTARY TO ADVANCE	M	BAWEEA	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRBN05M	ADVANCED BUSINESS ANALYTICS	M	ABA	4	0	0	0	4	4	

26. MINOR: CYBER SECURITY LAW

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	MIN	MIN-CORE	25MRCY01	INTRODUCTION TO CYBERLAW AND CYBERSPACE	R	ITCLCS	4	0	0	0	4	4	
2	MIN	MIN-CORE	25MRCY02	CYBERLAW AND E-COMMERCE IMPLICATIONS	R	CLECI	4	0	0	0	4	4	
3	MIN	MIN-CORE	25MRCY03	CYBERCRIMES IN INDIA	R	CCII	4	0	0	0	4	4	
4	MIN	MIN-CORE	25MRCY04	INTRODUCTION TO CYBERSECURITY, INCIDENTAL RESPONSE AND DIGITAL FORENSIC	R	ITCIRDF	4	0	0	0	4	4	
5	MSDC	MIN-SDP	25MRCY05	CYBER SECURITY: TOOLS, TECHNIQUES & COUNTERMEASURES	M	CSTTCM	4	0	0	0	4	4	

27. SPECIALIZATION: AGRI-BIOTECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25ABT3101	BIOSENSORS AND BIOELECTRONICS	R	BSBE	3	0	2	0	4	5	
2	PEC	PE-1	25ABT3101A	BIOSENSORS AND BIOELECTRONICS	A	BSBE	4	1	2	0	6	7	
3	PEC	PE-1	25ABT3101E	BIOSENSORS AND BIOELECTRONICS	E	BSBE	4	1	2	0	6	7	
4	PEC	PE-2	25ABT3202	IOT APPLICATIONS IN PRECISION AGRICULTURE	R	IOTAPA	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	PEC	PE-2	25ABT3203	MACHINE LEARNING FOR PRECISION AGRICULTURE	R	MLPA	3	0	0	0	3	3	
6	PEC	PE-3	25ABT3304	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	R	IPAA	3	0	0	2	3.5	5	
7	PEC	PE-3	25ABT3304A	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	A	IPAA	4	1	0	2	5.5	7	
8	PEC	PE-3	25ABT3304E	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	E	IPAA	4	1	0	2	5.5	7	
9	PEC	PE-4	25ABT3405	BIOINSTRUMENTATION	R	BIIS	3	0	0	0	3	3	
10	PEC	PE-4	25ABT3406	DATA ACQUISITION AND COMMUNICATION SYSTEMS FOR AGRICULTURE	R	DACSA	3	0	0	0	3	3	
11	PEC	PE-5	25ABT3507	MICROFLUIDICS FOR AGRICULTURAL APPLICATIONS	R	MAP	3	0	0	0	3	3	
12	PEC	PE-5	25ABT3508	BIOINFORMATICS FOR AGRICULTURE	R	BIA	3	0	0	0	3	3	

28. SPECIALIZATION: AI & AUTONOMOUS SYSTEMS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25AAS3101	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	R	ADAS	3	0	2	0	4	5	
2	PEC	PE-1	25AAS3101A	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	A	ADAS	4	1	2	0	6	7	
3	PEC	PE-1	25AAS3101E	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	E	ADAS	4	1	2	0	6	7	
4	PEC	PE-1	25AAS3102	AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT	R	AICAFT	3	0	2	0	4	5	
5	PEC	PE-1	25AAS3102A	AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT	A	AICAFT	4	1	2	0	6	7	
6	PEC	PE-1	25AAS3102E	AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT	E	AICAFT	4	1	2	0	6	7	
7	PEC	PE-1	25AAS3112	ECU DESIGN FOR AUTONOMOUS SYSTEMS	R	EDAS	3	0	2	0	4	5	
8	PEC	PE-1	25AAS3112A	ECU DESIGN FOR AUTONOMOUS SYSTEMS	A	EDAS	4	1	2	0	6	7	
9	PEC	PE-1	25AAS3112E	ECU DESIGN FOR AUTONOMOUS SYSTEMS	E	EDAS	4	1	2	0	6	7	
10	PEC	PE-2	25AAS3203	AI AND IOT FOR AUTONOMOUS VEHICLE	R	AIAV	3	0	0	0	3	3	
11	PEC	PE-2	25AAS3205	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	R	AVECUD	3	0	0	0	3	3	
12	PEC	PE-2	25AAS3213	PERCEPTION ENGINEERING FOR AUTONOMY	R	PEA	3	0	0	0	3	3	
13	PEC	PE-2	25AAS3202	INTRODUCTION TO INTELLIGENT DRONES	R	IID	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-3	25AAS3304	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	R	ADLAS	3	0	0	2	3.5	5	
15	PEC	PE-3	25AAS3304A	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	A	ADLAS	4	1	0	2	5.5	7	
16	PEC	PE-3	25AAS3304E	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	E	ADLAS	4	1	0	2	5.5	7	
17	PEC	PE-3	25AAS3309	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	R	AAAV	3	0	0	2	3.5	5	
18	PEC	PE-3	25AAS3309A	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	A	AAAV	4	1	0	2	5.5	7	
19	PEC	PE-3	25AAS3309E	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	E	AAAV	4	1	0	2	5.5	7	
20	PEC	PE-3	25AAS3314	AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE	R	ANCE	3	0	0	2	3.5	5	
21	PEC	PE-3	25AAS3314A	AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE	A	ANCE	4	1	0	2	5.5	7	
22	PEC	PE-3	25AAS3314E	AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE	E	ANCE	4	1	0	2	5.5	7	
23	PEC	PE-4	25AAS3405	EXPERT SYSTEMS	R	ES	3	0	0	0	3	3	
24	PEC	PE-4	25AAS3406	SELF-DRIVING CARS	R	SDC	3	0	0	0	3	3	
25	PEC	PE-4	25AAS3415	REAL-TIME NETWORKS, COMMUNICATION & SECURITY FOR AUTONOMOUS SYSTEMS	R	RTNCSAS	3	0	0	0	3	3	
26	PEC	PE-4	25AAS3410	CYBERSECURITY IN AUTONOMOUS VEHICLE	R	CAV	3	0	0	0	3	3	
27	PEC	PE-5	25AAS3507	LOCALIZATION & PROGRAMMING REAL-TIME AUTONOMOUS SYSTEMS	R	LPRAS	3	0	0	0	3	3	
28	PEC	PE-5	25AAS3508	REINFORCEMENT LEARNING FOR AUTONOMOUS SYSTEM	R	RLA	3	0	0	0	3	3	
29	PEC	PE-5	25AAS3511	AI DRIVEN ECU DESIGN FOR AUTONOMOUS VEHICLES	R	AEDATT	3	0	0	0	3	3	
30	PEC	PE-5	25AAS3516	CYBER-PHYSICAL SECURITY IN AUTONOMOUS PLATFORMS	R	CPSAP	3	0	0	0	3	3	

29. SPECIALIZATION: AI FOR COMPUTATIONAL INTELLIGENCE

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25ACI3101	GENERATIVE ADVERSARIAL NETWORKS	R	GANWS	3	0	2	0	4	5	
2	PEC	PE-1	25ACI3101A	GENERATIVE ADVERSARIAL NETWORKS	A	GANWS	4	1	2	0	6	7	
3	PEC	PE-1	25ACI3101E	GENERATIVE ADVERSARIAL NETWORKS	E	GANWS	4	1	2	0	6	7	
4	PEC	PE-2	25ACI3202	EXPLAINABLE AI AND COMMUNICATIONS	R	EAIC	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	PEC	PE-3	25ACI3303	FUZZY LOGIC WITH SET THEORY	R	FLST	3	0	0	2	3.5	5	
6	PEC	PE-3	25ACI3303A	FUZZY LOGIC WITH SET THEORY	A	FLST	4	1	0	2	5.5	7	
7	PEC	PE-3	25ACI3303E	FUZZY LOGIC WITH SET THEORY	E	FLST	4	1	0	2	5.5	7	
8	PEC	PE-4	25ACI3404	HEURISTIC ALGORITHMS	R	HA	3	0	0	0	3	3	
9	PEC	PE-4	25ACI3405	SWARM INTELLIGENCE APPROACHES	R	SIA	3	0	0	0	3	3	
10	PEC	PE-5	25ACI3506	DATA MANIPULATION	R	DM	3	0	0	0	3	3	
11	PEC	PE-5	25ACI3507	REINFORCEMENT LEARNING	R	RIL	3	0	0	0	3	3	
12	PEC	PE-5	25ACI3508	EVOLUTIONARY COMPUTATION	R	ECP	3	0	0	0	3	3	

30. SPECIALIZATION: AI SYSTEMS FOR VISUAL INTELLIGENCE

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25AVI3101	DEEP LEARNING	R	DL	3	0	2	0	4	5	
2	PEC	PE-1	25AVI3101A	DEEP LEARNING	A	DL	4	1	2	0	6	7	
3	PEC	PE-1	25AVI3101E	DEEP LEARNING	E	DL	4	1	2	0	6	7	
4	PEC	PE-1	25AVI3102	AI DRIVEN VIDEO PROCESSING	R	AIDVP	3	0	2	0	4	5	
5	PEC	PE-1	25AVI3102A	AI DRIVEN VIDEO PROCESSING	A	AIDVP	4	1	2	0	6	7	
6	PEC	PE-1	25AVI3102E	AI DRIVEN VIDEO PROCESSING	E	AIDVP	4	1	2	0	6	7	
7	PEC	PE-2	25AVI3203	COMPUTER VISION	R	CV	3	0	0	0	3	3	
8	PEC	PE-3	25AVI3304	OBJECT DETECTION	R	OD	3	0	0	2	3.5	5	
9	PEC	PE-3	25AVI3304A	OBJECT DETECTION	A	OD	4	1	0	2	5.5	7	
10	PEC	PE-3	25AVI3304E	OBJECT DETECTION	E	OD	4	1	0	2	5.5	7	
11	PEC	PE-4	25AVI3405	VISUAL RECOGNITION AND SCENE UNDERSTANDING	R	VRSU	3	0	0	0	3	3	
12	PEC	PE-4	25AVI3406	DEEP REINFORCEMENT LEARNING FOR VISION	R	DRLV	3	0	0	0	3	3	
13	PEC	PE-5	25AVI3507	HUMAN COMPUTER INTERACTION	R	HCI	3	0	0	0	3	3	
14	PEC	PE-5	25AVI3508	OBJECT LOCALIZATION	R	OL	3	0	0	0	3	3	
15	PEC	PE-5	25AVI3509	ADVANCED IMAGE PROCESSING AND ANALYSIS	R	AIPA	3	0	0	0	3	3	

31. SPECIALIZATION: AI-DRIVEN EDGE ARCHITECTURES & APPLICATIONS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25ADE3101	EDGE COMPUTING FUNDAMENTALS	R	ECF	3	0	2	0	4	5	
2	PEC	PE-1	25ADE3101A	EDGE COMPUTING FUNDAMENTALS	A	ECF	4	1	2	0	6	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
3	PEC	PE-1	25ADE3101E	EDGE COMPUTING FUNDAMENTALS	E	ECF	4	1	2	0	6	7	
4	PEC	PE-2	25ADE3202	AI AT THE EDGE	R	AIAE	3	0	0	0	3	3	
5	PEC	PE-3	25ADE3303	EDGE AI ARCHITECTURES AND APPLICATIONS	R	EAIAA	3	0	0	2	3.5	5	
6	PEC	PE-3	25ADE3303A	EDGE AI ARCHITECTURES AND APPLICATIONS	A	EAIAA	4	1	0	2	5.5	7	
7	PEC	PE-3	25ADE3303E	EDGE AI ARCHITECTURES AND APPLICATIONS	E	EAIAA	4	1	0	2	5.5	7	
8	PEC	PE-4	25ADE3404	EDGE AI AND 5G	R	EAI5G	3	0	0	0	3	3	
9	PEC	PE-4	25ADE3405	EDGE AI SECURITY AND PROTECTION	R	EAI5P	3	0	0	0	3	3	
10	PEC	PE-5	25ADE3506	EDGE AI DEVELOPMENT FRAMEWORKS AND TOOLS	R	EAI5FT	3	0	0	0	3	3	
11	PEC	PE-5	25ADE3507	EDGE AI ANALYTICS AND DATA MANAGEMENT	R	EAI5DM	3	0	0	0	3	3	
12	PEC	PE-5	25ADE3508	EDGE AI AND SUSTAINABILITY	R	EAI5AS	3	0	0	0	3	3	

32. SPECIALIZATION: AI-DRIVEN LANGUAGE TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25ALT3101	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	R	AMLFTA	3	0	2	0	4	5	
2	PEC	PE-1	25ALT3101A	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	A	AMLFTA	4	1	2	0	6	7	
3	PEC	PE-1	25ALT3101E	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	E	AMLFTA	4	1	2	0	6	7	
4	PEC	PE-2	25ALT3202	DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING	R	DLFNLP	3	0	0	0	3	3	
5	PEC	PE-3	25ALT3303	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	R	CAICBD	3	0	0	2	3.5	5	
6	PEC	PE-3	25ALT3303A	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	A	CAICBD	4	1	0	2	5.5	7	
7	PEC	PE-3	25ALT3303E	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	E	CAICBD	4	1	0	2	5.5	7	
8	PEC	PE-4	25ALT3404	TEXT UNDERSTANDING	R	TUS	3	0	0	0	3	3	
9	PEC	PE-4	25ALT3405	NATURAL LANGUAGE PROCESSING	R	NLP	3	0	0	0	3	3	
10	PEC	PE-4	25ALT3506	LANGUAGE UNDERSTANDING WITH PRE-TRAINED MODELS	R	LUWPTM	3	0	0	0	3	3	
11	PEC	PE-5	25ALT3507	LARGE LANGUAGE MODEL FOR SPEECH PROCESSING	R	LLMFSP	3	0	0	0	3	3	

33. SPECIALIZATION: AUTOMOTIVE ELECTRONICS & AUTOSAR

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25AEA3101	AUTOMOTIVE SENSOR AND APPLICATIONS	R	ASA	3	0	2	0	4	5	
2	PEC	PE-1	25AEA3101A	AUTOMOTIVE SENSOR AND APPLICATIONS	A	ASA	4	1	2	0	6	7	
3	PEC	PE-1	25AEA3101E	AUTOMOTIVE SENSOR AND APPLICATIONS	E	ASA	4	1	2	0	6	7	
4	PEC	PE-2	25AEA3202	AUTOTRONICS	R	AT	3	0	0	0	3	3	
5	PEC	PE-2	25AEA3203	AUTOMOTIVE POLLUTION AND ITS CONTROL	R	APC	3	0	0	0	3	3	
6	PEC	PE-3	25AEA3304	ALTERNATE DRIVES, TRACTION AND CONTROLS	R	ADTC	3	0	0	2	3.5	5	
7	PEC	PE-3	25AEA3304A	ALTERNATE DRIVES, TRACTION AND CONTROLS	A	ADTC	4	1	0	2	5.5	7	
8	PEC	PE-3	25AEA3304E	ALTERNATE DRIVES, TRACTION AND CONTROLS	E	ADTC	4	1	0	2	5.5	7	
9	PEC	PE-4	25AEA3405	VEHICLE CONTROL SYSTEMS	R	VCS	3	0	0	0	3	3	
10	PEC	PE-4	25AEA3406	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	R	AEES	3	0	0	0	3	3	
11	PEC	PE-5	25AEA3507	SOFT COMPUTING TECHNIQUES FOR AUTOMOTIVE APPLICATIONS	R	SCTAA	3	0	0	0	3	3	
12	PEC	PE-5	25AEA3508	AUTOMOTIVE NETWORKING AND PROTOCOLS	R	ANP	3	0	0	0	3	3	

34. SPECIALIZATION: AUTOMOTIVE ENERGY ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25AEE3101	AUTOMOBILE ENGINEERING	R	AEG	3	0	2	0	4	5	
2	PEC	PE-1	25AEE3101A	AUTOMOBILE ENGINEERING	A	AEG	4	1	2	0	6	7	
3	PEC	PE-1	25AEE3101E	AUTOMOBILE ENGINEERING	E	AEG	4	1	2	0	6	7	
4	PEC	PE-2	25AEE3202	AUTOTRONICS AND SAFETY	R	AESS	3	0	0	0	3	3	
5	PEC	PE-2	25AEE3203	REFRIGERATION & AIR CONDITIONING	R	RAC	3	0	0	0	3	3	
6	PEC	PE-3	25AEE3304	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	R	TMEES	3	0	0	2	3.5	5	
7	PEC	PE-3	25AEE3304A	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	A	TMEES	4	1	0	2	5.5	7	
8	PEC	PE-3	25AEE3304E	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	E	TMEES	4	1	0	2	5.5	7	
9	PEC	PE-4	25AEE3405	SPECIAL PURPOSE VEHICLES	R	SPV	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-4	25AEE3406	VEHICLE DYNAMICS	R	VDS	3	0	0	0	3	3	
11	PEC	PE-5	25AEE3507	AUTONOMOUS VEHICLES	R	AVS	3	0	0	0	3	3	
12	PEC	PE-5	25AEE3508	ALTERNATE ENERGY SOURCES FOR AUTOMOBILES	R	AESA	3	0	0	0	3	3	

35. SPECIALIZATION: BIOINFORMATICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25BIS3101	MOLECULAR MODELLING AND DRUG DESIGN	R	MMDD	3	0	2	0	4	5	
2	PEC	PE-1	25BIS3101A	MOLECULAR MODELLING AND DRUG DESIGN	A	MMDD	4	1	2	0	6	7	
3	PEC	PE-1	25BIS3101E	MOLECULAR MODELLING AND DRUG DESIGN	E	MMDD	4	1	2	0	6	7	
4	PEC	PE-2	25BIS3202	BIOMEDICAL INFORMATICS	R	BMI	3	0	0	0	3	3	
5	PEC	PE-2	25BIS3203	PYTHON AND R PROGRAMMING	R	P&RP	3	0	0	0	3	3	
6	PEC	PE-3	25BIS3304	STRUCTURAL BIOLOGY	R	SB	3	0	0	2	3.5	5	
7	PEC	PE-3	25BIS3304A	STRUCTURAL BIOLOGY	A	SB	4	1	0	2	5.5	7	
8	PEC	PE-3	25BIS3304E	STRUCTURAL BIOLOGY	E	SB	4	1	0	2	5.5	7	
9	PEC	PE-4	25BIS3405	APPLIED BIOINFORMATICS	R	ABI	3	0	0	0	3	3	
10	PEC	PE-4	25BIS3406	NGS SEQUENCING AND DATA ANALYSIS	R	NGSDA	3	0	0	0	3	3	
11	PEC	PE-5	25BIS3507	SYSTEMS BIOLOGY	R	SSB	3	0	0	0	3	3	
12	PEC	PE-5	25BIS3508	DATA BASE MANAGEMENT SYSTEM FOR BIOLOGIST	R	DBMS	3	0	0	0	3	3	

36. SPECIALIZATION: BLOCKCHAIN ENGINEERING FOR WEB3

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25BEW3101	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	R	IBCTCCT	3	0	2	0	4	5	
2	PEC	PE-1	25BEW3101A	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	A	IBCTCCT	4	1	2	0	6	7	
3	PEC	PE-1	25BEW3101E	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	E	IBCTCCT	4	1	2	0	6	7	
4	PEC	PE-2	25BEW3202	SMART CONTRACTS	R	SC	3	0	0	0	3	3	
5	PEC	PE-2	25BEW3110	SMART CONTRACT DEVELOPMENT & TESTING	R	SCDT	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
6	PEC	PE-2	25BEW3211	BLOCKCHAIN NETWORK ARCHITECTURE & CONSENSUS MECHANISMS	R	BNAC	3	0	0	0	3	3	
7	PEC	PE-3	25BEW3303	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	R	DADW	3	0	0	2	3.5	5	
8	PEC	PE-3	25BEW3303A	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	A	DADW	4	1	0	2	5.5	7	
9	PEC	PE-3	25BEW3303E	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	E	DADW	4	1	0	2	5.5	7	
10	PEC	PE-3	25BEW3312	WEB3 APPLICATION DEVELOPMENT & INTEGRATION	R	WADI	3	0	0	2	3.5	5	
11	PEC	PE-3	25BEW3312A	WEB3 APPLICATION DEVELOPMENT & INTEGRATION	A	WADI	4	1	0	2	5.5	7	
12	PEC	PE-3	25BEW3312E	WEB3 APPLICATION DEVELOPMENT & INTEGRATION	E	WADI	4	1	0	2	5.5	7	
13	PEC	PE-4	25BEW3404	BLOCKCHAIN PLATFORMS AND PROTOCOLS	R	BCPFP	3	0	0	0	3	3	
14	PEC	PE-4	25BEW3405	BLOCKCHAIN SECURITY	R	BCF	3	0	0	0	3	3	
15	PEC	PE-4	25BEW3406	ORACLES AND DATA FEEDS	R	ODF	3	0	0	0	3	3	
16	PEC	PE-4	25BEW3413	DECENTRALIZED FINANCE (DEFI) SYSTEMS ENGINEERING	R	DFSE	3	0	0	0	3	3	
17	PEC	PE-4	25BEW3414	POST-QUANTUM CRYPTOGRAPHY FOR BLOCKCHAIN	R	PQCB	3	0	0	0	3	3	
18	PEC	PE-5	25BEW3507	BLOCKCHAIN SCALABILITY AND LAYER 2 SOLUTIONS	R	BCSALS	3	0	0	0	3	3	
19	PEC	PE-5	25BEW3508	REGULATORY LANDSCAPE AND COMPLIANCE	R	RLAC	3	0	0	0	3	3	
20	PEC	PE-5	25BEW3509	FUTURE TRENDS IN BLOCKCHAIN AND WEB3	R	FTBCAW	3	0	0	0	3	3	
21	PEC	PE-5	25BEW3515	DECENTRALIZED STORAGE, IDENTITY & MIDDLEWARE SYSTEMS	R	DSIM	3	0	0	0	3	3	
22	PEC	PE-5	25BEW3516	QUANTUM ALGORITHMS FOR BLOCKCHAIN DATA ANALYSIS	R	QABA	3	0	0	0	3	3	

37. SPECIALIZATION: CLOUD & EDGE COMPUTING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CEC3101	CLOUD INFRASTRUCTURE AND SERVICES	R	CIS	3	0	2	0	4	5	
2	PEC	PE-2	25CEC3202	ADVANCED OPERATING SYSTEMS	R	AOS	3	0	0	0	3	3	
3	PEC	PE-2	25CEC3203	FUNCTIONAL AND CONCURRENT PROGRAMMING	R	FCP	3	0	0	0	3	3	
4	PEC	PE-2	25CEC3204	CLOUD DEVOPS	R	CD	3	0	0	0	3	3	
5	PEC	PE-3	25CEC3305	CLOUD AND SERVERLESS COMPUTING	R	CSC	3	0	0	2	3.5	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
6	PEC	PE-3	25CEC3305A	CLOUD AND SERVERLESS COMPUTING	A	CSC	4	1	0	2	5.5	7	
7	PEC	PE-3	25CEC3305E	CLOUD AND SERVERLESS COMPUTING	E	CSC	4	1	0	2	5.5	7	
8	PEC	PE-4	25CEC3406	ADVANCED COMPUTER ARCHITECTURE	R	ACA	3	0	0	0	3	3	
9	PEC	PE-4	25CEC3407	PARALLEL ALGORITHMS	R	PA	3	0	0	0	3	3	
10	PEC	PE-4	25CEC3408	CLOUD SECURITY	R	CS	3	0	0	0	3	3	
11	PEC	PE-4	25CEC3409	ARCHITECTING CLOUD SOLUTIONS*	R	ACS	3	0	0	0	3	3	
12	PEC	PE-5	25CEC3510	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
13	PEC	PE-5	25CEC3511	HIGH PERFORMANCE COMPUTING	R	HPC	3	0	0	0	3	3	
14	PEC	PE-5	25CEC3512	DESIGN OF DISTRIBUTED APPLICATIONS ON CLOUD (DDA)	R	DDAC	3	0	0	0	3	3	
15	PEC	PE-5	25CEC3513	CLOUD NETWORKING	R	CN	3	0	0	0	3	3	

38. SPECIALIZATION: CLOUD INFRASTRUCTURE DESIGN & ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CID3101	CLOUD INFRASTRUCTURE ENGINEERING	R	CIE	3	0	2	0	4	5	
2	PEC	PE-1	25CID3101A	CLOUD INFRASTRUCTURE ENGINEERING	A	CIE	4	1	2	0	6	7	
3	PEC	PE-1	25CID3101E	CLOUD INFRASTRUCTURE ENGINEERING	E	CIE	4	1	2	0	6	7	
4	PEC	PE-2	25CID3202	ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS	R	ECT	3	0	0	0	3	3	
5	PEC	PE-2	25CID3203	ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS	R	AHASCE	3	0	0	0	3	3	
6	PEC	PE-3	25CID3304	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	R	CIA	3	0	0	2	3.5	5	
7	PEC	PE-3	25CID3304A	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	A	CIA	4	1	0	2	5.5	7	
8	PEC	PE-3	25CID3304E	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	E	CIA	4	1	0	2	5.5	7	
9	PEC	PE-4	25CID3405	RELIABLE CLOUD INFRASTRUCTURE: DESIGN AND PROCESS	R	RID	3	0	0	0	3	3	
10	PEC	PE-4	25CID3406	HYBRID CLOUD INTEGRATION AND MANAGEMENT	R	HCIM	3	0	0	0	3	3	
11	PEC	PE-5	25CID3507	CLOUD ENGINEERING	R	CE	3	0	0	0	3	3	
12	PEC	PE-5	25CID3508	CLOUD DATA MANAGEMENT AND STORAGE SOLUTIONS	R	CDMSS	3	0	0	0	3	3	

39. SPECIALIZATION: CLOUD NATIVE SECURITY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CNS3101	INTRODUCTION TO CLOUD NATIVE COMPUTING	R	ITCNC	3	0	2	0	4	5	
2	PEC	PE-1	25CNS3101A	INTRODUCTION TO CLOUD NATIVE COMPUTING	A	ITCNC	4	1	2	0	6	7	
3	PEC	PE-1	25CNS3101E	INTRODUCTION TO CLOUD NATIVE COMPUTING	E	ITCNC	4	1	2	0	6	7	
4	PEC	PE-2	25CNS3202	FUNDAMENTALS OF CLOUD SECURITY	R	FOCS	2	0	2	0	3	4	
5	PEC	PE-3	25CNS3303	CONTAINER SECURITY	R	CTSY	3	0	0	2	3.5	5	
6	PEC	PE-3	25CNS3303A	CONTAINER SECURITY	A	CTSY	4	1	0	2	5.5	7	
7	PEC	PE-3	25CNS3303E	CONTAINER SECURITY	E	CTSY	4	1	0	2	5.5	7	
8	PEC	PE-4	25CNS3404	MICROSERVICES SECURITY	R	MSS	3	0	0	0	3	3	
9	PEC	PE-4	25CNS3405	INFRASTRUCTURE AS CODE SECURITY	R	ISACS	3	0	0	0	3	3	
10	PEC	PE-4	25CNS3406	IDENTITY AND ACCESS MANAGEMENT IN CLOUD NATIVE ENVIRONMENTS	R	IAMCNE	3	0	0	0	3	3	
11	PEC	PE-4	25CNS3407	NETWORK SECURITY IN CLOUD NATIVE ARCHITECTURES	R	NSCNA	3	0	0	0	3	3	
12	PEC	PE-5	25CNS3508	MONITORING AND LOGGING FOR CLOUD NATIVE SECURITY	R	MLCNS	3	0	0	0	3	3	
13	PEC	PE-5	25CNS3509	COMPLIANCE AND GOVERNANCE IN CLOUD NATIVE ENVIRONMENTS	R	CGCNE	3	0	0	0	3	3	
14	PEC	PE-5	25CNS3510	SERVERLESS SECURITY	R	SLSY	3	0	0	0	3	3	
15	PEC	PE-5	25CNS3512	FUTURE TRENDS IN CLOUD NATIVE SECURITY	R	FTCNS	3	0	0	0	3	3	

40. SPECIALIZATION: CLOUD NATIVE SOFTWARE ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CNE3101	FOUNDATIONS OF CLOUD NATIVE COMPUTING	R	FCNC	3	0	2	0	4	5	
2	PEC	PE-1	25CNE3101A	FOUNDATIONS OF CLOUD NATIVE COMPUTING	A	FCNC	4	1	2	0	6	7	
3	PEC	PE-1	25CNE3101E	FOUNDATIONS OF CLOUD NATIVE COMPUTING	E	FCNC	4	1	2	0	6	7	
4	PEC	PE-2	25CNE3202	CLOUD NATIVE APPLICATION DEVELOPMENT	R	CNAD	3	0	0	0	3	3	
5	PEC	PE-2	25CNE3203	CLOUD NATIVE DESIGN PROCESS	R	CNDP	3	0	0	0	3	3	
6	PEC	PE-3	25CNE3304	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	R	SEC	3	0	0	2	3.5	5	
7	PEC	PE-3	25CNE3304A	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	A	SEC	4	1	0	2	5.5	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
8	PEC	PE-3	25CNE3304E	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	E	SEC	4	1	0	2	5.5	7	
9	PEC	PE-4	25CNE3405	SERVERLESS COMPUTING AND EVENT-DRIVEN ARCHITECTURES	R	SCEDA	3	0	0	0	3	3	
10	PEC	PE-4	25CNE3406	CLOUD NATIVE SOFTWARE ARCHITECTURES	R	CNSA	3	0	0	0	3	3	
11	PEC	PE-5	25CNE3507	CLOUD NATIVE NETWORKING AND STORAGE SYSTEMS	R	CNNSS	3	0	0	0	3	3	
12	PEC	PE-5	25CNE3508	CLOUD INFRASTRUCTURE AND VIRTUALIZATION	R	CIIV	3	0	0	0	3	3	

41. SPECIALIZATION: CLOUD-BASED SCIENTIFIC COMPUTING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CSC3101	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	R	FCS	3	0	2	0	4	5	
2	PEC	PE-1	25CSC3101A	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	A	FCS	4	1	2	0	6	7	
3	PEC	PE-1	25CSC3101E	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	E	FCS	4	1	2	0	6	7	
4	PEC	PE-2	25CSC3202	DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY	R	DSA	3	0	0	0	3	3	
5	PEC	PE-2	25CSC3203	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	R	DSCC	3	0	0	0	3	3	
6	PEC	PE-3	25CSC3304	CLOUD BASED HIGH PERFORMANCE COMPUTING	R	CHC	3	0	0	2	3.5	5	
7	PEC	PE-3	25CSC3304A	CLOUD BASED HIGH PERFORMANCE COMPUTING	A	CHC	4	1	0	2	5.5	7	
8	PEC	PE-3	25CSC3304E	CLOUD BASED HIGH PERFORMANCE COMPUTING	E	CHC	4	1	0	2	5.5	7	
9	PEC	PE-4	25CSC3405	CLOUD-BASED GRID COMPUTING	R	CGC	3	0	0	0	3	3	
10	PEC	PE-4	25CSC3406	CLOUD COMPUTING FOR SCIENTIFIC DISCOVERY	R	CCFSD	3	0	0	0	3	3	
11	PEC	PE-5	25CSC3507	CLOUD-BASED SCALABLE COMPUTING AND BIG DATA ANALYTICS	R	CSCBD	3	0	0	0	3	3	
12	PEC	PE-5	25CSC3508	PARALLEL COMPUTING FOR SCIENTISTS USING CLOUD PLATFORMS	R	PCSCP	3	0	0	0	3	3	

42. SPECIALIZATION: CROSS PLATFORM DEVELOPMENT FRAMEWORKS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CPD3101	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	R	FMAD	3	0	2	0	4	5	
2	PEC	PE-1	25CPD3101A	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	A	FMAD	4	1	2	0	6	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
3	PEC	PE-1	25CPD3101E	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	E	FMAD	4	1	2	0	6	7	
4	PEC	PE-2	25CPD3202	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	R	RNA	3	0	0	0	3	3	
5	PEC	PE-2	25CPD3203	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	R	FBCPD	3	0	0	0	3	3	
6	PEC	PE-3	25CPD3304	SECURE MOBILE APPLICATION DEVELOPMENT	R	SMAD	3	0	0	2	3.5	5	
7	PEC	PE-3	25CPD3304A	SECURE MOBILE APPLICATION DEVELOPMENT	A	SMAD	4	1	0	2	5.5	7	
8	PEC	PE-3	25CPD3304E	SECURE MOBILE APPLICATION DEVELOPMENT	E	SMAD	4	1	0	2	5.5	7	
9	PEC	PE-4	25CPD3406	META REACT NATIVE SPECIALIZATION	R	MRNS	3	0	0	0	3	3	
10	PEC	PE-4	25CPD3405	UX DESIGN	R	UXD	3	0	0	0	3	3	
11	PEC	PE-5	25CPD3507	ADVANCED MOBILE APPLICATION DEVELOPMENT	R	AMAD	3	0	0	0	3	3	
12	PEC	PE-5	25CPD3508	CROSS PLATFORM USER INTERFACE DESIGN	R	CPED	3	0	0	0	3	3	

43. SPECIALIZATION: CYBER PHYSICAL SYSTEMS & IOT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CPS3101	IOT SENSING AND ACTUATING DEVICES	R	ISAD	3	0	2	0	4	5	
2	PEC	PE-1	25CPS3101A	IOT SENSING AND ACTUATING DEVICES	A	ISAD	4	1	2	0	6	7	
3	PEC	PE-1	25CPS3101E	IOT SENSING AND ACTUATING DEVICES	E	ISAD	4	1	2	0	6	7	
4	PEC	PE-2	25CPS3202	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	R	IOTAP	3	0	0	0	3	3	
5	PEC	PE-3	25CPS3303	CYBER PHYSICAL SYSTEMS	R	CPS	3	0	0	2	3.5	5	
6	PEC	PE-3	25CPS3303A	CYBER PHYSICAL SYSTEMS	A	CPS	4	1	0	2	5.5	7	
7	PEC	PE-3	25CPS3303E	CYBER PHYSICAL SYSTEMS	E	CPS	4	1	0	2	5.5	7	
8	PEC	PE-4	25CPS3404	FOUNDATIONS OF HYBRID AND EMBEDDED SYSTEMS	R	DVP	3	0	0	0	3	3	
9	PEC	PE-5	25CPS3507	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
10	PEC	PE-5	25CPS3505	CLOUD COMPUTING FOR IOT ENGINEERS	R	CCIOTE	3	0	0	0	3	3	
11	PEC	PE-5	25CPS3506	WIRELESS SENSOR NETWORKS	R	WSN	3	0	0	0	3	3	

44. SPECIALIZATION: CYBER SECURITY & BLOCKCHAIN TECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CSB3101	CRYPT ANALYSIS & CYBER DEFENSE	R	CACD	3	0	2	0	4	5	
2	PEC	PE-1	25CSB3101A	CRYPT ANALYSIS & CYBER DEFENSE	A	CACD	4	1	2	0	6	7	
3	PEC	PE-1	25CSB3101E	CRYPT ANALYSIS & CYBER DEFENSE	E	CACD	4	1	2	0	6	7	
4	PEC	PE-2	25CSB3202	NETWORK AND INFRASTRUCTURE SECURITY	R	NS	3	0	0	0	3	3	
5	PEC	PE-2	25CSB3203	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	R	IBCC	3	0	0	0	3	3	
6	PEC	PE-3	25CSB3304	DIGITAL FORENSICS	R	DF	3	0	0	2	3.5	5	
7	PEC	PE-3	25CSB3304A	DIGITAL FORENSICS	A	DF	4	1	0	2	5.5	7	
8	PEC	PE-3	25CSB3304E	DIGITAL FORENSICS	E	DF	4	1	0	2	5.5	7	
9	PEC	PE-4	25CSB3405	DATABASE SYSTEM AND SECURITY	R	DSS	3	0	0	0	3	3	
10	PEC	PE-4	25CSB3406	PROGRAMMING FOR SMART CONTRACTS	R	PSC	3	0	0	0	3	3	
11	PEC	PE-4	25CSB3407	CLOUD SECURITY	R	CS	3	0	0	0	3	3	
12	PEC	PE-5	25CSB3508	SECURE SOFTWARE ENGINEERING	R	SSE	3	0	0	0	3	3	
13	PEC	PE-5	25CSB3509	WEB SECURITY	R	WS	3	0	0	0	3	3	
14	PEC	PE-5	25CSB3510	SECURITY GOVERNANCE & MANAGEMENT	R	SGM	3	0	0	0	3	3	

45. SPECIALIZATION: DATA COMMUNICATIONS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25DCM3101	TCP/IP AND OTHER PROTOCOL SUITE	R	TCP	3	0	2	0	4	5	
2	PEC	PE-1	25DCM3101A	TCP/IP AND OTHER PROTOCOL SUITE	A	TCP	4	1	2	0	6	7	
3	PEC	PE-1	25DCM3101E	TCP/IP AND OTHER PROTOCOL SUITE	E	TCP	4	1	2	0	6	7	
4	PEC	PE-2	25DCM3202	CLOUD COMPUTING AND NETWORKS SECURITY	R	CCNS	3	0	0	0	3	3	
5	PEC	PE-3	25DCM3303	VOIP AND BROADBAND NETWORKS	R	VOIP	3	0	0	2	3.5	5	
6	PEC	PE-3	25DCM3303A	VOIP AND BROADBAND NETWORKS	A	VOIP	4	1	0	2	5.5	7	
7	PEC	PE-3	25DCM3303E	VOIP AND BROADBAND NETWORKS	E	VOIP	4	1	0	2	5.5	7	
8	PEC	PE-4	25DCM3404	5G MOBILE AND IEEE STANDARDS	R	5GMI	3	0	0	0	3	3	
9	PEC	PE-5	25DCM3505	IP MULTIMEDIA SUB-SYSTEM AND EMERGING TECHNOLOGIES	R	IMSET	3	0	0	0	3	3	

46. 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	25DEA3101	FUNDAMENTALS OF DATA ENGINEERING	R	FDE	3	0	2	0	4	5	
2	PEC	PE-1	25DEA3101A	FUNDAMENTALS OF DATA ENGINEERING	A	FDE	4	1	2	0	6	7	
3	PEC	PE-1	25DEA3101E	FUNDAMENTALS OF DATA ENGINEERING	E	FDE	4	1	2	0	6	7	
4	PEC	PE-2	25DEA3202	DATA EXPLORATION AND PREPARATION	R	DEP	3	0	0	0	3	3	
5	PEC	PE-3	25DEA3303	BIG DATA TECHNOLOGIES	R	BDT	3	0	0	2	3.5	5	
6	PEC	PE-3	25DEA3303A	BIG DATA TECHNOLOGIES	A	BDT	4	1	0	2	5.5	7	
7	PEC	PE-3	25DEA3303E	BIG DATA TECHNOLOGIES	E	BDT	4	1	0	2	5.5	7	
8	PEC	PE-4	25DEA3404	DATA WAREHOUSING AND BUSINESS INTELLIGENCE	R	DWBI	3	0	0	0	3	3	
9	PEC	PE-5	25DEA3505	MACHINE LEARNING ENGINEERING FOR BIG DATA	R	MLEBD	3	0	0	0	3	3	

47. SPECIALIZATION: DATA SCIENCE & BIG DATA ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25DSB3101	DATA ANALYTICS AND VISUALIZATION	R	DAV	3	0	2	0	4	5	
2	PEC	PE-1	25DSB3101A	DATA ANALYTICS AND VISUALIZATION	A	DAV	4	1	2	0	6	7	
3	PEC	PE-1	25DSB3101E	DATA ANALYTICS AND VISUALIZATION	E	DAV	4	1	2	0	6	7	
4	PEC	PE-2	25DSB3202	DATA WAREHOUSING AND MINING	R	DWHM	3	0	0	0	3	3	
5	PEC	PE-3	25DSB3303	BIG DATA ANALYTICS	R	BDA	3	0	0	2	3.5	5	
6	PEC	PE-3	25DSB3303A	BIG DATA ANALYTICS	A	BDA	4	1	0	2	5.5	7	
7	PEC	PE-3	25DSB3303E	BIG DATA ANALYTICS	E	BDA	4	1	0	2	5.5	7	
8	PEC	PE-4	25DSB3404	BIG DATA OPTIMIZATION	R	BDO	3	0	0	0	3	3	
9	PEC	PE-4	25DSB3407	DATA ANALYTICS ON CLOUD	R	DAC	3	0	0	0	3	3	
10	PEC	PE-4	25DSB3408	DIGITAL MEDIA ANALYTICS	R	DMA	3	0	0	0	3	3	
11	PEC	PE-5	25DSB3509	ADVANCED DATABASES	R	AD	3	0	0	0	3	3	
12	PEC	PE-5	25DSB3510	BUSINESS ANALYTICS	R	BA	3	0	0	0	3	3	
13	PEC	PE-5	25DSB3511	GRAPH & WEB ANALYTICS	R	GWA	3	0	0	0	3	3	
14	PEC	PE-5	25DSB3512	DATA GOVERNANCE ON CLOUD	R	DGC	3	0	0	0	3	3	

48. SPECIALIZATION: DISTRIBUTED LEDGER ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25DLA3101	BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS	R	SNTSA	3	0	2	0	4	5	
2	PEC	PE-1	25DLA3101A	BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS	A	SNTSA	4	1	2	0	6	7	
3	PEC	PE-1	25DLA3101E	BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS	E	SNTSA	4	1	2	0	6	7	
4	PEC	PE-2	25DLA3202	MACHINE LEARNING FOR FINANCIAL RISK & BEHAVIORAL INTELLIGENCE	R	MLFRBI	3	0	0	0	3	3	
5	PEC	PE-2	25DLA3203	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	R	BTDT	3	0	0	0	3	3	
6	PEC	PE-3	25DLA3304	MULTI AGENT SYSTEMS	R	MAS	3	0	0	2	3.5	5	
7	PEC	PE-3	25DLA3304A	MULTI AGENT SYSTEMS	A	MAS	4	1	0	2	5.5	7	
8	PEC	PE-3	25DLA3304E	MULTI AGENT SYSTEMS	E	MAS	4	1	0	2	5.5	7	
9	PEC	PE-3	25DLA3303	SMART CONTRACTS & WEB3 APPLICATION ENGINEERING	R	SCW3	3	0	0	2	3.5	5	
10	PEC	PE-3	25DLA3303A	SMART CONTRACTS & WEB3 APPLICATION ENGINEERING	A	SCW3	4	1	0	2	5.5	7	
11	PEC	PE-3	25DLA3303E	SMART CONTRACTS & WEB3 APPLICATION ENGINEERING	E	SCW3	4	1	0	2	5.5	7	
12	PEC	PE-4	25DLA3405	BLOCKCHAIN ANALYTICS	R	BCA	3	0	0	0	3	3	
13	PEC	PE-4	25DLA3406	CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGY	R	CBT	3	0	0	0	3	3	
14	PEC	PE-4	25DLA3404	TOKENOMICS, DIGITAL ASSETS & CRYPTO INFRASTRUCTURE	R	TDCI	3	0	0	0	3	3	
15	PEC	PE-5	25DLA3507	DISTRIBUTED LEDGER ARCHITECTURE FOR AUTOMATION	R	DLAA	3	0	0	0	3	3	
16	PEC	PE-5	25DLA3508	PERMISSIONED DISTRIBUTED LEDGER	R	PDL	3	0	0	0	3	3	
17	PEC	PE-5	25DLA3505	PRIVACY, COMPLIANCE & DECENTRALIZED SECURITY ENGINEERING	R	PCDS	3	0	0	0	3	3	

49. SPECIALIZATION: EMBEDDED SYSTEMS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25EDS3101	ADVANCED EMBEDDED SYSTEMS	R	AES	3	0	2	0	4	5	
2	PEC	PE-1	25EDS3101A	ADVANCED EMBEDDED SYSTEMS	A	AES	4	1	2	0	6	7	
3	PEC	PE-1	25EDS3101E	ADVANCED EMBEDDED SYSTEMS	E	AES	4	1	2	0	6	7	
4	PEC	PE-2	25EDS3202	EMBEDDED SYSTEMS FOR IOT	R	ESIOT	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	PEC	PE-3	25EDS3303	EMBEDDED AND REAL-TIME SYSTEMS	R	ERTS	3	0	0	2	3.5	5	
6	PEC	PE-3	25EDS3303A	EMBEDDED AND REAL-TIME SYSTEMS	A	ERTS	4	1	0	2	5.5	7	
7	PEC	PE-3	25EDS3303E	EMBEDDED AND REAL-TIME SYSTEMS	E	ERTS	4	1	0	2	5.5	7	
8	PEC	PE-4	25EDS3404	CLOUD ARCHITECTURE IN IOT	R	CAIOT	3	0	0	0	3	3	
9	PEC	PE-5	25EDS3505	EDGE COMPUTING AND DATA ANALYTICS IN IOT	R	ECDAI	3	0	0	0	3	3	

50. SPECIALIZATION: E-MOBILITY ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25EME3101	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	R	PTDEV	3	0	2	0	4	5	
2	PEC	PE-1	25EME3101A	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	A	PTDEV	4	1	2	0	6	7	
3	PEC	PE-1	25EME3101E	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	E	PTDEV	4	1	2	0	6	7	
4	PEC	PE-2	25EME3202	COMMUNICATION PROTOCOLS AND TESTING OF ELECTRIC VEHICLE	R	CPTEV	3	0	0	0	3	3	
5	PEC	PE-2	25EME3203	AUTONOMOUS VEHICLES AND AUTOMOTIVE ELECTRONICS	R	AVAE	3	0	0	0	3	3	
6	PEC	PE-3	25EME3304	CHARGING STATIONS FOR ELECTRIC VEHICLES	R	CSEV	3	0	0	2	3.5	5	
7	PEC	PE-3	25EME3304A	CHARGING STATIONS FOR ELECTRIC VEHICLES	A	CSEV	4	1	0	2	5.5	7	
8	PEC	PE-3	25EME3304E	CHARGING STATIONS FOR ELECTRIC VEHICLES	E	CSEV	4	1	0	2	5.5	7	
9	PEC	PE-4	25EME3405	INTRODUCTION TO BATTERY-MANAGEMENT SYSTEMS	R	IBMS	3	0	0	0	3	3	
10	PEC	PE-4	25EME3406	BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE	R	BSAEV	3	0	0	0	3	3	
11	PEC	PE-5	25EME3507	AI AND IOT FOR ELECTRIC VEHICLE	R	AIEV	3	0	0	0	3	3	
12	PEC	PE-5	25EME3508	EV SYSTEM AND WIRING DESIGN	R	ESWS	3	0	0	0	3	3	

51. SPECIALIZATION: ENGINEERING DESIGN

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25EGD3101	ADVANCED STRENGTH OF MATERIALS	R	ASM	3	0	2	0	4	5	
2	PEC	PE-1	25EGD3101A	ADVANCED STRENGTH OF MATERIALS	A	ASM	4	1	2	0	6	7	
3	PEC	PE-1	25EGD3101E	ADVANCED STRENGTH OF MATERIALS	E	ASM	4	1	2	0	6	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
4	PEC	PE-2	25EGD3202	CREEP, FATIGUE AND FRACTURE MECHANICS	R	CFFM	3	0	0	0	3	3	
5	PEC	PE-2	25EGD3203	THEORY OF ELASTICITY AND PLASTICITY	R	KDARS	3	0	0	0	3	3	
6	PEC	PE-3	25EGD3304	MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS	R	MADRS	3	0	0	2	3.5	5	
7	PEC	PE-3	25EGD3304A	MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS	A	MADRS	4	1	0	2	5.5	7	
8	PEC	PE-3	25EGD3304E	MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS	E	MADRS	4	1	0	2	5.5	7	
9	PEC	PE-4	25EGD3405	SUSTAINABLE DESIGN AND SOCIAL INNOVATION IN ENGINEERING DESIGN	R	SDSIED	3	0	0	0	3	3	
10	PEC	PE-4	25EGD3406	ADVANCED VIBRATIONS	R	AV	3	0	0	0	3	3	
11	PEC	PE-5	25EGD3507	MECHANICS OF COMPOSITE MATERIALS	R	MOCM	3	0	0	0	3	3	
12	PEC	PE-5	25EGD3508	HYBRID AND ELECTRIC VEHICLE DESIGN	R	HEVD	3	0	0	0	3	3	

52. SPECIALIZATION: GAME DEVELOPMENT & UX DESIGN

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25GDU3101	PROGRAMMING FOR GAME DEVELOPMENT	R	PGD	3	0	2	0	4	5	
2	PEC	PE-1	25GDU3101A	PROGRAMMING FOR GAME DEVELOPMENT	A	PGD	4	1	2	0	6	7	
3	PEC	PE-1	25GDU3101E	PROGRAMMING FOR GAME DEVELOPMENT	E	PGD	4	1	2	0	6	7	
4	PEC	PE-2	25GDU3202	UX DESIGN	R	UXD	3	0	0	0	3	3	
5	PEC	PE-3	25GDU3303	AR AND VR APPLICATION DEVELOPMENT	R	AR&VR	3	0	0	2	3.5	5	
6	PEC	PE-3	25GDU3303A	AR AND VR APPLICATION DEVELOPMENT	A	AR&VR	4	1	0	2	5.5	7	
7	PEC	PE-3	25GDU3303E	AR AND VR APPLICATION DEVELOPMENT	E	AR&VR	4	1	0	2	5.5	7	
8	PEC	PE-4	25GDU3404	COMPUTER GRAPHICS	R	CG	3	0	0	0	3	3	
9	PEC	PE-4	25GDU3405	3D MODELLING & ANIMATION	R	3DMA	3	0	0	0	3	3	
10	PEC	PE-5	25GDU3506	PRINCIPLES OF GAME DESIGN	R	PRGD	3	0	0	0	3	3	
11	PEC	PE-5	25GDU3507	BUSINESS OF GAMES & ENTREPRENEURSHIP	R	BGE	3	0	0	0	3	3	

53. SPECIALIZATION: GREEN ENERGY TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25GET3101	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	R	SPMET	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
2	PEC	PE-1	25GET3101A	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	A	SPMET	4	1	2	0	6	7	
3	PEC	PE-1	25GET3101E	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	E	SPMET	4	1	2	0	6	7	
4	PEC	PE-2	25GET3202	WIND AND ENERGY STORAGE TECHNOLOGIES	R	WEST	3	0	0	0	3	3	
5	PEC	PE-2	25GET3203	ENERGY ECONOMICS AND POLICY	R	EEP	3	0	0	0	3	3	
6	PEC	PE-3	25GET3304	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	R	GIRES	3	0	0	2	3.5	5	
7	PEC	PE-3	25GET3304A	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	A	GIRES	4	1	0	2	5.5	7	
8	PEC	PE-3	25GET3304E	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	E	GIRES	4	1	0	2	5.5	7	
9	PEC	PE-4	25GET3405	ENERGY MANAGEMENT AND GREEN BUILDING	R	EMGB	3	0	0	0	3	3	
10	PEC	PE-4	25GET3406	HYDROGEN FUEL CELL TECHNOLOGY	R	HFCT	3	0	0	0	3	3	
11	PEC	PE-5	25GET3507	AI AND IOT FOR GREEN ENERGY INTEGRATION	R	AIGEI	3	0	0	0	3	3	
12	PEC	PE-5	25GET3508	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	R	PERES	3	0	0	0	3	3	

54. SPECIALIZATION: GENERATIVE AI & MACHINE LEARNING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25GAM3101	NATURAL LANGUAGE PROCESSING AND APPLICATIONS	R	NLPA	3	0	2	0	4	5	
2	PEC	PE-1	25GAM3101A	NATURAL LANGUAGE PROCESSING AND APPLICATIONS	A	NLPA	4	1	2	0	6	7	
3	PEC	PE-1	25GAM3101E	NATURAL LANGUAGE PROCESSING AND APPLICATIONS	E	NLPA	4	1	2	0	6	7	
4	PEC	PE-2	25GAM3202	DEEP LEARNING FOR COMPUTER VISION APPLICATIONS	R	DLCVA	3	0	0	0	3	3	
5	PEC	PE-3	25GAM3303	GENERATIVE AI ARCHITECTURES	R	GAA	3	0	0	2	3.5	5	
6	PEC	PE-3	25GAM3303A	GENERATIVE AI ARCHITECTURES	A	GAA	4	1	0	2	5.5	7	
7	PEC	PE-3	25GAM3303E	GENERATIVE AI ARCHITECTURES	E	GAA	4	1	0	2	5.5	7	
8	PEC	PE-4	25GAM3404	DESIGN OF LARGE LANGUAGE MODELS	R	DLLM	3	0	0	0	3	3	
9	PEC	PE-5	25GAM3505	AI PRODUCT DEVELOPMENT AND MANAGEMENT	R	APDM	3	0	0	0	3	3	

55. 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	PEC	PE-1	25HSS3101	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	R	ITHSCD	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
2	PEC	PE-1	25HSS3101A	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	A	ITHSCD	4	1	2	0	6	7	
3	PEC	PE-1	25HSS3101E	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	E	ITHSCD	4	1	2	0	6	7	
4	PEC	PE-2	25HSS3202	FUNDAMENTALS OF COMPUTER SECURITY	R	FOCS	3	0	0	0	3	3	
5	PEC	PE-3	25HSS3303	HARDWARE SECURITY MECHANISMS	R	HSM	3	0	0	2	3.5	5	
6	PEC	PE-3	25HSS3303A	HARDWARE SECURITY MECHANISMS	A	HSM	4	1	0	2	5.5	7	
7	PEC	PE-3	25HSS3303E	HARDWARE SECURITY MECHANISMS	E	HSM	4	1	0	2	5.5	7	
8	PEC	PE-4	25HSS3404	SOFTWARE SECURITY PRINCIPLES	R	SSP	3	0	0	0	3	3	
9	PEC	PE-4	25HSS3405	SECURE CO-DESIGN METHODOLOGIES	R	SCDM	3	0	0	0	3	3	
10	PEC	PE-4	25HSS3406	HARDWARE TROJAN DETECTION AND PREVENTION	R	HTDAP	3	0	0	0	3	3	
11	PEC	PE-5	25HSS3507	SIDE-CHANNEL ATTACKS AND COUNTER MEASURES	R	SCACM	3	0	0	0	3	3	
12	PEC	PE-5	25HSS3508	FORMAL METHODS FOR HARDWARE-SOFTWARE SECURITY	R	FMHSS	3	0	0	0	3	3	
13	PEC	PE-5	25HSS3509	TRUSTED PLATFORM MODULES AND SECURE ELEMENTS	R	TPMASE	3	0	0	0	3	3	
14	PEC	PE-5	25HSS3511	HARDWARE-SOFTWARE CO-DESIGN	R	HSCCS	3	0	0	0	3	3	
15	PEC	PE-5	25HSS3512	FUTURE TRENDS IN HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY	R	FTHSCS	3	0	0	0	3	3	

56. SPECIALIZATION: HEALTHCARE DATA ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25HDA3101	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	R	ISDPDD	3	0	2	0	4	5	
2	PEC	PE-1	25HDA3101A	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	A	ISDPDD	4	1	2	0	6	7	
3	PEC	PE-1	25HDA3101E	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	E	ISDPDD	4	1	2	0	6	7	
4	PEC	PE-2	25HDA3204	PYTHON FOR GENOMIC DATA SCIENCE	R	PFGDS	3	0	0	0	3	3	
5	PEC	PE-2	25HDA3202	BIO MEDICAL INFORMATICS	R	BMI	3	0	0	0	3	3	
6	PEC	PE-2	25HDA3203	GENETIC PROGRAMMING	R	GP	3	0	0	0	3	3	
7	PEC	PE-3	25HDA3305	COMPUTATIONAL NEUROSCIENCE	R	CNSE	3	0	0	2	3.5	5	
8	PEC	PE-3	25HDA3305A	COMPUTATIONAL NEUROSCIENCE	A	CNSE	4	1	0	2	5.5	7	
9	PEC	PE-3	25HDA3305E	COMPUTATIONAL NEUROSCIENCE	E	CNSE	4	1	0	2	5.5	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
10	PEC	PE-4	25HDA3406	NGS SEQUENCING AND DATA ANALYSIS	R	NGSDA	3	0	0	0	3	3	
11	PEC	PE-4	25HDA3407	INTRODUCTION TO GENOMIC TECHNOLOGIES	R	IGT	3	0	0	0	3	3	
12	PEC	PE-5	25HDA3511	EPI GENETIC CONTROL FOR GENE EXPRESSION	R	ECBI	3	0	0	0	3	3	
13	PEC	PE-5	25HDA3510	GENOMIC DATASCIENCE AND CLUSTERING	R	GDSC	3	0	0	0	3	3	
14	PEC	PE-5	25HDA3509	MOLECULAR MODELLING AND DRUG DESIGN	R	MMOD	3	0	0	0	3	3	

57. SPECIALIZATION: INDUSTRIAL AUTOMATION

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25ILA3101	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	R	IIIoT	3	0	2	0	4	5	
2	PEC	PE-1	25ILA3101A	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	A	IIIoT	4	1	2	0	6	7	
3	PEC	PE-1	25ILA3101E	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	E	IIIoT	4	1	2	0	6	7	
4	PEC	PE-2	25ILA3202	INDUSTRIAL AUTOMATION AND ROBOTICS	R	IAR	3	0	0	0	3	3	
5	PEC	PE-2	25ILA3203	EDGE COMPUTING FOR INDUSTRY 4.0	R	ECI	3	0	0	0	3	3	
6	PEC	PE-3	25ILA3304	INDUSTRIAL DRIVES AND CONTROL	R	ID&C	3	0	0	2	3.5	5	
7	PEC	PE-3	25ILA3304A	INDUSTRIAL DRIVES AND CONTROL	A	ID&C	4	1	0	2	5.5	7	
8	PEC	PE-3	25ILA3304E	INDUSTRIAL DRIVES AND CONTROL	E	ID&C	4	1	0	2	5.5	7	
9	PEC	PE-4	25ILA3405	INDUSTRIAL COMMUNICATION PROTOCOLS AND CYBER SECURITY	R	ICPCS	3	0	0	0	3	3	
10	PEC	PE-4	25ILA3406	DIGITAL MANUFACTURING AND DESIGN	R	DMD	3	0	0	0	3	3	
11	PEC	PE-5	25ILA3507	SMART SENSORS AND SENSOR NETWORKING	R	SSSN	3	0	0	0	3	3	
12	PEC	PE-5	25ILA3508	PLC PROGRAMMING AND CONTROL	R	PLCPC	3	0	0	0	3	3	

58. SPECIALIZATION: INDUSTRIAL BIOTECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25IBT3101	PHARMACEUTICAL BIOTECHNOLOGY	R	PBT	3	0	2	0	4	5	
2	PEC	PE-1	25IBT3101A	PHARMACEUTICAL BIOTECHNOLOGY	A	PBT	4	1	2	0	6	7	
3	PEC	PE-1	25IBT3101E	PHARMACEUTICAL BIOTECHNOLOGY	E	PBT	4	1	2	0	6	7	
4	PEC	PE-2	25IBT3202	PHARMACOVIGILANCE AND SAFETY	R	PCS	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	PEC	PE-2	25IBT3203	BIOPROCESS ECONOMICS AND PLANT DESIGN	R	BEPD	3	0	0	0	3	3	
6	PEC	PE-3	25IBT3304	ENZYME ENGINEERING	R	EE	3	0	0	2	3.5	5	
7	PEC	PE-3	25IBT3304A	ENZYME ENGINEERING	A	EE	4	1	0	2	5.5	7	
8	PEC	PE-3	25IBT3304E	ENZYME ENGINEERING	E	EE	4	1	0	2	5.5	7	
9	PEC	PE-4	25IBT3405	BIOPROCESS VALIDATION AND CGMP	R	BVCGMP	3	0	2	0	4	5	
10	PEC	PE-4	25IBT3406	FOOD TECHNOLOGY	R	FT	3	0	0	0	3	3	
11	PEC	PE-5	25IBT3507	MICROBIAL TECHNOLOGY	R	MBT	3	0	0	0	3	3	
12	PEC	PE-5	25IBT3508	METABOLIC ENGINEERING	R	MBE	3	0	0	0	3	3	

59. SPECIALIZATION: IOT ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25IOT3101	INDUSTRIAL INTERNET OF THINGS	R	IIOT	3	0	2	0	4	5	
2	PEC	PE-1	25IOT3101A	INDUSTRIAL INTERNET OF THINGS	A	IIOT	4	1	2	0	6	7	
3	PEC	PE-1	25IOT3101E	INDUSTRIAL INTERNET OF THINGS	E	IIOT	4	1	2	0	6	7	
4	PEC	PE-2	25IOT3202	EDGE COMPUTING	R	EC	3	0	0	0	3	3	
5	PEC	PE-2	25IOT3203	PRECISION AGRICULTURE	R	PA	3	0	0	0	3	3	
6	PEC	PE-2	25IOT3204	SMART FARMING	R	SF	3	0	0	0	3	3	
7	PEC	PE-3	25IOT3305	DEEP LEARNING	R	DL	3	0	0	2	3.5	5	
8	PEC	PE-3	25IOT3305A	DEEP LEARNING	A	DL	4	1	0	2	5.5	7	
9	PEC	PE-3	25IOT3305E	DEEP LEARNING	E	DL	4	1	0	2	5.5	7	
10	PEC	PE-4	25IOT3406	DATA VISUALIZATION TECHNIQUES	R	DVT	3	0	0	0	3	3	
11	PEC	PE-4	25IOT3407	APPLIED MACHINE LEARNING FOR AGRICULTURE	R	AMLA	3	0	0	0	3	3	
12	PEC	PE-5	25IOT3508	BIG DATA ANALYTICS	R	BDA	3	0	0	0	3	3	

60. SPECIALIZATION: MEDICAL BIOTECHNOLOGY

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25MBT3101	STEM CELL TECHNOLOGY	R	SCT	3	0	2	0	4	5	
2	PEC	PE-1	25MBT3101A	STEM CELL TECHNOLOGY	A	SCT	4	1	2	0	6	7	
3	PEC	PE-1	25MBT3101E	STEM CELL TECHNOLOGY	E	SCT	4	1	2	0	6	7	
4	PEC	PE-2	25MBT3203	NANOBIOTECHNOLOGY	R	TE	3	0	0	0	3	3	
5	PEC	PE-2	25MBT3202	VIROLOGY	R	VR	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
6	PEC	PE-3	25MBT3304	HEALTHCARE BIOTECHNOLOGY	R	HBT	3	0	0	2	3.5	5	
7	PEC	PE-3	25MBT3304A	HEALTHCARE BIOTECHNOLOGY	A	HBT	4	1	0	2	5.5	7	
8	PEC	PE-3	25MBT3304E	HEALTHCARE BIOTECHNOLOGY	E	HBT	4	1	0	2	5.5	7	
9	PEC	PE-4	25MBT3406	NEUROBIOLOGY	R	NB	3	0	0	0	3	3	
10	PEC	PE-4	25MBT3405	CANCER BIOLOGY	R	CB	3	0	0	0	3	3	
11	PEC	PE-5	25MBT3508	TISSUE ENGINEERING	R	NBT	3	0	0	0	3	3	
12	PEC	PE-5	25MBT3507	BIOELECTRONICS AND BIOSENSORS	R	BB	3	0	0	0	3	3	

61. SPECIALIZATION: NANO TECHNOLOGY & OPTOELECTRONICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25NTO3102	NANOSCALE ENGINEERING FOR CLEAN ENERGY	R	NEC	3	0	2	0	4	5	
2	PEC	PE-1	25NTO3102A	NANOSCALE ENGINEERING FOR CLEAN ENERGY	A	NEC	4	1	2	0	6	7	
3	PEC	PE-1	25NTO3102E	NANOSCALE ENGINEERING FOR CLEAN ENERGY	E	NEC	4	1	2	0	6	7	
4	PEC	PE-1	25NTO3101	THIN FILM TECHNOLOGIES FOR NANO ELECTRONICS	R	TTN	3	0	2	0	4	5	
5	PEC	PE-1	25NTO3101A	THIN FILM TECHNOLOGIES FOR NANO ELECTRONICS	A	TTN	4	1	2	0	6	7	
6	PEC	PE-1	25NTO3101E	THIN FILM TECHNOLOGIES FOR NANO ELECTRONICS	E	TTN	4	1	2	0	6	7	
7	PEC	PE-2	25NTO3204	NANOPHOTONICS AND BIOPHOTONICS	R	NAB	3	0	0	0	3	3	
8	PEC	PE-2	25NTO3203	NANOTECHNOLOGY AND NANOSENSORS	R	NAN	3	0	0	0	3	3	
9	PEC	PE-3	25NTO3306	NANOROBOTICS FOR ADVANCED APPLICATIONS	R	NAA	3	0	0	2	3.5	5	
10	PEC	PE-3	25NTO3306A	NANOROBOTICS FOR ADVANCED APPLICATIONS	A	NAA	4	1	0	2	5.5	7	
11	PEC	PE-3	25NTO3306E	NANOROBOTICS FOR ADVANCED APPLICATIONS	E	NAA	4	1	0	2	5.5	7	
12	PEC	PE-3	25NTO3305	NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS	R	NBA	3	0	0	2	3.5	5	
13	PEC	PE-3	25NTO3305A	NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS	A	NBA	4	1	0	2	5.5	7	
14	PEC	PE-3	25NTO3305E	NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS	E	NBA	4	1	0	2	5.5	7	
15	PEC	PE-4	25NTO3408	INDUSTRIAL NANOTECHNOLOGY	R	INT	3	0	0	0	3	3	
16	PEC	PE-4	25NTO3407	COMPUTATIONAL DATA SCIENCE FOR NANOTECHNOLOGY	R	CDN	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	25NTO3510	MICRO/NANO FLUIDIC SYSTEMS FOR SENSORS	R	MFS	3	0	0	0	3	3	
18	PEC	PE-5	25NTO3509	BIOSENSING AND BIOELECTRONICS	R	BAB	3	0	0	0	3	3	

62. SPECIALIZATION: ROBOTICS & AUTOMATION

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25RAN3102	ADVANCED ROBOTICS	R	AR	3	0	2	0	4	5	
2	PEC	PE-1	25RAN3102A	ADVANCED ROBOTICS	A	AR	4	1	2	0	6	7	
3	PEC	PE-1	25RAN3102E	ADVANCED ROBOTICS	E	AR	4	1	2	0	6	7	
4	PEC	PE-1	25RAN3101	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	R	RMPDC	3	0	2	0	4	5	
5	PEC	PE-1	25RAN3101A	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	A	RMPDC	4	1	2	0	6	7	
6	PEC	PE-1	25RAN3101E	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	E	RMPDC	4	1	2	0	6	7	
7	PEC	PE-2	25RAN3203	ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS	R	RMWR	3	0	0	0	3	3	
8	PEC	PE-2	25RAN3202	AUTONOMOUS VEHICLES AND AUTOMOTIVE ELECTRONICS	R	AVAE	3	0	0	0	3	3	
9	PEC	PE-3	25RAN3304	AUTONOMOUS MOBILE ROBOT SYSTEMS	R	AMRS	3	0	0	2	3.5	5	
10	PEC	PE-3	25RAN3304A	AUTONOMOUS MOBILE ROBOT SYSTEMS	A	AMRS	4	1	0	2	5.5	7	
11	PEC	PE-3	25RAN3304E	AUTONOMOUS MOBILE ROBOT SYSTEMS	E	AMRS	4	1	0	2	5.5	7	
12	PEC	PE-4	25RAN3406	HUMAN MACHINE INTERFACE AND BRAIN MACHINE INTERFACE	R	HMIBMI	3	0	0	0	3	3	
13	PEC	PE-4	25RAN3405	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	R	AIR	3	0	0	0	3	3	
14	PEC	PE-5	25RAN3507	COMPUTER VISION AND APPLICATIONS	R	CVA	3	0	0	0	3	3	

63. SPECIALIZATION: SMART GRID TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25SGT3101	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	R	DERSG	3	0	2	0	4	5	
2	PEC	PE-1	25SGT3101A	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	A	DERSG	3	1	2	0	5	6	
3	PEC	PE-1	25SGT3101E	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	E	DERSG	4	1	2	0	6	7	
4	PEC	PE-2	25SGT3203	MICROGRID DYNAMICS AND CONTROL	R	MDC	3	0	0	0	3	3	
5	PEC	PE-2	25SGT3202	DISTRIBUTION SYSTEM PRACTICES	R	DSP	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
6	PEC	PE-3	25SGT3304	ENERGY MANAGEMENT SYSTEMS AND SCADA	R	EMS&SCADA	3	0	0	2	3.5	5	
7	PEC	PE-3	25SGT3304A	ENERGY MANAGEMENT SYSTEMS AND SCADA	A	EMS&SCADA	4	1	0	2	5.5	7	
8	PEC	PE-3	25SGT3304E	ENERGY MANAGEMENT SYSTEMS AND SCADA	E	EMS&SCADA	4	1	0	2	5.5	7	
9	PEC	PE-4	25SGT3405	SMART GRID COMMUNICATION AND CYBERSECURITY	R	SGCCS	3	0	0	0	3	3	
10	PEC	PE-4	25SGT3406	SMART METERS AND SMART CITIES	R	SMSC	3	0	0	0	3	3	
11	PEC	PE-5	25SGT3508	SMART GRID PROTECTION	R	SGP	3	0	0	0	3	3	
12	PEC	PE-5	25SGT3507	INTERNET OF THINGS AND SMART GRID ANALYTICS	R	IOT&SGA	3	0	0	0	3	3	

64. SPECIALIZATION: SMART MANUFACTURING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25SMF3101	AI AND IOT IN MANUFACTURING	R	AIM	3	0	2	0	4	5	
2	PEC	PE-1	25SMF3101A	AI AND IOT IN MANUFACTURING	A	AIM	4	1	2	0	6	7	
3	PEC	PE-1	25SMF3101E	AI AND IOT IN MANUFACTURING	E	AIM	4	1	2	0	6	7	
4	PEC	PE-2	25SMF3202	FLEXIBLE MANUFACTURING SYSTEMS	R	FMS	3	0	0	0	3	3	
5	PEC	PE-2	25SMF3203	PRECISION AND MICRO MANUFACTURING	R	PMM	3	0	0	0	3	3	
6	PEC	PE-3	25SMF3304	ADDITIVE AND HYBRID MANUFACTURING	R	AHM	3	0	0	2	3.5	5	
7	PEC	PE-3	25SMF3304A	ADDITIVE AND HYBRID MANUFACTURING	A	AHM	4	1	0	2	5.5	7	
8	PEC	PE-3	25SMF3304E	ADDITIVE AND HYBRID MANUFACTURING	E	AHM	4	1	0	2	5.5	7	
9	PEC	PE-4	25SMF3405	DIGITAL MANUFACTURING	R	DM	3	0	0	0	3	3	
10	PEC	PE-4	25SMF3406	PRECISION INNOVATION & ENTREPRENEURSHIP	R	PIE	3	0	0	0	3	3	
11	PEC	PE-5	25SMF3507	SUSTAINABLE MANUFACTURING	R	SM	3	0	0	0	3	3	
12	PEC	PE-5	25SMF3508	MACHINE TO MACHINE COMMUNICATION	R	MMC	3	0	0	0	3	3	

65. SPECIALIZATION: SOCIAL & DIGITAL MEDIA ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25SDM3101	SENTIMENT ANALYSIS	R	SA	3	0	2	0	4	5	
2	PEC	PE-1	25SDM3101A	SENTIMENT ANALYSIS	A	SA	4	1	2	0	6	7	
3	PEC	PE-1	25SDM3101E	SENTIMENT ANALYSIS	E	SA	4	1	2	0	6	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
4	PEC	PE-2	25SDM3203	META SOCIAL MEDIA ANALYTICS	R	MSMA	3	0	0	0	3	3	
5	PEC	PE-2	25SDM3202	OPINION MINING AND RECOMMENDER SYSTEMS	R	OMRS	3	0	0	0	3	3	
6	PEC	PE-3	25SDM3304	SOCIAL MEDIA MARKETING ANALYTICS	R	SMMA	3	0	0	2	3.5	5	
7	PEC	PE-3	25SDM3304A	SOCIAL MEDIA MARKETING ANALYTICS	A	SMMA	4	1	0	2	5.5	7	
8	PEC	PE-3	25SDM3304E	SOCIAL MEDIA MARKETING ANALYTICS	E	SMMA	4	1	0	2	5.5	7	
9	PEC	PE-4	25SDM3406	ETHICAL SOCIAL MEDIA	R	ESM	3	0	0	0	3	3	
10	PEC	PE-4	25SDM3405	DIGITAL MEDIA ANALYTICS	R	DMA	3	0	0	0	3	3	
11	PEC	PE-5	25SDM3508	SEARCH ENGINE OPTIMIZATION	R	SEO	3	0	0	0	3	3	
12	PEC	PE-5	25SDM3507	INTELLIGENT SOCIAL MEDIA MONITORING SYSTEMS	R	ISMMS	3	0	0	0	3	3	

66. SPECIALIZATION: SOFTWARE MODELLING & DEVOPS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25SMD3101	SOFTWARE VERIFICATION & VALIDATION	R	SVV	3	0	2	0	4	5	
2	PEC	PE-1	25SMD3101A	SOFTWARE VERIFICATION & VALIDATION	A	SVV	4	1	2	0	6	7	
3	PEC	PE-1	25SMD3101E	SOFTWARE VERIFICATION & VALIDATION	E	SVV	4	1	2	0	6	7	
4	PEC	PE-2	25SMD3202	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	R	DPCT	3	0	0	2	3.5	5	
5	PEC	PE-3	25SMD3303	CONTINUOUS DELIVERY & DEVOPS	R	CDD	3	0	0	2	3.5	5	
6	PEC	PE-3	25SMD3303A	CONTINUOUS DELIVERY & DEVOPS	A	CDD	4	1	0	2	5.5	7	
7	PEC	PE-3	25SMD3303E	CONTINUOUS DELIVERY & DEVOPS	E	CDD	4	1	0	2	5.5	7	
8	PEC	PE-4	25SMD3405	SOFTWARE ARCHITECTURE & DESIGN	R	SAD	3	0	0	0	3	3	
9	PEC	PE-4	25SMD3404	SOFTWARE PROJECT MANAGEMENT	R	SPM	3	0	0	0	3	3	
10	PEC	PE-5	25SMD3507	CROSS-PLATFORM USER INTERFACE DESIGN	R	CPUIF	3	0	0	0	3	3	
11	PEC	PE-5	25SMD3506	SOFTWARE RELIABILITY	R	SR	3	0	0	0	3	3	

67. SPECIALIZATION: SPATIAL COMPUTING & IMMERSIVE TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25SCI3101	SPATIAL DATA VISUALIZATION	R	SDV	3	0	2	0	4	5	
2	PEC	PE-1	25SCI3101A	SPATIAL DATA VISUALIZATION	A	SDV	4	1	2	0	6	7	
3	PEC	PE-1	25SCI3101E	SPATIAL DATA VISUALIZATION	E	SDV	4	1	2	0	6	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
4	PEC	PE-2	25SCI3202	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	R	SCMG	3	0	0	0	3	3	
5	PEC	PE-3	25SCI3303	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	R	SCPD	3	0	0	2	3.5	5	
6	PEC	PE-3	25SCI3303A	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	A	SCPD	4	1	0	2	5.5	7	
7	PEC	PE-3	25SCI3303E	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	E	SCPD	4	1	0	2	5.5	7	
8	PEC	PE-4	25SCI3404	SPATIAL AND SOCIAL IMPLICATIONS OF IMMERSIVE TECHNOLOGIES	R	SSIIT	3	0	0	0	3	3	
9	PEC	PE-4	25SCI3405	SPATIAL AUDIO DESIGN FOR GAMES	R	SADG	3	0	0	0	3	3	
10	PEC	PE-5	25SCI3506	SPATIAL USER INTERFACE DESIGN	R	SUID	3	0	0	0	3	3	
11	PEC	PE-5	25SCI3507	INTRODUCTION TO SPATIAL COMPUTING	R	ITSC	3	0	0	0	3	3	

68. SPECIALIZATION: STRUCTURAL ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25STE3101	ADVANCED CONCRETE TECHNOLOGY	R	ACT	3	0	2	0	4	5	
2	PEC	PE-1	25STE3101A	ADVANCED CONCRETE TECHNOLOGY	A	ACT	4	1	2	0	6	7	
3	PEC	PE-1	25STE3101E	ADVANCED CONCRETE TECHNOLOGY	E	ACT	4	1	2	0	6	7	
4	PEC	PE-2	25STE3202	ADVANCED STRUCTURAL ANALYSIS	R	ASA	3	0	0	0	3	3	
5	PEC	PE-3	25STE3303	PRESTRESSED CONCRETE	R	PSC	3	0	0	2	3.5	5	
6	PEC	PE-3	25STE3303A	PRESTRESSED CONCRETE	A	PSC	4	1	0	2	5.5	7	
7	PEC	PE-3	25STE3303E	PRESTRESSED CONCRETE	E	PSC	4	1	0	2	5.5	7	
8	PEC	PE-4	25STE3404	SUSTAINABLE CONSTRUCTION TECHNOLOGY	R	SCT	3	0	0	0	3	3	
9	PEC	PE-5	25STE3505	CONSTRUCTION PLANNING AND SCHEDULING	R	CPS	3	0	0	0	3	3	

69. SPECIALIZATION: VLSI

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25VLS3101	ANALOG VLSI DESIGN	R	AVD	3	0	2	0	4	5	
2	PEC	PE-1	25VLS3101A	ANALOG VLSI DESIGN	A	AVD	4	1	2	0	6	7	
3	PEC	PE-1	25VLS3101E	ANALOG VLSI DESIGN	E	AVD	4	1	2	0	6	7	
4	PEC	PE-2	25VLS3202	TESTING AND VERIFICATION OF VLSI CIRCUITS	R	TVVC	3	0	0	0	3	3	
5	PEC	PE-3	25VLS3303	VLSI PHYSICAL DESIGN AUTOMATION	R	VPDA	3	0	0	2	3.5	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
6	PEC	PE-3	25VLS3303A	VLSI PHYSICAL DESIGN AUTOMATION	A	VPDA	4	1	0	2	5.5	7	
7	PEC	PE-3	25VLS3303E	VLSI PHYSICAL DESIGN AUTOMATION	E	VPDA	4	1	0	2	5.5	7	
8	PEC	PE-4	25VLS3404	MIXED SIGNAL IC DESIGN	R	MSID	3	0	0	0	3	3	
9	PEC	PE-5	25VLS3505	SYSTEM-ON-CHIP	R	SOC	3	0	0	0	3	3	

70. SPECIALIZATION: INFRASTRUCTURE & ENVIRONMENTAL ENGINEERING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25WRE3101	ADVANCED FOUNDATION ENGINEERING	R	AFE	3	0	2	0	4	5	
2	PEC	PE-1	25WRE3101A	ADVANCED FOUNDATION ENGINEERING	A	AFE	4	1	2	0	6	7	
3	PEC	PE-1	25WRE3101E	ADVANCED FOUNDATION ENGINEERING	E	AFE	4	1	2	0	6	7	
4	PEC	PE-2	25WRE3202	INTELLIGENT TRANSPORTATION SYSTEMS	R	ITS	3	0	0	0	3	3	
5	PEC	PE-3	25WRE3303	GROUND IMPROVEMENT TECHNIQUES	R	GIT	3	0	0	2	3.5	5	
6	PEC	PE-3	25WRE3303A	GROUND IMPROVEMENT TECHNIQUES	A	GIT	4	1	0	2	5.5	7	
7	PEC	PE-3	25WRE3303E	GROUND IMPROVEMENT TECHNIQUES	E	GIT	4	1	0	2	5.5	7	
8	PEC	PE-4	25WRE3404	RIVER ENGINEERING	R	REG	3	0	0	0	3	3	
9	PEC	PE-5	25WRE3505	ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSIS	R	EIALCA	3	0	0	0	3	3	

71. SPECIALIZATION: 5G - 6G WIRELESS TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25WLT3101	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	R	4GW	3	0	2	0	4	5	
2	PEC	PE-1	25WLT3101A	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	A	4GW	4	1	2	0	6	7	
3	PEC	PE-1	25WLT3101E	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	E	4GW	4	1	2	0	6	7	
4	PEC	PE-2	25WLT3202	MODERN SATELLITE COMMUNICATION SYSTEMS	R	MSCS	3	0	0	0	3	3	
5	PEC	PE-3	25WLT3303	5G NR-WIRELESS TECHNOLOGIES	R	5GWT	3	0	0	2	3.5	5	
6	PEC	PE-3	25WLT3303A	5G NR-WIRELESS TECHNOLOGIES	A	5GWT	4	1	0	2	5.5	7	
7	PEC	PE-3	25WLT3303E	5G NR-WIRELESS TECHNOLOGIES	E	5GWT	4	1	0	2	5.5	7	
8	PEC	PE-5	25WLT3505	MACHINE LEARNING FOR WIRELESS COMMUNICATION	R	MLWC	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
9	PEC	PE-5	25WLT3404	OPTICAL WIRELESS COMMUNICATIONS	R	OWC	3	0	0	0	3	3	

72. SPECIALIZATION: GENRATIVE AI FOR AGENTIC AND MULTI-MODAL INTELLIGENCE

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25GMI3101	PRINCIPLES OF DEEP NEURAL COMPUTATION	R	PDNC	3	0	2	0	4	5	
2	PEC	PE-1	25GMI3101A	PRINCIPLES OF DEEP NEURAL COMPUTATION	A	PDNC	4	1	2	0	6	7	
3	PEC	PE-1	25GMI3101E	PRINCIPLES OF DEEP NEURAL COMPUTATION	E	PDNC	4	1	2	0	6	7	
4	PEC	PE-2	25GMI3202	ENGINEERING LARGE LANGUAGE MODEL SYSTEMS	R	ELLMS	3	0	0	0	3	3	
5	PEC	PE-3	25GMI3303	REINFORCEMENT LEARNING	R	RL	3	0	0	2	3.5	5	
6	PEC	PE-3	25GMI3303A	REINFORCEMENT LEARNING	A	RL	4	1	0	2	5.5	7	
7	PEC	PE-3	25GMI3303E	REINFORCEMENT LEARNING	E	RL	4	1	0	2	5.5	7	
8	PEC	PE-4	25GMI3404	GENERATIVE AI, AGENTIC AI & RETRIEVAL AUGMENTED GENERATION	R	GAAR	3	0	0	0	3	3	
9	PEC	PE-5	25GMI3505	MULTI-MODAL INTELLIGENCE	R	MMI	3	0	0	0	3	3	

73. SPECIALIZATION: HUMAN-CENTRIC AI SYSTEMS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25HCA3101	MULTI-MODAL INFORMATION PROCESSING	R	MMIP	3	0	2	0	4	5	
2	PEC	PE-1	25HCA3101A	MULTI-MODAL INFORMATION PROCESSING	A	MMIP	4	1	2	0	6	7	
3	PEC	PE-1	25HCA3101E	MULTI-MODAL INFORMATION PROCESSING	E	MMIP	4	1	2	0	6	7	
4	PEC	PE-2	25HCA3202	NATURAL LANGUAGE PROCESSING	R	NLP	3	0	0	0	3	3	
5	PEC	PE-2	25HCA3203	COMPUTER VISION & OBJECT DETECTION	R	CVOD	3	0	0	0	3	3	
6	PEC	PE-2	25HCA3204	COMPUTATIONAL PARALINGUISTICS	R	CPL	3	0	0	0	3	3	
7	PEC	PE-3	25HCA3305	LARGE LANGUAGE MODELS & CONVERSATIONAL AI	R	LLMC	3	0	0	2	3.5	5	
8	PEC	PE-3	25HCA3305A	LARGE LANGUAGE MODELS & CONVERSATIONAL AI	A	LLMC	4	1	0	2	5.5	7	
9	PEC	PE-3	25HCA3305E	LARGE LANGUAGE MODELS & CONVERSATIONAL AI	E	LLMC	4	1	0	2	5.5	7	
10	PEC	PE-3	25HCA3306	IMAGE PROCESSING & SCENE UNDERSTANDING	R	IPSU	3	0	0	2	3.5	5	
11	PEC	PE-3	25HCA3306A	IMAGE PROCESSING & SCENE UNDERSTANDING	A	IPSU	4	1	0	2	5.5	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
12	PEC	PE-3	25HCA3306E	IMAGE PROCESSING & SCENE UNDERSTANDING	E	IPSU	4	1	0	2	5.5	7	
13	PEC	PE-3	25HCA3307	SPEECH PROCESSING	R	SP	3	0	0	2	3.5	5	
14	PEC	PE-3	25HCA3307A	SPEECH PROCESSING	A	SP	4	1	0	2	5.5	7	
15	PEC	PE-3	25HCA3307E	SPEECH PROCESSING	E	SP	4	1	0	2	5.5	7	
16	PEC	PE-4	25HCA3408	VISION TRANSFORMERS & GENERATIVE MODELS FOR VISION	R	VTGM	3	0	0	0	3	3	
17	PEC	PE-5	25HCA3509	AI ETHICS, FAIRNESS & RESPONSIBLE DEPLOYMENT	R	AIFD	3	0	0	0	3	3	
18	PEC	PE-5	25HCA3510	HUMAN-AI INTERACTION & USER-CENTERED DESIGN	R	HAI	3	0	0	0	3	3	

74. SPECIALIZATION: DATA SCIENCE & ENGINEERING FOR AI

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25DSE3101	DATA ANALYTICS & VISUALIZATION	R	DAV	3	0	2	0	4	5	
2	PEC	PE-1	25DSE3101A	DATA ANALYTICS & VISUALIZATION	A	DAV	4	1	2	0	6	7	
3	PEC	PE-1	25DSE3101E	DATA ANALYTICS & VISUALIZATION	E	DAV	4	1	2	0	6	7	
4	PEC	PE-2	25DSE3202	DATA EXPLORATION & PREPARATION	R	DEP	3	0	0	0	3	3	
5	PEC	PE-2	25DSE3203	DATA WAREHOUSING& BUSINESS INTELLIGENCE	R	DWBI	3	0	0	0	3	3	
6	PEC	PE-3	25DSE3304	BIG DATA ENGINEERING	R	BDE	3	0	0	2	3.5	5	
7	PEC	PE-3	25DSE3304A	BIG DATA ENGINEERING	A	BDE	4	1	0	2	5.5	7	
8	PEC	PE-3	25DSE3304E	BIG DATA ENGINEERING	E	BDE	4	1	0	2	5.5	7	
9	PEC	PE-3	25DSE3305	BUSINESS ANALYTICS	R	BA	3	0	0	2	3.5	5	
10	PEC	PE-3	25DSE3305A	BUSINESS ANALYTICS	A	BA	4	1	0	2	5.5	7	
11	PEC	PE-3	25DSE3305E	BUSINESS ANALYTICS	E	BA	4	1	0	2	5.5	7	
12	PEC	PE-4	25DSE3406	AI-DRIVEN DATA ENGINEERING	R	AIDE	3	0	0	0	3	3	
13	PEC	PE-4	25DSE3407	DATA GOVERNANCE ON CLOUD	R	DGC	3	0	0	0	3	3	
14	PEC	PE-5	25DSE3508	DATA ANALYTICS ON CLOUD	R	DAC	3	0	0	0	3	3	
15	PEC	PE-5	25DSE3509	GRAPH & WEB ANALYTICS	R	GWA	3	0	0	0	3	3	

75. SPECIALIZATION: DATA LAKE SYSTEMS & STREAMING ANALYTICS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25DLS3101	STREAMING DATA ARCHITECTURES & FRAMEWORKS	R	SDAF	3	0	2	0	4	5	
2	PEC	PE-1	25DLS3101A	STREAMING DATA ARCHITECTURES & FRAMEWORKS	A	SDAF	4	1	2	0	6	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
3	PEC	PE-1	25DLS3101E	STREAMING DATA ARCHITECTURES & FRAMEWORKS	E	SDAF	4	1	2	0	6	7	
4	PEC	PE-2	25DLS3202	DESIGNING REAL-TIME DATA PIPELINES	R	RTDP	3	0	0	0	3	3	
5	PEC	PE-3	25DLS3303	DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS	R	DLSS	3	0	0	2	3.5	5	
6	PEC	PE-3	25DLS3303A	DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS	A	DLSS	4	1	0	2	5.5	7	
7	PEC	PE-3	25DLS3303E	DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS	E	DLSS	4	1	0	2	5.5	7	
8	PEC	PE-4	25DLS3404	REAL-TIME ANALYTICS & COMPLEX EVENT PROCESSING	R	RTAC	3	0	0	0	3	3	
9	PEC	PE-5	25DLS3505	STREAMING ANALYTICS FOR IOT AND EDGE ENVIRONMENTS	R	SAIE	3	0	0	0	3	3	

76. SPECIALIZATION: CLOUD NATIVE APPLICATION ENGINEERING & DEVOPS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CND3101	CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION	R	CNAD	3	0	2	0	4	5	
2	PEC	PE-1	25CND3101A	CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION	A	CNAD	4	1	2	0	6	7	
3	PEC	PE-1	25CND3101E	CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION	E	CNAD	4	1	2	0	6	7	
4	PEC	PE-2	25CND3202	CLOUD-NATIVE ARCHITECTURE & INFRASTRUCTURE AS CODE	R	CNAI	3	0	0	0	3	3	
5	PEC	PE-3	25CND3303	ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING	R	DORS	3	0	0	2	3.5	5	
6	PEC	PE-3	25CND3303A	ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING	A	DORS	4	1	0	2	5.5	7	
7	PEC	PE-3	25CND3303E	ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING	E	DORS	4	1	0	2	5.5	7	
8	PEC	PE-4	25CND3404	CLOUD-NATIVE MLOPS & A1-DRIVEN APPLICATION DEPLOYMENT	R	CNMA	3	0	0	0	3	3	
9	PEC	PE-5	25CND3505	HIGH-PERFORMANCE & SECURE CLOUD-NATIVE SYSTEMS	R	HPCS	3	0	0	0	3	3	

77. SPECIALIZATION: AI DRIVEN EDGE COMPUTING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25AEC3101	EDGE AI HARDWARE ARCHITECTURES & ACCELERATION	R	EHA	3	0	2	0	4	5	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
2	PEC	PE-1	25AEC3101A	EDGE AI HARDWARE ARCHITECTURES & ACCELERATION	A	EHA	4	1	2	0	6	7	
3	PEC	PE-1	25AEC3101E	EDGE AI HARDWARE ARCHITECTURES & ACCELERATION	E	EHA	4	1	2	0	6	7	
4	PEC	PE-2	25AEC3202	SECURE & SCALABLE EDGE AI NETWORKING	R	SEAN	3	0	0	0	3	3	
5	PEC	PE-3	25AEC3303	SERVICE MESH & OBSERVABILITY FOR EDGE AI	R	SMOA	3	0	0	2	3.5	5	
6	PEC	PE-3	25AEC3303A	SERVICE MESH & OBSERVABILITY FOR EDGE AI	A	SMOA	4	1	0	2	5.5	7	
7	PEC	PE-3	25AEC3303E	SERVICE MESH & OBSERVABILITY FOR EDGE AI	E	SMOA	4	1	0	2	5.5	7	
8	PEC	PE-4	25AEC3404	SERVERLESS & COST-OPTIMIZED AI AT THE EDGE	R	SCAE	3	0	0	0	3	3	
9	PEC	PE-5	25AEC3505	EDGE AI ORCHESTRATION & LIFECYCLE MANAGEMENT	R	EAOM	3	0	0	0	3	3	

78. SPECIALIZATION: CLOUD AI & ACCELERATED COMPUTING

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CAC3101	GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC	R	GPAH	3	0	2	0	4	5	
2	PEC	PE-1	25CAC3101A	GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC	A	GPAH	4	1	2	0	6	7	
3	PEC	PE-1	25CAC3101E	GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC	E	GPAH	4	1	2	0	6	7	
4	PEC	PE-2	25CAC3202	PARALLEL & FUNCTIONAL PROGRAMMING FOR SCIENTIFIC APPLICATIONS	R	PFPS	3	0	0	0	3	3	
5	PEC	PE-3	25CAC3303	ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION	R	ACHA	3	0	0	2	3.5	5	
6	PEC	PE-3	25CAC3303A	ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION	A	ACHA	4	1	0	2	5.5	7	
7	PEC	PE-3	25CAC3303E	ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION	E	ACHA	4	1	0	2	5.5	7	
8	PEC	PE-3	25CAC3304	QUANTUM PROGRAMMING FUNDAMENTALS	R	QPF	3	0	0	2	3.5	5	
9	PEC	PE-3	25CAC3304A	QUANTUM PROGRAMMING FUNDAMENTALS	A	QPF	4	1	0	2	5.5	7	
10	PEC	PE-3	25CAC3304E	QUANTUM PROGRAMMING FUNDAMENTALS	E	QPF	4	1	0	2	5.5	7	
11	PEC	PE-4	25CAC3405	CLOUD ARCHITECTURES FOR HPC & AI WORKLOADS	R	CHAW	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
12	PEC	PE-4	25CAC3406	QUANTUM ALGORITHMS FOR AI & OPTIMIZATION	R	QAAO	3	0	0	0	3	3	
13	PEC	PE-5	25CAC3507	MLOPS & SCIENTIFIC WORKFLOW AUTOMATION IN CLOUD	R	MSWC	3	0	0	0	3	3	
14	PEC	PE-5	25CAC3508	HYBRID QUANTUM-CLASSICAL CLOUD SYSTEMS	R	HQCC	3	0	0	0	3	3	

79. SPECIALIZATION: CYBER THREAT INTELLIGENCE AND SECURITY OPERATIONS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25CTI3101	DIGITAL FORENSICS & INCIDENT RESPONSE	R	DFIR	3	0	2	0	4	5	
2	PEC	PE-1	25CTI3101A	DIGITAL FORENSICS & INCIDENT RESPONSE	A	DFIR	4	1	2	0	6	7	
3	PEC	PE-1	25CTI3101E	DIGITAL FORENSICS & INCIDENT RESPONSE	E	DFIR	4	1	2	0	6	7	
4	PEC	PE-1	25CTI3102	MALWARE ANALYSIS & REVERSE ENGINEERING	R	MARE	3	0	2	0	4	5	
5	PEC	PE-1	25CTI3102A	MALWARE ANALYSIS & REVERSE ENGINEERING	A	MARE	4	1	2	0	6	7	
6	PEC	PE-1	25CTI3102E	MALWARE ANALYSIS & REVERSE ENGINEERING	E	MARE	4	1	2	0	6	7	
7	PEC	PE-2	25CTI3203	ETHICAL HACKING & OFFENSIVE SECURITY	R	EHOS	3	0	0	0	3	3	
8	PEC	PE-2	25CTI3204	VULNERABILITY ASSESSMENT & PENETRATION TESTING	R	VAPT	3	0	0	0	3	3	
9	PEC	PE-3	25CTI3305	BLUE TEAM OPERATIONS & SIEM	R	BTOS	3	0	0	2	3.5	5	
10	PEC	PE-3	25CTI3305A	BLUE TEAM OPERATIONS & SIEM	A	BTOS	4	1	0	2	5.5	7	
11	PEC	PE-3	25CTI3305E	BLUE TEAM OPERATIONS & SIEM	E	BTOS	4	1	0	2	5.5	7	
12	PEC	PE-3	25CTI3306	SOC MANAGEMENT	R	SOC	3	0	0	2	3.5	5	
13	PEC	PE-3	25CTI3306A	SOC MANAGEMENT	A	SOC	4	1	0	2	5.5	7	
14	PEC	PE-3	25CTI3306E	SOC MANAGEMENT	E	SOC	4	1	0	2	5.5	7	
15	PEC	PE-4	25CTI3407	CLOUD SECURITY	R	CS	3	0	0	0	3	3	
16	PEC	PE-4	25CTI3408	DEVSECOPS & INFRASTRUCTURE SECURITY	R	DSI	3	0	0	0	3	3	
17	PEC	PE-5	25CTI3509	QUANTUM CRYPTOGRAPHY & POST-QUANTUM SECURITY	R	QCPS	3	0	0	0	3	3	
18	PEC	PE-5	25CTI3510	APPLIED CRYPTOGRAPHY FOR CYBERSECURITY	R	ACC	3	0	0	0	3	3	

80. SPECIALIZATION: INTELLIGENT GAME DEVELOPMENT & IMMERSIVE TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25IGD3101	GAME DEVELOPMENT WITH UNREAL ENGINE (C++)	R	GDUE	3	0	2	0	4	5	
2	PEC	PE-1	25IGD3101A	GAME DEVELOPMENT WITH UNREAL ENGINE (C++)	A	GDUE	4	1	2	0	6	7	
3	PEC	PE-1	25IGD3101E	GAME DEVELOPMENT WITH UNREAL ENGINE (C++)	E	GDUE	4	1	2	0	6	7	
4	PEC	PE-1	25IGD3102	GAME DEVELOPMENT WITH UNITY ENGINE (C#)	R	GDUN	3	0	2	0	4	5	
5	PEC	PE-1	25IGD3102A	GAME DEVELOPMENT WITH UNITY ENGINE (C#)	A	GDUN	4	1	2	0	6	7	
6	PEC	PE-1	25IGD3102E	GAME DEVELOPMENT WITH UNITY ENGINE (C#)	E	GDUN	4	1	2	0	6	7	
7	PEC	PE-2	25IGD3203	MULTIPLAYER GAME DEVELOPMENT AND NETWORKING	R	MGDN	3	0	0	0	3	3	
8	PEC	PE-2	25IGD3204	GAME DEVOPS AND CLOUD DEPLOYMENT	R	GDCD	3	0	0	0	3	3	
9	PEC	PE-3	25IGD3305	3D GAME PROGRAMMING AND PHYSICS SIMULATION	R	3DPS	3	0	0	2	3.5	5	
10	PEC	PE-3	25IGD3305A	3D GAME PROGRAMMING AND PHYSICS SIMULATION	A	3DPS	4	1	0	2	5.5	7	
11	PEC	PE-3	25IGD3305E	3D GAME PROGRAMMING AND PHYSICS SIMULATION	E	3DPS	4	1	0	2	5.5	7	
12	PEC	PE-3	25IGD3306	PROCEDURAL WORLD BUILDING	R	PWB	3	0	0	2	3.5	5	
13	PEC	PE-3	25IGD3306A	PROCEDURAL WORLD BUILDING	A	PWB	4	1	0	2	5.5	7	
14	PEC	PE-3	25IGD3306E	PROCEDURAL WORLD BUILDING	E	PWB	4	1	0	2	5.5	7	
15	PEC	PE-4	25IGD3407	IMMERSIVE GAME DEVELOPMENT	R	IGD	3	0	0	0	3	3	
16	PEC	PE-4	25IGD3408	SPATIAL COMPUTING FOR INTERACTIVE SYSTEMS	R	SCIS	3	0	0	0	3	3	
17	PEC	PE-5	25IGD3509	GAME AI AND AUTONOMOUS AGENTS	R	GAIA	3	0	0	0	3	3	
18	PEC	PE-5	25IGD3510	GENERATIVE AI IN GAME DESIGN	R	GAID	3	0	0	0	3	3	

81. SPECIALIZATION: GREEN & SUSTAINABLE DIGITAL SYSTEMS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25GSD3101	GREEN SOFTWARE ENGINEERING	R	GSE	3	0	2	0	4	5	
2	PEC	PE-1	25GSD3101A	GREEN SOFTWARE ENGINEERING	A	GSE	4	1	2	0	6	7	
3	PEC	PE-1	25GSD3101E	GREEN SOFTWARE ENGINEERING	E	GSE	4	1	2	0	6	7	
4	PEC	PE-2	25GSD3202	GREEN ALGORITHMS AND SUSTAINABLE APP DESIGN	R	GAD	3	0	0	0	3	3	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
5	PEC	PE-3	25GSD3303	SUSTAINABLE CLOUD AND EDGE COMPUTING	R	SCE	3	0	0	2	3.5	5	
6	PEC	PE-3	25GSD3303A	SUSTAINABLE CLOUD AND EDGE COMPUTING	A	SCE	4	1	0	2	5.5	7	
7	PEC	PE-3	25GSD3303E	SUSTAINABLE CLOUD AND EDGE COMPUTING	E	SCE	4	1	0	2	5.5	7	
8	PEC	PE-4	25GSD3404	HARDWARE FOR SUSTAINABLE DIGITAL INFRASTRUCTURE	R	HSDI	3	0	0	0	3	3	
9	PEC	PE-5	25GSD3505	SMART INFRASTRUCTURE FOR GREEN DATA CENTERS	R	SIGD	3	0	0	0	3	3	

82. SPECIALIZATION: BIO-MEDICAL INSTRUMENTATION

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25BMI3101	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	R	BSIP	3	0	2	0	4	5	
2	PEC	PE-1	25BMI3101A	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	A	BSIP	4	1	2	0	6	7	
3	PEC	PE-1	25BMI3101E	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	E	BSIP	4	1	2	0	6	7	
4	PEC	PE-2	25BMI3202	ADVANCED BIOMEDICAL SIGNAL PROCESSING	R	ABSP	3	0	0	0	3	3	
5	PEC	PE-3	25BMI3303	MATERIALS FOR BIO-MEDICAL APPLICATIONS	R	MBMA	3	0	0	2	3.5	5	
6	PEC	PE-3	25BMI3303A	MATERIALS FOR BIO-MEDICAL APPLICATIONS	A	MBMA	4	1	0	2	5.5	7	
7	PEC	PE-3	25BMI3303E	MATERIALS FOR BIO-MEDICAL APPLICATIONS	E	MBMA	4	1	0	2	5.5	7	
8	PEC	PE-4	25BMI3404	NANOTECHNOLOGY AND NANOSENSORS	R	NTN	3	0	0	0	3	3	
9	PEC	PE-5	25BMI3505	BIOSENSING AND BIOELECTRONICS	R	BSBE	3	0	0	0	3	3	

83. SPECIALIZATION: RF & MICROWAVE

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25RFM3101	MICROWAVE ENGINEERING	R	ME	3	0	2	0	4	5	
2	PEC	PE-1	25RFM3101A	MICROWAVE ENGINEERING	A	ME	4	1	2	0	6	7	
3	PEC	PE-1	25RFM3101E	MICROWAVE ENGINEERING	E	ME	4	1	2	0	6	7	
4	PEC	PE-2	25RFM3202	ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS	R	AADW	3	0	0	0	3	3	
5	PEC	PE-3	25RFM3303	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	R	MRSN	3	0	0	2	3.5	5	
6	PEC	PE-3	25RFM3303A	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	A	MRSN	4	1	0	2	5.5	7	
7	PEC	PE-3	25RFM3303E	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	E	MRSN	4	1	0	2	5.5	7	

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
8	PEC	PE-4	25RFM3404	RF AND MILLIMETER-WAVE CIRCUIT DESIGN	R	RMWCD	3	0	0	0	3	3	
9	PEC	PE-5	25RFM3505	SATELLITE DESIGN	R	SD	3	0	0	0	3	3	

84. SPECIALIZATION: QUANTUM COMMUNICATIONS

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25QCS3101	QUANTUM HARDWARE AND CONTROL SYSTEMS	R	QHCS	3	0	2	0	4	5	
2	PEC	PE-1	25QCS3101A	QUANTUM HARDWARE AND CONTROL SYSTEMS	A	QHCS	4	1	2	0	6	7	
3	PEC	PE-1	25QCS3101E	QUANTUM HARDWARE AND CONTROL SYSTEMS	E	QHCS	4	1	2	0	6	7	
4	PEC	PE-2	25QCS3202	QUANTUM OPTICS	R	QO	3	0	0	0	3	3	
5	PEC	PE-3	25QCS3303	QUANTUM SENSING	R	QS	3	0	0	2	3.5	5	
6	PEC	PE-3	25QCS3303A	QUANTUM SENSING	A	QS	4	1	0	2	5.5	7	
7	PEC	PE-3	25QCS3303E	QUANTUM SENSING	E	QS	4	1	0	2	5.5	7	
8	PEC	PE-4	25QCS3404	QUANTUM RADAR	R	QR	3	0	0	0	3	3	
9	PEC	PE-5	25QCS3506	QUANTUM INFORMATION THEORY	R	QIT	3	0	0	0	3	3	
10	PEC	PE-5	25QCS3505	QUANTUM SATELLITE COMMUNICATIONS	R	QSC	3	0	0	0	3	3	

85. SPECIALIZATION: QUANTUM TECHNOLOGIES

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PEC	PE-1	25QTS3101	QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE	R	QCCAFT	3	0	2	0	4	5	
2	PEC	PE-1	25QTS3101A	QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE	A	QCCAFT	4	1	2	0	6	7	
3	PEC	PE-1	25QTS3101E	QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE	E	QCCAFT	4	1	2	0	6	7	
4	PEC	PE-2	25QTS3202	QUANTUM CRYPTOGRAPHY & QUANTUM COMMUNICATION	R	QCQC	3	0	0	0	3	3	
5	PEC	PE-3	25QTS3303	QUANTUM SENSING & METROLOGY	R	QSM	3	0	0	2	3.5	5	
6	PEC	PE-3	25QTS3303A	QUANTUM SENSING & METROLOGY	A	QSM	4	1	0	2	5.5	7	
7	PEC	PE-3	25QTS3303E	QUANTUM SENSING & METROLOGY	E	QSM	4	1	0	2	5.5	7	
8	PEC	PE-4	25QTS3404	QUANTUM MATERIALS & TOPOLOGICAL MATTER	R	QMTM	3	0	0	0	3	3	
9	PEC	PE-5	25QTS3505	QUANTUM AI & MACHINE LEARNING	R	QAIML	3	0	0	0	3	3	

86. PROJECT: RESEARCH PROJECT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PRI	PRI-CORE	25IE4057	RESEARCH PROJECT-1	R	RP-1	0	0	8	16	8	12	
2	PRI	PRI-CORE	25IE4058	RESEARCH PROJECT-2	R	RP-2	0	0	8	16	8	12	

87. PROJECT: INNOVATION PROJECT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PRI	PRI-CORE	25IE4055	INNOVATION PROJECT-1	R	IP-1	0	0	8	16	8	12	
2	PRI	PRI-CORE	25IE4056	INNOVATION PROJECT-2	R	IP-2	0	0	8	16	8	12	

88. PROJECT: CAPSTONE PROJECT

S#	Cat	Sub-Cat	CourseCode	Course Title	Mode	Acrym	L	T	P	S	CR	CH	Pre-req
1	PRI	PRI-CORE	25IE4053	ENGINEERING CAPSTONE PROJECT - 1	R	ECP-1	0	0	8	16	8	12	
2	PRI	PRI-CORE	25IE4054	ENGINEERING CAPSTONE PROJECT - 2	R	ECP-2	0	0	8	16	8	12	

Program Articulation Matrix

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1	HAS	25FL3054 - 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	25FL3054 - FLG	CO2	Classify questions and respond in the affirmative or negative with ?tre and avoir and form plurals						2				2			
3	HAS	25FL3054 - FLG	CO3	Utilize and apply the adjectives and essential verbs.								3		3			
4	HAS	25FL3054 - FLG	CO4	Construct and use in speech, vocabulary, reading, questions and answers								3			3		
5	HAS	25FL3055 - 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	25FL3055 - 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	25FL3055 - GLG	CO3	Utilize their understanding with suitable prepositions, questions, and possessive pronouns, and the importance of four German cases. Prepositions in Akkusativ and Dativ										3			
8	HAS	25FL3055 - 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.								3			3		

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
9	HAS	25FL3058 - JLG	CO1	Classify Hiragana, Katakana, and basic Kanji characters used in greetings and simple scripts					2			2					
10	HAS	25FL3058 - 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	25FL3058 - 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								3		3			
12	HAS	25FL3058 - 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								3			3		
13	HAS	25FL3064 - KLG	CO1	Understanding of key features of Korean, Introduction to Hangul, Everyday greetings & expressions			2					2					
14	HAS	25FL3064 - KLG	CO2	Learning of important grammar particles & Parts of speeches			3					3					
15	HAS	25FL3064 - KLG	CO3	Verbs, Adjectives & additional vocabularies for daily life conversation			3							3			
16	HAS	25FL3064 - KLG	CO4	Sentence formation & Different aspects of tenses		3							3				
17	HAS	25MB4053 - MPF	CO1	Understanding Personal Finance	2												
18	HAS	25MB4053 - MPF	CO2	Applying and Building a Budget and Tracking Your Money		3											

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
19	HAS	25MB4053 - MPF	CO3	Applying and Managing Debt and Credit in present context			3										
20	HAS	25MB4053 - MPF	CO4	Applying Saving and Investment to present scenario			3										
21	HAS	25MB4054 - BME	CO1	Understand the basic concepts of marketing management						2							
22	HAS	25MB4054 - BME	CO2	Understand the concepts of Marketing environment, consumer behaviour and Segmentation, Targeting and Positioning (STP)						2							
23	HAS	25MB4054 - BME	CO3	Apply the marketing mix strategies with special focus on technology products			3										
24	HAS	25MB4054 - BME	CO4	Apply promotion and distribution strategies for marketing of high tech products and services			3										
25	HAS	25MB4055 - OMG	CO1	Remember and understand the various management theories and management approaches.	2								2				
26	HAS	25MB4055 - OMG	CO2	Remember and understand organization theories, structures and organization principles.	2								2				
27	HAS	25MB4055 - 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								2				
28	HAS	25MB4055 - OMG	CO4	Remember and understand the various issues in industrial relations, trade unions and college bargaining and industrial safety.	2								2				
29	HAS	25MB4056 - PMT	CO1	Understand the basic management concepts along with an insight into levels of management									2				

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
30	HAS	25MB4056 - PMT	CO2	Understand the key contributions of classical approach to Management											2		
31	HAS	25MB4056 - PMT	CO3	Understand and apply Quantitative methods to improve Management performance.									3				
32	HAS	25MB4056 - PMT	CO4	Understand the key contributions of Behavioural and contemporary approaches to Management.									3				
33	HAS	25MB4058 - SSYB	CO1	Six sigma principalsSix Sigma Foundations, Principles, Roles and Responsibilities			3	3									
34	HAS	25MB4058 - SSYB	CO2	Quality Tools and Six Sigma Metrics			3		3								
35	HAS	25MB4058 - SSYB	CO3	Six Sigma Principles			3	3									
36	HAS	25MB4058 - SSYB	CO4	Six Sigma Principles and practice					3								
37	HAS	25MB4060 - FINT	CO1	Understanding the comprehension of finance functions and diverse business models to facilitate informed decision-making processes within financial management		2											
38	HAS	25MB4060 - FINT	CO2	Analyzing the investment decisions through an understanding of capital budgeting techniques, both traditional and modern, emphasizing long-term implications.				3									
39	HAS	25MB4060 - FINT	CO3	Analyze and make informed decisions regarding working capital management, considering the short-term financial health of organizations through practical case studies.				3									
40	HAS	25MB4060 - FINT	CO4	Developing proficiency in comprehending and utilizing various sources of finance while discerning the implications of different dividend policies in practical financial scenarios.				3									

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41	HAS	25MB4067 - IMPP	CO1	Understand the basic management concepts along with an insight into production and control											1		1
42	HAS	25MB4067 - IMPP	CO2	Utilize time series and regression techniques for accurate demand prediction and production planning	2												2
43	HAS	25MB4067 - IMPP	CO3	Schedule batch and job order production to optimize resource use and efficiency				2								2	
44	HAS	25MB4067 - IMPP	CO4	Apply method study techniques to analyze and improve work processes systematically											2		2
45	HAS	25MB4068 - FMFE	CO1	Understanding the comprehension of finance functions and diverse business models to facilitate informed decision-making processes within financial management		2											
46	HAS	25MB4068 - FMFE	CO2	Analyzing the investment decisions through an understanding of capital budgeting techniques, both traditional and modern, emphasizing long-term implications.				3									
47	HAS	25MB4068 - FMFE	CO3	Analyze and make informed decisions regarding working capital management, considering the short-term financial health of organizations through practical case studies.				3									
48	HAS	25MB4068 - FMFE	CO4	Developing proficiency in comprehending and utilizing various sources of finance while discerning the implications of different dividend policies in practical financial scenarios.				3									
49	HAS	25MB4070 - SLSI	CO1	Understand the fundamental concepts of sustainability and the role of leadership in driving sustainable practices	2					2							

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50	HAS	25MB4070 - SLSI	CO2	Analyze the strategic implications of sustainability in business and policymaking				3		3					3		
51	HAS	25MB4070 - SLSI	CO3	Evaluate sustainable business models and leadership frameworks for long-term impact			3				3						
52	HAS	25MB4070 - SLSI	CO4	Develop strategic solutions and leadership approaches to address real-world sustainability challenges				3					3	3			
53	HAS	25MB4071 - RSQM	CO1	Interpreting the basic systems of manpower and materials management	2		2	2									
54	HAS	25MB4071 - RSQM	CO2	Explaining the basic systems of machinery management			2	2									
55	HAS	25MB4071 - RSQM	CO3	Classify the basic systems of safety management	2		2	2									
56	HAS	25MB4071 - RSQM	CO4	Understand the basic systems of quality management	2		2	2									
57	HAS	25MB4072 - IPTBF	CO1	Explain investment concepts, risk - return trade-off, and factors influencing required rate of return.	2	2											
58	HAS	25MB4072 - IPTBF	CO2	Apply fundamental and technical analysis to evaluate securities, industries, and firms.	3				3								
59	HAS	25MB4072 - IPTBF	CO3	Construct and analyze portfolios using CAPM, APT, and modern portfolio theories.			3					3					
60	HAS	25MB4072 - IPTBF	CO4	Evaluate portfolio performance using risk-adjusted performance measures and selection models.						3				3			
61	HAS	25MB4073 - IM	CO1	Develop value proposition for the problem identified	2	3											
62	HAS	25MB4073 - IM	CO2	Build MVP for the solution developed			3			2							

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63	HAS	25MB4073 - IM	CO3	Devise go to market strategy				2	3								
64	HAS	25MB4073 - IM	CO4	Create a Pitch-deck with funding strategy							1	2					
65	HAS	25MB4231 - DMK	CO1	Outline the key concepts of digital marketing.	2												
66	HAS	25MB4231 - DMK	CO2	Apply SEO to a website.	3												
67	HAS	25MB4231 - DMK	CO3	Use the key PPC concepts to draw visitors to a business websites		3											
68	HAS	25MB4231 - DMK	CO4	Analyze Campaign Management to manage the marketing concepts		3											
69	HAS	25MB4231 - DMK	CO5	Analyze digital marketing strategies		3											
70	HAS	25UC0021 - SIL-1	CO1	Apply effective communication and collaboration skills to work with diverse populations in addressing social issues within the community								3	3				
71	HAS	25UC0021 - SIL-1	CO2	Build technological solutions to real-world problems or challenges with peers to achieve common goals.								3	3				
72	HAS	25UC0021 - SIL-1	CO3	Plan effectively to communicate ideas and collaborate with others to achieve artistic or recreational goals.				3									
73	HAS	25UC0021 - SIL-1	CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment				3							3		
74	HAS	25UC0021 - SIL-1	CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences.			3								3		

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75	HAS	25UC0022 - SIL-2	CO1	Apply effective communication and collaboration skills to work with diverse populations in addressing social issues within the community		3						3	3				
76	HAS	25UC0022 - SIL-2	CO2	Build technological solutions to real-world problems or challenges with peers to achieve common goals		3						3	3				
77	HAS	25UC0022 - SIL-2	CO3	Plan effectively to communicate ideas and collaborate with others to achieve artistic or recreational goals.		3						3	3				
78	HAS	25UC0022 - SIL-2	CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment		3						3	3				
79	HAS	25UC0022 - SIL-2	CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences		3						3	3				
80	HAS	25UC0026 - UHV	CO1	Understanding the basic concepts of value education								2	2				
81	HAS	25UC0026 - UHV	CO2	Gain basic understanding of principles in harmony among human beings								2	2				
82	HAS	25UC0026 - UHV	CO3	Gain knowledge in the concept of Harmony in the family and society								3	3				
83	HAS	25UC0026 - UHV	CO4	Acquire knowledge in the concepts of harmony in the nature								3	3				
84	HAS	25UC1102 - LSE	CO1	Understand the essential listening, speaking, and reading skills, preparing them form effective communication in various personal and professional contexts.										2			

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85	HAS	25UC1102 - LSE	CO2	Apply essential writing and non-verbal communication skills, preparing them for effective written and non-verbal interactions in various personal and professional										3			
86	HAS	25UC1203 - DTI	CO1	Understand the importance of Design thinking mindset for identifying contextualized		2											
87	HAS	25UC1203 - DTI	CO2	Analyze the problem statement by empathizing with user							3						
88	HAS	25UC1203 - DTI	CO3	Develop ideation and test the prototypes made			3										
89	HAS	25UC1203 - DTI	CO4	Explore the fundamentals of entrepreneurship skills for transforming the challenge											3		
90	HAS	25UC1204 - CSE	CO1	Understand the essential career skills, including resume writing, interview techniques, group discussions, and exploring career opportunities, preparing them for successful career advancement									3	3			
91	HAS	25UC1204 - CSE	CO2	Apply a comprehensive understanding of essential team skills, preparing them for successful collaboration and contribution in professional team environments.									3	3			
92	BSC	25CY1001 - SCE2	CO1	Apply the operation of electrochemical systems to produce electric energy and stored devices.	3	3											
93	BSC	25CY1001 - SCE2	CO2	Use the fundamental aspects of electrochemistry and materials science relevant to corrosion phenomena.	3	3											
94	BSC	25CY1001 - SCE2	CO3	Examine water quality and apply appropriate purification technique for intended problem.	3	3											

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95	BSC	25CY1001 - SCE2	CO4	Employ the fundamental principles and general properties of materials in various engineering applications.	3	3											
96	BSC	25CY1001 - SCE2	CO5	Analyze the data, develop skills in chemical analysis and their application in engineering.	3						3						
97	BSC	25ME2105 - MMS	CO1	Understand crystallography and various material testing methods	1	1										1	
98	BSC	25ME2105 - MMS	CO2	Understand and distinguish various types of materials based on their engineering applications	1	1										1	
99	BSC	25ME2105 - MMS	CO3	Apply the concepts of cooling curves and phase diagrams	2	2										2	
100	BSC	25ME2105 - MMS	CO4	Apply the concepts of heat treatment processes and their strengthening mechanisms	2	2										2	
101	BSC	25ME2105 - MMS	CO5	Apply practical knowledge and skills in conducting a wide range of experiments on metallography and heat treatment processes, gaining hands-on experience	2	2										2	
102	BSC	25MT1001 - LCE	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												
103	BSC	25MT1001 - LCE	CO2	Apply multivariate differential calculus to find maxima & minima of functions and understand the concepts of second order differential equations and its applications.	3												
104	BSC	25MT1001 - LCE	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												

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105	BSC	25MT1001 - LCE	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												
106	BSC	25MT2003 - MNMM	CO1	Apply difference equations to model and solve real life problems.	3		3										
107	BSC	25MT2003 - MNMM	CO2	Apply method of least squares for the best fitting linear and nonlinear models.	3		3										
108	BSC	25MT2003 - MNMM	CO3	Apply simulation modeling to Interpret real life problems.	3		3										
109	BSC	25MT2003 - MNMM	CO4	Apply mathematical modelling through differential equations	3		3										
110	BSC	25MT2003 - MNMM	CO5	Verify the solution of the equations using MATLAB				3									
111	BSC	25MT2004 - MTO	CO1	Apply various methods for finding the optimal solution of Linear Programming Problem.	3				3								
112	BSC	25MT2004 - MTO	CO2	Apply Integer Programming and Gradient methods for solving optimization problems.	3		3										
113	BSC	25MT2004 - MTO	CO3	Express a practical problem, such as an engineering analysis or design problem and to optimize a multivariate quadratic function subject to linear constraints on the variables.	3		3										
114	BSC	25MT2004 - MTO	CO4	Apply and understand the search and optimization methodologies applicable to the resolution of multi disciplinary decision problems, under a decision support framework.	3		3										
115	BSC	25MT2019 - PNS	CO1	Apply the importance of probabilistic concepts in a wide spectrum of problems arising in engineering applied science.	3		3	3									

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116	BSC	25MT2019 - PNS	CO2	Assess the relationship between variables using correlation and regression techniques	3		3	3									
117	BSC	25MT2019 - PNS	CO3	Apply the role of Statistical tests of significance in solving real world engineering problems	3		3	3									
118	BSC	25MT2019 - PNS	CO4	Formulate Stochastic process in terms of Markov chains and solve problems in queueing systems, and network	3		3	3									
119	ESC	25EC1101 - BEEC	CO1	Understand the basic concepts of AC and DC circuits and apply them to solve electric circuit problems.	2												
120	ESC	25EC1101 - BEEC	CO2	Apply different circuit analysis techniques to find voltage, current, impedance and power in electrical circuits.	3												
121	ESC	25EC1101 - BEEC	CO3	Comprehend the behavior of basic electronic components, such as diodes and transistor, and their applications.	2												
122	ESC	25EC1101 - BEEC	CO4	Understand the basic functional principles of different analog ICs, such as IC 741 Op Amp, IC 555 Timer and IC Voltage Regulators.	2												
123	ESC	25EC1101 - BEEC	CO5	Utilize measurement tools and equipment for validating theoretical concepts of different electrical and electronic circuits and develop problem solving capabilities through hands on experimentation.	3												
124	ESC	25ME1001 - EM	CO1	Apply the concept of forces, governing static equations, and analyze the planar system of forces.		2											
125	ESC	25ME1001 - EM	CO2	Use analytical techniques for analyzing forces in statically determinate structures		2											

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126	ESC	25ME1001 - EM	CO3	Apply the concepts of planar and non-planar system of parallel forces and estimate the moment of inertia for lamina and material bodies.			2										
127	ESC	25ME1001 - EM	CO4	Apply fundamental concepts of kinematics and kinetics of particles to solve simple practical problems of rigid bodies and particles.			2										
128	ESC	25ME1002 - EG	CO1	Apply the principles of orthographic and pictorial projections to visualize, sketch, and interpret engineering objects.	2				2								
129	ESC	25ME1002 - EG	CO2	Develop 3D part models, assemblies, and tolerance drawings using Autodesk CAD & Fusion 360.	2				2								
130	ESC	25ME1004 - WPE	CO1	Demonstrate fundamental skills in foundry, molding, casting, and both arc and gas welding operations.	2				2							2	
131	ESC	25ME1004 - WPE	CO2	Perform basic machining operations using lathe, drill and milling machines.	2				2							2	
132	ESC	25ME1103 - DTW	CO1	Demonstrate proficiency in typing sentence , paragraph , report , presentations along spread sheets using office tools, LaTeX tools and PowerBI		2			2								
133	ESC	25ME1103 - DTW	CO2	Build a static website and blog with using html along with Special features of HTML5, CSS and Javascript					3					3			
134	ESC	25ME1103 - DTW	CO3	Develop a virtual environment with cospace and construct a marker based Augmented Reality	3		3										
135	ESC	25ME1103 - DTW	CO4	Utilising the softwares of Autodesk Fusion 360 and the same can be printed in 3D printer as physical prototype	3		3										

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136	ESC	25ME2109 - TD	CO1	Understand the basic concepts of thermodynamics and apply first law of thermodynamics to various flow and non-flow processes	2												
137	ESC	25ME2109 - TD	CO2	Apply second law of thermodynamics and principle of entropy to verify the reversibility , irreversibility and assess the availability in a process. Also, Understand the relationship between thermodynamic properties using maxwell's relations	2												
138	ESC	25ME2109 - TD	CO3	Analyze the properties of steam and assess various methods to improve the performance of a vapour power cycle		2											
139	ESC	25ME2109 - TD	CO4	Apply thermodynamic principles to estimate the performance of different air standard cycles.		2											
140	ESC	25SC1101 - PSTC	CO1	Develop Basic and Complex Building Blocks for real world problems using structured programming paradigm	3	3	3		3								
141	ESC	25SC1101 - PSTC	CO2	Develop logical building blocks using conditional statements to solve real world problems	3	3	3		3								
142	ESC	25SC1101 - PSTC	CO3	Develop logical solutions using the concepts of arrays and functions	3	3	3		3								
143	ESC	25SC1101 - PSTC	CO4	Develop solutions by applying various operations on user defined data types such as structures and unions	3	3	3		3								
144	ESC	25SC1101 - PSTC	CO5	Apply the structured programming paradigm with logic building skills on Basic and Linear Data Structures for solving real world problems	3	3	3		3								

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145	ESC	25SC1101 - PSTC	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	3	3		3								
146	ESC	25SC1203 - DST	CO1	Understand various sorting algorithms and analyze the efficiency of the algorithms	2	2	2		2								
147	ESC	25SC1203 - DST	CO2	Implement and evaluate Linear Data Structures and Demonstrate their applications	3	3	3		3								
148	ESC	25SC1203 - DST	CO3	Implement and evaluate tree data structures and understand hashing techniques	3	3	3		3								
149	ESC	25SC1203 - DST	CO4	Understand graph data structures and apply graphs to solve problems	2	2	2		2								
150	ESC	25SC1203 - DST	CO5	Design, Develop and evaluate common practical applications for linear and nonlinear data structures	3	3	3		3								
151	ESC	25SC1203 - DST	CO6	Skill the students in such a way that students will be able to develop and create programs as well as applications in DS	3	3	3		3								
152	ESC	25SC2007 - PP	CO1	Apply the concepts of Basic Data types, Operators, Decision and Looping Control Statements, String	3	3	3		3								
153	ESC	25SC2007 - PP	CO2	Apply the concepts of Lists, Tuples, Dictionaries. Functions, Modules, Class, Object, OOPS principles.	3	3	3		3								
154	ESC	25SC2007 - PP	CO3	Apply the concept of OOP principles, Classes and Objects, Call by value vs call by reference, recursion and nested classes	3	3	3		3								
155	ESC	25SC2007 - PP	CO4	Apply the concept of files, interfaces, packages, threads	3	3	3		3								

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156	ESC	25SC2007 - PP	CO5	Design, implement and evaluate python program using basic datatypes, variables, expressions, conditional statements, loops, functions, built-in data structures, object oriented concepts, python libraries and modules, debugging techniques and file I/O to solve programming problems	3	3	3		3				3		3		
157	PCC	25AD2001 - AIML	CO1	Apply classical AI techniques such as search, constraint satisfaction, and logical inference to solve real-world problems.		3	3										
158	PCC	25AD2001 - AIML	CO2	Demonstrate ability to build intelligent systems using probabilistic reasoning and basic learning models		3	3										
159	PCC	25AD2001 - AIML	CO3	Apply supervised and unsupervised machine learning algorithms to practical problems and interpret results using performance metrics.		3	3										
160	PCC	25AD2001 - AIML	CO4	Implement deep learning models, reinforcement learning, and deploy models while addressing ethical concerns in AI applications		3	3		3								
161	PCC	25AD2001 - AIML	CO5	Lead peer teams in model development, experimentation, and responsible deployment using MLOps and explainability tools.									3	3			
162	PCC	25ME2106 - FMHM	CO1	Apply the knowledge of fluid properties and the laws of fluid statics to estimate the total pressure, Centre of pressure and forces on submerged and floating bodies	2	2										2	
163	PCC	25ME2106 - FMHM	CO2	Apply continuity, Euler and Bernoulli equations and estimate the discharge through different flow measuring devices	2	2										2	

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164	PCC	25ME2106 - FMHM	CO3	Apply the principles of fluid laws to estimate the losses in pipe flows and impact of jets on different plate geometries	2	2										2	
165	PCC	25ME2106 - FMHM	CO4	Analyze the performance of hydraulic turbines and pumps using velocity triangles and model similitude.	2	2	2									2	
166	PCC	25ME2106 - FMHM	CO5	Conduct experiments to verify and apply various fluid flow principles and performance evaluation of various hydraulic machines like turbines and	2	2	2									2	
167	PCC	25ME2107 - MOS	CO1	Analyze stresses in members with axial loading or torsion	2	2										2	
168	PCC	25ME2107 - MOS	CO2	Analyze members with multi axial loading and lateral loading	2	2										2	
169	PCC	25ME2107 - MOS	CO3	Analyze members with multi axial loading and lateral loading	2	2										2	
170	PCC	25ME2107 - MOS	CO4	Analyse columns and pressure vessels	2	2										2	
171	PCC	25ME2107 - MOS	CO5	Apply the theoretical concepts to conduct various experiments of strength of materials practically and analyze the data					2							2	
172	PCC	25ME2108 - MPT	CO1	Apply the principles of pattern design, gating system configuration, and metal forming to suitable casting and welding techniques for manufacturing applications.			2		2								2
173	PCC	25ME2108 - MPT	CO2	Apply the principles of metal cutting mechanics to analyze tool geometry and compute machining time and power requirements for conventional machine tools.		2			2								2

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
174	PCC	25ME2108 - MPT	CO3	Explain the working principles, process parameters and applications of various unconventional machining processes.	1	1											1
175	PCC	25ME2108 - MPT	CO4	Explain the concepts of Geometric Dimensioning and Tolerancing (GD&T), and the application of Taylors Principle in inspection processes.	1	1											1
176	PCC	25ME2108 - MPT	CO5	Apply the concepts of casting, welding, conventional and unconventional machining, and metrology to perform and evaluate manufacturing experiments using appropriate tools and techniques.	2		2										2
177	PCC	25ME2210 - AMT	CO1	Apply advanced automation techniques to design and optimize smart production systems.		2			2							2	
178	PCC	25ME2210 - AMT	CO2	Interpret and apply the concepts of Industry 4.0 and Cyber-Physical Systems (CPS)			2		2								2
179	PCC	25ME2210 - AMT	CO3	Apply the concepts of inspection methods to inspect the end products		2	2									2	
180	PCC	25ME2210 - AMT	CO4	Design and implement Digital twins technologies to monitor real-time system in Manufacturing		2	2										2
181	PCC	25ME2210 - AMT	CO5	Develop, integrate, and evaluate smart manufacturing systems		2	2										2
182	PCC	25ME2211 - KDOM	CO1	Apply the basic principles and concepts of kinematics and mobility of the	2				2								
183	PCC	25ME2211 - KDOM	CO2	Analyze and kinematic design of mechanisms and machines using velocity and acceleration analysis	2				2								

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184	PCC	25ME2211 - KDOM	CO3	Apply principles of cams to draw cam profiles and understand gear systems and gear trains for various applications.	2				2								
185	PCC	25ME2211 - KDOM	CO4	Understand the principles of balancing and vibrations and analyze gyroscopic effect on naval ships and automobiles	2				2								
186	PCC	25ME2211 - KDOM	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.	2												
187	PCC	25ME3112 - HT	CO1	Apply Fourier law of conduction and combined conduction convection concepts to 1-D heat transfer problems	2	2										2	
188	PCC	25ME3112 - HT	CO2	Analyze heat transfer through extended surfaces and apply unsteady state heat transfer to various systems	2	2										2	
189	PCC	25ME3112 - HT	CO3	Apply the empirical correlations for solving convection heat transfer and heat transfer during phase change.	2	2										2	
190	PCC	25ME3112 - HT	CO4	Analyze various types of heat exchangers by applying the principles of conduction, convection, radiation	2	2										2	
191	PCC	25ME3112 - HT	CO5	Analyze various parameters of heat transfer in different thermal systems physically/numerically	2	2										2	
192	PCC	25ME3212 - MD	CO1	Analyze transmission shafts, couplings and springs for given design conditions			2										2
193	PCC	25ME3212 - MD	CO2	Analyze welding, bolted fastening systems for given design conditions			2										2

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194	PCC	25ME3212 - MD	CO3	Analyze and select the appropriate bearings, belt drives and chain drives for given working conditions			2										2
195	PCC	25ME3212 - MD	CO4	Analyze the spur and helical gears, band and block brakes for given working conditions			2										2
196	PCC	25ME3212 - MD	CO5	Simulate and Evaluate a virtual/functional prototype				3									3
197	PCC	25ME3214 - DTS	CO1	Apply the concepts of vapour power cycles to analyze steam turbines and nozzles to determine flow parameters and discharge conditions.	2	2											
198	PCC	25ME3214 - DTS	CO2	Apply the principles of thermodynamics to determine the performance of single and multistage compressors	2	2											
199	PCC	25ME3214 - DTS	CO3	Apply the concepts of Psychrometry to analyze the simple and vapour compression refrigeration processes.	2	2											
200	PCC	25ME3214 - DTS	CO4	Design and optimization of various thermal energy systems such as heat exchangers and engines.				2									
201	PCC	25ME3214 - DTS	CO5	Conduct parametric study to design thermal systems such as steam turbines, nozzles and compressors using equation solver.				2									
202	PRI	25IE2040 - 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			2										

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
203	PRI	25IE2040 - SIP	CO2	Remember the water sustainability and water resilience of village, city, residential facilities and households using multi-level water scorecards				2									
204	PRI	25IE2040 - SIP	CO3	Apply the design thinking positive action plan for a village, campus, residential					3								
205	PRI	25IE2040 - SIP	CO4	Apply the water positive solutions within an urban watershed, a rural watershed						3							
206	PRI	25IE3041 - TIP	CO1	Ability to demonstrate the impact of academic skills and logical thinking			3										
207	PRI	25IE3041 - TIP	CO2	Ability to integrate existing and new technical knowledge for industrial application				3									
208	PRI	25IE3041 - TIP	CO3	Ability to demonstrate the impact of the internship on their learning and professional development					3								
209	PRI	25IE3041 - TIP	CO4	Demonstrate the ability to harness resources by analyzing challenges						3							
210	PRI	25IE4042 - INT	CO5	INTERNSHIP	3	3											
211	PRI	25IE4048 - EPJ	CO1	Develop skills to conduct comprehensive searches, critically assess the credibility of sources, and apply research findings to support their academic or professional work.	3												
212	PRI	25IE4048 - EPJ	CO2	Analyze situations critically, identify underlying causes, and articulate clear problem statements that guide effective problem-solving strategies.		3											

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
213	PRI	25IE4048 - EPJ	CO3	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							
214	PRI	25IE4048 - EPJ	CO4	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				
215	PRI	25IE4051 - INT-1	CO5	INTERNSHIP	3	3											
216	PRI	25IE4052 - INT-2	CO5	INTERNSHIP	3	3											
217	PRI	25IE4053 - ECP-1	CO1	Exercise to acquire knowledge within the chosen area of technology for project development.	2												
218	PRI	25IE4053 - ECP-1	CO2	Identify, discuss and justify the technical aspects of the chosen area for problem analysis		3											
219	PRI	25IE4053 - ECP-1	CO3	Reproduce, improve and refine technical aspects for chosen problem						2							
220	PRI	25IE4053 - ECP-1	CO4	Communicate and report effectively project related activities and findings.									3				
221	PRI	25IE4054 - ECP-2	CO1	Develop skills to conduct comprehensive searches, critically assess the credibility of sources, and apply research findings to support their academic or professional work.	3												
222	PRI	25IE4054 - ECP-2	CO2	Analyze situations critically, identify underlying causes, and articulate problem statements that guide effective problem-solving strategies.		3											

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
223	PRI	25IE4054 - ECP-2	CO3	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							
224	PRI	25IE4054 - ECP-2	CO4	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				
225	PRI	25IE4055 - IP-1	CO1	Understand the fundamental principles and processes of innovation			2	2	2								
226	PRI	25IE4055 - IP-1	CO2	Develop skills to identify and evaluate opportunities for innovation			3	3	3								
227	PRI	25IE4055 - IP-1	CO3	Apply research methodologies to gather and analyze data for innovative solutions.				3	3				3				
228	PRI	25IE4055 - IP-1	CO4	Enhance team collaboration and project management skills in an innovation context.				3	3				3				
229	PRI	25IE4056 - IP-2	CO1	Develop advanced project management skills for innovation projects.			2	2	2								
230	PRI	25IE4056 - IP-2	CO2	Apply advanced analytical tools to refine innovative ideas.			3	3	3								
231	PRI	25IE4056 - IP-2	CO3	Create detailed business plans for innovative solutions.				3	3	3							
232	PRI	25IE4056 - IP-2	CO4	Present and defend innovation projects effectively to stakeholders.				3	3	3							
233	PRI	25IE4057 - RP-1	CO1	Demonstrate the basic principles of research methodology.			2	2	2								
234	PRI	25IE4057 - RP-1	CO2	Conduct a literature review and identify simple research problems.			3	3	3								

S#	Cat	Course	CO	CO Description	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
235	PRI	25IE4057 - RP-1	CO3	Formulate basic research questions and hypotheses.				3	3	3							
236	PRI	25IE4057 - RP-1	CO4	Develop a straightforward research proposal including methodology and expected outcomes				3	3	3							
237	PRI	25IE4058 - RP-2	CO1	Implement advanced research methodologies for data collection and analysis.			2	2	2								
238	PRI	25IE4058 - RP-2	CO2	Interpret complex research findings and discuss their implications.			3	3	3								
239	PRI	25IE4058 - RP-2	CO3	Develop advanced skills in academic writing and publication.			3	3					3				
240	PRI	25IE4058 - RP-2	CO4	Present research findings effectively to an academic and professional audience.			3	3					3				
					2.4	2.5	2.7	2.7	2.6	2.6	2.5	2.7	2.8	2.9	2.6	1.9	1.9



(DEEMED TO BE UNIVERSITY)

Y25: B.Tech. - Mechanical Engineering

Category: Skill Development Courses (SDC)

25SDME01 - FINITE ELEMENT ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDME01	FINITE ELEMENT ANALYSIS	FEA	R	1	0	0	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform basic and advanced structural analysis of engineering components	4	PO2, PO5, PSO2
CO2	Explore advanced analysis methods in engineering design	4	PO2, PO5, PSO2
CO3	Design a finite element analysis project demonstrating advanced mechanical engineering skills	5	PO2, PO5, PSO2

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

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.

25SDME02 - COMPUTER INTEGRATED MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDME02	COMPUTER INTEGRATED MANUFACTURING	CIM	R	1	0	0	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamentals of Computer Integrated Manufacturing (CIM), its hierarchical structure in modern manufacturing systems.	2	PO1, PO2, PSO1
CO2	Apply the principles of CNC technology to identify machine configurations and analyze the construction and drive systems of CNC machines	3	PO1, PO3, PSO1
CO3	Analyse CNC part programs by interpreting coordinate systems, G-code/M-code structures, and machining strategies to optimize operations.	4	PO3, PO5, PSO2
CO4	Apply CAD/CAM tools to generate toolpaths, perform post-processing, and simulate CNC programs for various machining operations.	3	PO1, PO2, PSO1
CO5	Apply the concepts of CIM to perform and evaluate CNC machining operations and quality inspections using industry-relevant software and equipment.	3	PO1, PO3, PSO1

Syllabus

Introduction to CIM, Evolution of manufacturing systems, Computer-aided functions: CAD, CAM, CAE, CAPP, CAQC, Hierarchical structure of CIM, Role of CAPP in CIM, Types of CAPP systems: Retrieval and Generative.

Introduction to CNC Technology, Evolution of NC, CNC, and DNC, Structure of CNC system, Constructional features of CNC lathes, CNC milling, and CNC drilling machines, Axis nomenclature and machine configurations (3-axis, 5-axis), Spindle drives and feed drives,

CNC Part Programming-Manual Programming, Coordinate systems: Absolute and incremental, G-code and M-code structure, Programming for: Facing, Turning, Taper turning, Thread cutting (CNC Lathe), Slot milling, Pocket milling, Drilling, Contouring (CNC Milling), Subprograms and cycles (canned cycles)

Computer-Aided CNC Programming, Role of CAD/CAM in CNC programming, Toolpath generation using software (e.g., Mastercam, Fusion 360), Post-processing and NC code generation, Simulation and verification of toolpaths

Concepts of CIM to perform and evaluate CNC machining operations and quality inspections using industry-relevant software and equipment.

Reference Books

- 1 Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, 4, Pearson Education.
- 2 Internet of Things: Principles and Paradigms, Rajkumar Buyya, Amir Vahid Dastjerdi, 1, Elsevier..
- 3 CAD/CAM/CIM, P. Radhakrishnan, S. Subramanyan, V. Raju, 2, New Age International. .
- 4 Mastering CAD/CAM, Ibrahim Zeid, 1, McGraw Hill..

25SDME03 - APPLIED MECHANICAL DESIGN PRACTICE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDME03	APPLIED MECHANICAL DESIGN PRACTICE	AMDP	R	1	0	0	4	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply design philosophy to develop any new product	3	PO1, PSO2
CO2	Apply material selection strategy to do design with materials	3	PO1, PSO2
CO3	Apply generative design and Design for X principles to develop a product	3	PO1, PO2
CO4	Analyse developed product for static and fatigue strength	4	PO1, PO2
CO5	Evaluate product for its performance and functionality	5	PO1, PO2

Syllabus

Design Philosophy, Generic Phases of the Design, concurrent Engineering, Product development Methodology.

Mechanical behaviour of Materials, Material selection in Engineering Design, Design with Materials.

Computer aided generative design, Design for sustainability, Ergonomics in product design, Design for X.

Design for static strength: Theories of failures, Design for fluctuating stresses: Goodman line and Soderberg line

Prototyping robust design, Design for Manufacturing and assembly (DFMA) guidelines, product evaluation for performance, patents and intellectual property

Reference Books

- 1 Production Design and Development, Karl T. Ulrich and Steven D. Eppinger, 2007, Tata McGraw Hill.
- 2 Engineering Design, George E. Dieter, 2000., McGraw Hill.
- 3 The Mechanical Design Process, David G. Ullman, 2003, McGraw Hill.
- 4 Materials selection in Mechanical Design, Michael F. Ashby, 2020, Elsevier Butterworth-Heinemann. .
- 5 Design of machine elements, V. B. Bhandari, 2020, McGraw-Hill International..

25SDME04 - ANALYSIS OF ENERGY SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDME04	ANALYSIS OF ENERGY SYSTEMS	AES	R	1	0	0	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, PSO2
CO2	Analyze the performance of various thermal energy storage devices	4	PO1, PO5, PSO2
CO3	Model and simulation of thermal management of electronic components	4	PO1, PO5, PSO2
CO4	Simulate multi-phase flows	4	PO1, PO5, PSO2

Syllabus

Tube-in-tube, shell-and-tube, and plate-type heat exchangers-Design considerations: flow arrangement (parallel, counter, cross-flow), material selection, and compactness.

Heat Transfer Enhancement Techniques: Surface augmentation, turbulators, twisted tapes, Passive and active enhancement methods. Nanofluids in Heat Exchangers: Thermophysical properties of nanofluids (thermal conductivity, viscosity). Types of nanoparticles: Al₂O₃, CuO, TiO₂, carbon nanotubes, etc. Nanofluid preparation and stability.

Sensible Heat Storage: Materials (water, molten salts, oils) System design and heat storage efficiency. Latent Heat Storage with PCMs: Phase change materials (PCMs): paraffin, salt hydrates, eutectics Advantages and limitations. Encapsulation techniques.

Overview of Battery Cooling Techniques: Air Cooling: Natural and forced convection methods, Liquid Cooling: Direct and indirect cooling using coolant channels, Phase Change Cooling: Integration of PCMs for peak heat absorption. Introduction to Multiphase Flows: Types: liquid-liquid, gas-liquid, liquid-solid, Flow regimes: bubbly, slug, annular, stratified, dispersed Industrial Applications: Oil-water separation, bubble columns, slurry pipelines, chemical reactors

Reference Books

- 1 Numerical Heat Transfer and Fluid Flow, S. V. Patankar, 4, Hemisphere.
- 2 Thermal Energy Storage Systems and Applications , Ibrahim Dincer and Mark A. Rosen, 1, John Wiley & Sons.
- 3 Energy Storage Systems: Fundamentals, Classification and a Technical Comparative, os? Manuel And?jar M?rquez , Francisca Segura Manzano , Jes?s Rey Luengo, 1, Springer.
- 4 Energy Storage Systems: An Introduction , Satyender Singh , 2, Nova Science Publishers Inc.

25SDME04A - ANALYSIS OF ENERGY SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDME04A	ANALYSIS OF ENERGY SYSTEMS	AES	A	2	0	2	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, PSO2
CO2	Analyze the performance of various thermal energy storage devices	4	PO1, PO5, PSO2
CO3	Model and simulation of thermal management of electronic components	4	PO1, PO5, PSO2
CO4	Simulate multi-phase flows	4	PO1, PO5, PSO2
CO5	Perform exergy analysis of energy systems for identifying inefficiencies	4	PO1, PO5, PSO2
CO6	Analyze the performance of energy system components through CFD-based simulations of thermal and flow processes	4	PO1, PO5, PSO2

Syllabus

Tube-in-tube, shell-and-tube, and plate-type heat exchangers-Design considerations: flow arrangement (parallel, counter, cross-flow), material selection, and compactness.

Heat Transfer Enhancement Techniques: Surface augmentation, turbulators, twisted tapes, Passive and active enhancement methods. Nanofluids in Heat Exchangers: Thermophysical properties of nanofluids thermal conductivity, viscosity. Types of nanoparticles: Al₂O₃, CuO, TiO, carbon nanotubes, etc. Nanofluid preparation and stability.

Sensible Heat Storage: Materials (water, molten salts, oils) System design and heat storage efficiency. Latent Heat Storage with PCMs: Phase change materials (PCMs): paraffin, salt hydrates, eutectics Advantages and limitations. Encapsulation techniques.

Overview of Battery Cooling Techniques: Air Cooling: Natural and forced convection methods, Liquid Cooling: Direct and indirect cooling using coolant channels, Phase Change Cooling: Integration of PCMs for peak heat absorption. Introduction to Multiphase Flows: Types: liquid-liquid, gas-liquid, liquid-solid, Flow regimes: bubbly, slug, annular, stratified, dispersed Industrial Applications: Oil-water separation, bubble columns, slurry pipelines, chemical reactors

Governing equations and numerical solution methods. Turbulence and multiphase modelling for energy devices. Use of commercial solvers (ANSYS Fluent, Open FOAM)

Fundamentals of exergy, Exergy balance and second-law efficiency, Exergy destruction and irreversibility, Exergy analysis of heat exchangers, Exergy in thermal energy storage (sensible and latent), Exergy in thermal management of electronics, Exergy in multiphase flow systems, Case studies: power plants and renewable energy systems

Reference Books

- 1 Numerical Heat Transfer and Fluid Flow,, S. V. Patankar, 4, Hemisphere.
- 2 Thermal Energy Storage Systems and Applications, Ibrahim Dincer and Mark A. Rosen, 1, John Wiley & Sons..
- 3 Energy Storage Systems: Fundamentals, Classification and a Technical Comparative, Jos & Manuel Andjar Mrquez , Francisca Segura Manzano , Jes?s Rey Luengo, 1, Springer.
- 4 Energy Storage Systems: An Introduction, Satyender Singh, 2, Nova Science Publishers Inc.



Y25: B.Tech. - Mechanical Engineering

Category: Honors Through Experiential Learning Courses (HEC)

25ME01EF - ENERGY STORAGE SYSTEMS AND TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME01EF	ENERGY STORAGE SYSTEMS AND TECHNOLOGIES	ESST	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the various types of energy storage technologies and its applications.	3	PO1, PSO1
CO2	Apply the various modelling techniques of energy storage systems	3	PO3, PSO1
CO3	Apply the concepts of types of the batteries	3	PO3, PSO1
CO4	Apply the principle of operation of Hydrogen and Biogas storage systems.	3	PO3, PSO1
CO5	Analyse the energy storage system using Ansys	4	PO3, PSO1

Syllabus

Energy storage systems overview - Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines

Thermal storage system-heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage-organic and inorganic materials, efficiencies, and economic evaluation of thermal energy storage systems

Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market

Chemical storage system- hydrogen, methane etc., concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage

Reference Books

- 1 Thermal Energy Storage Systems and Applications, Ibrahim Dincer and Mark A. Rosen, 1, 2002, Ibrahim Dincer and Mark A. Rosen.
- 2 Fuel cell principle and applications, Viswanathan, 2, 2007, university press.
- 3 Advances in Thermal Energy Storage Systems: Methods and Applications, Luisa F.Cabeza, 3, 1997, Elsevier Wood head Publishing.
- 4 Electrochemical technologies for energy storage and conversion, Ru-shiliu, Leizhang, Xueliang sun, 2, 1992, Wiley publications .

25ME02EF - MECHANICAL SYSTEMS DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME02EF	MECHANICAL SYSTEMS DESIGN	MSD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Model the complex 2D, sheet metal engineering products.	3	PO5, PO9, PO10, PSO2
CO2	Model the complex 3D engineering products.	3	PO5, PO9, PO10, PSO2
CO3	Clean and convert CAD drawings to Finite element models and perform mesh editing and optimisation	3	PO3, PO5, PO10, PSO2
CO4	Model, create FEM and analyse the mechanical products	3	PO5, PO10

Syllabus

Modeling of the complex 2D, sheetmetal engineering products: Introduction to CATIA: Overview of CATIA interface and functionalities Sketcher module: Creating 2D sketches Constraints and dimensions 2D Geometry Modeling: Complex profile creation Use of geometric and dimensional constraints Advanced sketching techniques Sheet Metal Design in CATIA: Introduction to sheet metal design Basic sheet metal operations: Bend, flange, cutout, etc. Advanced sheet metal features: Lofted bends, swept walls Sheet metal parameter settings and design rules Analysis Preparation in HyperMesh: Importing 2D CAD models from CATIA into HyperMesh Geometry cleanup and defeaturing for analysis Creating and editing 2D mesh for sheet metal components Boundary conditions and load applications for sheet metal analysis Basic structural analysis using HyperWorks

Modeling of the complex 3D engineering products: Advanced 3D Modeling in CATIA: Part design module: Solid and surface modeling Advanced features: Multi-body parts, ribs, stiffeners Boolean operations: Union, subtract, intersect Assembly Design in CATIA: Creating assemblies and sub-assemblies Constraints in assemblies: Coincidence, parallelism, tangency Managing large assemblies: Techniques for efficiency Surface Modeling Techniques: Introduction to surface modeling Advanced surfacing tools: Sweep, loft, fillet, blend Creating complex surfaces for aesthetic and functional parts Analysis Preparation in HyperMesh: Importing 3D models from CATIA Geometry cleanup for complex 3D models Solid meshing techniques: Tetrahedral, hexahedral, and hybrid meshes Setting up boundary conditions and loads for 3D models Performing preliminary finite element analysis (FEA) using HyperWorks

Geometry cleanup and conversion of CAD drawings to Finite element models: Geometry Import and Cleanup in HyperMesh: Importing various CAD formats Identifying and fixing geometry issues: Gaps, overlaps, duplicates Defeating: Removing unnecessary features for meshing Mesh Generation Basics: 1D, 2D, and 3D meshing fundamentals Tetrahedral and hexahedral meshing techniques Shell and solid meshing approaches Mesh Quality and Refinement: Mesh quality criteria: Aspect ratio, skewness, Jacobian Mesh refinement techniques: Local and global refinement Adaptive meshing strategies Mesh Editing and Optimization: Mesh editing tools: Splitting, merging, and remeshing Optimization techniques: Mesh smoothing, element quality improvement Introduction to topology and shape optimization Using HyperMesh optimization tools to refine models

Performing mesh editing and optimisation and analysing the mechanical products: Advanced FEM Modeling: Creating detailed FEM models for complex mechanical products Assigning material properties and section definitions Defining contacts and interactions in assemblies Static Structural Analysis: Setting up and running linear static analysis Interpreting stress, strain, and displacement results Addressing convergence issues Dynamic Analysis: Introduction to dynamic analysis: Modal, harmonic, transient Setting up and running basic dynamic analyses Analyzing vibration modes and frequencies Non-linear Analysis: Introduction to non-linear material models: Plasticity, hyperelasticity Large deformation and contact non-linearities Setting up and running non-linear analyses using RADIOSS/OptiStruct Optimization and Advanced Analysis: Performing optimization studies: Topology, size, and shape optimization Using advanced analysis techniques: Buckling, fatigue, and thermal analysis Case studies and real-world applications

- 1 CATIA V5 for Designers, Sham Tickoo, 17, 2019, BPB publications.
- 2 CATIA V5-6R2017 for Engineers and Designers, Tutorial Books, 1, 2018, Tutorial Books.
- 3 Altair HyperMesh 2022, Core Tutorials, 1, 2022, ALTAIR.
- 4 Altair HyperMesh 2022 User Guide, Altaiar, 1, 2022, ALTAIR.

25ME03EF - ADVANCED MANUFACTURING PROCESSES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME03EF	ADVANCED MANUFACTURING PROCESSES	AMP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles, equipment, and applications of various modern mechanical energy-based machining processes	2	PO1, PO2, PSO1
CO2	Analyze the operational parameters and limitations of chemical and thermoelectric energy-based machining techniques	4	PO1, PO2, PSO1
CO3	Comprehend the principles, equipment, and practical applications of non-traditional welding and forming processes.	2	PO1, PO2, PSO1
CO4	Evaluate the benefits and challenges of non-traditional welding and forming processes in advanced manufacturing.	4	PO1, PO2, PSO1

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 Machinin

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 Hamm

Reference Books

- 1 Modern Machining Processes: Advanced Manufacturing, J. Paulo Davim, 4, Springer..
- 2 Nontraditional Manufacturing Processes: Manufacturing Engineering and Materials Processing, Bradley L. Prevost, George W. Woodruff, 3, CRC Press.
- 3 Machining and Machine-tools: Research and Development, J. Paulo Davim, 2, Springer.
- 4 Nontraditional Machining Handbook, E. Paul DeGarmo, J. Temple Black, Ronald A. Kohser, 4, CRC Press.

25ME04EF - MECHATRONICS AND ROBOTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME04EF	MECHATRONICS AND ROBOTICS	MTR	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concept of Mechatronics and Robotic	2	PO1, PSO1
CO2	Apply the concept of Mechanical design for Generation of kinematic motion for Robotics	3	PO3, PSO1
CO3	Apply the concept of sensory devices and actuators for Mechatronics & robotic systems	3	PO4, PSO1
CO4	Apply the Concept of Microcontrollers and Embedded Systems for Real time operating of Robotics systems	3	PO1, PO4, PSO1
CO5	Apply the Concept of basic programming languages required to control the path motion of Robos and Mechatronics products	3	PO5, PSO1

Syllabus

Introduction to Mechatronics and Robotics system and basic components, Historical background and applications for checking kinematic structures Degrees of Freedom, Kinematics introduction like link, Joint, and Forward kinematics, and jacobian for 2R and 3DOF Robots

Sensors, classification, Proximity, Range, Force and other sensors required for checking the Robotics performance, actuators classifications, requirements of actuators for the field of Robotics and Mechatronics systems

Micro controllers -Embedded systems- Interfacing sensors and actuators with microcontrollers Real-time operating systems (RTOS) for robotics- PID controllers, Motion planning and trajectory generation

Robotic Applications and Case Studies Industrial robotics Mobile robots Robotic manipulation and grasping

Reference Books

- 1 Robotics Modelling, Planning and Control, Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, 2009, Springer.
- 2 Embedded Systems: Introduction to Arm(r) Cortex(tm)-M Microcontrollers, Jonathan W Valvano, 2012, Createspace Independent Publishing Platform.
- 3 Robotics, Vision and Control: Fundamentals, Peter Corke, 2011, Springer.
- 4 Robotics and Mechatronics, Chin-Hsing Kuo, Pei-ChunLin, Guan-ChenChen, 2019, Springer.
- 5 A text book on Industrial Engineering Robotics and Mechatronics, Dr Swadesh Kumar Singh, Dr Rajesh Purohit, 2016, Made Easy Publication.

25ME05EF - TECHNOLOGIES FOR CLEAN AND RENEWABLE ENERGY PRODUCTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME05EF	TECHNOLOGIES FOR CLEAN AND RENEWABLE ENERGY PRODUCTION	TCREP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO



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

Y25: B.Tech. - Mechanical Engineering

Category: Honors Through Innovation Courses (HIC)

25DT01IF - ENTREPRENEURIAL TECHNOLOGY DEVELOPMENT AND PROTOTYPING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DT01IF	ENTREPRENEURIAL TECHNOLOGY DEVELOPMENT AND PROTOTYPING	ETDP	E	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop an entrepreneurial mindset to identify and seek opportunities within	2	PO1, PO2
CO2	Apply techniques of additive manufacturing, including 3D printing and laser cutting, for prototyping	3	PO3, PO5
CO3	Analyze the integration of PCB design, microcontrollers, and soldering techniques to develop and refine functional electronic models.	4	PO1, PO4
CO4	Apply digital and physical prototyping tools to create mockups and develop a Bill of Materials (BOM) for prototypes.	3	PO5, PO8

Syllabus

Foundational Concepts in Entrepreneurship and Innovation Development of an entrepreneurial mindset for identifying and pursuing opportunities within problems. Methods for overcoming inherent biases, internal blockages, and external industry barriers. The strategic importance of timing. The purpose, essential safety protocols, and standard operational workflows of innovation and idea labs.

Digital Design and Embedded Systems Digital design tools for wireframing and UI prototyping (Figma) and an introduction to basic no-code platforms. Embedded prototyping using Arduino, ESP32, and sensors to build functional mockups. Fundamentals of electronic product development include circuit design software, the process for printing circuit boards (PCBs), and techniques for mounting components.

Physical Fabrication and Reverse Engineering Additive manufacturing via 3D printing, including slicing software and material selection criteria. Subtractive manufacturing processes covering laser cutting and CNC wood router operation with associated file preparation. Reverse engineering techniques using 3D scanning for digital capture and modeling of existing products.

Project Realization and Product Development Strategy Integration of skills through hands-on project lab sessions focused on fabrication, assembly, and technical documentation. Development of a Bill of Materials (BOM), including component sourcing and cost estimation. Analysis of how these skills support the future development of a Minimum Viable Product (MVP) and a market-ready product.

Reference Books

- 1 The Lean Startup, Eric Ries, 1st Edition (2011), Crown Business / Penguin Random House.
- 2 Practical Electronics for Inventors, Paul Scherz and Simon Monk, 4th Edition (2016), McGraw-Hill Education.
- 3 The Hardware Startup: Building Your Product, Business and Brand, Renee DiResta, Brady Forrest and Ryan Vinyard, 1st Edition (2015), O'Reilly Media.
- 4 Making Things Move: DIY Mechanisms for Inventors, Hobbyists, and Artists, Dustyn Roberts, 1st Edition (2010), McGraw-Hill Education.
- 5 Product Design and Development, Karl T. Ulrich and Steven D. Eppinger, 6th Edition (2019), McGraw-Hill Education.
- 6 The Art of Innovation, Tom Kelley, 1st Edition (2001), Currency/Doubleday.
- 7 Innovation and Entrepreneurship, Peter F. Drucker, 1st Edition (1985), Harper Business.

25DT02IF - PROBLEM DEFINITION AND VALIDATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DT02IF	PROBLEM DEFINITION AND VALIDATION	PDV	E	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Lean Business Model Canvas framework and its components	2	PO1, PO2
CO2	Formulate a Business Model Canvas based on identified problem and hypotheses	3	PO2, PO3
CO3	Design and implement experiments to validate each block of the Business Model Canvas (BMC)	4	PO3, PO4, PO5
CO4	Iterate and refine the BMC to reach problem-solution fit based on customer insights	5	PO4, PO6

Syllabus

Lean Business Model Canvas Framework: Introduction to the Lean Business Model Canvas (BMC) framework, exploring its key components and their significance. Understanding how the BMC helps in mapping out a business model and driving strategic decision-making. Emphasis on the relationship between the different blocks of the canvas and their role in identifying and addressing customer problems. Overview of customer segments, value propositions, channels, customer relationships, revenue streams, key resources, activities, and partnerships.

Formulating a Business Model Canvas: Techniques for formulating a Business Model Canvas based on identified problems and hypotheses. Exploring how to define customer segments, value propositions, and other key components of the canvas. Focus on hypothesis-driven development and its application in creating a robust business model. Hands-on activities for students to develop their own BMC by analyzing market needs and potential solutions.

Designing and Implementing Experiments: Methods for designing and implementing experiments to validate each block of the BMC. Introduction to techniques such as customer interviews, surveys, and testing prototypes to gather real-world data. Understanding how to refine each block based on insights gained from experiments. Exploring the role of data-driven decision-making in validating assumptions and improving business models.

Iterating and Refining the Business Model Canvas: Focus on iteration and refinement of the BMC based on customer insights and feedback. Techniques for adjusting the business model to achieve problem-solution fit. Emphasis on continuous improvement through testing, customer feedback, and re-validation of hypotheses. Analyzing case studies of successful business models that evolved through iterative refinement based on real-world data.

Reference Books

- 1 The Startup Owners Manual, Steve Blank and Bob Dorf, 2012, K S Ranch.
- 2 Value Proposition Design, Alexander Osterwalder, 2014, Wiley.
- 3 The Lean Startup, Eric Ries, 2014, Crown Business.
- 4 Running Lean, Ash Maurya, 2012, O Reilly Media.

25DT03IF - PRODUCT DESIGN AND PROTOTYPE VALIDATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DT03IF	PRODUCT DESIGN AND PROTOTYPE VALIDATION	PDPV	E	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Translate customer problems into product concepts and features.	3	PO1, PSO1
CO2	Design low and high-fidelity prototypes for user testing.	4	PO4, PO6, PSO1
CO3	Conduct validation experiments using MVPs.	5	PO2, PO7, PSO1
CO4	Incorporate user feedback to refine product design.	6	PO3, PO9, PSO1

Syllabus

Understanding how to translate customer problems into actionable product concepts and features. Techniques for identifying and defining customer pain points. Methods for mapping customer problems to product requirements and features. Exploration of design thinking frameworks to conceptualize solutions. Emphasis on analyzing customer needs and aligning them with potential product solutions.

Introduction to the design of both low and high-fidelity prototypes. Methods for creating wireframes, mockups, and interactive prototypes. Techniques for user testing and feedback collection. Iteration of prototypes based on test results. Focus on aligning prototypes with product goals and customer expectations for optimized user experience.

Learning to build and validate Minimum Viable Products (MVPs) to test core product assumptions. Techniques for collecting data from MVPs through user interaction and feedback. Using customer interviews, surveys, and usage metrics to validate the product concept. Analyzing results to determine whether to pivot or proceed with further development. Emphasis on iterative validation of product ideas.

Incorporating User Feedback to Refine Product Design: Understanding how to gather and incorporate user feedback into the product development process. Techniques for analyzing feedback and identifying areas for improvement. Methods for refining product features to better meet user needs. Focus on iterative design and continuous improvement based on real-world user insights. Understanding the role of feedback loops in product design and development

Reference Books

- 1 Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Alexander Osterwalder & Yves Pigneur, First edition, July 2010, John Wiley & Sons (Wiley).
- 2 Creative Confidence, Tom Kelley and David Kelley, 2013, Crown Business.

25DT04IF - SCALABLE SOLUTION DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DT04IF	SCALABLE SOLUTION DEVELOPMENT	SSD	E	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design scalable business models aligned with validated products.	6	PO3, PO9, PSO1
CO2	Evaluate product-market fit and growth potential.	5	PO4, PO7, PSO1
CO3	Craft effective go-to-market strategies.	4	PO5, PO6, PO10
CO4	Develop plans for growth metrics and monetization	6	PO3, PO6, PO9

Syllabus

Designing Scalable Business Models Aligned with Validated Products: Understanding how to design scalable business models that are aligned with validated product concepts. Exploration of different business model frameworks and their application to product development. Techniques for aligning value propositions, customer segments, and revenue streams with market validation. Methods for designing business models that allow for future scalability and sustainability.

Evaluating Product-Market Fit and Growth Potential Techniques for evaluating product-market fit through customer feedback, usage data, and market analysis. Understanding how to assess whether a product meets customer needs and expectations. Methods for identifying growth potential by analyzing market trends, customer acquisition costs, and long-term retention strategies. Focus on metrics that indicate whether a product is ready to scale in the market.

Crafting Effective Go-to-Market Strategies Learning how to create and execute a go-to-market strategy that targets the right customer segments. Methods for positioning the product in the market and differentiating it from competitors. Exploring channels for distribution and communication to maximize reach. Techniques for building brand awareness, driving customer engagement, and scaling marketing efforts.

Developing Plans for Growth Metrics and Monetization Understanding the importance of defining growth metrics to track the performance and success of a product in the market. Methods for developing monetization strategies based on customer value and market demand. Techniques for creating pricing models that maximize revenue while maintaining customer satisfaction. Emphasis on measuring key growth indicators, customer acquisition costs, and lifetime value.

Reference Books

- 1 The Startup Owners Manual, Steve Blank and Bob Dorf, 2012, K S Ranch.
- 2 Crossing the Chasm, Geoffrey Moore, 2014, Harper Business.



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

Y25: B.Tech. - Mechanical Engineering

Category: Honors Through Research Courses (HRC)

25IE01RF - INDEPENDENT STUDY & RESEARCH (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE01RF	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	
CO2	Apply advanced research methodologies to design and conduct experiments or studies and manage projects independently to achieve research objectives within specified timelines	3	
CO3	Utilize appropriate statistical and analytical tools to evaluate experimental data.	4	
CO4	Integrate research findings into comprehensive technical reports and presentations, and conduct peer reviews to provide in-depth, constructive feedback	4	
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	

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.

25IE02RF - RESEARCH METHODOLOGY, ETHICS & SCIENTIFIC WRITING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE02RF	RESEARCH METHODOLOGY, ETHICS & SCIENTIFIC WRITING	RMESW	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To apply the fundamental concepts and methods in research and collect the data relevant to research problem	3	
CO2	To analyze the data and gather the insights of the data and testing of hypothesis	4	
CO3	To be able to format a research paper, compile and interpret the results at the end, further scope of research	4	
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	
CO5	To be able to design the model by applying SPSS to the data and interpret results obtained, test for plagiarism, prepare article/thesis using Latex	5	

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 Methods for Engineers , David V Thiel, 1st, Cambridge Univ Pr..
- 2 Engineering Research Methodology, Krishnan Nallaperumal, 1st, PHI Learning Private Limited.
- 3 Engineering Research Methodology -A Practical Insight for Researchers, Dipankar Deb and Balas, 1st, Springer Verlag, Singapore.
- 4 Research Methods for Engineers-2, Dr. Sanjeevreddy K. Hudgikar, 1st, Kripa-Drishti Publications.
- 5 Business Research Methods, Donald R Cooper , 12th, McGraw Hill Education.
- 6 Business Research Methods-2, William G Zikmund, 8th, Cengage India Private Limited.
- 9 Business Statistics , Ken Black , 11th, John Wiley & Sons.
- 10 R in Action , Robert I. Kabacoff, 2nd, Manning Publications.

25IE03RF - RESEARCH SEMINAR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE03RF	RESEARCH SEMINAR	RS	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and interpret research data using appropriate statistical and qualitative methods.	5	
CO2	Collaborate with peers, professionals and Communicate research findings, effectively through written reports, presentations, and publications	5	
CO3	Design and Development of solutions for the complex problems	5	

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

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.

25IE04RF - TERM PAPER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE04RF	TERM PAPER	TP	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Literature Review	2	
CO2	Problem Identification	2	
CO3	Methodology	3	
CO4	Implementation	3	

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,2022, The MIT Press.
- 5 Data and Computer Communications, William Stallings, 10th,2013, Pearson.



(DEEMED TO BE UNIVERSITY)

Y25: B.Tech. - Mechanical Engineering

Category: Honors Flexi Core Courses (HFC)

25ME01HF - RENEWABLE ENERGY SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME01HF	RENEWABLE ENERGY SYSTEMS	RES	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand renewable energy (RE) technologies and applications	2	PO1, PO2
CO2	Integrate renewable energy systems into existing infrastructure while considering factors such as resource availability and environmental impact	3	PO1, PO2
CO3	Apply Hydroelectric Energy Systems and estimate the performance of Hydroelectric Energy Systems	3	PO1, PO2
CO4	Evaluate trade-offs and policy implications of different renewable energy systems.	4	PO1, PO2
CO5	Analyze and classify technical findings, project outcomes, and policy proposals effectively through reports, presentations.	4	PO1, PO2, PO3

Syllabus

Introduction to Renewable Energy, Overview of renewable energy sources, Importance of renewable energy in sustainable development

Hydroelectric Energy Systems, Types of hydroelectric power plants, Small-scale and micro-hydro systems, Environmental and social considerations

Wind Energy Systems, Wind turbine technology and design, Wind resource assessment site selection ,Grid integration and power electronics

Integration of Renewable Energy Systems, Hybrid renewable energy systems, Energy storage technologies, Grid integration challenges and solutions

Reference Books

- 1 Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, 4, 2021, Oxford.
- 2 Renewable Energy Systems, Roland Wengenmayr, Thomas Bahrke,, 1, 2020, Springer.
- 3 Renewable Energy Systems: A Smart Energy Systems Approach to the Choice and Modeling of 100% Renewable Solutions, Henrik Lund, 2, 2012, Academic Press.
- 4 Renewable Energy Systems, Olindo Isabella, Miro Zeman, 2, 2020, Academic Press.

25ME02HF - ROBOTICS AND CONTROL : THEORY AND PRACTICE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME02HF	ROBOTICS AND CONTROL : THEORY AND PRACTICE	RCTP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25ME03HF - ADVANCED MANUFACTURING TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME03HF	ADVANCED MANUFACTURING TECHNOLOGIES	AMT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of advanced manufacturing technologies, including additive, subtractive, and hybrid methods, alongside automation, robotics, and Industry 4.0 concepts.	2	PO1, PO2, PSO2
CO2	Analyze the integration of advanced manufacturing technologies, including rapid prototyping, CNC machining, laser cutting, and 3D printing, for process optimization and quality control.	3	PO1, PO2, PSO2
CO3	Apply the effects of advanced manufacturing technologies on productivity, quality, and safety in automated industrial processes and robotic applications.	3	PO1, PO2, PSO2
CO4	Apply advanced manufacturing technologies to design solutions for industrial challenges, integrating theory with practical case studies and group projects	3	PO1, PO5, PSO2
CO5	Apply knowledge to conduct experiments in Advanced Manufacturing Technologies. Explore integration into production systems, case studies, challenges, opportunities, and design solutions	3	PO1, PO2

Syllabus

Introduction to Advanced Manufacturing Technologies: Overview of advanced manufacturing processes such as additive manufacturing, subtractive manufacturing, and hybrid manufacturing. Discussion on the role of automation and robotics in modern manufacturing. Introduction to Industry 4.0 concepts and smart manufacturing

Advanced Manufacturing Processes: In-depth study of advanced manufacturing processes including rapid prototyping, CNC machining, laser cutting, and 3D printing. Analysis of their advantages, limitations, and applications in various industries. Understanding the principles of process optimization and quality control.

Automation and Robotics in Manufacturing: Exploration of automation technologies such as PLC programming, industrial robots, and automated assembly systems. Study of robotic applications in manufacturing for tasks such as material handling, welding, and inspection. Evaluation of the impact of automation on productivity and safety.

Integration of Advanced Technologies: Examination of the integration of advanced manufacturing technologies into production systems. Case studies and practical examples of successful implementations. Discussion on challenges, opportunities, and future trends in advanced manufacturing. Group projects on designing advanced manufacturing solutions for real-world problems.

Reference Books

- 1 Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker, 2, 2025, Springer.
- 2 Manufacturing Processes for Engineering Materials, Serope Kalpakjian, Steven R. Schmid, 6, 2009, Pearson.
- 3 Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, 4, 2014, Pearson.
- 4 Introduction to Robotics: Mechanics and Control, John J. Craig, 3, 2004, Pearson.

25ME04HF - ADVANCED FINITE ELEMENT ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME04HF	ADVANCED FINITE ELEMENT ANALYSIS	AFEA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply finite element method to solve two dimensional structural problems	3	PO3, PO5, PSO2
CO2	Apply finite element method to solve problems in Bending of plates and shells and Conforming and Non-Conforming elements.	3	PO3, PO5, PSO2
CO3	Formulate and solve the non linear problems in Elasto Plasticity.	4	PO3, PO5, PSO2
CO4	Formulate the dynamic problems in free, transient and forced vibration	4	PO3, PO5, PSO2
CO5	Gain hands on experience in converting a given structure into desired shape and size and to perform the suitable analysis using ANSYS software	4	PO3, PO5, PSO2

Syllabus

Two Dimensional Problems: Basic concepts of plane stress and plane strain, stiffness matrix of CST element, finite element solution of plane stress problems

BENDING OF PLATES AND SHELLS: Review of Elasticity equation, Bending of plates and shells, Finite Element formulation of plates and shell elements, Conforming and Non-Conforming elements, C0 and C1 Continuity elements, application and examples.

NON-LINEAR PROBLEM: Introduction, Iterative Techniques, Material Non-Linearity, Elasto Plasticity, Plasticity, Viscos Plasticity, Geometric Non linearity, Large displacement formulation, application in metal forming process and contact problems.

DYNAMIC PROBLEMS: Direct formulation-free, transient and forced response, Solution procedures, Subspace iterative Techniques, Houbot, Wilson, Newmark, Methods, Examples.

Reference Books

- 1 The Finite Element Method, Zienkiewicz, O.C. and Taylor, R.L, 5, Mc Graw Hill International Edition.
- 2 Concept and Applications of Finite Element Analysis, Cook R.D, 3, John Wiley and Sons Inc.
- 3 Finite Element Procedure in Engineering Analysis, Bathe K.J, 3, Prentice Hall.
- 4 Introduction to Non Linear Finite Element Analysis, Nam-Ho Kin, 1, Springer.

25ME05HF - MULTIDISCIPLINARY DESIGN OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME05HF	MULTIDISCIPLINARY DESIGN OPTIMIZATION	MDO	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand interdisciplinary concepts merging engineering, mathematics, and computational methods in Multidisciplinary Design Optimization (MDO).	2	PO1, PO3
CO2	Apply optimization algorithms to solve complex engineering problems, integrating multiple disciplines and constraints effectively	3	PO1, PO5
CO3	Analyze and evaluate design trade-offs using mathematical models, fostering informed decision-making in MDO processes.	4	PO1, PO5
CO4	Develop proficiency in utilizing software tools for MDO, demonstrating competence in implementing and interpreting optimization results.	5	PO3, PO5
CO5	Apply MDO principles and optimization techniques practically, using software tools to solve real-world engineering design challenges and optimize system performance	4	PO3, PO5

Syllabus

Introduction to MDO principles, interdisciplinary integration, and computational methods for analyzing machine kinematics and dynamics in engineering design optimization

Optimization algorithms application, solving complex engineering problems considering multiple disciplines, constraints, and efficient integration in Multidisciplinary Design Optimization (MDO).

Analysis and evaluation of design trade-offs using mathematical models, facilitating informed decision-making in Multidisciplinary Design Optimization (MDO) processes

Proficiency development in utilizing software tools for MDO, implementing and interpreting optimization results to optimize system performance in engineering design applications.

Reference Books

- 1 Multidisciplinary Design Optimization Supported by Knowledge Based Engineering, Jaroslaw Sobieszczanski-Sobieski, Alan Morris, Michel van Tooren, 2017, Wiley.
- 2 Collaborative Multidisciplinary Design Optimization for Conceptual Design of Complex Products, Edris Safavi, 2016, Linkping University Electronic Press.
- 3 Multidisciplinary Design Optimization, Tommy Haynes, 2017, NY Research Press.
- 4 Multidisciplinary Design Optimization in Computational Mechanics, Piotr Breitkopf, Rajan Filomeno Coelho, 2013, Wiley.



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

Y25: B.Tech. - Mechanical Engineering

Category: Flexi Core Courses (FCC)

25ME1001F - ENGINEERING MECHANICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME1001F	ENGINEERING MECHANICS	EM	R	2	1	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25ME2109F - THERMODYNAMICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2109F	THERMODYNAMICS	TD	R	2	1	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25ME2221F - MODERN VEHICLE TECHNOLOGY (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2221F	MODERN VEHICLE TECHNOLOGY	MVT	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of Thermodynamics to understand the working of hydrogen and electric vehicles	3	PO1, PO2
CO2	Analyse the working of various vehicle suspension, safety and pollution	3	PO1, PO2
CO3	Analyse the working of various vehicle suspension, safety and pollution control systems.	3	PO1, PO2
CO4	Investigate the vehicle automated tracks for proper road maintenance and national highway network	4	PO4
CO5	Conduct experiments using software to analyse the performance of different vehicular systems	4	PO5

Syllabus

Trends in Automotive Power Plants: Hybrid Vehicles, Stratified charged or lean burn engines, Hydrogen Engines-battery vehicles Electric propulsion with cables, Magnetic track vehicles.

Suspension Brakes and Safety: Air suspension-Closed loop suspension-antiskid braking system, Retarders, Regenerative braking safety cage air bags-crash resistance, Passenger comfort noise & Pollution: Reduction of noise, Internal & external pollution control through alternate fuels power plants-Catalytic converters and filters for particular emission.

Vehicle Operation and Control: Computer Control for pollution and noise control and for fuel economy-Transducers and operation of the vehicle like optimum speed and direction.

Vehicle Automated Tracks: Preparation and maintenance of proper road network-National highway network with automated roads and vehicles-Satellite control of vehicle operation for safe and fast travel.

Reference Books

- 1 Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives , Chris Mi, M. Abul Masrur, 2, Wiley.
- 2 Electric Vehicle Technology Explained, James Larminie, John Lowry, 2, Wiley.
- 3 Automotive Engineering: Powertrain, Chassis System and Vehicle Body, David Crolla, 2009, 3 Automotive Engineering: Powertrain, Chassis System and Vehicle Body, David Crolla, 2009, Butterworth-Heinemann.
- 4 Automotive Control Systems, Uwe Kiencke, Lars Nielsen, 1, Springer.

25ME2225F - MATERIAL SCIENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2225F	MATERIAL SCIENCE	MS	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25ME3122F - ROBOTICS & MECHATRONICS (F)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME3122F	ROBOTICS & MECHATRONICS	R&M	F	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of Robotics and Mechatronics	2	PO1, PO2, PSO2
CO2	Analyze different types of sensors, transducers, and actuators used in robotic and mechatronics systems.	3	PO1, PO2, PSO2
CO3	Apply transformations, Denavit-Hartenberg (DH) representation, kinematics and dynamics for Robotic devices	3	PO1, PO3, PSO2
CO4	Develop control systems, model mechanical and electrical systems, and basic PLC programs.	3	PO1, PO3, PSO2
CO5	Perform computational simulations for kinematics, dynamics, and control systems using Software tools	4	PO5, PSO2

Syllabus

Introduction to Robotics and Mechatronics: Definition and Scope, History, Major components, Applications. Classification of Robots: Classification by coordinate system and by control method. End-Effectors: Introduction, types of End effectors: grippers and tools, considerations in the selection and design of end-effector.

Sensors and Transducers: Introduction, Classification, Position and Displacement, Proximity, Force and Pressure, Velocity, Temperature, Vision sensors, Touch & Slip. Selection of Sensors. Actuators: Pneumatic and hydraulic actuators systems, Electrical actuators.

Positions and orientations, Transformations, Homogeneous Transformation matrix. Robot Kinematics: Introduction, kinematic parameters, Link Description, Denavit- Hartenberg (DH) representation, Concept of forward and inverse kinematics. Robot Dynamics: Forward dynamics: Lagrangian (Lagrange-Euler) and Newton-Euler formulations, Inverse dynamics.

Control System: Open and closed loop control system, PID control system. System modeling: Modelling of one and two order Mechanical and Electrical Systems, Transfer function of Mechanical and Electrical Systems. PLC: Introduction, basic structure, programming of PLC, selection of a PLC. CASE STUDY: pick and place Robot, CNC Machine, etc.

Computational exercises using Python for Transformations, Denavit- Hartenberg (DH) representation, Kinematics. Simulations of Kinematic and Dynamic models using Robo Analyzer. Transfer function of Mechanical and Electrical Systems using Octave PLC Programming using OpenPLC Editor.

Reference Books

- 1 Introduction To Robotics: Mechanics and Control , John J. Craig, , 2009, Pearson Education,.
- 2 Robot Modeling and Control , Mark W. Spong, Seth Hutchinson, M. Vidyasagar,, 2005, Wiley,.
- 3 Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Mechatronics:, 2008. , Pearson Education.



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

Y25: B.Tech. - Mechanical Engineering

Category: Professional Core Courses (PCC)

25AD2001 - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AD2001	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	AIML	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply classical AI techniques such as search, constraint satisfaction, and logical inference to solve real-world problems.	3	PO2, PO3
CO2	Demonstrate ability to build intelligent systems using probabilistic reasoning and basic learning models	3	PO2, PO3
CO3	Apply supervised and unsupervised machine learning algorithms to practical problems and interpret results using performance metrics.	3	PO2, PO3
CO4	Implement deep learning models, reinforcement learning, and deploy models while addressing ethical concerns in AI applications	4	PO2, PO3, PO5
CO5	Lead peer teams in model development, experimentation, and responsible deployment using MLOps and explainability tools.	3	PO9, PO10

Syllabus

Foundations of AI and Search Overview of AI history applications intelligent agents and environments Problem solving Uninformed search BFS DFS Informed search A Star Best first Local search Hill Climbing Simulated Annealing Adversarial search Minimax Alpha beta pruning Constraint Satisfaction Problems Backtracking Forward checking

Knowledge Representation and Probabilistic Reasoning Propositional and predicate logic forward and backward chaining resolution Knowledge representation techniques and inference engines Introduction to probability theory Bayesian networks Naive Bayes Reasoning under uncertainty Bayes theorem

Supervised and Unsupervised Learning Data preprocessing cleaning normalization splitting batching Supervised learning Linear Logistic regression SVM Decision Trees KNN Ensemble methods Random Forest AdaBoost XGBoost Unsupervised learning K Means Hierarchical clustering

Advanced Topics and Applications Introduction to Deep Learning MLP CNNs RNNs activation functions loss functions Reinforcement learning basics Q learning applications NLP fundamentals and Time Series Analysis AI Ethics fairness accountability explainability Model deployment with Flask Streamlet and intro to MLOps

Reference Books

- 1 Artificial Intelligence A Modern Approach, Stuart Russell, Peter Norvig, 3rd Edition, Pearson.
- 2 Machine Learning, Tom M Mitchell, 1st Edition 1997, McGraw Hill Education.
- 3 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 1st Edition (2016), MIT Press.
- 4 Pattern Recognition and Machine Learning, Christopher Bishop, 1st Edition (2006), Springer.

25ME2106 - FLUID MECHANICS & HYDRAULIC MACHINES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2106	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 fluid statics to estimate the total pressure, Centre of pressure and forces on submerged and floating bodies	3	PO1, PO2, PSO1
CO2	Apply continuity, Euler and Bernoulli equations and estimate the discharge through different flow measuring devices	3	PO1, PO2, PSO1
CO3	Apply the principles of fluid laws to estimate the losses in pipe flows and impact of jets on different plate geometries	3	PO1, PO2, PSO1
CO4	Analyze the performance of hydraulic turbines and pumps using velocity triangles and model similitude.	4	PO1, PO2, PO3, PSO1
CO5	Conduct experiments to verify and apply various fluid flow principles and performance evaluation of various hydraulic machines like turbines and	4	PO1, PO2, PO3, PSO1

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; Introduction, pressure, Pascals law, hydrostatic law, measurement of pressure, simple and differential manometers, Total pressure and center of pressure on vertical, horizontal, inclined and curved surfaces. Buoyancy: Buoyancy, forces on submerged bodies, stability of floating bodies.

Fluid kinematics: Introduction, types of fluid flow, Discharge, Continuity equation, velocity potential function and stream function. Fluid dynamics: Introduction, Eulers equation of motion, Bernoullis equation and applications, Venturimeter, Orifice meter, Nozzles. Flow through pipes: Introduction, major and minor energy losses, friction coefficient in laminar and turbulent flow, Hagen-Poiseuille law, Hydraulic gradient and total energy line, pipes in series and parallel, power transmission through pipes, Reynolds experiment and water hammer.

Dimensional analysis and model similitude Boundary layer theory: Introduction, laminar, turbulent boundary layer, boundary layer thickness, displacement thickness, momentum thickness, energy thickness, boundary layer separation, methods of preventing separation. Impact of jets: Introduction to impulse-momentum equation and its applications, Force exerted by jet on fixed target, moving target, and series of curved vanes.. Fluidics: Applications, principles and components.

Hydraulic Machines-Turbines: Introduction, types and classification Pelton wheel, Francis turbine, Kaplan turbine-theory, work done and efficiency, design parameters, problems. Hydraulic Machines-Centrifugal pumps: Definition of pump, classification, description & general principle of working, priming, work done & efficiencies of a centrifugal pump, Minimum starting speed, cavitation in centrifugal pumps, Multistage pumps, problems on centrifugal pumps.

Conduct experiments to verify and apply various fluid flow principles and performance evaluation of various hydraulic machines like turbines and pumps

Reference Books

- 1 Fluid Mechanics and Hydraulic Machines, R.K. Bansal, 3, Mc Graw Hill.
- 2 Fluid Mechanics, S. K. Som and G. Biswas, 4, Tata McGraw Hill publications.
- 3 Fluid Mechanics, Yunus A. Cengel, 3, McGraw Hill publications..
- 4 Fluid Mechanics and Hydraulic Machines, D. S. Kumar, 3, Narosa Publishing House Private Limited..
- 5 Fluid Mechanics, Frank M. White, 9, McGraw-Hill Education.

- 6 Hydraulics and Fluid Mechanics including Hydraulic Machines, P.N. Modi, S.M. Seth, 21, Standard Book House.

25ME2107 - MECHANICS OF SOLIDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2107	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 members with multi axial loading and lateral loading	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.

25ME2108 - MANUFACTURING PROCESS & TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2108	MANUFACTURING PROCESS & TECHNOLOGY	MPT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of pattern design, gating system configuration, and metal forming to suitable casting and welding techniques for manufacturing applications.	3	PO3, PO5, PSO2
CO2	Apply the principles of metal cutting mechanics to analyze tool geometry and compute machining time and power requirements for conventional machine tools.	3	PO2, PO5, PSO2
CO3	Explain the working principles, process parameters and applications of various unconventional machining processes.	2	PO1, PO2, PSO2
CO4	Explain the concepts of Geometric Dimensioning and Tolerancing (GD&T), and the application of Taylors Principle in inspection processes.	2	PO1, PO2, PSO2
CO5	Apply the concepts of casting, welding, conventional and unconventional machining, and metrology to perform and evaluate manufacturing experiments using appropriate tools and techniques.	3	PO1, PO3, PSO2

Syllabus

Pattern design considerations; Gating system design, Special casting processes, Advanced welding techniques, Concepts of hot and cold working processes.

Mechanics of metal cutting, tool geometry, tool wear and life, Grinding operations, reciprocating machine tools. Machining time calculations and power required on conventional machine tools.

Unconventional Machining Processes: Wire Electric Discharge Machining, Plasma cutting machine, CO2 Laser machine, Abrasive jet machining, Ultra sonic Machining, Electrochemical Machining

Introduction to GD & T, Limits, Fits and Tolerances, Hole and shaft basis system, Gauges, Taylors Principle, Linear and angular measurements.

Reference Books

- 1 Manufacturing Engineering and Technology, Serope Kalpakjian, Steven R. Schmid, 4th Edition, 2014, Pearson Education.
- 2 Manufacturing Technology, R K Rajput, 1, Laxmi Publications Pvt Limited..
- 3 Elements of Workshop Technology Vol. I & II, S.K. Hajra Choudhury, H.K. Hajra Choudhury, 15th Edition, 2018, Media Promoters & Publishers Pvt. Ltd..
- 4 Production Technology: Manufacturing Processes, Technology and Automation, R.K. Jain, 1, Pearson Education.

25ME2210 - AUTOMATED MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2210	AUTOMATED MANUFACTURING	AMT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply advanced automation techniques to design and optimize smart production systems.	3	PO2, PO5, PSO1
CO2	Interpret and apply the concepts of Industry 4.0 and Cyber-Physical Systems (CPS)	4	PO3, PO5, PSO2
CO3	Apply the concepts of inspection methods to inspect the end products	3	PO2, PO3, PSO1
CO4	Design and implement Digital twins technologies to monitor real-time system in Manufacturing	3	PO2, PO3, PSO2
CO5	Develop, integrate, and evaluate smart manufacturing systems	3	PO2, PO3, PSO2

Syllabus

Factory Automation: Automation scalability (fixed, programmable, flexible and reconfigurable); Design and analysis of automated flow lines; Average production time, production rate, line efficiency; Analysis of transfer lines without storage; Partial and full automation.

Cyber-Physical Systems and Cyber-Security in Manufacturing: Introduction, key aspects of CPS, role of cyber-physical systems in smart factories, challenges of implementing CPS in factories, future trends of CPS. Cyber-security in manufacturing: Historic development, strategies and risks, integration of CPS and Cyber security. Case studies on real world cyber security threats and solutions.

Inspection Technologies in Manufacturing: Conventional measuring and gauging techniques, co-ordinate measuring machines, surface measurement, optical inspections methods, non-contact non-optical inspection techniques, machine vision. Quantum technologies in Manufacturing.

Digital Twins and Simulation in Smart Manufacturing: Concepts, features, architecture of DT, characteristics, types of digital twins, applications and challenges in implementing digital twins. Simulation tools and real-time system monitoring using digital twins.

Reference Books

- 1 Automation, Production Systems, and Computer-Integrated Manufacturing, , Mikell P. Groover, 4th Edition, 2014., Pearson Education.
- 2 Digital Twin Driven Smart Manufacturing, , Fei Tao, Ang Liu, Tianliang Hu, A. Y. C. Nee,),, 1st Edition, 2019., Academic Press (Elsevier).
- 3 Introduction to Mechatronics and Measurement Systems, , David G. Alciatore, Michael B. Hstand, 5th Edition, 2020, McGraw-Hill Education.
- 4 Internet of Things: , A Hands-On-Approach by Arshdeep Bahga and , 1, Vijay Madiseti.
- 5 Industrial Cloud-Based Cyber-Physical Systems: , Approach by Armando W. Colombo and Thomas Bangemann, 1, The IMC-AESOP.

25ME2211 - KINEMATICS & DYNAMICS OF MACHINES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2211	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	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, , k.Amitabha Ghosh, Asok Kumar Malli, 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.

25ME3112 - HEAT TRANSFER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME3112	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 during phase change.	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, Thermal energy storage using PCM s -Heat Sinks

Basic concepts of heat exchangers; Heat exchanger classification, analysis of heat exchangers-LMTD & NTU method. 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, S. Chand & Company Limited .
- 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.

25ME3212 - MACHINE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME3212	MACHINE DESIGN	MD	R	3	1	0	2	4.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze transmission shafts, couplings and springs for given design conditions	4	PO3, PSO2
CO2	Analyze welding, bolted fastening systems for given design conditions	4	PO3, PSO2
CO3	Analyze and select the appropriate bearings, belt drives and chain drives for given working conditions	4	PO3, PSO2
CO4	Analyze the spur and helical gears, band and block brakes for given working conditions	4	PO3, PSO2
CO5	Simulate and Evaluate a virtual/functional prototype	5	PO4, PSO2

Syllabus

Shafts: Design of solid and hollow shafts for strength and rigidity, Design of shaft for variable load, Design of shafts for gear and belt drives. Couplings: Design of Rigid and Flexible Couplings Design of Helical springs, Torsion springs, Spiral springs, Leaf springs

Design of welded and bolted joints for eccentric loading

Design of welded and bolted joints for eccentric loading

Design of spur, helical gear drives and design of brake systems

Reference Books

- 1 Design of machine elements,, VB Bhandari, 5th;2020, Tata McGraw Hill book Co...
- 2 Design of Machine Elements, , M F Spotts, 8th;2019, Pearson Education.
- 3 The Mechanical Design Process, , D.Ullman, , 4th;2011,, McGraw-Hill..
- 4 Product Design and Development, , K.T. Ulrich and S.D. Eppinger,, 7th;2020, Standard Publishers..

25ME3214 - DESIGN OF THERMAL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME3214	DESIGN OF THERMAL SYSTEMS	DTS	R	3	1	0	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of vapour power cycles to analyze steam turbines and nozzles to determine flow parameters and discharge conditions.	3	PO1, PO2
CO2	Apply the principles of thermodynamics to determine the performance of single and multistage compressors	3	PO1, PO2
CO3	Apply the concepts of Psychrometry to analyze the simple and vapour compression refrigeration processes.	3	PO1, PO2
CO4	Design and optimization of various thermal energy systems such as heat exchangers and engines.	4	PO4
CO5	Conduct parametric study to design thermal systems such as steam turbines, nozzles and compressors using equation solver.	4	PO4

Syllabus

STEAM TURBINES: Classifications, construction details, compounding, velocity diagrams, governing, losses in steam turbines. **STEAM NOZZLES:** Types of nozzles, isentropic flow through nozzles, effect of friction, nozzle efficiency, condition for maximum discharge, throat and exit areas using Mollier diagram.

RECIPROCATING AIR COMPRESSORS: Reciprocating Air Compressor - Single and Multistage, computation of work done, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram. **ROTARY COMPRESSOR:** Introduction, Classification, Displacement Compressors, Steady Flow Compressors.

PSYCHROMETRY: Properties of atmospheric air Gibbs and Daltons law-humidity degree of saturation dry and wet bulb temperatures psychrometric chart. Psychrometric processes: mixing of two streams-sensible heating sensible cooling, cooling and dehumidification -cooling and humidification heating and humidification-heating and dehumidification **REFRIGERATION:** Introduction to refrigeration COP ideal cycles Simple refrigeration cycle Vapour Compression cycle: p-h and T-s diagrams.

MODELLING OF THERMAL SYSTEMS: Types of Models, Design of thermal system for different application areas. Optimization of thermal systems, constrained and unconstrained optimization problems applicable to thermal systems. Modelling of thermal equipment.

Reference Books

- 1 Applied Thermodynamics for Engineering Technologies, T.D Eastop, 5th edition: 1993, Wiley..
- 2 Engineering Thermodynamics , P.K.Nag, 6th edition:1982, Tata McGraw Hill .
- 3 Thermal Engineering, Er.R.K.Rajput, 2005, Laxmi Publications.
- 4 Refrigeration and Air Conditioning, Refrigeration and Air Conditioning, 7th edition, Tata McGraw Hill.



(DEEMED TO BE UNIVERSITY)

Y25: B.Tech. - Mechanical Engineering

Category: Engineering Science Courses (ESC)

25EC1101 - BASIC ELECTRICAL AND ELECTRONIC CIRCUITS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EC1101	BASIC ELECTRICAL AND ELECTRONIC CIRCUITS	BEEC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of AC and DC circuits and apply them to solve electric circuit problems.	2	PO1
CO2	Apply different circuit analysis techniques to find voltage, current, impedance and power in electrical circuits.	3	PO1
CO3	Comprehend the behavior of basic electronic components, such as diodes and transistor, and their applications.	2	PO1
CO4	Understand the basic functional principles of different analog ICs, such as IC 741 Op Amp, IC 555 Timer and IC Voltage Regulators.	2	PO1
CO5	Utilize measurement tools and equipment for validating theoretical concepts of different electrical and electronic circuits and develop problem solving capabilities through hands on experimentation.	4	PO1

Syllabus

DC Fundamentals: Basic Circuit Elements and Sources, Series and Parallel Connection of Circuit Elements, Star Delta Transformation, Ohms Law, Kirchhoffs Laws. AC Fundamentals: Peak Value, Time Period, Frequency, RMS & Average Values, Form Factor, Peak Factor and Power Factor

Circuit Analysis Techniques: Mesh Analysis, Nodal Analysis, Superposition Theorem, Thevenins Theorem, Nortons Theorem, Maximum Power Transfer Theorem, Steady State Analysis of RL, RC, RLC Circuits, Resonance and its Parameters (Resonant Frequency, Q-Factor, Bandwidth)

Semiconductor Devices: PN Junction Diode (Operation, V-I Characteristics), Applications: Diode as a Switch, Rectifiers (HWR, FWR), Clippers and Clampers, Operation of Zener Diode (Breakdown), Zener as a Voltage Regulator, LED. Bipolar Junction Transistor: Operation of a Transistor, Input and Output Characteristics of CB, CE, CC Configurations, Transistor as a Switch

Analog Integrated Circuits: Operational Amplifiers (IC 741), Ideal and Practical Characteristics, Inverting and Non-Inverting amplifiers and Applications of Op-Amp, IC 555 Timer and Applications, Voltage, Regulators: 78XX, 79XX and LM723

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.

25ME1001 - ENGINEERING MECHANICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME1001	ENGINEERING MECHANICS	EM	R	3	0	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	PO2
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	PO3
CO4	Apply fundamental concepts of kinematics and kinetics of particles to solve simple practical problems of rigid bodies and particles.	3	PO3

Syllabus

TWO DIMENSIONAL FORCE SYSTEMS: Introduction to force systems, 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, 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, Newtons Second Law for rigid bodies, Work-energy principle, Impulse-momentum principle, D'Alemberts principle and dynamic equilibrium. Introduction to Free Vibration of a Particle/System 1 DOF

Reference Books

- 1 Engineering Mechanics Statics and Dynamics, A K Tayal, 14th, Umesh publications .
- 2 Engineering Mechanics Statics and Dynamics, , R C Hibbeler, 3, Pearson..
- 3 Engineering Mechanics , Irving H. Shames, 4th, Prentice-Hall.
- 4 Vector Mechanics for Engineers in SI units Statics & Dynamics, F. P. Beer and E.R. Johnston, 12, Mc Graw Hill Publications .

25ME1002 - ENGINEERING GRAPHICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME1002	ENGINEERING GRAPHICS	EG	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of orthographic and pictorial projections to visualize, sketch, and interpret engineering objects.	3	PO1, PO5
CO2	Develop 3D part models, assemblies, and tolerance drawings using Autodesk CAD & Fusion 360.	3	PO1, PO5

Syllabus

Principles of Orthographic Projections, Projection of points, lines, planes, solids, Full and half sectional views for complex objects,

Pictorial Representation Isometric projections and drawings, Perspective views and basic rendering concepts, Visualization of complex parts from given views

CAD Modelling using Fusion 360 Sketching constraints and dimensions, 3D part modeling: extrude, revolve, sweep, loft, Boolean operations and parametric constraints

Reference Books

- 1 Engineering Drawing, N.D. Bhatt, 53, Charotar Publishing .
- 2 Engineering Drawing and Graphics, K. Venugopal, 5, New Age International .

25ME1004 - WORKSHOP PRACTICES FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME1004	WORKSHOP PRACTICES FOR ENGINEERS	WPE	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate fundamental skills in foundry, molding, casting, and both arc and gas welding operations.	3	PO1, PO5, PSO1
CO2	Perform basic machining operations using lathe, drill and milling machines.	3	PO1, PO5, PSO1

Syllabus

Foundry Practice Introduction to Casting Process, Pattern Making, Molding, Metal Melting and Pouring, Casting Defects, Foundry Safety. Lab Activities: Introduction to Foundry Tools and Equipment , Preparation of Green Sand Molds, Metal Melting and Pouring Demonstration Welding Processes Arc Welding: Principle of operation, electrode types, straight vs reverse polarity, bead formation. Gas Welding (Oxy-Acetylene): Flame types, filler materials, precautions. Lab Activities: Practice butt joint and lap joint using arc welding. Demonstrate gas welding on sheet metal.

Machining Processes Turning and Facing: Introduction to lathe, cutting tool geometry, turning and facing operations, speeds and feeds, chip formation. Drilling: Types of drill machines, drilling operations. Milling: Types of milling machines, up and down milling, slotting and face milling operations. Lab Activities: Perform facing and turning on a mild steel rod. Demonstrate milling slot on a flat workpiece. Perform drilling operations.

Reference Books

- 1 Manufacturing Technology , P.N. Rao , 5, McGraw Hill Education.
- 2 Workshop Technology , Hajra Choudhury , Volume1, Media Promoters.
- 3 Workshop Technology , Vol. I & II, 12th Edition, Media Promoters & Publishers Pvt. Ltd.
- 4 Fundamentals of Modern Manufacturing , Mikell P. Groover , 7th, Wiley.

25ME1103 - DESIGN TOOLS WORKSHOP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME1103	DESIGN TOOLS 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	PO2, PO5
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	PO1, PO3
CO4	Utilising the softwares of Autodesk Fusion 360 and the same can be printed in 3D printer as physical prototype	3	PO1, PO3

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

25ME2109 - THERMODYNAMICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2109	THERMODYNAMICS	TD	R	3	1	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of thermodynamics and apply first law of thermodynamics to various flow and non-flow processes	3	PO1
CO2	Apply second law of thermodynamics and principle of entropy to verify the reversibility, irreversibility and assess the availability in a process. Also, Understand the relationship between thermodynamic properties using maxwell's relations	3	PO1
CO3	Analyze the properties of steam and assess various methods to improve the performance of a vapour power cycle	4	PO2
CO4	Apply thermodynamic principles to estimate the performance of different air standard cycles.	4	PO2

Syllabus

Fundamental Concepts and Definitions: Thermodynamic system, processes, thermodynamic equilibrium and quasi-static process, Reversible and irreversible processes, Zeroth law, Work and Heat in flow and non-flow processes First Law of Thermodynamics for Non-Flow Systems: First law of thermodynamics for flow and non-flow processes, 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. Entropy: Definition of entropy, Clausius theorem, inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy, availability and irreversibility, Maxwells and Tds relations.

PURE SUBSTANCE: Vapour-liquid-solid phase equilibrium, independent properties, Equations of state, Tables of thermodynamic properties. VAPOUR POWER CYCLES: Rankine cycle, Effect of pressure and temperature, Reheat & Regenerative cycle, Binary vapour cycle.

Air standard cycles: Assumptions, P-v & T-s diagrams of Otto, diesel, dual and Brayton cycle. Mean effective pressure, efficiency and performance comparison of the cycles.

Reference Books

- 1 Thermodynamics, an Engineering Approach, Yunus A. Cengel & Michael Boles, 2,1990, Tata McGraw Hill, .
- 2 Engineering Thermodynamics, P. K. Nag, 4,1995, Tata McGraw Hill.
- 3 Engineering Thermodynamics, Cohen and Rogers, 1,1995, Pearson Education India limited .
- 4 Thermodynamics, E Rathakrishnan, 2,2005, Eastern economy edition .

25SC1101 - PROBLEM SOLVING THROUGH C (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SC1101	PROBLEM SOLVING THROUGH C	PSTC	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop Basic and Complex Building Blocks for real world problems using structured programming paradigm	3	PO1, PO2, PO3, PO5
CO2	Develop logical building blocks using conditional statements to solve real world problems	3	PO1, PO2, PO3, PO5
CO3	Develop logical solutions using the concepts of arrays and functions	3	PO1, PO2, PO3, PO5
CO4	Develop solutions by applying various operations on user defined data types such as structures and unions	3	PO1, PO2, PO3, PO5
CO5	Apply the structured programming paradigm with logic building skills on Basic and Linear Data Structures for solving real world problems	3	PO1, PO2, PO3, PO5
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	PO1, PO2, PO3, PO5

Syllabus

Fundamentals of Computing, Structured Programming Paradigm: Problem Solving Approach, Algorithms and Flowcharts, Structure of C Program, Pre-Processor Directives Phases of developing and running computer program in C. Data concepts in C: Tokens, Constants, variables, expressions, Data types: size and values. Primitive Data Types, Type Modifiers, Unsigned and Signed data types. Number systems and representations. Constants, Pointers: Pointer variables. Declaring and dereferencing pointer variables. Input-Output Statements, Formatted I/O, Operators: Operators and expressions, Types of operators, Precedence, Associativity Pointer Arithmetic

Statements: Declarations, Compound statements, Decision Making using conditional statements, Branching, simple-if, if-else, elseif ladder, switch, break and continue. Iterative statements: While construct, Do-while Construct, For construct, Nested Loops

1-D arrays, 2-D Arrays, Initialization. Searching: Linear Search and Binary Search Sorting: Selection Sort, Matrices. Strings: string handling functions, Array of Strings Accessing arrays through pointers. Pointers and strings. Modular programming approach. Functions: The prototype declaration, Function definition. Function call, Passing arguments to a function, by value, by reference. Scope of variable names, Storage Classes. pointer to functions. Recursion, Recursive function calls, linear recursion, Tail recursion, Tree of recursion

Structures: Motivation, examples, Declaration, and use. Operations on structures. Passing structures as function arguments. type defining structures, structure pointer, Dynamic Memory Allocation, Self-referential structures, Bit-Fields, Unions and enumerated data types. File input-output: Streams. Input, output and error streams. Opening, closing and reading and writing of files. Programming for command line arguments

Reference Books

- 1 The C Programming Language: ANSI C Version, Brian W. Kernighan, Dennis M. Ritchie, 2nd Edition, Prentice-Hall/Pearson Education-2005.
- 2 Programming in ANSI C, E. Balagurusamy , 8th Edition, Tata McGraw-Hill Education.
- 3 C How to program, H. M. Deitel, P. J. Deitel, 7th edition, Pearson Education.
- 4 Problem Solving and Program Design in C, J.R. Hanly and E.B. Koffman, 6th Edition, Pearson Education, 2009..

- 5 Computer Science: A Structured Programming Approach Using C, B.A. Forouzan and R.F. Gilberg, 3rd Edition, Thomson Course Technology.
- 6 C for Engineers and Scientists , Harry H, International Edition-2010, Mc Graw Hill .

25SC1203 - DATA STRUCTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SC1203	DATA STRUCTURES	DST	R	3	0	2	4	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand various sorting algorithms and analyze the efficiency of the algorithms	2	PO1, PO2, PO3, PO5
CO2	Implement and evaluate Linear Data Structures and Demonstrate their applications	3	PO1, PO2, PO3, PO5
CO3	Implement and evaluate tree data structures and understand hashing techniques	3	PO1, PO2, PO3, PO5
CO4	Understand graph data structures and apply graphs to solve problems	2	PO1, PO2, PO3, PO5
CO5	Design, Develop and evaluate common practical applications for linear and nonlinear data structures	4	PO1, PO2, PO3, PO5
CO6	Skill the students in such a way that students will be able to develop and create programs as well as applications in DS	3	PO1, PO2, PO3, PO5

Syllabus

Searching and Sorting: Algorithm Analysis: Mathematical Background, Model, Analyze, Running Time Calculations. Searching Linear Search, Binary Search analysis Sorting: Introduction to Sorting Algorithm, Bubble sort Insertion sort, Shell sort, Heap sort, Merge sort, Quick sort, Bucket sort, External Sorting.

Lists: Abstract Data Types (ADTs), List ADT, Linked list implementation, singly linked lists, circularly linked lists, doubly linked lists, Applications of lists, Polynomial ADT. Stacks And Queues: Stack ADT, Operations, Applications: Representing & Evaluating arithmetic expressions, Infix to Postfix conversion, Balancing Symbols. Queue ADT, Operations, Circular Queue, Dequeue. Implementing stacks and queues using Linked List.

Hashing & Trees: Priority Queues (Heaps): Model, Simple Implementations, Binary Heap, Applications of Priority Queues. Hashing: Introduction to Hashing, Hash Function, Separate Chaining, Open Addressing, Rehashing, Extendible Hashing. Trees: Introduction to trees, Binary Trees, Tree Traversals, expression trees, The Search Tree: Binary Search Trees, AVL Trees, Splay Trees, B-Trees, Red black trees

Graph Data Structure: Introduction to Graph data structure basic terminologies transitive closure representation of graphs adjacency matrix linked representation of graphs graph traversals Breadth First Search Depth First Search minimal spanning trees Prims and Kruskals Algorithm

Reference Books

- 1 Data Structures and Algorithm Analysis in C, Mark Allen Weiss, 2010 Second Edition, Pearson Education..
- 2 Fundamentals of Data Structures in C, Ellis Horowitz, Second Edition, 2015., Universities Press (India) Private Limited Orient Blackswan CBS Publishers & Distributors Pvt Ltd.
- 3 Data Structures and Algorithms, A.V. Aho, J. E. Hopcroft, and J. D. Ullman, First Edition Reprint 2003, Pearson Education.
- 4 Fundamentals of data structures in C, Horowitz, Sahni, Anderson Freed, Second Edition-2007, Silicon Press.
- 5 Data Structures, F. Gilberg, B. A. Forouzan, Second Edition 2005, Thomson India Edition.
- 6 Data Structures & Program Design in C, Robert Kruse, C.L. Tondo, Bruce Leung, Shashi Mogalla, FourthEdition-2007, Pearson Education..

25SC2007 - PYTHON PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SC2007	PYTHON PROGRAMMING	PP	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of Basic Data types, Operators, Decision and Looping Control Statements, String	3	PO1, PO2, PO3, PO5
CO2	Apply the concepts of Lists, Tuples, Dictionaries. Functions, Modules, Class, Object, OOPS principles.	3	PO1, PO2, PO3, PO5
CO3	Apply the concept of OOP principles, Classes and Objects, Call by value vs call by reference, recursion and nested classes	3	PO1, PO2, PO3, PO5
CO4	Apply the concept of files, interfaces, packages, threads	3	PO1, PO2, PO3, PO5
CO5	Design, implement and evaluate python program using basic datatypes, variables, expressions, conditional statements, loops, functions, built-in data structures, object oriented concepts, python libraries and modules, debugging techniques and file I/O to solve programming problems	4	PO1, PO2, PO3, PO5, PO9, PO11

Syllabus

Python interpreter and interactive mode; values and types: int, float, Boolean, string, and list, variables, expressions, statements, tuple assignment, precedence of operators, comments, Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Strings: string slices, immutability, string functions and methods, string module

Fruitful functions: functions, function definition and use, flow of execution, parameters and arguments return values, parameters, local and global scope; List, Tuples, Set, Dictionary data types, Classes, Object: command line arguments, Class, object, methods, constructors, OOPs principles

Polymorphism: Static and Dynamic Polymorphism (Overloading, Overriding), Inheritance Super classes sub classes Protected members constructors in sub classes, Super keyword, Encapsulation: Data Encapsulation and Data Abstraction, Object as argument and return value: Call by value vs. Call by reference, recursion, and Nested classes

Files, Interfaces, Packages, and Threads: Introduction to files: Create, Read Write, Append, Delete Interfaces defining an interface, implementing & Applying interface, differences between classes and interfaces and extending interfaces, Packages, importing packages. Exception Exceptions exception hierarchy throwing and catching exceptions builtin exceptions, creating own exceptions fundamentals, Threads: Difference between multi threading and Multitasking, Different Thread objects

Reference Books

- 1 Think Python: How to Think like a Computer Scientist, Allen B. Downey, 2nd (2016), O Reilly Publishers.
- 2 Python for Programmers, Paul Deitel, Harvey Deitel, 1st (2021), Pearson Education.
- 3 Python 3 Object Oriented Programming, Dusty Phillips, 2nd, Packt Publishing.
- 4 Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Charles Dierbach, Wiley India Edition (2013), Wiley India.
- 5 Introduction to Programming in Python: An Interdisciplinary Approach, Robert Sedgewick, Kevin Wayne, Robert Dondero, 2016, Pearson India Education Services Pvt. Ltd..



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

Y25: B.Tech. - Mechanical Engineering

Category: Basic Science Courses (BSC)

25CY1001 - ENGINEERING CHEMISTRY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CY1001	ENGINEERING CHEMISTRY	SCE2	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, 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, Wiley.
- 4 Engineering Chemistry: Fundamentals and Applications, Shikha Agarwal, 2nd, Cambridge University Press.

25ME2105 - MATERIAL SCIENCE & METALLURGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ME2105	MATERIAL SCIENCE & METALLURGY	MMS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand crystallography and various material testing methods	2	PO1, PO2, PSO1
CO2	Understand and distinguish various types of materials based on their engineering applications	2	PO1, PO2, PSO1
CO3	Apply the concepts of cooling curves and phase diagrams	3	PO1, PO2, PSO1
CO4	Apply the concepts of heat treatment processes and their strengthening mechanisms	3	PO1, PO2, PSO1
CO5	Apply practical knowledge and skills in conducting a wide range of experiments on metallography and heat treatment processes, gaining hands-on experience	3	PO1, PO2, PSO1

Syllabus

Introduction to Engineering materials, Crystallography, Crystal systems and Bravais lattices, Crystal imperfections, Material testing Methods-Destructive and Non Destructive Methods, Dye penetrate test, Magnetic flux test, Radiography and Ultrasonic test.

Ferrous and Non Ferrous Materials, Ceramics, Composites, Nanomaterials and Biomaterials: Introduction, classification and applications. Smart Materials: Introduction, shape memory effect, classification of shape memory alloys.

Constitution of alloys: Necessity of alloying, Solid solutions, Gibbs Phase rule, Cooling Curves. Phase Diagrams: Introduction, classification based on components and transformations, construction, reactions involved in FeC, CuNi alloys.

Heat Treatment of steels: Introduction, stages, classification: Annealing, Normalising, Tempering, Hardening, Hardenability test by Jominy end quench apparatus, TTT diagram, CCT diagrams. Special heat treatment techniques: Introduction, classification, surface hardening and case hardening methods such as carburizing, nitriding, cyaniding and carbonitriding.

Reference Books

- 1 Material Science & Metallurgy, Dr.V.D.Kodgire, 46, Everest Publishing House.
- 2 Material Science & Metallurgy, O.P. Khanna, 10, Dhanpat Rai Publications .
- 3 Introduction to Physical Metallurgy, Sidney H Avner, 2, Mc Grawhill publishers.
- 4 Materials science and Engineering, V. Raghavan, 5, Prentice-Hall of India .
- 5 Engineering Metallurgy, R.A.Higgins, 6, Butterworth-Heinemann .

25MT1001 - LINEAR ALGEBRA AND CALCULUS FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MT1001	LINEAR ALGEBRA AND CALCULUS FOR ENGINEERS	LCE	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

Differential calculus Partial derivatives Jacobian total differentiation and their applications chain rule Taylors series for function of two variables maxima and minima of functions of two variables Lagranges method of undetermined multipliers Differential Equations Higher order differential equations and their applications Mass Spring phenomenon and electric circuits

Integral Calculus Improper integrals Beta Gamma functions and their relationship Double and triple integrals and applications change of order of integration change of coordinate system

Vector Calculus Scalar and vector point functions Gradient Directional Derivative Divergence and Curl Evaluation of line integrals Surface integrals Applications of Greens and Stokes theorems

Reference Books

- 1 Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition (2010), John Wiley & Sons, New Delhi, India.
- 2 Higher Engineering Mathematics, Dr. B S Grewal, edition -44th/45th, Khanna Publishers, New Delhi.
- 3 Advanced Numerical Methods with MATLAB, S C Chapra, 3rd Edition, Tata McGraw Hill.

25MT2003 - MATHEMATICAL MODELLING & NUMERICAL METHODS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MT2003	MATHEMATICAL MODELLING & NUMERICAL METHODS	MNMM	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply difference equations to model and solve real life problems.	3	PO1, PO3
CO2	Apply method of least squares for the best fitting linear and nonlinear models.	3	PO1, PO3
CO3	Apply simulation modeling to Interpret real life problems.	3	PO1, PO3
CO4	Apply mathematical modelling through differential equations	3	PO1, PO3
CO5	Verify the solution of the equations using MATLAB	3	PO4

Syllabus

Modeling Change, Proportionality, and Geometric Similarity: Modeling Change with DifferenceEquations, A Savings Certificate, Mortgaging a Home, Approximating Change with Difference Equations,Solutions to Dynamical Systems. Mathematical Models, Modeling Using Proportionality, Modeling UsingGeometric Similarity

To apply Method of least squares to Model Fitting: Fitting Models to Data Graphically, Analytic Methods of ModelFitting, Applying the Least-Squares Criterion, Choosing a Best Model, Vehicular Stopping Distance,Comparing the Criterion.Determining a Production Schedule. Simulation Modeling: SimulatingDeterministic Behavior, Area Under a Curve, Generating Random Numbers, Simulating ProbabilisticBehavior, Inventory Models

To Model and solve differential Equation:Population Growth, Graphical Solutionsof Autonomous Differential Equations, Drawing a Phase Line and Sketching Solution Curves, LogisticGrowth, 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, GraphicalSolutions of Autonomous Systems of First-Order Differential Equations, A Competitive Hunter Model, APredator-Prey Model.

To Apply MATLAB to validate the solutions of the mathematical equations

Reference Books

- 1 Mathematical Modelling, Kapur J. N, 2007, New Age International Publishers.
- 2 Mathematical Modelling Models,, Analysis and Applications,, s, Banerjee Sandip, 2014, CRC Press, Taylor &Francis Group.
- 3 A first course in mathematical modeling, F. R., Fox W. P., and Horton S. B., 2014, ,Brooks/Cole.

25MT2004 - MATHEMATICAL OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MT2004	MATHEMATICAL OPTIMIZATION	MTO	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply various methods for finding the optimal solution of Linear Programming Problem.	3	PO1, PO5
CO2	Apply Integer Programming and Gradient methods for solving optimization problems.	3	PO1, PO3
CO3	Express a practical problem, such as an engineering analysis or design problem and to optimize a multivariate quadratic function subject to linear constraints on the variables.	3	PO1, PO3
CO4	Apply and understand the search and optimization methodologies applicable to the resolution of multi disciplinary decision problems, under a decision support framework.	3	PO1, PO3

Syllabus

Introduction to Optimization: Types of optimization problems, Applications across disciplines. Linear Programming: Formulation of LP Problem (LPP), Graphical method, Simplex method.(maximization and minimization) Duality concept in LPP. Transportation problem, Assignment method.

Integer Programming, Branch & bound algorithms, valid inequalities & cut plane method. Constrained optimization: Gradient descent Newton's method Conjugate gradient method.

Non Linear Programming Quadratic programs Constrained quadratic programming problems Beales 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, Evolutionary algorithms Genetic Algorithm, Trajectory algorithms- Simulated annealing, Tabu search. Nature- inspired metaheuristics-Ant-colony optimization, Particle swarm optimization

Reference Books

- 1 Applied Mathematical Programming by Bradley, Hax and Magnanti, 1st edition (1977)., Addison-Wesley.
- 2 Introduction to Operations Research, Frederick S. Hillier & Gerald J. Lieberman, 2024 edition, McGraw Hill.
- 3 Linear and Non Linear Programming Theory and Algorithms, Mokhtar S. Bazaraa, Hanif D. Sherali, C. M. Shetty, 3rd edition., Wiley.

25MT2019 - PROBABILITY AND STATISTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MT2019	PROBABILITY AND STATISTICS	PNS	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the importance of probabilistic concepts in a wide spectrum of problems arising in engineering applied science.	3	PO1, PO3, PO4
CO2	Assess the relationship between variables using correlation and regression techniques	4	PO1, PO3, PO4
CO3	Apply the role of Statistical tests of significance in solving real world engineering problems	3	PO1, PO3, PO4
CO4	Formulate Stochastic process in terms of Markov chains and solve problems in queueing systems, and network	4	PO1, PO3, PO4

Syllabus

Descriptive Statistics Introduction to statistics construction of Frequency distribution diagrammatical and graphical presentation of data Measures of central tendency and dispersion measures Coefficient of variation

Correlation and Regression Correlation coefficient for grouped and ungrouped data Rank correlation for tied and untied observations simple correlation and regression of their properties and relations Applications on linear regression models

Probability Basics on probability theory and definition of probability addition and multiplication theorems conditional probability and Bayes theorem Discrete and continuous random variables Standard Univariate Distributions Discrete and continuous distributions binomial Poisson normal distribution and their applications

Inferential Statistics Basics of statistical inference Large sample tests Test for an assumed mean and equality of two population means with known and unknown SD and tests for proportions Exact sampling tests t test for an assumed mean and equality of means of two populations variance ratio test Chi square test goodness of fit and independence of attributes Analysis of variance tests one factor and two factor ANOVA

Reference Books

- 1 Probability and Statistics for Engineers and Scientists, Ronald E Walpole, Sharon L Myers, Keying Ye, 9th Edition, Pearson.
- 2 Miller and Freund's Probability and Statistics for Engineers, Richard A Johnson, 11th Edition (2011), PHI, New Delhi.
- 3 Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, John Wiley & Sons.
- 4 Higher Engineering Mathematics, B S Grewal, Khanna Publishers, India, edition -44th/45th.



(DEEMED TO BE UNIVERSITY)

Y25: B.Tech. - Mechanical Engineering

Category: Humanities Arts And Social Sciences (HAS)

25FL3054 - FRENCH LANGUAGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25FL3054	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, PO11

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 auxiliaries 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 Nouvel Esprit: M?thode de Fran?ais, Tome 1, The image is not clear, but a common author for this series is Meenal Tiwari., 2001, Langers International.
- 2 Cours de Langue et de Civilisation Fran?aises, Tome 1, The most common authors are Gaston Mauger with collaborator Vergne-Sirieys., The image indicates 2004, but this is likely a specific reprint. The original publication dates for different volumes of this series vary., Hachette.
- 3 Bonjour Tristesse, Fran?oise Sagan, Folio (French Edition), Gallimard.
- 4 L'?tranger, Albert Camus, Folio (French Edition), Gallimard.

25FL3055 - GERMAN LANGUAGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25FL3055	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, PO11

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, Hermann Funk, Christina Kuhn, 2000, Cornelsen, Goyal Publishers & Distributors Pvt. Ltd..
- 2 Collins Easy Learning German Grammar & Practice, Collins Dictionaries, 2004, HarperCollins Specials, Goyal Publishers & Distributors Pvt. Ltd..
- 3 Tangram aktuell 1 Kursbuch + Arbeitsbuch, Rosa-Maria Dallapiazza, Till Huebner, Lilli Marlen Minter, 2007, Hueber, Goyal Publishers and Distributors Pvt. Ltd..
- 4 Studio d A1 Deutsch als Fremdsprache A1, Vocabulary, Hermann Funk, 2004, Cornelsen, Goyal Publishers & Distributors Pvt. Ltd..

25FL3058 - JAPANESE LANGUAGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25FL3058	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, PO11

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 Publishers.
- 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.

25FL3064 - KOREAN LANGUAGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25FL3064	KOREAN LANGUAGE	KLG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding of key features of Korean, Introduction to Hangeul, Everyday greetings & expressions	2	PO3, PO8
CO2	Learning of important grammar particles & Parts of speeches	3	PO3, PO8
CO3	Verbs, Adjectives & additional vocabularies for daily life conversation	3	PO3, PO10
CO4	Sentence formation & Different aspects of tenses	3	PO2, PO9

Syllabus

History and key features of the Korean language Introduction to Hangeul: consonants, vowels, pronunciation rules
 Everyday greetings & expressions Korean cultural aspects in communication

Important grammar particles (subject, object, topic, possessive, etc.) Parts of speech: nouns, pronouns, adjectives, adverbs
 Basic sentence patterns (declarative, interrogative, imperative) Formal vs informal speech

Essential verbs and conjugation patterns Adjectives and descriptive sentences Vocabulary for everyday situations (food, travel, shopping, directions) Dialogues for daily communication practice

Sentence formation with complex structures Different aspects of tenses (present, past, future, progressive, honorifics)
 Politeness levels and speech styles Writing short passages and conversations in Korean

Reference Books

- 1 Integrated Korean, Carol Schulz, 1, University of Hawai.
- 2 Korean Made Simple, Billy Go, 1st Edition, Billy Korean.
- 3 Elementary Korean, Ross King, Jaehoon Yeon, 2nd Edition, Tuttle Publishing.

25MB4053 - MANAGING PERSONAL FINANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4053	MANAGING PERSONAL FINANCE	MPF	R	3	0	0	0	3

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.

25MB4054 - BASICS OF MARKETING FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4054	BASICS OF MARKETING FOR ENGINEERS	BME	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of marketing management	2	PO6
CO2	Understand the concepts of Marketing environment, consumer behaviour and Segmentation, Targeting and Positioning (STP)	2	PO6
CO3	Apply the marketing mix strategies with special focus on technology products	3	PO3
CO4	Apply promotion and distribution strategies for marketing of high tech products and services	3	PO3

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.

25MB4055 - ORGANIZATION MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4055	ORGANIZATION MANAGEMENT	OMG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Remember and understand the various management theories and management approaches.	2	PO1, PO9
CO2	Remember and understand organization theories, structures and organization principles.	2	PO1, PO9
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	PO1, PO9
CO4	Remember and understand the various issues in industrial relations, trade unions and college bargaining and industrial safety.	2	PO1, PO9

Syllabus

Development of management thought covers its introduction and various theories, including the functional approach, scientific management approach, human relations approach, and the latest management thoughts. Organisation theory explores the evolution of organisational ideas through classical organisation theory, neo-classical organisation theory, and modern organisation theory.

Organisation structure focuses on the principles of organisation, major organisational theories, and methods of departmentalisation. It also examines authority, power, organising processes, organisational effectiveness, structuring the organisation, and organisational change. Additional topics include the preparation and use of organisation charts, different types of organisations such as line, functional, and line-and-staff relations, along with the development of organisational manuals.

Motivation covers its characteristics, importance, and kinds as well as key motivational philosophies like Douglas McGregors Theory X and Theory Y and Herzbergs two factor theory. It includes human needs, incentives as motivators, and methods of managing dissatisfaction and frustration. Morale, absenteeism, and behavioural science concepts such as group dynamics and group behaviour are discussed. Leadership explores meaning, importance, styles, major theories, and the distinction between leaders and managers.

Management concepts explain management, administration, and organisation, highlighting their differences, relationships, importance, characteristics, managerial skills, objectives, harmonisation of objectives, and hierarchy of objectives. Industrial relations topics include industrial psychology, industrial disputes, conflict management, and views about conflict, along with labour policy, workers grievances, and suggestion systems. Trade unions, collective bargaining, negotiations, and industrial safety covering working conditions, accidents, preventive measures, and safety training are also addressed.

Reference Books

- 1 Organizational behavior, , Stephen P. Robins, 11t edition , 2008, Pearson education.
- 2 Essentials of Management, Koontz &Wehrich, 12th edition, 2007, Tata Mc Grawhill.

25MB4056 - PARADIGMS IN MANAGEMENT THOUGHT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4056	PARADIGMS IN MANAGEMENT THOUGHT	PMT	R	3	0	0	0	3

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	PO11
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.

25MB4058 - SIX SIGMA YELLOW BELT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4058	SIX SIGMA YELLOW BELT	SSYB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Six sigma principalsSix Sigma Foundations, Principles, Roles and Responsibilities	3	PO3, PO4
CO2	Quality Tools and Six Sigma Metrics	3	PO3, PO5
CO3	Six Sigma Principles	4	PO3, PO4
CO4	Six Sigma Principles and practice	4	PO5

Syllabus

Introduction to Six Sigma and Lean purpose value to organizations basic principles roles responsibilities tools and metrics includes readings videos quizzes discussions and peer review exercises curriculum based on The Certified Six Sigma Handbook 2nd edition recommended but not required

Define and introduction to Measure phase of DMAIC project development and implementation project management tools introduction to statistics significance of statistics in Six Sigma and data collection methods includes readings videos quizzes and peer review exercises curriculum based on The Certified Six Sigma Handbook 2nd edition recommended but not required

Measure and partial Analyze phase of DMAIC lean tools for process analysis FMEA MSA GRR and introduction to basic statistics with example problems includes readings discussions videos and quizzes curriculum based on The Certified Six Sigma Handbook 2nd edition recommended but not required

Completion of Analyze Improve and Control phases of DMAIC correlation and regression hypothesis testing improvement tools and techniques importance and characteristics of control plans for sustaining improvements includes readings discussions videos and quizzes curriculum based on The Certified Six Sigma Handbook 2nd edition recommended but not required

Reference Books

- 1 The ASQ Certified Six Sigma Yellow Belt Handbook, Govindarajan Ramu, 2nd Edition, ASQ Quality Press.

25MB4060 - FINTECH:FINANCE INDUSTRY TRANSFORMATION AND REGULATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4060	FINTECH:FINANCE INDUSTRY TRANSFORMATION AND REGULATION	FINT	R	3	0	0	0	3

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.

25MB4067 - INDUSTRIAL MANAGEMENT & PRODUCTION PLANNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4067	INDUSTRIAL MANAGEMENT & PRODUCTION PLANNING	IMPP	R	3	0	0	0	3

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	Utilize time series and regression techniques for accurate demand prediction and production planning	3	PO1, PSO2
CO3	Schedule batch and job order production to optimize resource use and efficiency	3	PO4, PSO1
CO4	Apply method study techniques to analyze and improve work processes systematically	3	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, computer integrated production planning systems, Agile Manufacturing System, 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, Total Quality Management

Introduction to quality, quality control, SQC, control charts for variables & attributes, Inventory control: Purpose of holding stock, Effect of demand on inventories. Determination of Economic order quantity (EOQ) and economic lot size, Problems on EOQ, 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, , obRoberta S. Russell and Bernard W. Taylor, 4: 2003, Prentice Hall..

25MB4068 - FINANCIAL MANAGEMENT FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4068	FINANCIAL MANAGEMENT FOR ENGINEERS	FMFE	R	3	0	0	0	3

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.

25MB4070 - SUSTAINABILITY LEADERSHIP AND STRATEGIC IMPACT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4070	SUSTAINABILITY LEADERSHIP AND STRATEGIC IMPACT	SLSI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of sustainability and the role of leadership in driving sustainable practices	2	PO1, PO6
CO2	Analyze the strategic implications of sustainability in business and policymaking	4	PO4, PO6, PO11
CO3	Evaluate sustainable business models and leadership frameworks for long-term impact	5	PO3, PO7
CO4	Develop strategic solutions and leadership approaches to address real-world sustainability challenges	6	PO4, PO9, PO10

Syllabus

Definition and dimensions of sustainability (environmental, social, economic) Principles of sustainability in global and local contexts Role of leadership in sustainability transitions Case studies of influential sustainability leaders

Strategic frameworks and tools (SWOT, PESTLE) for sustainability analysis Sustainable Development Goals (SDGs) and business alignment Risk assessment and opportunity identification in sustainability Systems thinking and long-term planning

Circular economy and sustainable value chains Green innovation and product development Business model transformation for sustainability ESG (Environmental, Social, Governance) performance and reporting

Transformational and ethical leadership approaches Change management and stakeholder engagement Driving sustainability in organizations and communities Strategic decision-making and measuring impact

Reference Books

- 1 Sustainability by Design: Subversive Strategy for Transforming Our Consumer Culture, John R. Ehrenfeld, 1st Edition, Yale University Press.
- 2 The Necessary Revolution: How Individuals and Organizations Are Working Together to Create a Sustainable World, Peter Senge, Bryan Smith, Nina Kruschwitz, Joe Laur, Sara Schley, Latest, Currency / Doubleday.
- 3 Leadership for Sustainability: Strategies for Tackling Wicked Problems, R. Bruce Hull, 1st Edition, Island Press.

25MB4071 - RESOURCE SAFETY AND QUALITY MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4071	RESOURCE SAFETY AND QUALITY MANAGEMENT	RSQM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpreting the basic systems of manpower and materials management	2	PO1, PO3, PO4
CO2	Explaining the basic systems of machinery management	2	PO3, PO4
CO3	Classify the basic systems of safety management	2	PO1, PO3, PO4
CO4	Understand the basic systems of quality management	2	PO1, PO3, PO4

Syllabus

Resource Management (Man Power, Materials & Machinery): Introduction; Resource smoothing; Resource Leveling; Establishing workers productivity; Objectives of material management; Functions of material management department; ABC classification of materials; Inventory of materials; Material procurement; Storage management.

Classification of construction equipment; Earthmoving equipment; Excavation equipment; Hauling equipment; Earth compaction equipment; Hoisting equipment; Concrete plant and equipment; Time and motion study; Selection of equipment-Task consideration, cost consideration; Factors affecting the selection; Factors affecting the cost of owning and operating the equipment; Equipment maintenance

Safety and Quality Management: Accident prevention program; Immediate attention in case of an accident; Approaches to improve safety in construction; Safety benefits to employers, employees and customers; Prevention of fire in construction industries; Fault tree analysis; Safety information system; Safety budgeting

Importance of quality; Elements of quality; Organization for quality control; Quality assurance techniques; Documentation; Quality control circles; Total quality management; ISO 9000 - 2008.

Reference Books

- 1 Construction Management and Planning, B. Sengupta and H. Guha, 1, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- 2 Construction Planning, Equipment and Methods, Peurifoy R. L., 2, McGraw-Hill International Book Company.

25MB4072 - INVESTEMENT, PORTFOLIO THEORY AND BEHAVIOURAL FINANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4072	INVESTEMENT, PORTFOLIO THEORY AND BEHAVIOURAL FINANCE	IPTBF	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain investment concepts, risk - return trade-off, and factors influencing required rate of return.	2	PO1, PO2
CO2	Apply fundamental and technical analysis to evaluate securities, industries, and	3	PO1, PO5
CO3	Construct and analyze portfolios using CAPM, APT, and modern portfolio theories.	4	PO3, PO8
CO4	Evaluate portfolio performance using risk-adjusted performance measures and selection models.	5	PO6, PO10

Syllabus

Competency Level I Meaning of investment, features of investment, objectives of investment, Investment Vs Speculation, Investment Vs Gambling, types of investors and investment avenues, Mutual funds and fund management, Investment Setting, Financial Markets, Financial Assets and Instruments, elements of risk, Risk and Return, Analysis of different types of Risks and Returns, Measures of Return and Risk, Determinants of Required Rate of Return, Risk free rate and factors influencing the risk free rate, Risk Premium

Competency Level II Investment Scenario, Risk and Return, Alpha and Beta, Fundamental Analysis, Equity stock valuation models, Bond Valuation, Industry analysis, Business Cycle and Industry Sectors, Evaluating the industry life cycle, Analysis of Industry Competition, Estimation of Industry Rates of Return, Technical Analysis, Assumptions, Advantages and Challenges, Technical Trading Rules and Indicators, Technical Analysis of Equity Markets, Firm Competitive Strategies, SWOT Analysis, Analysis of Growth and Value Companies

Competency Level III Introduction to Portfolio Management, Measurement of Expected Risk and Return of Portfolio, Alternative Measures of Risk, Markowitz Portfolio Theory, The Efficient Frontier and Investor Utility, Capital Asset Pricing Model, Overview of Capital Market Theory, Market Portfolio, Capital Asset Pricing Model Assumptions, Security Market Line and Capital Market Line, Zero beta Model, Multi Factor Models, Arbitrage Pricing Theory APT, Security Valuation and APT, Empirical Tests of APT, Estimating Risk in a Multi factor Setting

Competency Level IV Optimal Portfolio Selection Models, Markowitz Theory, Risk adjusted performance models, Sharpes Single Index Model, Treynors model, Lagrange Multiplier Theory, Evaluation of Portfolio Performance, Treynor, Sharpe, Jensen and Information Ratio Performance Measures, Application of Portfolio Performance Measures, Factors affecting the use of Performance Measures

Reference Books

- 1 Investment Management: Security Analysis and Portfolio Management, Bhalla V K, 7th Edition, Sultan Chand.
- 2 Investment Analysis and Portfolio Management, Ranganathan M and Madhumathi R, 2nd Edition, Pearson Education.
- 3 Security Analysis and Portfolio Management, Fischer Donald E and Ronald J Jordan, 1st Edition, Prentice Hall of India.

25MB4073 - INNOVATION MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4073	INNOVATION MANAGEMENT	IM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop value proposition for the problem identified	3	PO1, PO2
CO2	Build MVP for the solution developed	3	PO3, PO6
CO3	Devise go to market strategy	4	PO4, PO5
CO4	Create a Pitch-deck with funding strategy	6	PO7, PO8

Syllabus

Introduction to Innovation Management Definition and importance of innovation Types of innovation Innovation's impact on competitive advantage

: The Innovation Process Stages of the innovation process Idea generation and screening Feasibility analysis and concept development

Fostering Creativity and Idea Generation Techniques for stimulating creativity Brainstorming and ideation sessions Tools for idea generation

Developing a Comprehensive Pitch Deck for Your Startup Including Strategies for Funding, Investment, and Investor Communication

Reference Books

- 1 The Lean Startup, Eric Ries, 1st Edition (2011), Crown Business / Penguin Random House.
- 2 Managing Innovation: Integrating Technological, Market and Organizational Change, Joe Tidd and John Bessant, 7th Edition (2021), Wiley.
- 3 Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers, Alexander Osterwalder and Yves Pigneur, 1st Edition (2010), Wiley.
- 4 Innovation Management and New Product Development, Paul Trott, 6th Edition (2016), Pearson Education.
- 5 Creative Confidence: Unleashing the Creative Potential Within Us All, Tom Kelley and David Kelley, 1st Edition (2013), Crown Business.

25MB4231 - DIGITAL MARKETING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MB4231	DIGITAL MARKETING	DMK	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline the key concepts of digital marketing.	2	PO1
CO2	Apply SEO to a website.	3	PO1
CO3	Use the key PPC concepts to draw visitors to a business websites	3	PO2
CO4	Analyze Campaign Management to manage the marketing concepts	4	PO2
CO5	Analyze digital marketing strategies	4	PO2

Syllabus

Key Concepts of Digital Marketing Fundamental Need Scope of Digital marketing Traditional v Digital Marketing the Opportunity of Digital Marketing Characteristics of Digital Marketing Implications of Digital Marketing Market Research v Market Reality Principles and Drivers of New Marketing Environment

Online Marketing Environment Dotcom Evolution Key SEO Concepts Keyword Research Selection Search Results & Positioning Content Updates & Layout Benefits of Search Position Meta Tags Stakeholders in Search SEO Site Map Mechanics of Search SEO Webmaster Tools On-Page Optimization Off-Page Optimization

The SEO Process: Inbound Links & Link Building Customer Insights Ranking Analysis Review Laws Guidelines Key PPC Concepts Budgets Strengths of Pay per click Scheduling Keyword Research Display Networks Google PPC Ad Centre Research Tools

Campaign Management Search Campaign Process Conversion Tracking Keyword Selection Conversion Metrics CPA, CTR Ad Copy Bidding Landing Pages Analytics Targeting Laws Guidelines

Analyze digital marketing strategies of various companies

Reference Books

- 1 Social Media Marketing, Michael Solomon and Tracy Tuten,, Aug 2013, , Pearson.
- 2 Social Media Marketing Successfully for Beginners: Create Successful Campaigns, Gain More Fans, And Boost Sales., F.R. Media, 2013, pearson.
- 3 Digital Marketing Combo A Modern Marketers GoTo, Kavita Kamath , 2023, Vibrant Publishers .
- 4 Digital Marketing| , Seema Gupta , 2022, Megrahill.

25UC0021 - SOCIAL IMMERSIVE LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC0021	SOCIAL IMMERSIVE LEARNING	SIL-1	R	0	0	2	0	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	PO4
CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment	3	PO4, PO11
CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences.	3	PO3, PO11

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, 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.

25UC0022 - SOCIAL IMMERSIVE LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC0022	SOCIAL IMMERSIVE LEARNING	SIL-2	R	0	0	2	0	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	PO2, PO8, PO9
CO2	Build technological solutions to real-world problems or challenges with peers to achieve common goals	3	PO2, PO8, PO9
CO3	Plan effectively to communicate ideas and collaborate with others to achieve artistic or recreational goals.	3	PO2, PO8, PO9
CO4	Develop innovative solutions by thinking critically and creatively within a collaborative social immersive learning environment	3	PO2, PO8, PO9
CO5	Identify the strategies to promote personal well-being for healthy living through social interaction and shared experiences	3	PO2, 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.

25UC0026 - HUMAN VALUES, GENDER EQUALITY AND PROFESSIONAL ETHICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC0026	HUMAN VALUES, GENDER EQUALITY AND PROFESSIONAL ETHICS	UHV	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 principles in harmony among 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, 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 P Bagaria, 1, Penguin press, Excel Books.
- 2 Seeing like a Feminist, Menon, Nivedita, 1, Excel Books. , Zubaan.
- 3 A Foundation Course in Human Values and Professional Ethics, R.R. Gaur, R. Sangal, G.P. Bagaria, 1, Excel Books / Penguin Press.

25UC1102 - LANGUAGE SKILLS FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC1102	LANGUAGE SKILLS FOR ENGINEERS	LSE	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the essential listening, speaking, and reading skills, preparing them form effective communication in various personal and professional contexts.	2	PO10
CO2	Apply essential writing and non-verbal communication skills, preparing them for effective written and non-verbal interactions in various personal and professional	3	PO10

Syllabus

Listening Techniques of effective Listening Listening and Comprehension Probing Questions Barriers to Listening Speaking Pronunciation Enunciation Vocabulary Fluency Common Errors Reading Techniques of Effective Reading Gathering ideas and Information from a given text Evaluating these ideas and information Interpret the text

Writing Clearly State the Claims Avoid Ambiguity Vagueness Unwanted Generalizations and Oversimplification of Issues Provide Background Information Effectively Argue the Claim Provide Evidence for the Claims Use Examples to Explain Concepts Follow the Convention Be Properly Sequenced Use Proper Signposting Techniques Be Well Structured Different Modes of Writing Nonverbal Communication Meaning of Nonverbal Communication Advantages of Using Nonverbal Communication Introduction to Modes of Nonverbal Communication i Open and Closed Body Language ii Eye Contact and Facial Expression iii Hand Gestures Dos and Dents of NVC Learning from Experts Activities based Learning

Reference Books

- 1 On Writing Well The Classic Guide to Writing Nonfiction, William Zinsser, 5th Edition (1976), Harper Perennial.
- 2 Speaking English Effectively, Krishna Mohan, N P Singh, 2nd Edition (2015), Laxmi Publications, New Delhi.
- 3 The Ace of Soft Skills, Gopaldaswamy Ramesh et al., 4th Edition (2010), Pearson.
- 4 Effective Speech, Richard W Clark, 3rd Edition (1988), Glencoe Publishing Co..
- 5 Body Language How to Read Others Thoughts by Their Gestures, Allan Pease, 7th Edition (1988), Sheldon Press.

25UC1203 - DESIGN THINKING FOR INNOVATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC1203	DESIGN THINKING FOR 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	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	2	PO11

Syllabus

Introduction to Design Thinking and Innovation: Introduction to design thinking and its principles, 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 for contextualized problem-solving, Incorporating sustainable development goals into design thinking

Design Thinking Process: Overview of the design thinking process, 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 Unmukt Science and Art of Design Thinking, Arun Jain, 2019, School of Design Thinking.
- 3 The Design Thinking Play Book, Michael Lewrick, Patrick Link, Larry Leifer, 2018, Wiley Press.
- 4 The Art of Innovation: Lessons in Creativity from IDEO, America, Tom Kelley, Jonathan Littman, Tom Peters, 2001, Doubleday Broadway Publishing, USA.

25UC1204 - COMMUNICATION SKILLS FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC1204	COMMUNICATION SKILLS FOR ENGINEERS	CSE	R	0	0	4	0	2

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the essential career skills, including resume writing, interview techniques, group discussions, and exploring career opportunities, preparing them for successful career advancement	3	PO9, PO10
CO2	Apply a comprehensive understanding of essential team skills, preparing them for successful collaboration and contribution in professional team environments.	3	PO9, PO10

Syllabus

Resume Skills Preparation and Presentation, Interview Skills: Preparation and Presentation, Group Discussion Skills: Meaning and Methods, Exploring Career Opportunities Preparing for a career.

TEAM SKILLS Cognitive and Non-cognitive Skills, Presentation Skills, Trust and Collaboration, Listening as a Team Skill, Brainstorming, Social and Cultural Etiquette, Internal Communication

Reference Books

- 1 Resume Magic: Trade Secrets of a Professional Resume Writer, Susan Britton Whitcomb, 4th, JIST Works.
- 2 Modernize Your Resume: Get Noticed...Get Hired, Wendy Enelow, Louise Kursmark, 3rd edition, Emerald Career Publishing.
- 3 The Ace of Soft Skills, Mr. Gopalaswamy Ramesh et al, 1st edition 2010 , Pearson publishers.
- 4 Effective speech, Richard W.Clark, 2nd Edition, Glencoe Pub. Co.
- 5 The Wisdom of Teams: Creating the High-Performance Organization, Jon R. Katzenbach, 2nd 2003, , Harvard Business Review Press.



(DEEMED TO BE UNIVERSITY)

Y25: B.Tech. - Mechanical Engineering

Category: Professional Elective Courses (PEC)

25AAS3101 - AUTONOMOUS DRIVER ASSISTIVE SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3101	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	ADAS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental theory of operation of ADAS and the concept of remote sensing and the types of sensors technology needed to implement remote sensing.	2	PO1
CO2	Apply various Machine Learning models for driver assistance in ADAS	3	PO1
CO3	Apply various Deep Learning models for target recognition and support for driver assistance	3	PO1
CO4	Apply various Reinforcement Learning models for different parking scenarios	3	PO1
CO5	Apply assistance systems is that they enable communication between different vehicles, vehicle infrastructure systems and transportation management centres	3	PO4
CO6	Learning to provide vital information about traffic, closure and blockage of roads ahead, congestion levels, suggested routes to avoid congestion	3	PO4

Syllabus

Introduction to ADAS, Overview of ADAS technologies and their application, Historical context and development of ADAS, Current trends and future prospects in ADAS, Sensor Technologies for ADAS, Overview of various sensors used in ADAS (e.g., cameras, radar, lidar), Principles of operation and characteristics of each sensor type Sensor fusion techniques for integrating sensor data

Perception and Environment Understanding, Computer vision techniques for object detection, recognition, and tracking, Sensor data processing and feature extraction Scene understanding and semantic segmentation, Machine Learning for ADAS Introduction to machine learning algorithms and techniques, Training and optimization of models for ADAS tasks, Deep learning architectures for ADAS applications

Control Systems for ADAS Fundamentals of control theory and system dynamics, Control algorithms for ADAS functions (e.g., adaptive cruise control, lane keeping), Trajectory planning and motion control, Human-Machine Interaction and User Experience Design principles for ADAS interfaces and displays, Driver monitoring and attention management, User-centered evaluation and usability testing

MODULE-4 Safety and Regulation Safety considerations in ADAS design and operation Functional safety standards and regulations Risk assessment and mitigation strategies

Case Studies and Applications Real-world examples of ADAS implementations Autonomous vehicle technologies and their integration with ADAS Industry trends and challenges in ADAS development

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: Technical, Legal and Social Aspects, Markus Maurer; J. Christian Gerdes; Barbara Lenz; Hermann Winner, 1st edition (2016), Springer, Berlin / Heidelberg.
- 2 Vehicle Dynamics and Control, Rajesh Rajamani, 2nd edition (2011), Springer (Mechanical Engineering Series), New York.
- 3 Multisensor Data Fusion: From Algorithms and Architectural Design to Applications, Edited by Hassen Fourati, 1st edition (2016), CRC Press / Taylor & Francis Group, Boca Raton.

25AAS3101A - AUTONOMOUS DRIVER ASSISTIVE SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3101A	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	ADAS	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental theory of operation of ADAS and the concept of remote sensing and the types of sensors technology needed to implement remote sensing.	2	PO1
CO2	Apply various Machine Learning models for driver assistance in ADAS	3	PO1
CO3	Apply various Deep Learning models for target recognition and support for driver assistance	3	PO1
CO4	Apply various Reinforcement Learning models for different parking scenarios.	3	PO1
CO5	CO-5 Apply assistance systems is that they enable communication between different vehicles, vehicle infrastructure systems and transportation management centres PO4,PSO2 3	3	PO4
CO6	Learning to provide vital information about traffic, closure and blockage of roads ahead, congestion levels, suggested routes to avoid congestion	3	PO5
CO7	Apply autonomous driver assistive systems in real Time	3	PO5

Syllabus

Introduction to ADAS, Overview of ADAS technologies and their application, Historical context and development of ADAS, Current trends and future prospects in ADAS, Sensor Technologies for ADAS, Overview of various sensors used in ADAS (e.g., cameras, radar, lidar), Principles of operation and characteristics of each sensor type Sensor fusion techniques for integrating sensor data

Perception and Environment Understanding, Computer vision techniques for object detection, recognition, and tracking, Sensor data processing and feature extraction Scene understanding and semantic segmentation, Machine Learning for ADAS Introduction to machine learning algorithms and techniques, Training and optimization of models for ADAS tasks, Deep learning architectures for ADAS applications

Control Systems for ADAS Fundamentals of control theory and system dynamics, Control algorithms for ADAS functions (e.g., adaptive cruise control, lane keeping), Trajectory planning and motion control, Human-Machine Interaction and User Experience Design principles for ADAS interfaces and displays, Driver monitoring and attention management, User-centered evaluation and usability testing

MODULE-4 Safety and Regulation Safety considerations in ADAS design and operation Functional safety standards and regulations Risk assessment and mitigation strategies

Case Studies and Applications Real-world examples of ADAS implementations Autonomous vehicle technologies and their integration with ADAS Industry trends and challenges in ADAS development

Reference Books

- 1 Autonomous Driving: How the Driverless Revolution Will Change the World, Andreas Herrmann, Walter Brenner, Rupert Stadler, 1st edition, published in 2018, Emerald Publishing Limited.
- 2 Automated Driving: Safer and More Efficient Future Driving, Daniel Watzenig; Martin Horn, 1st edition (2017), Springer International Publishing.

25AAS3101E - AUTONOMOUS DRIVER ASSISTIVE SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3101E	AUTONOMOUS DRIVER ASSISTIVE SYSTEMS	ADAS	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental theory of operation of ADAS and the concept of remote sensing and the types of sensors technology needed to implement remote sensing.	2	PO1
CO2	Apply various Machine Learning models for driver assistance in ADAS	3	PO1
CO3	Apply various Deep Learning models for target recognition and support for driver assistance	3	PO1
CO4	Apply various Reinforcement Learning models for different parking scenarios.	3	PO1
CO5	CO-5 Apply assistance systems is that they enable communication between different vehicles, vehicle infrastructure systems and transportation management centres PO4,PSO2 3	3	PO4
CO6	Learning to provide vital information about traffic, closure and blockage of roads ahead, congestion levels, suggested routes to avoid congestion	3	PO5
CO7	Apply autonomous driver assistive systems in real Time	3	PO5

Syllabus

Introduction to ADAS, Overview of ADAS technologies and their application, Historical context and development of ADAS, Current trends and future prospects in ADAS, Sensor Technologies for ADAS, Overview of various sensors used in ADAS (e.g., cameras, radar, lidar), Principles of operation and characteristics of each sensor type Sensor fusion techniques for integrating sensor data

Perception and Environment Understanding, Computer vision techniques for object detection, recognition, and tracking, Sensor data processing and feature extraction Scene understanding and semantic segmentation, Machine Learning for ADAS Introduction to machine learning algorithms and techniques, Training and optimization of models for ADAS tasks, Deep learning architectures for ADAS applications

Control Systems for ADAS Fundamentals of control theory and system dynamics, Control algorithms for ADAS functions (e.g., adaptive cruise control, lane keeping), Trajectory planning and motion control, Human-Machine Interaction and User Experience Design principles for ADAS interfaces and displays, Driver monitoring and attention management, User-centered evaluation and usability testing

MODULE-4 Safety and Regulation Safety considerations in ADAS design and operation Functional safety standards and regulations Risk assessment and mitigation strategies

Case Studies and Applications Real-world examples of ADAS implementations Autonomous vehicle technologies and their integration with ADAS Industry trends and challenges in ADAS development

Reference Books

- 1 Autonomous Driving: How the Driverless Revolution Will Change the World, Andreas Herrmann, Walter Brenner, Rupert Stadler, 1st edition, published in 2018, Emerald Publishing Limited.
- 2 Automated Driving: Safer and More Efficient Future Driving, Daniel Watzenig; Martin Horn, 1st edition (2017), Springer International Publishing.

25AAS3102 - AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3102	AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT	AICAFT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamental principles of AI and control theory for electric and autonomous vehicle systems	3	PO1, PO3
CO2	Develop understanding of AI integration with control systems for EV and AV functions	3	PO3, PO5
CO3	Apply AI techniques for perception, planning, decision-making, and performance optimization	4	PO3, PO4
CO4	Analyze EV/AV systems through AI-based testing and tools (Simulink, OBD2, CAN Analyzer)	5	PO1, PO5
CO5	Analyze the various AI control of Autonomous Vehicle transportation components testing using software tools with Simulink, OBD2, and Can Analyzer.	5	PO5

Syllabus

Fundamentals of Autonomous vehicle: Introduction to autonomous vehicles, Vehicle dynamics and control, Sensor fusion and perception, Path planning and motion planning, Control system design for autonomous vehicles.

AI for Autonomous Vehicle: Autonomous driving - Machine learning and deep learning, Computer vision and image processing for perception, Natural language processing for human-vehicle interaction, Reinforcement learning for autonomous decision-making.

EV Fundamentals: Electric vehicle components and systems, Battery technology and management, Electric powertrain and control, Energy management strategies, Charging Infrastructure and Power Electronics.

AI for Electric Vehicle: Battery management and state estimation with AI, Electric powertrain optimization strategies, AI for charging infrastructure management, AI for vehicle-to-grid (V2G) interactions, Energy-efficient autonomous driving, AI-based predictive control for EVs, Challenges and future directions.

Reference Books

- 1 AI-enabled Technologies for Autonomous and Connected Vehicles, Yi Lu Murphey, Ilya Kolmanovsky, Paul Watta, 1st Edition, Springer.
- 2 Building Chatbots with Python Using Natural Language Processing and Machine Learning, Sumit Raj, 1st Edition , Apress.
- 3 Computer Vision for Visual Effects, Richard J. Radke, 2nd Edition , Cambridge University Press.

25AAS3102A - AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3102A	AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT	AICAFT	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of AI and control theory for electric vehicle systems	3	PO1, PO3, PSO2
CO2	Develop a deep understanding of AI integration with control systems for EV functions	3	PO3, PO5, PSO1
CO3	Apply AI techniques for perception, planning, decision-making, and control of autonomous vehicles	3	PO3, PO4
CO4	Examine the role of AI in optimizing EV performance, energy management, and charging infrastructure	4	PO1, PO5
CO5	Analyze AI-based control and testing of AV transportation components using software tools (Simulink, OBD2, CAN Analyzer)	5	PO5

Syllabus

Fundamentals of Autonomous vehicle: Introduction to autonomous vehicles, Vehicle dynamics and control, Sensor fusion and perception, Path planning and motion planning, Control system design for autonomous vehicles.

AI for Autonomous Vehicle: Autonomous driving - Machine learning and deep learning, Computer vision and image processing for perception, Natural language processing for human-vehicle interaction, Reinforcement learning for autonomous decision-making.

EV Fundamentals: Electric vehicle components and systems, Battery technology and management, Electric powertrain and control, Energy management strategies, Charging Infrastructure and Power Electronics.

AI for Electric Vehicle: Battery management and state estimation with AI, Electric powertrain optimization strategies, AI for charging infrastructure management, AI for vehicle-to-grid (V2G) interactions, Energy-efficient autonomous driving, AI-based predictive control for EVs, Challenges and future directions.

Reference Books

- 1 AI-enabled Technologies for Autonomous and Connected Vehicles, Yi Lu Murphey, Ilya Kolmanovsky, Paul Watta, 1st Edition, Springer.
- 2 Building Chatbots with Python Using Natural Language Processing and Machine Learning, Sumit Raj, 1st Edition, Apress.
- 3 Computer Vision for Visual Effects, Richard J. Radke, 2nd Edition, Cambridge University Press.

25AAS3102E - AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3102E	AI AND CONTROLS FOR AUTONOMUS FUTURE TRANSPORT	AICAFT	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of AI and control theory for electric vehicle systems	3	PO1, PO3
CO2	Develop a deep understanding of AI integration with control systems for EV functions	3	PO3, PO5
CO3	Apply AI techniques for perception, planning, decision-making, and control of autonomous vehicles	3	PO3, PO4
CO4	Examine the role of AI in optimizing EV performance, energy management, and charging infrastructure	4	PO1, PO5
CO5	Analyze AI-based control and testing of AV transportation components using software tools (Simulink, OBD2, CAN Analyzer)	5	PO5

Syllabus

Fundamentals of Autonomous vehicle: Introduction to autonomous vehicles, Vehicle dynamics and control, Sensor fusion and perception, Path planning and motion planning, Control system design for autonomous vehicles.

AI for Autonomous Vehicle: Autonomous driving - Machine learning and deep learning, Computer vision and image processing for perception, Natural language processing for human-vehicle interaction, Reinforcement learning for autonomous decision-making.

EV Fundamentals: Electric vehicle components and systems, Battery technology and management, Electric powertrain and control, Energy management strategies, Charging Infrastructure and Power Electronics.

AI for Electric Vehicle: Battery management and state estimation with AI, Electric powertrain optimization strategies, AI for charging infrastructure management, AI for vehicle-to-grid (V2G) interactions, Energy-efficient autonomous driving, AI-based predictive control for EVs, Challenges and future directions.

Reference Books

- 1 AI-enabled Technologies for Autonomous and Connected Vehicles, Yi Lu Murphey, Ilya Kolmanovsky, Paul Watta, 1st Edition, Springer.
- 2 Building Chatbots with Python Using Natural Language Processing and Machine Learning, Sumit Raj, 1st Edition , Apress.
- 3 Neural Network Methods for Natural Language Processing, Yoav Goldberg, 1st Edition , Morgan & Claypool Publishers.

25AAS3112 - ECU DESIGN FOR AUTONOMOUS SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3112	ECU DESIGN FOR AUTONOMOUS SYSTEMS	EDAS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze classic ECU hardware/software and AUTOSAR workflow.	4	PO7, PO8
CO2	Evaluate and contrast Classic/Adaptive AUTOSAR, develop SOA modules.	5	PO7
CO3	Design and optimize AI/ML pipelines on modern ECUs using MBD tools.	5	PO9
CO4	Implement secure, real-time ECU-level communication/middleware.	4	PO8

Syllabus

Evolution of ECUs Microcontrollers domains hardware trends Automotive software stack overview Classic AUTOSAR layered architecture RTE BSW MCAL SWC Software Component design and integration Toolchains DaVinci Vector opensource stacks ECU life cycle Boot diagnostics flashing

Module 2 Adaptive AUTOSAR and Modern ECU Architectures Need for adaptive AUTOSAR in datacentric AI workloads Adaptive AUTOSAR Service oriented POSIX OS flexible scheduling Key differences Classic vs Adaptive Application and middleware services communication diagnostics updates Real world case studies Mercedes MBUX NVIDIA Drive

Module 3 AI Integrated ECUs and Model Based Design Hardware for AI ECUs NVIDIA NXP BlueBox Mobileye custom SoCs Integration of AI accelerators GPU NPU TPU Model based engineering Simulink dSPACE HILSILMIL Integrating deep learning models TensorRT ONNX TFLite Real time scheduling optimization energy management

Module 4 ECU Communication and Middleware ECU Focused Communication protocols CAN LIN FlexRay Automotive Ethernet Middleware for ECUs SOMEIP DDS ROS 2 ECU level data exchange and synchronization Overtheair OTA software update basics Cybersecurity at ECU integration level secure comms secure boot basics

Reference Books

- 1 AUTOSAR Compendium Part 1 Application and RTE, Oliver Scheid, 2022, CreateSpace Independent Publishing Platform.
- 2 Automotive Embedded Systems Handbook, Nicolas Navet, Francoise Simonot-Lion, 2008, CRC Press.
- 3 Embedded Systems: Introduction to the MSP432 Microcontroller, Jonathan W. Valvano, 2015, 2015.

25AAS3112A - ECU DESIGN FOR AUTONOMOUS SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3112A	ECU DESIGN FOR AUTONOMOUS SYSTEMS	EDAS	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze classic ECU hardware/software and AUTOSAR workflow	4	PO7, PO8
CO2	Evaluate and contrast Classic/Adaptive AUTOSAR, develop SOA modules	5	PO7
CO3	Design and optimize AI/ML pipelines on modern ECUs using MBD tools	5	
CO4	Implement secure, real-time ECU-level communication/middleware	4	PO9
CO5	: Apply safety, validation, and documentation standards in ECU projects	3	PO8

Syllabus

Evolution of ECUs Microcontrollers domains hardware trends Automotive software stack overview Classic AUTOSAR layered architecture RTE BSW MCAL SWC Software Component design and integration Toolchains DaVinci Vector opensource stacks ECU life cycle Boot diagnostics flashing

Adaptive AUTOSAR and Modern ECU Architectures Need for adaptive AUTOSAR in datacentric AI workloads Adaptive AUTOSAR Service oriented POSIX OS flexible scheduling Key differences Classic vs Adaptive Application and middleware services communication diagnostics updates Real world case studies Mercedes MBUX NVIDIA Drive

AI Integrated ECUs and Model Based Design Hardware for AI ECUs NVIDIA NXP BlueBox Mobileye custom SoCs Integration of AI accelerators GPU NPU TPU Model based engineering Simulink dSPACE HILSILMIL Integrating deep learning models TensorRT ONNX TFLite Real time scheduling optimization energy management

ECU Communication and Middleware ECU Focused Communication protocols CAN LIN FlexRay Automotive Ethernet Middleware for ECUs SOMEIP DDS ROS 2 ECU level data exchange and synchronization Overtheair OTA software update basics Cybersecurity at ECU integration level secure comms secure boot basics

Safety Validation & Industry Practices for ECU Development Functional safety ISO 26262 SOTIF ASPICE Fault injection scenario based validation FMEA ECU validation workflows SIL MIL HIL Documentation traceability change configuration management Industry practices Agile ASPICE DevOps for ECUs

Reference Books

- 1 AUTOSAR Compendium Part 1 Application and RTE, Oliver Scheid, 2022, CreateSpace Independent Publishing Platform.
- 2 Automotive Embedded Systems Handbook, Nicolas Navet Francoise Simonot Lion, 2023, CRC Press.

25AAS3112E - ECU DESIGN FOR AUTONOMOUS SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3112E	ECU DESIGN FOR AUTONOMOUS SYSTEMS	EDAS	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	: Analyze classic ECU hardware/software and AUTOSAR workflow	4	
CO2	Evaluate and contrast Classic/Adaptive AUTOSAR, develop SOA modules	5	
CO3	: Design and optimize AI/ML pipelines on modern ECUs using MBD tools	5	
CO4	Implement secure, real-time ECU-level communication/middleware	4	
CO5	Apply safety, validation, and documentation standards in ECU projects	3	

Syllabus

Evolution of ECUs Microcontrollers domains hardware trends Automotive software stack overview Classic AUTOSAR layered architecture RTE BSW MCAL SWC Software Component design and integration Toolchains DaVinci Vector opensource stacks ECU life cycle Boot diagnostics flashing

Need for adaptive AUTOSAR in datacentric AI workloads Adaptive AUTOSAR Service oriented POSIX OS flexible scheduling Key differences Classic vs Adaptive Application and middleware services communication diagnostics updates Real world case studies Mercedes MBUX NVIDIA Drive

Hardware for AI ECUs NVIDIA NXP BlueBox Mobileye custom SoCs Integration of AI accelerators GPU NPU TPU Model based engineering Simulink dSPACE HILSILMIL Integrating deep learning models TensorRT ONNX TFLite Real time scheduling optimization energy management

Communication protocols CAN LIN FlexRay Automotive Ethernet Middleware for ECUs SOMEIP DDS ROS 2 ECU level data exchange and synchronization Overtheair OTA software update basics Cybersecurity at ECU integration level secure comms secure boot basics

Safety Validation & Industry Practices for ECU Development Functional safety ISO 26262 SOTIF ASPICE Fault injection scenario based validation FMEA ECU validation workflows SIL MIL HIL Documentation traceability change configuration management Industry practices Agile ASPICE DevOps for ECUs

Reference Books

- 1 AUTOSAR Compendium Part 1 Application and RTE, Oliver Scheid, 2022, CreateSpace Independent Publishing Platform.
- 2 Automotive Embedded Systems Handbook, Nicolas Navet Francoise Simonot Lion, 2023, CRC Press.

25AAS3202 - INTRODUCTION TO INTELLIGENT DRONES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3202	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
CO2	Analyze the applications and use cases of intelligent drones across various industries, identifying their benefits and limitations.	4	PO1, PO3
CO3	Apply programming languages and development tools to implement basic control algorithms and autonomous behaviors in intelligent drones.	3	PO3
CO4	Demonstrate proficiency in operating and troubleshooting intelligent drones, adhering to safety regulations and ethical considerations.	3	PO5

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, RandalW.Beard, TimothyW.McLain, 2022 , Princeton University Press.
- 2 Python Machine Learning Sebastian Raschka, Vahid Mirjalili, 2016, Packt Publishing.
- 3 Fundamentals of Drone Technology Paperback, Mr. I.V.S.Yeswanth, 26 August 2024, Dr. A.V.S.Sridhar Kuma.

25AAS3203 - AI AND IOT FOR AUTONOMOUS VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3203	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
CO2	Identify the key components and technologies involved in autonomous vehicles, including sensors, actuators, and communication systems.	3	PO1
CO3	Develop algorithms for autonomous navigation, path planning, and obstacle avoidance using AI.	3	PO1
CO4	Inspect the fundamental principles of artificial intelligence and its application in autonomous vehicle systems.	4	PO1

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 , 1st edition (2019), Elsevier Science.
- 2 Artificial Intelligence for Autonomous Networks, Mazin Gilbert, 1st edition (2018), Chapman & Hall / CRC Press.
- 3 Internet of Things: A Hands-On Approach, Arshdeep Bahga, 2014, Arshdeep Bahga.

25AAS3205 - AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3205	AUTONOMOUS VEHICLE ECU DESIGN WITH AUTOSAR	AVECUDA	R	3	0	0	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, PO5
CO2	Apply the fundamentals of Autonomous and EV ECU design including hardware	3	PO2, PO4
CO3	Analyze the Autonomous and EV ECU design including hardware architecture, software testing methodologies.	4	PO1, PO5
CO4	Explore how the industry is applying Autosar Standards for developing the Software for Autonomous and EV Vehicle.	4	PO2, PO5

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, Nitsch, T., 1st Edition 2018, GRIN
- 2 Vehicular Communications for Smart Cars: Protocols, Applications and Security Concerns, Chowdhury, Niaz , Mackenzie, Lewis, 1st Edition 2021, CRC Press.
- 3 Autonomous and Connected Vehicles: Network Architectures from Legacy Networks to Automotive Ethernet, Paret, D. Rebaine, H., 1st Edition 2022, Wiley.

25AAS3213 - PERCEPTION ENGINEERING FOR AUTONOMY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3213	PERCEPTION ENGINEERING FOR AUTONOMY	PEA	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
CO2	Identify the key components and technologies involved in autonomous vehicles, including sensors, actuators, and communication systems.	3	PO1
CO3	Develop algorithms for autonomous navigation, path planning, and obstacle avoidance using AI.	3	PO1
CO4	Inspect the fundamental principles of artificial intelligence and its application in autonomous vehicle systems.	4	PO1

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, 1st Edition, Elsevier Science Ltd.
- 2 Artificial Intelligence for Autonomous Networks, Mazin Gilbert, 1st Edition, Chapman.
- 3 Internet of Things: A Hands-On Approach, Arshdeep Bahga, 2014, VPT.

25AAS3304 - APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3304	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	ADLAS	R	3	0	0	2	3.5

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
CO2	Develop the fundamentals of deep learning architectures, training techniques, and optimization strategies for solving complex problem	3	PO3, PO4
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
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
CO5	Design, implement, and ethically analyze high-performing and secure autonomous systems using deep learning.	6	PO3
CO6	Evaluate ethical considerations and ensure the safety and robustness of autonomous systems.	6	PO1, PO2

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..
- 6 Applied Deep Learning,, Dr. Rajkumar Tekchandani , Dr. Neeraj Kumar, 2023, BPB Publication.

25AAS3304A - APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3304A	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	ADLAS	A	4	1	0	2	5.5

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, PO3, PO4
CO2	Develop the fundamentals of deep learning architectures, training techniques, and optimization strategies for solving complex problems	3	PO1, PO3, PO4
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
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
CO5	Design, implement, and ethically analyze high-performing and secure autonomous systems using deep learning.	4	PO2, PO4
CO6	Evaluate end-to-end deep learning solutions for autonomous navigation and environment interaction.	5	PO2, PO4
CO7	Adapt the ethical implications and safety considerations in deploying deep learning for autonomous systems.	6	PO2, PO4

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, Yoshua Bengio, Aaron Courville, 2016, Alanna Maldonado.
- 2 Autonomous Robotics and Deep Learning, Vishnu Nath, Stephen E. Levinson, 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..

25AAS3304E - APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3304E	APPLIED DEEP LEARNING FOR AUTONOMOUS SYSTEMS	ADLAS	E	4	1	0	2	5.5

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, PO4
CO2	Develop the fundamentals of deep learning architectures, training techniques, and optimization strategies for solving complex problems	3	PO1, PO2, PO3
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, PO4
CO4	Build knowledge and techniques to design intelligent agents that can learn to make optimal decisions, navigate complex environments, and control dynamical systems.	4	PO3, PO4
CO5	Design, implement, and ethically analyze high-performing and secure autonomous systems using deep learning.	5	PO2
CO6	Evaluate end-to-end deep learning solutions for autonomous navigation and environment interaction.	5	PO2
CO7	Adapt the ethical implications and safety considerations in deploying deep learning for autonomous systems	6	PO2

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.

25AAS3309 - AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3309	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	AAAV	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and understand the design, principles, and application features of Autonomous and Electric Vehicles	2	PO1, PO2
CO2	Explore AI/ML/DL fundamentals and IoT in autonomous and electric vehicle applications	3	PO1, PO2
CO3	Analyze vehicular networks, V2X communication, and related traffic/energy management techniques	4	PO1, PO2
CO4	Evaluate software design considerations including AUTOSAR stack and gateway ECU design	5	PO1, PO2
CO5	Analyze different Autonomous/Electric Vehicle control, safety and vehicular networking systems performance by various tools like python, MATLAB, SUMO	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.

Reference Books

- 1 Deep Learning for Autonomous Vehicle Control: Algorithms and Implementations, Suman Gupta, Kuntal Sengupta, 1st Edition , CRC Press.
- 2 Autonomous Driving: How the Driverless Revolution Will Change the World, rt Stadler, Andreas Herrmann, Walter Brenner, Rupe, 1st Edition, Emerald Publishing.
- 3 Deep Learning and Autonomous Vehicles: Computer Vision and AI Techniques for ADAS, Brandon Correa, 1st Edition, Springer.

25AAS3309A - AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3309A	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	AAAV	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and understand the principles, features, and applications of Autonomous Vehicles	3	PO1, PO2
CO2	Explore the design and features of Electric Vehicles and their application aspects	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, 1st Edition, CRC Press.
- 2 Autonomous Driving: How the Driverless Revolution Will Change the World, rt Stadler, Andreas Herrmann, Walter Brenner, Rupe, 1st Edition , Emerald Publishing.
- 3 Deep Learning and Autonomous Vehicles: Computer Vision and AI Techniques for ADAS, Brandon Correa, 1st Edition , Springer.
- 4 Machine Learning and AI for Autonomous Vehicles, John Ball, Lentin Joseph, 2020, Packt Publishing..

25AAS3309E - AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3309E	AUTONOMOUS ELECTRIC MOBILITY - SYSTEMS AND APPLICATIONS	AAAV	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and understand the principles, features, and applications of Autonomous Vehicles	2	PO1, PO2
CO2	Explore the design and features of Electric Vehicles and their application aspects	3	PO1, PO2
CO3	Deploy AI/ML/DL fundamentals and IoT for autonomous and EV applications	3	PO1, PO2
CO4	Analyze vehicular networks, V2X communication, and traffic/energy management	4	PO1, PO2
CO5	Evaluate software design considerations including AUTOSAR stack and gateway ECU design	5	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.

Reference Books

- 1 Deep Learning for Autonomous Vehicle Control: Algorithms and Implementations, Suman Gupta, Kuntal Sengupta, 1st Edition, CRC Press.
- 2 Autonomous Driving: How the Driverless Revolution Will Change the World, rt Stadler, Andreas Herrmann, Walter Brenner, Rupe, 1st Edition , Emerald Publishing.
- 3 Deep Learning and Autonomous Vehicles: Computer Vision and AI Techniques for ADAS, Brandon Correa, 1st Edition , Springer.

25AAS3314 - AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3314	AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE	ANCE	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Evaluate and implement robust localization and SLAM for autonomy	5	PO1, PO2
CO2	Design advanced path planning and motion generation algorithms.	5	PO2, PO3
CO3	Develop and optimize classical, model-predictive, and AI-driven control	5	PO3
CO4	Deploy/adapt navigation/control AI on embedded/edge hardware.	5	PO3
CO5	Integrate, validate, and explain navigation/control subsystems for reliability and safety.	5	PO4

Syllabus

Localization: problem definition, global vs. local localization . Probabilistic methods: Bayesian filter, Kalman filter, Particle filter . 2D/3D mapping, feature extraction, data association. Simultaneous Localization and Mapping (SLAM): Graph-based SLAM, EKF/UKF SLAM, FastSLAM. Real-world challenges: dynamic environments, loop closure

Path planning: configuration space, graphs, search (A*, D*, Dijkstra). Sampling-based planning: RRT, PRM. Behavior planning, trajectory generation (splines, B-splines, polynomial methods) . Real-time constraints, kinodynamic planning. Multi-agent and dynamic environment planning

Fundamentals: kinematic/dynamic models, feedback vs. feedforward . Classical control: PID, cascade, disturbance rejection. Model Predictive Control (MPC), adaptive and robust control. AI/learning-based control (deep RL, imitation learning, adaptive policy tuning). Safety, redundancy, and fault tolerance in control

Hardware platforms: Jetson, Coral, Raspberry Pi, FPGAs, automotive ECUs. Model deployment: converting, compressing, quantizing, ONNX/TFLite/TensorRT. Real-time inference, low-latency pipelines, multi-threading. On-device learning, edge-case adaptation, failover systems. Fleet learning, over-the-air model updates

Hardware platforms: Jetson, Coral, Raspberry Pi, FPGAs, automotive ECUs . Model deployment: converting, compressing, quantizing, ONNX/TFLite/TensorRT. Real-time inference, low-latency pipelines, multi-threading . On-device learning, edge-case adaptation, failover systems. Fleet learning, over-the-air model updates

Reference Books

- 1 Probabilistic Robotics, Thrun, Burgard,, 2016, MIT Press,.
- 2 Modern Robotics: Mechanics, Planning, and Control, Kevin Lynch, Frank Park, 2022, Cambridge.
- 3 Autonomous Driving: Technical, Legal and Social Aspects, Markus Maurer et al, 2021, Springer.
- 4 Optimal and Robust Estimation: With an Introduction to Stochastic Control Theory, Frank L. Lewis, 2017, CRC Press.

25AAS3314A - AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3314A	AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE	ANCE	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Evaluate and implement robust localization and SLAM for autonomy	5	PO1, PO2, PO4
CO2	Design advanced path planning and motion generation algorithms.	5	PO2, PO3, PO4
CO3	Develop and optimize classical, model-predictive, and AI-driven control.	5	PO1, PO3, PO5
CO4	Deploy/adapt navigation/control AI on embedded/edge hardware.	5	PO1, PO4, PO7
CO5	Integrate, validate, and explain navigation/control subsystems for reliability and safety	5	PO3, PO4, PO5, PO6

Syllabus

Module 1 covers probabilistic localization and SLAM for autonomy, including localization problem definition, global versus local localization, probabilistic methods such as Bayesian filter, Kalman filter, and Particle filter, as well as 2D and 3D mapping, feature extraction, and data association. It further explores simultaneous localization and mapping (SLAM) with approaches like graph-based SLAM, EKF, UKF, and FastSLAM, while also addressing real-world challenges such as dynamic environments and loop closure. CO1 focuses on applying and evaluating probabilistic localization and SLAM algorithms for robust real-time positioning and mapping in autonomous vehicles or robots.

Module 2 discusses path planning and motion generation, introducing configuration space, graphs, and search algorithms like A, D, and Dijkstra. It also covers sampling-based planning methods such as RRT and PRM, along with behavior planning and trajectory generation techniques including splines, Bezier, and polynomial methods. Additional topics include real-time constraints, kinodynamic planning, and multi-agent or dynamic environment planning. CO2 emphasizes designing and implementing advanced path planning and motion generation algorithms for dynamic and constrained autonomous navigation scenarios.

Module 3 focuses on control systems for autonomous vehicles and robots, beginning with fundamentals such as kinematic and dynamic models and feedback versus feedforward mechanisms. It explores classical control strategies like PID, cascade, and disturbance rejection, as well as modern approaches including model predictive control, adaptive and robust control. AI and learning-based control methods such as deep reinforcement learning, imitation learning, and adaptive policy tuning are introduced, along with concepts of safety, redundancy, and fault tolerance. CO3 involves developing and optimizing classical, model-predictive, and AI-driven control strategies for stable and safe autonomous motion.

Module 4 addresses edge AI and embedded intelligence for on-device navigation. It examines hardware platforms like Jetson, Coral, Raspberry Pi, FPGAs, and automotive ECUs, followed by model deployment techniques such as converting, compressing, quantizing, and tools like ONNX, TFLite, and TensorRT. It emphasizes real-time inference, low-latency pipelines, multithreading, on-device learning, edge-case adaptation, and failover systems, while also considering fleet learning and over-the-air model updates. CO4 highlights deploying, benchmarking, and adapting AI-driven navigation and control algorithms on embedded edge devices for real-time autonomous operation.

Module 5 covers system integration, validation, and human-in-the-loop testing. It discusses integrating perception, planning, and control modules using frameworks like ROS2, CARLA, and Autoware, along with closed-loop simulation, hardware-in-the-loop (HIL), and software-in-the-loop (SIL) testing. It introduces scenario-based validation, edge-case mining, and robustness assessment, while also addressing human factors such as teleoperation, shared autonomy, and explainability in planning and control. Safety standards and frameworks such as ISO 26262 and SOTIF are emphasized. CO5 focuses on integrating, validating, and explaining navigation and control subsystems in full-stack autonomous systems to ensure reliability, robustness, and user trust.

Reference Books

- 1 Probabilistic Robotics, Sebastian Thrun, Wolfram Burgard, Dieter Fox, 2016 (still definitive), MIT Press.
- 2 Modern Robotics: Mechanics, Planning, and Control, Kevin Lynch, Frank Park, 2022, Cambridge University Press.
- 3 Autonomous Driving: Technical, Legal and Social Aspects, Markus Maurer et al., 2021, Springer.

25AAS3314E - AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3314E	AI FOR AUTONOMOUS NAVIGATION, CONTROL & EDGE INTELLIGENCE	ANCE	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Evaluate and implement robust localization and SLAM for autonomy.	5	PO1, PO2, PO4
CO2	Design advanced path planning and motion generation algorithms.	5	PO2, PO3, PO4
CO3	Develop and optimize classical, model-predictive, and AI-driven control.	5	PO1, PO3, PO4
CO4	Deploy/adapt navigation/control AI on embedded/edge hardware.	5	PO1, PO4, PO7
CO5	Integrate, validate, and explain navigation/control subsystems for reliability and safety.	5	PO3, PO4, PO5, PO6

Syllabus

Module 1 covers probabilistic localization and SLAM for autonomy, including localization problem definition, global versus local localization, probabilistic methods such as Bayesian filter, Kalman filter, and Particle filter, as well as 2D and 3D mapping, feature extraction, and data association. It further explores simultaneous localization and mapping (SLAM) with approaches like graph-based SLAM, EKF, UKF, and FastSLAM, while also addressing real-world challenges such as dynamic environments and loop closure. CO1 focuses on applying and evaluating probabilistic localization and SLAM algorithms for robust real-time positioning and mapping in autonomous vehicles or robots.

Module 2 discusses path planning and motion generation, introducing configuration space, graphs, and search algorithms like A, D, and Dijkstra. It also covers sampling-based planning methods such as RRT and PRM, along with behavior planning and trajectory generation techniques including splines, Bezier, and polynomial methods. Additional topics include real-time constraints, kinodynamic planning, and multi-agent or dynamic environment planning. CO2 emphasizes designing and implementing advanced path planning and motion generation algorithms for dynamic and constrained autonomous navigation scenarios.

Module 3 focuses on control systems for autonomous vehicles and robots, beginning with fundamentals such as kinematic and dynamic models and feedback versus feedforward mechanisms. It explores classical control strategies like PID, cascade, and disturbance rejection, as well as modern approaches including model predictive control, adaptive and robust control. AI and learning-based control methods such as deep reinforcement learning, imitation learning, and adaptive policy tuning are introduced, along with concepts of safety, redundancy, and fault tolerance. CO3 involves developing and optimizing classical, model-predictive, and AI-driven control strategies for stable and safe autonomous motion.

Module 4 addresses edge AI and embedded intelligence for on-device navigation. It examines hardware platforms like Jetson, Coral, Raspberry Pi, FPGAs, and automotive ECUs, followed by model deployment techniques such as converting, compressing, quantizing, and tools like ONNX, TFLite, and TensorRT. It emphasizes real-time inference, low-latency pipelines, multithreading, on-device learning, edge-case adaptation, and failover systems, while also considering fleet learning and over-the-air model updates. CO4 highlights deploying, benchmarking, and adapting AI-driven navigation and control algorithms on embedded edge devices for real-time autonomous operation.

Module 5 covers system integration, validation, and human-in-the-loop testing. It discusses integrating perception, planning, and control modules using frameworks like ROS2, CARLA, and Autoware, along with closed-loop simulation, hardware-in-the-loop (HIL), and software-in-the-loop (SIL) testing. It introduces scenario-based validation, edge-case mining, and robustness assessment, while also addressing human factors such as teleoperation, shared autonomy, and explainability in planning and control. Safety standards and frameworks such as ISO 26262 and SOTIF are emphasized. CO5 focuses on integrating, validating, and explaining navigation and control subsystems in full-stack autonomous systems to ensure reliability, robustness, and user trust.

Reference Books

- 1 Probabilistic Robotics, Sebastian Thrun, Wolfram Burgard, Dieter Fox, 2016 (still definitive), MIT Press.
- 2 Modern Robotics: Mechanics, Planning, and Control, Kevin Lynch, Frank Park, 2022, Cambridge University Press.
- 3 Autonomous Driving: Technical, Legal and Social Aspects, Markus Maurer et al., 2021, Springer.

25AAS3405 - EXPERT SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3405	EXPERT SYSTEMS	ES	R	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
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
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
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

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 The Handbook of Artificial Intelligence: Volume II, Avron Barr, Edward A, 2012, Morgan Kaufmann.
- 2 Digital Medicine: Health Care in the Internet Era, Darrell M. West, 2009, Brookings Institution Press.
- 3 Introduction to Expert Systems, Peter Jackson, 2010, Addison-Wesley.

25AAS3406 - SELF-DRIVING CARS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3406	SELF-DRIVING CARS	SDC	R	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, PO5, 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, PO5, 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, PO5, PSO1
CO4	Analyze planning, control and system integration concept in autonomous vehicle using ROS (Robot Operating System).	4	PO2, PO3, PO4, PO5, 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: Key Challenges and Future Directions, Steven M. Lavalle, 2020, River .
- 2 Robot Motion Planning and Control, Jean-Claude Latombe, 2006, SpringerS.
- 3 Introduction to Self-Driving Vehicle Technology , Hanky Sjafrie , 2007, CRC Press/Chapman & Hall.
- 4 Self-Driving Cars , Lauren Newman, 2017, Cherry Lake Publishing.

25AAS3410 - CYBERSECURITY IN AUTONOMOUS VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3410	CYBERSECURITY IN AUTONOMOUS VEHICLE	CAV	R	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, PO5
CO2	Expose to Cybersecurity attacks of AV and EV system and understand various control measures.	3	PO2, PO3
CO3	Analyze the Software development for Cybersecurity controls.	4	PO2, PO3
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

Syllabus

Autonomous Feature Scoping, Threat Analysis and Risk Assessment, Asset Identification, Threat scenarios identification of AEV System, Identify the damage scenarios and analyze impact rating of AV and EV System ,Identify goals, AI based Threat Analysis 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, James M. Anderson, 1st Edition, RAND Corporation.
- 2 Cybersecurity for Connected and Autonomous Vehicles, Iyad Rahwan, 1st Edition, Springer.
- 3 The Car Hacker's Handbook, Craig Smith, 2nd Edition, Springer.

25AAS3415 - REAL-TIME NETWORKS, COMMUNICATION & SECURITY FOR AUTONOMOUS SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3415	REAL-TIME NETWORKS, COMMUNICATION & SECURITY FOR AUTONOMOUS SYSTEMS	RTNCSAS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and configure real-time in-vehicle networks	4	
CO2	Evaluate/implement advanced V2X and edge/TSN connectivity	5	
CO3	Analyze/secure embedded networks against cyber threats	4	
CO4	Implement and validate diagnostics, fault tolerance, and intrusion detection	4	
CO5	Integrate and validate end-to-end networking/security for autonomy	5	

Syllabus

Automotive communication requirements and challenges (real-time, safety, fault tolerance), Protocols: CAN, LIN, FlexRay, Automotive Ethernet, MOST, Message arbitration, time-triggered vs. event-triggered comms. Zonal/domain-based network architectures. Configuration, diagnosis, and performance analysis

V2V, V2I, V2X: architecture, standards (DSRC, C-V2X, 5G NR). Time Sensitive Networking (TSN) and deterministic Ethernet. Edge/cloud offload, fog computing, Over-the-Air (OTA) updates. Wireless security basics and reliability under mobility. Distributed diagnostics and monitoring

Security goals: confidentiality, integrity, availability, authenticity. Common attacks: replay, spoofing, DoS, message injection. Protocol security: CAN/CAN FD, Ethernet MACsec, TLS/DTLS. Secure key management, cryptographic primitives (AES, RSA, ECC). Secure boot, secure firmware updates

Diagnostics protocols: OBD-II, UDS, DoIP, XCP. Health monitoring, error frames, and error handling. Fault tolerance strategies: redundancy, failover, limp-home mode. Intrusion detection and anomaly detection for automotive networks. Real-time logging, remote diagnostics, cybersecurity events

Integrating ECU, perception, and navigation modules over real/simulated vehicle networks (CAN, Ethernet, V2X). Performance analysis: latency, jitter, throughput, reliability. Simulation/emulation: Vector CANoe, Wireshark, NS-3, SUMO, OMNeT++. Test, validation, and certification (ISO 21434, WP.29). Privacy, data logging, regulatory compliance

Reference Books

- 1 Automotive Cybersecurity: Foundations, Principles and Applications, Shlomi Dolev & Ilvaro A. Cerdas, 2022, Springer.
- 2 Networking Vehicles to Everything: V2X Communications, Michael Faerber, 2021, Wiley.
- 3 Automotive SPICE in Practice: Surviving Implementation and Assessment, Kuo-Chung Tai, 2021, Springer.
- 4 Handbook of Automotive Embedded Systems, Nicolas Navet & Françoise Simonot-Lion, 2023, Springer.
- 5 Guide to Automotive Connectivity and Cybersecurity, Dietmar P.F. Müller, 2022, Springer.

25AAS3507 - LOCALIZATION & PROGRAMMING REAL-TIME AUTONOMOUS SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3507	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
CO2	Develop the fundamentals of deep learning architectures, training techniques, and optimization strategies for solving complex problems	3	PO3, PO4
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
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

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 Publication..

25AAS3508 - REINFORCEMENT LEARNING FOR AUTONOMOUS SYSTEM (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3508	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
CO2	Identify different RL algorithms and their suitability for various applications.	3	PO1, PO3, PO4
CO3	Build Reinforcement Learning algorithms for autonomous systems.	3	PO1, PO2, PO3
CO4	Examine real-world applications of RL in autonomous vehicles, robotics, and other domains.	4	PO1, PO2, PO3

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..

25AAS3511 - AI DRIVEN ECU DESIGN FOR AUTONOMOUS VEHICLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3511	AI DRIVEN ECU DESIGN FOR AUTONOMOUS VEHICLES	AEDATT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply embedded system functions for autonomous vehicle ECU functioning.	3	PO1, PO5
CO2	Analyze machine learning functions for autonomous vehicle ECU network.	4	PO2, PO5
CO3	Analyze deep learning functions for autonomous vehicle ECU network.	4	PO2, PO5
CO4	Analyze ECU performance with integrated artificial intelligent control.	4	PO2, PO5

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 Contro, Suman Chakravorty, 2020, Springer.
- 3 Machine Learning for Embedded Systems and Edge AI, , Michael T. Koch, 2021, O'Reilly Media.

25AAS3516 - CYBER-PHYSICAL SECURITY IN AUTONOMOUS PLATFORMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AAS3516	CYBER-PHYSICAL SECURITY IN AUTONOMOUS PLATFORMS	CPSAP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply ISO 26262/SOTIF for functional safety analysis and documentation	3	
CO2	Analyze and mitigate security threats using standards-based practices.	4	
CO3	Evaluate and implement hardware security and root-of-trust solutions	5	
CO4	Evaluate and execute V&V/certification workflows for autonomy	4	
CO5	Integrate and manage end-to-end safety/security for project lifecycle.	5	

Syllabus

Functional Safety, ISO 26262 & SOTIF for Autonomous Systems

Security Threat Modeling & Countermeasures in Autonomous Platforms

Hardware Security, Root-of-Trust & Secure Boot

Verification, Validation, and Certification of Autonomous Systems

End-to-End Safety & Security Integration in Autonomous Projects

Reference Books

- 1 Functional Safety for Road Vehicles: New Challenges and Solutions for E-mobility and Automated Driving, Marco Bozzano & Adolfo Villafiorita , 2022, Springer.
- 2 SO 26262 in Practice: Solutions for Functional Safety in Automotive, Marco Arena, 2021, -.
- 3 Automotive Cybersecurity: Engineering Principles and Practice, y Dietmar P.F. M?ller, Roland E. Haas, 2021, Springer.
- 4 Security and Safety for Autonomous Driving Systems, Gianmarco Baldini , 2023, Springer.
- 5 Engineering Safe and Secure Software Systems, C. Warren Axelrod , 2023, Artech House.
- 6 Autonomous Vehicle Software: Safety, Security, Validation, Gerard Rauwerda , 2024, Elsevier.

25ABT3101 - BIOSENSORS AND BIOELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3101	BIOSENSORS AND BIOELECTRONICS	BSBE	R	3	0	2	0	4

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.

25ABT3101A - BIOSENSORS AND BIOELECTRONICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3101A	BIOSENSORS AND BIOELECTRONICS	BSBE	A	4	1	2	0	6

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.

25ABT3101E - BIOSENSORS AND BIOELECTRONICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3101E	BIOSENSORS AND BIOELECTRONICS	BSBE	E	4	1	2	0	6

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 Luis M. P. Flix, 6 (2009), Springer.

25ABT3202 - IOT APPLICATIONS IN PRECISION AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3202	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, Sherine M Abd El Kader and Basma Mamdouh Mohammad El Basoni, 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 Joao Manuel R. S. Tavares, 1 (2011), Springer.

25ABT3203 - MACHINE LEARNING FOR PRECISION AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3203	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	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

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, Aurelien Geron, 1 (2012), O Reilly Media.
- 4 Precision Agriculture Technologies for Food Security and Sustainability, Jhuberli Pereira de Souza, 1 (2014), Springer.

25ABT3304 - IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3304	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	IPAA	R	3	0	0	2	3.5

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.

25ABT3304A - IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3304A	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	IPAA	A	4	1	0	2	5.5

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 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	7 Design and execute image processing projects for agricultural applications	6	

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 image processing in agriculture Importance and benefits of Case studies and examples (e.g., crop monitoring, disease detection, yield estimation) Tools and Software 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 (histogram equalization, contrast adjustment) Image enhancement techniques Noise reduction (filtering, smoothing) (scaling, rotation, cropping) Color and Intensity Transformations Image transformation Color space conversions (RGB to grayscale, HSV) Thresholding and binarization Hands-on Exercises 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) descriptors (SIFT, SURF, ORB) Image Segmentation Using feature Importance of segmentation in image analysis Threshold-based segmentation Region-based segmentation (region growing, watershed) detection, Hough transform) Edge-based segmentation (Canny edge Advanced segmentation techniques (semantic segmentation, U-Net) Applications in Agriculture Segmentation for crop and weed identification classification Hands-on Exercises Feature extraction for disease detection and Extracting features from agricultural images 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) classification models Object Detection Training and evaluating image 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 monitoring Hands-on Exercises Object detection for pest identification and Building and training image classification models 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 Applications Real-time image analysis using IoT devices Advanced 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 learning advancements in image processing

Design and execute image processing projects for agricultural applications, Overview of Image Processing and key concepts Importance of image processing in various fields Fundamentals of Digital Images formation and representation Definition Image 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.

25ABT3304E - IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3304E	IMAGE PROCESSING FOR AGRICULTURAL APPLICATIONS	IPAA	E	4	1	0	2	5.5

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
CO7	Design and execute image processing projects for agricultural applications	6	

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.

25ABT3405 - BIOINSTRUMENTATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3405	BIOINSTRUMENTATION	BIIS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the role of biological principles	3	PO1
CO2	Compare biological instruments for desing of bioproducts	3	PO4
CO3	Analyze data generated from bio-instrumentation experiments	4	PO9
CO4	Apply signal processing techniques to enhance the quality of biological data	3	PO1

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.

25ABT3406 - DATA ACQUISITION AND COMMUNICATION SYSTEMS FOR AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3406	DATA ACQUISITION AND COMMUNICATION SYSTEMS FOR AGRICULTURE	DACSA	R	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.

25ABT3507 - MICROFLUIDICS FOR AGRICULTURAL APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3507	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..

25ABT3508 - BIOINFORMATICS FOR AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ABT3508	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.

25ACI3101 - GENERATIVE ADVERSARIAL NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3101	GENERATIVE ADVERSARIAL NETWORKS	GANWS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Ability to express theoretical understanding of GANS, Images and CNNs	2	PO1, PO2
CO2	Ability to express theoretical understanding of Various Aspects of GANS that include Generators, discriminators, loss functions, optimization functions, and Performance Assessment	3	PO1, PO3
CO3	Be able to develop and implement IMAGE based GANS such as Vanilla, Conditional GANS, Convolutional GANS, Wasserstein GAN, Style-Based GANS, Progressive GANS, and self-attention GANS.	3	PO2, PO3
CO4	Be able to develop and implement an image-based GANS that include Text GAN, Tabular GANS, Sequence GANS, Graph GAN, Time GAN and 3D GAN	4	PO3
CO5	Ability to develop, debug, Analyze and evaluate experiments relating to specific theoretical concepts connected with GANS	4	PO5
CO6	Ability to develop, integrate, implement, Analyze and evaluate real life applications using different types of GANS	5	PO11

Syllabus

Introduction to GANS: Meaning, Evolution and Advancements, Introduction to the functioning of GANS: Generator, Discriminator, Training and Validation Process, Functioning of different Example GANS, Introduction to Image Processing: Image Structure, Pre-Processing, Noise and Input, Evaluation, Introduction to Image Processing: Generation, Visual Feasibility, Colour, Augmentation, Post Processing, Introduction and Example CNNs

Types and functioning of the Generators, Types and Functioning Discriminators, Loss functions in GANS; Activation Functions used in GANS; Optimizations Functions used in GANS; Metrics used for performance evaluation of GANS considering the Image and Non-Image based Processing

Vanilla GAN, Conditional GAN (cGAN), DCGAN (Deep Convolutional GAN), Wasserstein GAN (WGAN WGAN GP), Style Based GANS, CycleGAN, Pix2Pix GAN, Progressive Growing GAN, Self Attention GAN (SAGAN), BigGAN, Latent Space Manipulation GANS, Hybrid models Introduction.

TextGAN, SeqGAN, Tabular GAN, Tabular VAE) CTGAN, GraphGAN, NetGAN, Molecular and Genomic Data: MolGAN, Graph to sequence GANS, 3D-GAN, 3D Data GAN VoxelGAN, CTGAN, Time GAN

Reference Books

- 1 GANS in Action: Deep Learning with Generative Adversarial Networks, Jakub Langr and Vladimir Bok, 2019, Manning Publishers.
- 2 Deep Learning Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016, MIT Press.
- 3 Hands On GANS with PyTorch, John Hanny and Greg Walters, 2019, Packt.
- 4 Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, David Foster, 2019, O Reilly Media.
- 5 Deep Learning for Computer Vision: Expert Techniques to Train Advanced Neural Networks Using TensorFlow and Keras, Rajalingappaa Shanmugamani, 2018, Packt Publishing .
- 6 Generative Adversarial Networks Cookbook: Over 100 Recipes to Build Generative Models Using, Josh Kalin, 2018, Packt Publishing.

25ACI3101A - GENERATIVE ADVERSARIAL NETWORKS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3101A	GENERATIVE ADVERSARIAL NETWORKS	GANWS	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Ability to express theoretical understanding of GANS, Images and CNNs	2	PO1, PO2
CO2	Ability to express theoretical understanding of Various Aspects of GANS that include Generators, discriminators, loss functions, optimization functions, and Performance Assessment	3	PO1, PO3
CO3	Be able to develop and implement IMAGE-based GANS such as Vanilla, Conditional GANS, Convolutional GANS, Wasserstein GAN, Style-Based GANS, Progressive GANS, and self-attention GANS.	3	PO2, PO3
CO4	Be able to develop and implement an image-based GANS that include Text GAN, Tabular GANS, Sequence GANS, Graph GAN, Time GAN and 3D GAN	4	PO3
CO5	Be able to develop Advanced GANS that implement domain Adaptation, style transfer, data augmentation, Image Translation, and regularization and feature matching.	4	PO5
CO6	Ability to develop, debug, Analyze and evaluate experiments relating to specific theoretical concepts connected with GANS	4	
CO7	Ability to develop, integrate, implement, Analyze and evaluate real-life applications using different types of GANS	5	PO11

Syllabus

Introduction to GANS: Meaning, Evolution and Advancements, Introduction to the functioning of GANS: Generator, Discriminator, Training and Validation Process, Functioning of different Example GANS, Introduction to Image Processing: Image Structure, Pre-Processing, Noise and Input, Evaluation, Generation, Visual Feasibility, Colour, Augmentation, Post Processing, Introduction and Example CNNs

Types and functioning of the Generators, Types and Functioning Discriminators, Loss functions in GANS; Activation Functions used in GANS; Optimizations Functions used in GANS; Metrics used for performance evaluation of GANS considering the Image and Non-Image based Processing.

Vanilla GAN, Conditional GAN (cGAN), DCGAN (Deep Convolutional GAN), Wasserstein GAN (WGAN WGAN GP), Style Based GANS, CycleGAN, Pix2Pix GAN, Prograssive Growing GAN, Self Attention GAN (SAGAN), BigGAN, Latent Space Manipulation GANS, Hybrid models Introduction.

TextGAN, SeqGAN, Tabular GAN, Tabular VAE) CTGAN, GraphGAN, NetGAN, Molecular and Genomic Data: MolGAN, Graph to sequence GANS, 3D GAN, 3D Data GAN VoxelGAN, CTGAN, Time GAN

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; Regularisation; Feature Matching

Reference Books

- 1 GANs in Action: Deep learning with Generative Adversarial Networks, Jakub Langr and Vladimir Bok, 2019, Manning Publishers.
- 2 Deep Learning Ian Goodfellow, Yoshua Bengio and Aaron Courville, 2016, MIT Press.
- 3 Hands On GANs with PyTorch, John Hanny 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.

25ACI3101E - GENERATIVE ADVERSARIAL NETWORKS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3101E	GENERATIVE ADVERSARIAL NETWORKS	GANWS	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Ability to express theoretical understanding of GANS, Images and CNNs	2	PO1, PO2
CO2	Ability to express theoretical understanding of Various Aspects of GANS that include Generators, discriminators, loss functions, optimization functions, and Performance Assessment	3	PO1, PO3
CO3	Be able to develop and implement IMAGE-based GANS such as Vanilla, Conditional GANS, Convolutional GANS, Wasserstein GAN, Style-Based GANS, Progressive GANS, and self-attention GANS.	3	PO2, PO3
CO4	Be able to develop and implement an image-based GANS that include Text GAN, Tabular GANS, Sequence GANS, Graph GAN, Time GAN and 3D GAN	4	PO3
CO5	Be able to develop Advanced GANS that implement domain Adaptation, style transfer, data augmentation, Image Translation, and regularization and feature matching.	4	PO4
CO6	Ability to develop, debug, Analyze and evaluate experiments relating to specific theoretical concepts connected with GANS	4	PO5
CO7	Ability to develop, integrate, implement, Analyze and evaluate real-life applications using different types of GANS	5	PO11

Syllabus

Introduction to GANS: Meaning, Evolution and Advancements, Introduction to the functioning of GANS: Generator, Discriminator, Training and Validation Process, Functioning of different Example GANS, Introduction to Image Processing: Image Structure, Pre-Processing, Noise and Input, Evaluation, Generation, Visual Feasibility, Colour, Augmentation, Post Processing, Introduction and Example CNNs

Types and functioning of the Generators, Types and Functioning Discriminators, Loss functions in GANS; Activation Functions used in GANS; Optimizations Functions used in GANS; Metrics used for performance evaluation of GANS considering the Image and Non-Image based Processing.

Vanilla GAN, Conditional GAN (cGAN), DCGAN (Deep Convolutional GAN), Wasserstein GAN (WGAN / WGAN-GP), Style-Based GANS, CycleGAN, Pix2Pix GAN, Prograssive Growing GAN, Self-Attention GAN (SAGAN), BigGAN, Latent Space Manipulation GANS, Hybrid models Introduction.

TextGAN, SeqGAN, Tabular GAN, Tabular VAE) CTGAN, GraphGAN, NetGAN, Molecular and Genomic Data: MolGAN, Graph-to-sequence GANS, 3D-GAN, 3D Data GAN VoxelGAN, CTGAN, Time GAN

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; Regularisation; Feature Matching

Reference Books

- 1 GANS in Action: Deep Learning with Generative Adversarial Networks, Valdamir Bok, 2019, Manning Publishers.
- 2 Deep Learning (Adaptive Computation and Machine Learning series, Ian Goodfellow, Yoshua Bengio and Aron Courville, 2016, MIT Press .
- 3 Hands On Generative Adversarial Networks with PyTorch, GANS with Pytorch , 2019, PKCT.
- 4 Generative Deep Learning Teaching Machine, David Poster, 2019, orally.

- 5 Deep Learning for Computer Vision, Expert Techniques to Train Advanced Neural Networks Using TensorFlow and Keras, Raja Linhappa Shanmugam Mani, 2018, PKCT.

25ACI3202 - EXPLAINABLE AI AND COMMUNICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3202	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	2	PO1, PO3
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, PO4
CO3	Evaluate Critically evaluate the explainability of different AI models using standard metrics and frameworks.	3	PO1, PO3
CO4	Develop effective communication skills to articulate complex AI concepts and explanations to diverse audiences, including technical and non-technical stakeholders.	3	PO2, PO4

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 Explainable AI: Interpreting, Explaining and Visualizing Deep Learning, Wojciech Samek , Gr?goire Montavon , 2019, Springer.
- 2 Explainable AI in Healthcare: Unboxing Machine Learning for Biomedicine, Mehul S. Raval, Mohendra Roy, Tolga Kaya, and Rupal Kapdi, 2025, CRC Press.
- 3 Artificial Intelligence for Communications and Networks, Shuai Han, Liang Ye, and Weixiao Meng, 2020, Springer.
- 4 Interpretable AI: Building Explainable Machine Learning Systems by Ajay Thampi, Christoph Molnar, 2019, CRC Press.

25ACI3303 - FUZZY LOGIC WITH SET THEORY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3303	FUZZY LOGIC WITH SET THEORY	FLST	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basic knowledge of the fuzzy sets, operations and their properties.	2	PO2
CO2	Understand the fundamental concepts of Fuzzy functions and Fuzzy logic	2	PO2
CO3	Apply the concepts of Fuzzy sets in image processing, pattern reorganization and decision making.	2	PO2
CO4	Analyze the concepts of Fuzzy logic in image processing.	2	PO2

Syllabus

Basic concepts of fuzzy set t norm t conforms 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

Reference Books

- 1 Fuzzy sets and systems, Didier Buboïs and Henri Prade , 2019 , Edition 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.

25ACI3303A - FUZZY LOGIC WITH SET THEORY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3303A	FUZZY LOGIC WITH SET THEORY	FLST	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basic knowledge of the fuzzy sets, operations and their properties.	2	PO2
CO2	Understand the fundamental concepts of Fuzzy functions and Fuzzy logic	2	PO2
CO3	Apply the concepts of Fuzzy sets in image processing, pattern reorganization and decision making.	3	PO2
CO4	Analyze the concepts of Fuzzy logic in image processing.	4	PO2
CO5	Explain the applications of fuzzy systems	2	PO2
CO6	Apply the fuzzy sets and relations logic and systems	3	PO3
CO7	Apply fuzzy logic with set theory operations	3	PO3

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 Buboos and Henri Prade , 2019, Edition 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.

25ACI3303E - FUZZY LOGIC WITH SET THEORY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3303E	FUZZY LOGIC WITH SET THEORY	FLST	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basic knowledge of the fuzzy sets, operations and their properties	2	PO2
CO2	Understand the fundamental concepts of Fuzzy functions and Fuzzy logic	2	PO2
CO3	Apply the concepts of Fuzzy sets in image processing, pattern reorganization and decision making.	3	PO2
CO4	Analyze the concepts of Fuzzy logic in image processing.	3	PO2
CO5	Explain the applications of fuzzy systems	2	PO3
CO6	Apply the fuzzy sets and relations logic and systems	3	PO3
CO7	Apply fuzzy logic with set theory operations	3	PO3

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: Theory and Applications, Didier Buboïs and Henri Prade , 2019 , Edition 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.

25ACI3404 - HEURISTIC ALGORITHMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3404	HEURISTIC ALGORITHMS	HA	R	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, PO5
CO2	Applying Heuristic Methods to Solve Optimization Problems, mathematical optimization methods for linear and nonlinear	3	PO1, PO2
CO3	CO-3 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	PO2, PO3
CO4	CO-4 Analyzing Custom Heuristic Solutions for Complex Problems Solve problem models using existing software programs and critique the near optimal or optimal solution obtained.	4	PO2, PO3

Syllabus

MODULE-1 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.

MODULE-2 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 Metaheuristics: From Design to Implementation, El-Ghazali Talbi, 2009, Wiley.
- 2 Introduction to Metaheuristics: Algorithms and Applications, Bastien Chopard and Marco Tomassini., 2018, Springer.
- 3 Heuristics: Intelligent Search Strategies for Computer Problem Solving, Judea Pearl, 1984, Addison-Wesley.
- 4 An Introduction to Optimization, Edwin K.P. Chong and Stanislaw H. Zak 2nd, 2013, Wiley.
- 5 Handbook of Heuristics Rafael Mart , Panos M. Pardalos, Mauricio G. C. Resende (Editors)1st, 2008, Springer.

25ACI3405 - SWARM INTELLIGENCE APPROACHES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3405	SWARM INTELLIGENCE APPROACHES	SIA	R	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
CO2	Evaluate the strengths and weaknesses of alternative approaches to evolutionary and swarm-based methods.	2	PO1, PO2
CO3	Determine and analyze the key commonalities and differences in various evolutionary and swarm based models.	3	PO1, PO2
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

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 Recent Advances in Evolutionary Multi-objective Optimization, lim Bechikh, Rituparna Datta, Abhishek Gupta, 2017, Springer.
- 2 Hyper Heuristics: Theory and Applications, Nelishia Pillay, Rong Qu, 2018, Springer.
- 3 Evolutionary Approach to Machine Learning and Deep Neural Networks: Neuro Evolution and Gene Regulatory Networks, Hitoshi Iba, 2018, Springer.
- 4 Introduction to Evolutionary Computing (Natural Computing Series), A. E. Eiben, J. E. Smith, 2015, Springer.
- 5 Hands On Genetic Algorithms with Python, Eyal Wirsansky, 2020, Packt Publishing.
- 6 Hands On Neuroevolution with Python: Build High Performing Artificial Neural Network Architectures Using Neuroevolution based Algorithms, Iaroslav Omelianenko, 2019, Packt Publishing.

25ACI3506 - DATA MANIPULATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3506	DATA MANIPULATION	DM	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	PO2
CO2	Apply data manipulation techniques using relevant software tools and programming languages such as Python, R, or SQL to manipulate real-world datasets.	3	PO2
CO3	Evaluate different approaches to data manipulation and select the most appropriate methods based on the characteristics and objectives of the dataset.	3	PO2
CO4	Analyze the impact of data manipulation on the quality, accuracy, and reliability of data for downstream analysis and decision-making processes.	4	PO2

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, Springer.
- 2 R for Data Science, Hadley Wickham and Garrett Grolemund, 2nd Edition, O Reilly Media.
- 3 SQL Cookbook Query Solutions and Techniques for Database Developers, Anthony Molinaro, 2nd Edition, O'Reilly Media.
- 4 Pandas Cookbook, Theodore Petrou, 1st Edition, Packt Publishing.
- 5 R for Data Science, Hadley Wickham, 1st Edition, O Reilly Media.
- 6 Python for Data Analysis, Wes McKinney, 3rd Edition, O Reilly Media.

25ACI3507 - REINFORCEMENT LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3507	REINFORCEMENT LEARNING	RIL	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Discuss basic and advanced reinforcement learning techniques	2	PO1, PO2, PO4, PSO1
CO2	Demonstrate suitable learning tasks to which these learning techniques can be applied.	3	PO1, PO2, PO3, PSO2
CO3	Analyze some of the current limitations of reinforcement learning techniques.	4	PO1, PO2, PO3, PSO1
CO4	Formulate decision problems, set up and run computational experiments, evaluation of results from experiments.	5	PO1, PO2, PO3, 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 Deep Reinforcement Learning, Alexander Zai and Brandon Brown, 1st Edition, Manning Publications.
- 2 Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, First Edition, Springer.
- 3 Reinforcement Learning and Optimal Control, Dimitri P. Bertsekas and John N. Tsitsiklis, Second Edition, Athena Scientific.
- 4 Reinforcement Learning An Introduction, Richard S. Sutton and Andrew G. Barto, Second Edition, The MIT Press.
- 5 Algorithms for Reinforcement Learning, Csaba Szepesvári, First Edition, Morgan & Claypool Publishers.
- 6 Cognitive Analytics and Reinforcement Learning Theories, Techniques and Applications, Elakkiya R. and Subramaniaswamy V., First Edition, Wiley.

25ACI3508 - EVOLUTIONARY COMPUTATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ACI3508	EVOLUTIONARY COMPUTATION	ECP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental principles of evolutionary computation inspired by natural selection and biological evolution.	2	PO1, PO2
CO2	Design and implement Genetic Algorithms (GAs) for solving optimization problems with appropriate selection, crossover, and mutation techniques. Analyze and compare the performance of different evolutionary algorithms such as Evolution Strategies, Genetic Programming, and Differential Evolution	3	PO1, PO2, PO3
CO3	Analyze and compare the performance of different evolutionary algorithms such as Evolution Strategies, Genetic Programming, and Differential Evolution	4	PO2, PO4
CO4	Apply evolutionary computation techniques to solve real-world multi-objective, constrained, and domain-specific problems in engineering and science	5	PO1, PO2, PO5
CO5	Evaluate recent trends and research directions in evolutionary computation, including hybrid models and applications in AI, robotics, bioinformatics, and cloud computing	5	PO4, PO5

Syllabus

Introduction to Evolutionary Computation

Genetic Algorithms (GAs)

Other Evolutionary Techniques

Applications and Advanced Topics

Lab Program

Reference Books

- 1 Introduction to Evolutionary Computing, Authors: A. E. Eiben, J. E. Smith, 2015, Springer.
- 2 Genetic Algorithms in Search, Optimization, and Machine Learning, David E. Goldberg, 1989, Addison Wesley (Pearson Education imprint).
- 3 Evolutionary Computation: A Unified Approach, Kenneth A. De Jong, 2016, MIT Press.
- 4 Computational Intelligence: An Introduction, Andries P. Engelbrech, 2007, Addison Wesley (Pearson Education imprint).
- 5 Nature-Inspired Optimization Algorithms, Xin She Yang, 2014, Elsevier.
- 6 Genetic Algorithms Data Structures Evolution Programs, Zbigniew Michalewicz, 1996, Springer.

25ADE3101 - EDGE COMPUTING FUNDAMENTALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3101	EDGE COMPUTING FUNDAMENTALS	ECF	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Edge and Fog Computing and infer the opportunities and challenges	2	PO1, PO2, PO8
CO2	Examine the Architectural detail of Edge Computing and explore the issues that are being addressed by the industry	4	PO1, PO2, PO8
CO3	Interpret the Security Requirements for Edge Computing and its Middleware needed	4	PO1, PO2, PO8
CO4	Evaluate the applicability and need for Edge/Fog Computing in various real-time projects	4	PO2, PO3, PO8
CO5	Evaluate computing paradigms using various applications in Edge Computing	4	PO2, PO3, PO8
CO6	Implementaion of sensor based IOT applications	4	PO2, PO3, PO8

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 , 2018, Springer.
- 2 Fog and Edge Computing-Simply In-depth , Singh Ajit , 2019 , 2020, English Paperback.
- 3 Fog and Edge Computing: Principles and Paradigms , Rajkumar Buyya (Editor), Satish Narayana Sri rama , 2019, wiley.

25ADE3101A - EDGE COMPUTING FUNDAMENTALS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3101A	EDGE COMPUTING FUNDAMENTALS	ECF	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Edge and Fog Computing and infer the opportunities and challenges	2	PO1, PO2, PO7
CO2	Examine the Architectural detail of Edge Computing and explore the issues that are being addressed by the industry	4	PO1, PO2, PO7
CO3	Interpret the Security Requirements for Edge Computing and its Middleware needed	4	PO1, PO2, PO7
CO4	Evaluate the aplicability and need for Edge/Fog Computing in various real-time projects	4	PO2, PO3, PO7
CO5	Evaluate computing paradigms using various applications in Edge Computing	4	PO2, PO3, PO7
CO6	Implementaion of sensor based IOT applications	4	PO2, PO3, PO7
CO7	Demonstrate proficiency in connecting edge devices to edge computing platforms.	4	PO2, PO3, PO7

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

MODULE-4 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 CaoQuen Zhang Weisong Shi , 2018, Springer.
- 2 Fog and Edge Computing Simply In depth , Singh Ajit , 2019, 2020, English Paperback.
- 3 Fog and Edge Computing: Principles and Paradigms , Satish Narayana Sri rama, 2019, Wiley.

25ADE3101E - EDGE COMPUTING FUNDAMENTALS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3101E	EDGE COMPUTING FUNDAMENTALS	ECF	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Edge and Fog Computing and infer the opportunities and challenges	2	PO1, PO2, PO7
CO2	Examine the Architectural detail of Edge Computing and explore the issues that are being addressed by the industry	4	PO1, PO2, PO7
CO3	Interpret the Security Requirements for Edge Computing and its Middleware needed	4	PO1, PO2, PO7
CO4	Evaluate the aplicability and need for Edge/Fog Computing in various real-time projects	4	PO2, PO3, PO7
CO5	Evaluate computing paradigms using various applications in Edge Computing	4	PO2, PO3, PO7
CO6	Implementaion of sensor based IOT applications	4	PO2, PO3, PO7
CO7	Demonstrate proficiency in connecting edge devices to edge computing platforms.	4	PO2, PO3, PO7

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 , 2018, Springer.
- 2 Fog and Edge Computing-Simply In-depth , Singh Ajit , 2019 ,2020, English Paperback.
- 3 Fog and Edge Computing Principles and Paradigms , Satish Narayana Sri rama, 2019, Wiley.

25ADE3202 - AI AT THE EDGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3202	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 ML and DL.	2	PO1
CO2	Practice hands-on experience to understand the role of Python packages in data science for AI technology design.	3	PO1
CO3	Demonstrate Deep Learning using Classification, Regression, and CNN in the context of Natural Language Processing.	3	PO1
CO4	Practice deploying containers on edge devices using Recurrent Neural Networks and Unsupervised Learning.	3	PO1
CO5	Devise the latest Artificial Intelligence application technologies pertaining to EDGE computing.	4	PO1

Syllabus

Importance of Machine Learning principles and Deep Learning principles, Foundations of Edge Computing, Full Stack development in the context of AI, MLOps Machine Learning and DevOps, Cloud-native development and process flows

Hands-on machine learning development using main libraries: NumPy, Pandas, Matplotlib, SciKit-Learn.

Deep Learning development for key algorithms: Classification using Multi-layer Perceptron (MLP), Dropout technique, Regression (Linear, Logistic, Multivariate), Convolutional Neural Networks (CNN), Natural Language Processing (NLP).

Recurrent Neural Networks (RNN), Unsupervised Learning (Principal Component Analysis - PCA, K-means), Deployment of 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 Edition, O'Reilly.
- 2 TinyML: Machine Learning with TensorFlow Lite, Pete Warden & Daniel Situnayake, First Edition, O'Reilly.
- 3 AI at the Edge: Solving Real-World Problems with Embedded Machine Learning, , Daniel Situnayake & Jenny Plunkett, NA Edition, O'Reilly.

25ADE3303 - EDGE AI ARCHITECTURES AND APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3303	EDGE AI ARCHITECTURES AND APPLICATIONS	EAIAA	R	3	0	0	2	3.5

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	4	PO1, PO3

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 A

Edge AI Architectures: Centralized vs. decentralized edge architectures, Cloud vs. Edge Computing, Edge Device Characteristics, Edge AI Platform Comparison, Fog computing and cloudlet architectures, Micro-services 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 An IoT: Concepts and Applications. , Gupta, G., & Patel, D., 2021 , Wiley.
- 3 AI at the Edge Daniel Situnayake, Jenny Plunkett, 2003 , O'Reilly Media, Inc.

25ADE3303A - EDGE AI ARCHITECTURES AND APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3303A	EDGE AI ARCHITECTURES AND APPLICATIONS	EAIAA	A	4	1	0	2	5.5

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	4	PO1, PO3
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 A

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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.) , 2020 , Springer.
- 2 Edge Computing for An IoT Concepts and Applications. , Gupta, G., & Patel, D., 2021 , Wiley.
- 3 AI at the Edge Daniel Situnayake , Jenny Plunkett , 2003 , O'Reilly Media, Inc.

25ADE3303E - EDGE AI ARCHITECTURES AND APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3303E	EDGE AI ARCHITECTURES AND APPLICATIONS	EAIAA	E	4	1	0	2	5.5

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	4	PO1, PO4
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 A

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Reference Books

- 1 Edge AI: Vision and Challenges, . Lim, Y., Choi, J., & Kim, H. (Eds.), 2020 , Springer.
- 2 Edge Computing for An IoT: Concepts and Applications., Gupta, G., & Patel, D, 2021 , Wiley.
- 3 AI at the Edge , Daniel Situnayake, Jenny Plunkett , 2003, O'Reilly Media, Inc.

25ADE3404 - EDGE AI AND 5G (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3404	EDGE AI AND 5G	EAI5G	R	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
CO3	Analyze the effectiveness of different defense mechanisms against adversarial attacks on edge AI systems	4	PO4
CO4	Design a secure communication protocol for data transmission in edge AI environments	5	PO3

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 Mechanism

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.

25ADE3405 - EDGE AI SECURITY AND PROTECTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3405	EDGE AI SECURITY AND PROTECTION	EAISP	R	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
CO3	Analyze the effectiveness of different defense mechanisms against adversarial attacks on edge AI systems	4	PO4
CO4	Design a secure communication protocol for data transmission in edge AI environments	5	PO3

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 Mechanism

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

25ADE3506 - EDGE AI DEVELOPMENT FRAMEWORKS AND TOOLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3506	EDGE AI DEVELOPMENT FRAMEWORKS AND TOOLS	EAIDFT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Edge and Fog Computing and infer the opportunities and challenges	2	PO1, PO2, PO8
CO2	Examine the Architectural detail of Edge Computing and explore the issues that are being addressed by the industry	4	PO1, PO2, PO8
CO3	Interpret the Security Requirements for Edge Computing and its Middleware needed	4	PO1, PO2, PO8
CO4	Evaluate the applicability and need for Edge Fog Computing in various real time projects	4	PO2, PO3, PO8

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, 2018, Springer.
- 2 Fog and Edge Computing Simply In depth, Singh Ajit, 2020, Independently published (English Paperback).
- 3 Fog and Edge Computing: Principles and Paradigms, Rajkumar Buyya, Satish Narayana Srirama, 2019, Wiley.

25ADE3507 - EDGE AI ANALYTICS AND DATA MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3507	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
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	PO1
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
CO4	Analyse the Deployment Considerations and Performance Optimization for Edge AI	4	PO4

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 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, 1st Edition, Apress Publisher.
- 2 Edge Computing: Models, Technologies, and Applications, Danda B. Rawat, Joel J.P.C. Rodrigues, and Ivan Stojmenovic, 1st Edition, CRC Press.

25ADE3508 - EDGE AI AND SUSTAINABILITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ADE3508	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	PO4

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 Ethics of Artificial Intelligence and Robotics , Michael Rafael Capurro,Nagenborg, Johannes Holbrook , 1st Edition , Springer.

25AEA3101 - AUTOMOTIVE SENSOR AND APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3101	AUTOMOTIVE SENSOR AND APPLICATIONS	ASA	R	3	0	2	0	4

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	
CO2	Analyze the function and application of diverse sensors within engine management systems to achieve optimal engine performance and minimize emissions.	4	
CO3	Analyze how sensor data is utilized to achieve advanced functionalities in powertrain and vehicle motion control systems.	4	
CO4	Analyze the effectiveness of sensor integration within active and passive safety systems, considering the influence of electronic components and communication protocols.	4	
CO5	Evaluate the applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	5	
CO6	Develop Case studies for applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	6	

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)

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..

25AEA3101A - AUTOMOTIVE SENSOR AND APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3101A	AUTOMOTIVE SENSOR AND APPLICATIONS	ASA	A	4	1	2	0	6

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	
CO2	Analyze the function and application of diverse sensors within engine management systems to achieve optimal engine performance and minimize emissions.	4	
CO3	Apply how sensor data is utilized to achieve advanced functionalities in powertrain and vehicle motion control systems.	3	
CO4	Analyze the effectiveness of sensor integration within active and passive safety systems, considering the influence of electronic components and communication protocols.	4	
CO5	Analyze basic sensor-based systems for automotive applications.	4	
CO6	Evaluate the applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	6	
CO7	Develop case studies for applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	6	

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..

25AEA3101E - AUTOMOTIVE SENSOR AND APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3101E	AUTOMOTIVE SENSOR AND APPLICATIONS	ASA	E	4	1	2	0	6

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	
CO2	Analyze the function and application of diverse sensors within engine management systems to achieve optimal engine performance and minimize emissions.	4	
CO3	Apply how sensor data is utilized to achieve advanced functionalities in powertrain and vehicle motion control systems.	3	
CO4	Analyze the effectiveness of sensor integration within active and passive safety systems, considering the influence of electronic components and communication protocols.	4	
CO5	Analyze basic sensor-based systems for automotive applications.	5	
CO6	Evaluate the applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	5	
CO7	Develop Case studies for applications of AUTOMOTIVE SENSOR AND APPLICATIONS,	6	

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..

25AEA3202 - AUTOTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3202	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	
CO2	Apply the concept of control of fuel systems	3	
CO3	Apply the concept for Electronically controlled Injection and actuators	3	
CO4	Analyze and design OBD tools	4	

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,Satya Prakashan, 2021, Chand Publishers..

25AEA3203 - AUTOMOTIVE POLLUTION AND ITS CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3203	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	
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	
CO3	Design strategies to control emission from engines, effect of design and operating parameters on emission concentrations, modification in the engine design.	3	
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	

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.

25AEA3304 - ALTERNATE DRIVES, TRACTION AND CONTROLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3304	ALTERNATE DRIVES, TRACTION AND CONTROLS	ADTC	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of alternate technologies	3	
CO2	Apply the concept of speed and torque for automotive requirements	3	
CO3	Apply the concept for Hybrid architecture design	3	
CO4	Analyze the Concept of fuel cells	4	
CO5	Analyze power electronics dynamics and control	5	
CO6	Analyze various drives and compare their performance	6	

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, M, Mehrdad Ehsani,, 2015, CRC publisher..
- 2 Electric & Hybrid Vehicles,, Iqbal Hussein, 2015, 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.

25AEA3304A - ALTERNATE DRIVES, TRACTION AND CONTROLS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3304A	ALTERNATE DRIVES, TRACTION AND CONTROLS	ADTC	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of alternate technologies	3	
CO2	Apply the concept of speed and torque for automotive requirements	3	
CO3	Apply the concept for Hybrid architecture design	3	
CO4	Analyze the Concept of fuel cells	4	
CO5	Analyze power electronics dynamics and control	5	
CO6	Analyze the dynamic stability of the vehicle	6	
CO7	Apply the concept of hybrid vehicles and design drive layouts	6	

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.

25AEA3304E - ALTERNATE DRIVES, TRACTION AND CONTROLS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3304E	ALTERNATE DRIVES, TRACTION AND CONTROLS	ADTC	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of alternate technologies	3	
CO2	Apply the concept of speed and torque for automotive requirements	3	
CO3	Apply the concept for Hybrid architecture design	3	
CO4	Analyze the Concept of fuel cells	4	
CO5	Analyze power electronics dynamics and control	5	
CO6	Analyze the dynamic stability of the vehicle	6	
CO7	Apply the concept of hybrid vehicles and design drive layouts	6	

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.

25AEA3405 - VEHICLE CONTROL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3405	VEHICLE CONTROL SYSTEMS	VCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Classical Control Techniques for Vehicle Dynamics and Modeling	3	
CO2	Apply, Develop, and Put into Practice Vehicle-Specific Control Systems	3	
CO3	Applying modelling and simulation tools, apply the development of advanced vehicle control systems	3	
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,, 2011, Springer.
- 2 Automotive Control Systems: For Engine, Driveline, and Vehicle, , Uwe Kiencke and Lars Nielsen, 2005, Springer.
- 3 Modern Control Engineering,, Katsuhiko Ogata, 2010, Prentice Hall..
- 4 The Automotive Chassis: Engineering Principles, Reza N. Jazar,, 2014, Springer.
- 5 Fundamentals of Vehicle Dynamics,, Thomas D. Gillespie, 1992, Society of Automotive Engineers (SAE)..

25AEA3406 - AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3406	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	AEES	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of Automotive Electronics	3	
CO2	Apply the concept of Fuel Ignition Electronics	3	
CO3	Apply the concept for Fuel Injection Electronics	3	
CO4	Analyze the Concept of Electronics Accessories	4	

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.

25AEA3507 - SOFT COMPUTING TECHNIQUES FOR AUTOMOTIVE APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3507	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	
CO2	Apply neural networks to address complex automotive challenges	3	
CO3	Design and implement soft computing-based automotive systems	3	
CO4	Evaluate soft computing model performance in automotive contexts	3	

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.

25AEA3508 - AUTOMOTIVE NETWORKING AND PROTOCOLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEA3508	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	
CO2	Analysis of CAN protocols, bus access and Physical layer standards	3	
CO3	Analyze higher level CAN protocols	3	
CO4	Analysis of LIN protocols and standards	3	

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: LIN standard 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.

25AEC3101 - EDGE AI HARDWARE ARCHITECTURES & ACCELERATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEC3101	EDGE AI HARDWARE ARCHITECTURES & ACCELERATION	EHA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply architectural principles to design scalable AI systems at the edge integrating hardware software and networking layers	3	PO2, PO3
CO2	Analyze and select the right AI frameworks and acceleration libraries for specific edge workloads	4	PO2, PO3
CO3	Analyze performance tradeoffs in heterogeneous hardware setups and optimize for latency throughput and energy efficiency	4	PO2, PO3
CO4	Evaluate end to end edge AI platforms both commercial and open source and recommend suitable solutions for enterprise or industrial scenarios	5	PO2, PO3

Syllabus

Edge AI system architecture including reference architectures device edge node edge cluster cloud gateway hardware tiers ultra low power MCUs SBCs GPU TPU FPGA equipped edge servers AI workload placement split inference cascaded inference architectural patterns event driven stream processing microservices latency pipelines inference path optimization resilience strategies redundancy failover federated deployments

AI frameworks for edge including TensorFlow Lite PyTorch Mobile ExecuTorch ONNX Runtime Mobile OpenVINO NVIDIA TensorRT Qualcomm SNPE Google Coral Edge TPU APIs model conversion pipelines TensorFlow to TFLite EdgeTPU PyTorch to TorchScript ONNX GPU vs NPU inference paths optimizing data loaders and preprocessing pipelines

Heterogeneous hardware optimization including profiling AI workloads on CPU GPU TPU VPU concurrency management multi stream inference batching strategies memory footprint analysis thermal throttling prevention dynamic resource scaling DVFS load shedding hardware aware NAS at the edge

Edge AI platforms and ecosystem including Azure Percept AWS Panorama Google Edge TPU Cloud NVIDIA Fleet Command EdgeX Foundry container native ML serving KServe BentoML integration with MLOps pipelines criteria for platform evaluation scalability model lifecycle management security OTA capabilities developer ecosystem multi tenant edge AI deployments

Reference Books

- 1 Architecting AI Solutions on the Edge, Perry Lea, Latest, O Reilly.
- 2 Programming PyTorch for Deep Learning, Ian Pointer, Latest, O Reilly.
- 3 OpenVINO Toolkit Deep Learning Deployment Toolkit, Intel AI Labs, Latest, Intel Press.

25AEC3101A - EDGE AI HARDWARE ARCHITECTURES & ACCELERATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEC3101A	EDGE AI HARDWARE ARCHITECTURES & ACCELERATION	EHA	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply architectural principles to design scalable AI systems at the edge integrating hardware software and networking layers	3	PO2, PO3
CO2	Analyze and select appropriate AI frameworks and acceleration libraries for different edge workloads	4	PO2, PO3
CO3	Demonstrate optimization strategies for heterogeneous hardware focusing on latency throughput and energy efficiency	4	PO2, PO3
CO4	Evaluate commercial and open source edge AI platforms for enterprise or industrial use cases	5	PO2, PO3
CO5	Recommend suitable edge AI platform solutions aligned with scalability lifecycle management and deployment needs	5	PO2, PO3

Syllabus

Edge AI system architecture including reference architectures device edge node edge cluster cloud gateway hardware tiers ultra low power MCUs SBCs GPU TPU FPGA equipped edge servers AI workload placement split inference cascaded inference architectural patterns event driven stream processing microservices latency pipelines inference path optimization resilience strategies redundancy failover federated deployments

AI frameworks for edge including TensorFlow Lite PyTorch Mobile ExecuTorch ONNX Runtime Mobile OpenVINO NVIDIA TensorRT Qualcomm SNPE Google Coral Edge TPU APIs model conversion pipelines TensorFlow to TFLite EdgeTPU PyTorch to TorchScript ONNX GPU vs NPU inference paths optimizing data loaders and preprocessing pipelines

Heterogeneous hardware optimization including profiling AI workloads on CPU GPU TPU VPU concurrency management multi stream inference batching strategies memory footprint analysis thermal throttling prevention dynamic resource scaling DVFS load shedding hardware aware NAS at the edge

Edge AI platforms and ecosystem including Azure Percept AWS Panorama Google Edge TPU Cloud NVIDIA Fleet Command EdgeX Foundry container native ML serving KServe BentoML integration with MLOps pipelines criteria for platform evaluation scalability model lifecycle management security OTA capabilities developer ecosystem multi tenant edge AI deployments

Reference Books

- 1 Architecting AI Solutions on the Edge, Perry Lea, Latest, O Reilly.
- 2 Programming PyTorch for Deep Learning, Ian Pointer, Latest, O Reilly.
- 3 OpenVINO Toolkit Deep Learning Deployment Toolkit, Intel AI Labs, Latest, Intel Press.

25AEC3101E - EDGE AI HARDWARE ARCHITECTURES & ACCELERATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEC3101E	EDGE AI HARDWARE ARCHITECTURES & ACCELERATION	EHA	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply architectural principles to design scalable AI systems at the edge integrating hardware software and networking layers	3	PO2, PO3
CO2	Analyze and select appropriate AI frameworks and acceleration libraries for different edge workloads	4	PO2, PO3
CO3	Demonstrate optimization strategies for heterogeneous hardware focusing on latency throughput and energy efficiency	4	PO2, PO3
CO4	Evaluate commercial and open source edge AI platforms for enterprise or industrial use cases	5	PO2, PO3
CO5	Recommend suitable edge AI platform solutions aligned with scalability lifecycle management and deployment needs	5	PO2, PO3

Syllabus

Edge AI system architecture including reference architectures device edge node edge cluster cloud gateway hardware tiers ultra low power MCUs SBCs GPU TPU FPGA equipped edge servers AI workload placement split inference cascaded inference architectural patterns event driven stream processing microservices latency pipelines inference path optimization resilience strategies redundancy failover federated deployments

AI frameworks for edge including TensorFlow Lite PyTorch Mobile ExecuTorch ONNX Runtime Mobile OpenVINO NVIDIA TensorRT Qualcomm SNPE Google Coral Edge TPU APIs model conversion pipelines TensorFlow to TFLite EdgeTPU PyTorch to TorchScript ONNX GPU vs NPU inference paths optimizing data loaders and preprocessing pipelines

Heterogeneous hardware optimization including profiling AI workloads on CPU GPU TPU VPU concurrency management multi stream inference batching strategies memory footprint analysis thermal throttling prevention dynamic resource scaling DVFS load shedding hardware aware NAS at the edge

Edge AI platforms and ecosystem including Azure Percept AWS Panorama Google Edge TPU Cloud NVIDIA Fleet Command EdgeX Foundry container native ML serving KServe BentoML integration with MLOps pipelines criteria for platform evaluation scalability model lifecycle management security OTA capabilities developer ecosystem multi tenant edge AI deployments

Reference Books

- 1 Architecting AI Solutions on the Edge, Perry Lea, Latest, O Reilly.
- 2 Programming PyTorch for Deep Learning, Ian Pointer, Latest, O Reilly.
- 3 OpenVINO Toolkit: Deep Learning Deployment Toolkit, Intel AI Labs, Latest, O Reilly.

25AEC3202 - SECURE & SCALABLE EDGE AI NETWORKING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEC3202	SECURE & SCALABLE EDGE AI NETWORKING	SEAN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply edge networking fundamentals and select suitable protocols such as MQTT CoAP gRPC and HTTP3 for AI inference data paths	3	PO2
CO2	Analyze 5G and MEC features including latency slicing and mobility and map AI workloads to edge MEC and cloud for SLO compliance	4	PO3
CO3	Analyze service mesh patterns such as mTLS traffic shifting and retries to improve reliability and observability of edge AI microservices	4	PO3
CO4	Evaluate zero trust controls policy and cost or energy tradeoffs for secure and governed edge to cloud AI deployments	5	PO3

Syllabus

Edge networking for AI pipelines including camera audio sensor to preprocessing to inference to publish TCP vs UDP HTTP2 and HTTP3 QUIC basics gRPC for low latency RPC MQTT and CoAP for telemetry and command message schemas payload sizing back pressure batching gateway roles protocol bridging local buffering DNS NAT firewall traffic shaping jitter and time synchronization NTP chrony for event alignment

5G and MEC for edge AI including 5G architecture gNB 5GC control vs data plane user plane UPF service types URLLC eMBB mMTC network slicing for AI workloads MEC placement models locality mobility handover for mobile AI robots drones 5G latency and jitter vs WiFi uplink heavy vs downlink heavy pipelines and workload offload to MEC or cloud

Service mesh for edge microservices including sidecars vs ambient mesh Istio and Linkerd data plane Envoy and control plane mTLS service identity SPIFFE IDs retries timeouts circuit breaking bulkheads traffic splitting canary rollouts observability metrics golden signals distributed tracing egress control allow lists and mesh overhead tuning for edge nodes

Zero trust edge to cloud and governance including workload identity SPIFFE SPIRE signed artifacts cosign SBOMs syft quick scans trivy OPA Gatekeeper for policy secure MQTT TLS per device certificates secrets management FinOps for networking egress cost vs local inference SLOs for latency and availability alerting incident playbooks fallback and graceful degradation when WAN or 5G is impaired

Reference Books

- 1 Istio Up & Running (2e), Lee Calcote, Latest, O Reilly.
- 2 gRPC: Up & Running, Kasun Indrasiri, Latest, O Reilly.
- 3 5G Mobile Networks: A Systems Approach, Larry Peterson, Latest, O Reilly.

25AEC3303 - SERVICE MESH & OBSERVABILITY FOR EDGE AI (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEC3303	SERVICE MESH & OBSERVABILITY FOR EDGE AI	SMOA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply edge networking fundamentals and select suitable protocols (MQTT/CoAP/gRPC/HTTP-3) for AI inference pipelines.	3	PO1
CO2	Analyze 5G/MEC features (latency, slicing, mobility) and determine placement of AI workloads across edge, MEC, and cloud.	4	PO1, PO2, PO3
CO3	Evaluate service-mesh patterns (mTLS, retries, traffic splitting) for reliability, observability, and secure microservice communication in edge AI systems.	4	PO1, PO2, PO3
CO4	Design secure and governed edge-to-cloud AI deployments by applying zero-trust controls and considering cost/energy trade-offs.	5	PO2, PO3

Syllabus

AI data paths camera audio sensor inference publish, TCP vs UDP, HTTP2 HTTP3 basics, gRPC MQTT CoAP, payload sizing, back pressure, gateways, DNS NAT jitter time sync

5G architecture; control/data plane; URLLC/eMBB/mMTC; slicing for AI workloads; MEC placement; handovers for mobile AI; uplink vs downlink pipelines; MEC vs cloud offload.

Sidecars vs ambient mesh; Istio/Linkerd; Envoy data plane; mTLS, SPIFFE IDs; retries, timeouts, circuit breaking; canary rollouts; observability & tracing; overheads on edge nodes.

Per-workload identity (SPIFFE/SPIRE); signed artifacts (cosign); SBOMs; OPA/Gatekeeper; secure MQTT; FinOps for networking; egress costs; SLOs; fallback & graceful degradation.

Reference Books

- 1 Istio: Up & Running (2e), Lee Calcote, Zack Butcher, 2023, O Reilly.
- 2 Distributed Systems Observability, Cindy Sridharan, 2018, O Reilly.
- 3 Edge Computing: Models, Technologies and Applications, R. Mahmud, R. Buyya, 2018, Springer.

25AEC3303A - SERVICE MESH & OBSERVABILITY FOR EDGE AI (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEC3303A	SERVICE MESH & OBSERVABILITY FOR EDGE AI	SMOA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply edge networking fundamentals and select suitable protocols MQTT CoAP gRPC HTTP3 for AI inference data paths	3	PO1
CO2	Analyze 5G MEC features latency slicing mobility and map AI workloads to edge vs MEC vs cloud for SLO compliance	4	PO2, PO3
CO3	Analyze service-mesh patterns (mTLS, traffic shifting, retries) to improve reliability and observability of edge AI microservices.	4	PO1, PO2, PO3
CO4	Evaluate zero-trust controls and policy mechanisms for secure edge-to-cloud AI deployments.	5	PO2, PO3
CO5	Assess cost and energy trade-offs in designing governed, scalable AI inference pipelines across edge, MEC, and cloud.	2	PO2, PO3

Syllabus

AI data paths camera audio sensor inference publish, TCP vs UDP, HTTP2 HTTP3 basics, gRPC MQTT CoAP, payload sizing, back pressure, gateways, DNS NAT jitter time sync

5G architecture, control data plane, URLLC eMBB mMTC, slicing for AI workloads, MEC placement, handovers for mobile AI, uplink vs downlink pipelines, MEC vs cloud offload

Sidecars vs ambient mesh; Istio/Linkerd; Envoy data plane; mTLS, SPIFFE IDs; retries, timeouts, circuit breaking; canary rollouts; observability & tracing; overheads on edge nodes.

Per workload identity SPIFFE SPIRE, signed artifacts cosign, SBOMs, OPA Gatekeeper, secure MQTT, secrets, incident playbooks

FinOps for networking, egress costs vs local infer, SLOs for latency availability, alerting, fallback strategies, graceful degradation when WAN 5G impaired

Reference Books

- FinOps for networking, egress costs vs local infer, SLOs for latency availability, alerting, fallback strategies, graceful degradation when WAN 5G impaired, FinOps for networking, egress costs vs local infer, SLOs for latency availability, alerting, fallback strategies, graceful degradation when WAN 5G impaired, 2020, O Reilly.
- Distributed Systems Observability, Cindy Sridharan, 2018, O Reilly.
- Edge Computing: Models, Technologies and Applications, Edge Computing: Models, Technologies and Applications, 2019, Springer.

25AEC3303E - SERVICE MESH & OBSERVABILITY FOR EDGE AI (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEC3303E	SERVICE MESH & OBSERVABILITY FOR EDGE AI	SMOA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply edge networking fundamentals and select suitable protocols MQTT CoAP gRPC HTTP3 for AI inference data paths	3	PO1
CO2	Analyze 5G MEC features latency slicing mobility and map AI workloads to edge vs MEC vs cloud for SLO compliance	4	PO2, PO3
CO3	Analyze service-mesh patterns (mTLS, traffic shifting, retries) to improve reliability and observability of edge AI microservices.	4	PO1, PO2, PO3
CO4	Evaluate zero-trust controls and policy mechanisms for secure edge-to-cloud AI deployments.	5	PO2, PO3
CO5	Assess cost and energy trade-offs in designing governed, scalable AI inference pipelines across edge, MEC, and cloud.	5	PO2, PO3

Syllabus

AI data paths camera audio sensor inference publish, TCP vs UDP, HTTP2 HTTP3 basics, gRPC MQTT CoAP, payload sizing, back pressure, gateways, DNS NAT jitter time sync

5G architecture, control data plane, URLLC eMBB mMTC, slicing for AI workloads, MEC placement, handovers for mobile AI, uplink vs downlink pipelines, MEC vs cloud offload

Sidecars vs ambient mesh, Istio Linkerd, Envoy data plane, mTLS SPIFFE IDs, retries timeouts circuit breaking, canary rollouts, observability tracing, overheads on edge nodes

Per workload identity SPIFFE SPIRE, signed artifacts cosign, SBOMs, OPA Gatekeeper, secure MQTT, secrets, incident playbooks

FinOps for networking, egress costs vs local infer, SLOs for latency availability, alerting, fallback strategies, graceful degradation when WAN 5G impaired

Reference Books

- 1 Distributed Systems Observability, Cindy Sridharan, 2018, O Reilly.
- 2 5G Mobile Networks: A Systems Approach, Larry Peterson, Oguz Sunay, 2020, O Reilly.
- 3 Edge Computing: Models, Technologies and Applications, R. Mahmud, R. Buyya, 2019, Springer.

25AEC3404 - SERVERLESS & COST-OPTIMIZED AI AT THE EDGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEC3404	SERVERLESS & COST-OPTIMIZED AI AT THE EDGE	SCAE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply serverless and FaaS concepts to design low-latency, event-driven AI inference workflows at the edge.	3	PO2
CO2	Analyze multi cloud and hybrid edge cloud serverless patterns to optimize workload placement, latency, and performance	4	PO3
CO3	Evaluate cost drivers (compute, storage, network egress) and apply FinOps practices to optimize AI workloads.	4	PO2, PO3
CO4	Design deployment strategies comparing serverless, containerized, and on-device execution for cost, scalability, and SLO compliance	5	PO2, PO3

Syllabus

Serverless characteristics no server mgmt scale to zero billing granularity, FaaS vs BaaS, event sources HTTP MQTT file object events streams, AI inference triggers, cold start mitigation, concurrency limits, platforms AWS Lambda Azure Functions GCP Functions OpenFaaS Knative, local emulation testing, chaining functions

Reasons for multi cloud hybrid edge AI, event routing across edge MEC cloud, federated serverless deployments, Knative Eventing CloudEvents, KEDA for on prem edge autoscaling, fallback routing, integration with message brokers

ChatGPT said: Cost breakdown compute storage egress, serverless cost models, cold start cost impact, FinOps basics visibility chargeback showback, cloud cost calculators, optimize batch size invocation frequency, caching at edge, off peak scale to zero

Comparing serverless containers and on device execution, benchmarking low latency vs batch workloads, hybrid orchestration, security compliance implications, case studies, decision matrix latency cost availability operational complexity

Reference Books

- 1 Serverless Architectures on AWS, Peter Sbarski, Sam Kroonenburg, Ajay Nair, 2022, Manning.
- 2 Knative in Action, Jacques Chester, 2021, Manning.
- 3 Cloud FinOps, J.R. Storment, Mike Fuller, 2020, O Reilly.

25AEC3505 - EDGE AI ORCHESTRATION & LIFECYCLE MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEC3505	EDGE AI ORCHESTRATION & LIFECYCLE MANAGEMENT	EAOM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply edge-centric MLOps practices (model registry, versioning, rollout policies) to manage models from development to edge deployment.	3	PO1, PO2
CO2	Analyze platform engineering patterns GitOps IDPs fleet OTA config secrets to reliably operate large edge AI fleets	4	PO1, PO2
CO3	Evaluate observability, SLOs, and AIOps auto-remediation to maintain production edge AI services.	4	PO2, PO3
CO4	Design continuous learning strategies drift detection data feature pipelines federated learning to optimize accuracy cost latency trade offs	5	PO2, PO3

Syllabus

Edge vs cloud MLOps, artifact lineage, model registry versioning, canary shadow blue green rollouts, validation gates accuracy latency footprint power, packaging for constrained devices TFLite ORT OpenVINO TensorRT, model cards, promotion workflows, basic AB testing at edge nodes

GitOps (Argo CD/FluxCD); internal developer platforms (IDPs); fleet orchestration (k3s/MicroK8s), OTA; config & secrets management (Sealed-Secrets/Vault); per-device policy & zero-trust hooks; supply-chain basics (cosign, SBOM, scanning).

ChatGPT said: Golden signals latency traffic errors saturation, business model SLOs, metrics logs traces Prometheus Grafana Loki Fluent Bit Jaeger, model monitoring data quality drift skew, alerting auto remediation, incident response chaos drills at edge

ChatGPT said: Edge DataOps filtering, sample capture, privacy preserving sync, feature stores for consistency, retraining loops Kubeflow Vertex Azure ML, federated learning Flower PySyft, retraining scheduling, evaluation at edge, governance audit trails, total cost of ownership view

Reference Books

- 1 Practical MLOps, Noah Gift, Alfredo Deza, 2021, O Reilly.
- 2 Site Reliability Engineering, Betsy Beyer et al., 2016, O Reilly.
- 3 Architecting AI Solutions on the Edge, Perry Lea, 2022, O Reilly.

25AEE3101 - AUTOMOBILE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3101	AUTOMOBILE ENGINEERING	AEG	R	3	0	2	0	4

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

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.

25AEE3101A - AUTOMOBILE ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3101A	AUTOMOBILE ENGINEERING	AEG	A	4	1	2	0	6

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

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.

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- 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.

25AEE3101E - AUTOMOBILE ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3101E	AUTOMOBILE ENGINEERING	AEG	E	4	1	2	0	6

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

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.

25AEE3202 - AUTOTRONICS AND SAFETY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3202	AUTOTRONICS AND SAFETY	AESS	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

Introduction to Automotive Batteries Importance Overview History Basics of electrochemistry Chemical reactions in lead acid batteries Types of Automotive Batteries Lead acid batteries flooded gel Lithium ion batteries and hybrid vehicle batteries Specialty batteries start stop systems deep cycle batteries Battery Performance Factors Temperature effects State of charge and state of health 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

- 1 Automotive Electrical and Engine Performance, James D. Halderman, 1, Pearson.
- 2 Automotive Wiring and Electrical Systems, Tony Candela, 1, CarTech Inc.v.
- 3 Automotive Vehicle Safety, George A. Peters, Barbara J. Peters, 2, Taylor and Francis.

25AEE3203 - REFRIGERATION & AIR CONDITIONING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3203	REFRIGERATION & AIR CONDITIONING	RAC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of basic refrigeration cycles to estimate and enhance the performance of vapour compression refrigeration systems	3	PO1, PSO1
CO2	Analyse various vapour absorption systems and investigate the effect of refrigerants on the performance of refrigeration cycles	4	PO2, PSO1
CO3	Analyze the working and performance of Low temperature refrigeration and steam jet refrigeration systems	4	PO2, PSO1
CO4	Estimate the effect various air conditioning systems on human comfort and perform cooling load calculations	4	PO2, PSO1

Syllabus

Basics of Refrigeration: Air refrigeration cycle-working-methods-merits and demerits-simple air evaporative cooling- Bootstrap air cooling systems-comparison of various air cooling systems used in aircraft. Vapour Compression Refrigeration cycle: Working, Theoretical and actual cycles, Effect of suction and discharge pressures, performance enhancement of vapour compression cycle, Compound vapour refrigeration systems: Intercooler, subcooler.

Vapour Absorption refrigeration systems: Ideal and practical Vapour absorption cycle, Refrigerant-Absorbent requirements, COP, Domestic Electrolux, Lithium Bromide vapour absorption system. Refrigerants: Classification, properties of ideal refrigerant, Hydro-carbon and inorganic refrigerants, Designation of refrigerants, secondary refrigerants-Brines.

Low temperature refrigeration (Cryogenics): Limitations of VCR for low temperature production, Cascade Refrigeration, COP of two stage cascade system, Manufacture of solid and dry ice, Liquefaction of hydrogen and helium, Claude system of liquification of air. Steam jet Refrigeration: Principle and working of steam jet refrigeration, Steam Ejector, Analysis and efficiencies of steam jet refrigeration.

Air conditioning Systems: Psychrometric processes & relations, Factors effecting human comfort, Modified comfort chart, Classification of air conditioning systems, Comfort, industrial, winter, summer, year round, unitary and central air conditioning systems. Cooling Load Estimations: Components of cooling load, Heat gain due to-infiltration, ventilation, Occupants, appliances, products, lighting equipment, power systems and ducts.

Reference Books

- 1 Refrigeration and Air Conditioning, C.P.Arora, 4,2021, Mc Graw Hill.
- 2 Principles of Refrigeration, Roy J.Dossat, Thomas J. Horan, 2016, Pearson Education.
- 3 Refrigeration and Air Conditioning Technology, William C. Whitman, William M. Johnson, John A. Tomczyk, 8, 2020, Cengage Education.

25AEE3304 - THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3304	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	TMEES	R	3	0	0	2	3.5

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
CO5	Simulate Various battery management systems using Ansys Fluent Software	4	PO1, PO3

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, R. C. Chu, 2nd, ASME Press, New York (2002).
- 2 The Handbook of Lithium Ion Battery Pack Design Chemistry Components Types and Terminology, John Warner, 1st, Elsevier (2015).
- 3 Heat Transfer, J. P. Holman, 3rd, McGraw Hill (2017).

25AEE3304A - THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3304A	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	TMEES	A	4	1	0	2	5.5

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
CO5	Simulate Various battery management systems using Ansys Fluent Software	4	PO1, PO3

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, R. C. Chu, 2nd Edition, 2002, ASME Press, New York.
- 2 The Handbook of Lithium Ion Battery Pack Design Chemistry Components Types and Terminology, John Warner, 1st Edition, 2015, Elsevier.
- 3 Heat Transfer, Holman J. P., 3rd Edition, 2017, McGraw Hill Book Co..
- 4 Thermal Management of Electronics, Rajesh, C. Balaji, 1st Edition, 2019, Momentum Press.

25AEE3304E - THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3304E	THERMAL MANAGEMENT OF ELECTRIC AND ELECTRONIC SYSTEMS	TMEES	E	4	1	0	2	5.5

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
CO5	Simulate Various battery management systems using Ansys Fluent Software	4	PO1, PO3

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, R. C. Chu, 2nd, ASME Press, New York (2002).
- 2 The Handbook of Lithium Ion Battery Pack Design Chemistry Components Types and Terminology, John Warner, 1st, Elsevier (2015).
- 3 Heat Transfer, J. P. Holman, 3rd, McGraw Hill (2017).

25AEE3405 - SPECIAL PURPOSE VEHICLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3405	SPECIAL PURPOSE VEHICLES	SPV	R	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, M. Tushnyakov, 1986, MIR, Moscow.
- 2 Truck Cranes, A. Astskhov, 1977, MIR, Moscow.
- 3 Motor Graders, E.G. Robinson, 1961, MIR, Moscow.

25AEE3406 - VEHICLE DYNAMICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3406	VEHICLE DYNAMICS	VDS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and evaluate the natural frequency of a single and multi-degree freedom systems	3	PO1, PSO2
CO2	Apply the predict the stability of vehicle at different operating conditions	3	PO1, PSO2
CO3	Analyse the directional stability of the vehicle during cornering	3	PO1, PSO2
CO4	Analyse the directional stability of the vehicle during cornering	4	PO2, PSO2

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, SAE.
- 2 Steering, Suspension and Tyres, J. G. Giles, 4, Illiffe Books Ltd..
- 3 Theory of Ground Vehicles, J. Y. Wong, 2012, John Wiley and Sons Inc..

25AEE3507 - AUTONOMOUS VEHICLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3507	AUTONOMOUS VEHICLES	AVS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of basic refrigeration cycles to estimate and enhance the performance of vapour compression refrigeration systems	3	PO1, PSO1
CO2	Analyse various vapour absorption systems and investigate the effect of refrigerants on the performance of refrigeration cycles	4	PO2, PSO1
CO3	Analyze the working and performance of Low temperature refrigeration and steam jet refrigeration systems	4	PO2, PSO1
CO4	Estimate the effect various air conditioning systems on human comfort and perform cooling load calculations	4	PO2, PSO1

Syllabus

Basics of Refrigeration: Air refrigeration cycle-working-methods-merits and demerits-simple air evaporative cooling- Bootstrap air cooling systems-comparison of various air cooling systems used in aircraft. Vapour Compression Refrigeration cycle: Working, Theoretical and actual cycles, Effect of suction and discharge pressures, performance enhancement of vapour compression cycle, Compound vapour refrigeration systems: Intercooler, subcooler.

Vapour Absorption refrigeration systems: Ideal and practical Vapour absorption cycle, Refrigerant-Absorbent requirements, COP, Domestic Electrolux, Lithium Bromide vapour absorption system. Refrigerants: Classification, properties of ideal refrigerant, Hydro-carbon and inorganic refrigerants, Designation of refrigerants, secondary refrigerants-Brines.

Low temperature refrigeration (Cryogenics): Limitations of VCR for low temperature production, Cascade Refrigeration, COP of two stage cascade system, Manufacture of solid and dry ice, Liquefaction of hydrogen and helium, Claude system of liquification of air. Steam jet Refrigeration: Principle and working of steam jet refrigeration, Steam Ejector, Analysis and efficiencies of steam jet refrigeration.

Air conditioning Systems: Psychrometric processes & relations, Factors effecting human comfort, Modified comfort chart, Classification of air conditioning systems, Comfort, industrial, winter, summer, year round, unitary and central air conditioning systems. Cooling Load Estimations: Components of cooling load, Heat gain due to-infiltration, ventilation, Occupants, appliances, products, lighting equipment, power systems and ducts.

Reference Books

- 1 Refrigeration and Air Conditioning, C.P. Arora, 4, McGraw Hill.
- 2 Principles of Refrigeration, Roy J. Dossat, Thomas J. Horan, 5, Pearson Education.
- 3 Refrigeration and Air Conditioning Technology, William C. Whitman, William M. Johnson, John A. Tomczyk, 8, Cengage Education.

25AEE3508 - ALTERNATE ENERGY SOURCES FOR AUTOMOBILES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AEE3508	ALTERNATE ENERGY SOURCES FOR AUTOMOBILES	AESA	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 feed stocks 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, Florin Mariasiu, I: 2015, Springer.
- 2 Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Second Edition, Mehrdad Ehsani, Yimin Gao, Ali Emadi, II: 2010, Power Electronics and Applications Series.
- 3 Alternative Fuels Concepts, Technologies and Developments, S.S. Thipse, I: 2010, Jaico Publishers.

25ALT3101 - APPLIED MACHINE LEARNING FOR TEXT ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3101	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	AMLFTA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and explain the core principles of machine learning and natural language processing in the context of text analysis.	2	PO1
CO2	Apply and implement industry-standard techniques for preprocessing, representing, and modeling text data using Python and ML libraries.	3	PO2, PO3
CO3	Evaluate the performance of machine learning models for both supervised and unsupervised NLP tasks, and interpret results using explainability tools.	3	PO4, PO5
CO4	Design, develop, and deploy real world NLP solutions using state of the art tools and frameworks aligned with industry demands	3	PO3, PO6
CO5	Analyze the Critical Analysis and Interpretation Supervised Learning for Text Classification, Unsupervised Learning for Text Clustering	4	PO4, PO5

Syllabus

Overview of NLP and text analysis applications in industry (chatbots, sentiment analysis, recommendation engines), Introduction to supervised and unsupervised learning, Core machine learning algorithms (Logistic Regression, SVM, Decision Trees, Naive Bayes, KNN, Ensemble Methods), Basics of Python for NLP using scikit-learn, NLTK, spaCy

Text preprocessing pipeline: Tokenization, Lemmatization, Stemming, Removal of stop words, handling punctuation, lowercasing, and other normalization methods, Feature extraction: Bag-of-Words (BoW), TF IDF, Word embeddings: Word2Vec, GloVe, FastText Contextual embeddings: BERT (introductory concepts and usage via HuggingFace Transformers), Dimensionality reduction: PCA, t SNE, UMAP

Classification tasks: Spam detection, Sentiment analysis, Clustering tasks: Topic modeling (KMeans, LDA), Model evaluation metrics: Precision, Recall, F1 score, Confusion Matrix, ROC AUC, Model deployment overview using Flask or FastAPI basics of Docker

Introduction to transformer models and fine tuning BERT for text classification, Transfer learning for low resource text analysis, Explainable AI (XAI) for NLP: SHAP, LIME, Case studies from IBM Watson, Google BERT, Microsoft Azure NLP APIs, TCS Ignio, Capstone Project: End to End Text Classification Clustering System

Lab programs 15 experiments list designed

Reference Books

- 1 Foundations of Machine Learning, Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, 2nd Edition, MIT Press.
- 2 Natural Language Processing with Python (a.k.a. the NLTK Book), Steven Bird, Ewan Klein, Edward Loper, 2009, O Reilly Media.
- 3 Python Machine Learning, Sebastian Raschka, Vahid Mirjalili, 2019, Packt Publishing.
- 4 Speech and Language Processing, Daniel Jurafsky, James H. Martin, 2023, Pearson Prentice Hall (for earlier editions).
- 5 Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas C. Müller, Sarah Guido, 2016, O Reilly Media.
- 6 Hands-On Natural Language Processing with Python, Rajalingappaa Shanmugamani, 2020, Packt Publishing.
- 7 Hugging Face Documentation, Hugging Face Team (online resource), Continuously updated, (<https://huggingface.co/docs>).

25ALT3101A - APPLIED MACHINE LEARNING FOR TEXT ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3101A	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	AMLFTA	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and explain the core principles of machine learning and natural language processing in the context of text analysis.	2	PO1
CO2	Apply and implement industry standard techniques for preprocessing, representing, and modeling text data using Python and ML libraries.	3	PO2, PO3
CO3	Evaluate the performance of machine learning models for both supervised and unsupervised NLP tasks, and interpret results using	3	PO4, PO5
CO4	Design, develop, and deploy real world NLP solutions using state of the art tools and frameworks aligned with industry demands.	3	PO3, PO6, PO10
CO5	Analyze the Critical Analysis and Interpretation Supervised Learning for Text Classification, Unsupervised Learning for Text Clustering	4	PO4, PO5
CO6	Analyze the Ethical Considerations Understanding bias in text data and machine learning models, Ethical considerations in text analysis	4	PO1

Syllabus

Overview of NLP and text analysis applications in industry (chatbots, sentiment analysis, recommendation engines), Introduction to supervised and unsupervised learning, Core machine learning algorithms (Logistic Regression, SVM, Decision Trees, Naive Bayes, KNN, Ensemble Methods), Basics of Python for NLP using scikit learn, NLTK, spaCy

Text preprocessing pipeline: Tokenization, Lemmatization, Stemming, Removal of stop words, handling punctuation, lowercasing, and other normalization methods, Feature extraction: Bag of Words (BoW), TF IDF, Word embeddings: Word2Vec, GloVe, FastText Contextual embeddings: BERT (introductory concepts and usage via HuggingFace Transformers), Dimensionality reduction: PCA, t-SNE, UMAP

Classification tasks: Spam detection, Sentiment analysis, Clustering tasks: Topic modeling (KMeans, LDA), Model evaluation metrics: Precision, Recall, F1 score, Confusion Matrix, ROC AUC, Model deployment overview using Flask or FastAPI basics of Docker

Introduction to transformer models and fine tuning BERT for text classification, Transfer learning for low resource text analysis, Explainable AI (XAI) for NLP: SHAP, LIME, Case studies from IBM Watson, Google BERT, Microsoft Azure NLP APIs, TCS Ignio, Capstone Project: End to End Text Classification Clustering System

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.

Lab programs 15 experiments list designed

Reference Books

- 1 Foundations of Machine Learning, Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar , 2nd Edition , MIT Press.
- 2 Natural Language Processing with Python (a.k.a. the NLTK Book) , Steven Bird, Ewan Klein, Edward Loper , 2009 , O Reilly Media.
- 3 Python Machine Learning , Sebastian Raschka, Vahid Mirjalili , 2019 , Packt Publishing.
- 4 Speech and Language Processing , Daniel Jurafsky, James H. Martin , 2023, Pearson Prentice Hall (for earlier editions).

- 5 Introduction to Machine Learning with Python: A Guide for Data Scientists , Andreas C. Müller, Sarah Guido , 2016, O Reilly Media.
- 6 Hands-On Natural Language Processing with Python , Rajalingappaa Shanmugamani , 2010, Packt Publishing.
- 7 Hugging Face Documentation , Hugging Face Team (online resource) , Continuously updated , (<https://huggingface.co/docs>).

25ALT3101E - APPLIED MACHINE LEARNING FOR TEXT ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3101E	APPLIED MACHINE LEARNING FOR TEXT ANALYSIS	AMLFTA	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and explain the core principles of machine learning and natural language processing in the context of text analysis.	2	PO1
CO2	Apply and implement industry standard techniques for preprocessing, representing, and modeling text data using Python and ML libraries.	3	PO2, PO3
CO3	Evaluate the performance of machine learning models for both supervised and unsupervised NLP tasks, and interpret results using	3	PO4, PO5
CO4	Design, develop, and deploy real world NLP solutions using state of the art tools and frameworks aligned with industry demands.	3	PO3, PO6, PO10
CO5	Analyze the Critical Analysis and Interpretation Supervised Learning for Text Classification, Unsupervised Learning for Text Clustering	4	PO4, PO5
CO6	Analyze the Ethical Considerations Understanding bias in text data and machine learning models, Ethical considerations in text analysis	4	PO1

Syllabus

Overview of NLP and text analysis applications in industry (chatbots, sentiment analysis, recommendation engines), Introduction to supervised and unsupervised learning, Core machine learning algorithms (Logistic Regression, SVM, Decision Trees, Naive Bayes, KNN, Ensemble Methods), Basics of Python for NLP using scikit learn, NLTK, spaCy

Text preprocessing pipeline: Tokenization, Lemmatization, Stemming, Removal of stop words, handling punctuation, lowercasing, and other normalization methods, Feature extraction: Bag of Words (BoW), TF IDF, Word embeddings: Word2Vec, GloVe, FastText Contextual embeddings: BERT (introductory concepts and usage via HuggingFace Transformers), Dimensionality reduction: PCA, t-SNE, UMAP

Classification tasks: Spam detection, Sentiment analysis, Clustering tasks: Topic modeling (KMeans, LDA), Model evaluation metrics: Precision, Recall, F1 score, Confusion Matrix, ROC AUC, Model deployment overview using Flask or FastAPI basics of Docker

Introduction to transformer models and fine tuning BERT for text classification, Transfer learning for low resource text analysis, Explainable AI (XAI) for NLP: SHAP, LIME, Case studies from IBM Watson, Google BERT, Microsoft Azure NLP APIs, TCS Ignio, Capstone Project: End to End Text Classification Clustering System

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.

Lab programs 15 experiments list designed

Reference Books

- 1 Foundations of Machine Learning, Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar , 2nd Edition , MIT Press.
- 2 Natural Language Processing with Python (a.k.a. the NLTK Book) , Steven Bird, Ewan Klein, Edward Loper , 2009 , O Reilly Media.
- 3 Python Machine Learning , Sebastian Raschka, Vahid Mirjalili , 2019 , Packt Publishing.
- 4 Speech and Language Processing , Daniel Jurafsky, James H. Martin , 2023, Pearson Prentice Hall (for earlier editions).

- 5 Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas C. Müller, Sarah Guido , 2016, O Reilly Media.

25ALT3202 - DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3202	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
CO2	Apply statistical estimation, HMMs (with Forward and Viterbi algorithms), and sequence labeling for NLP system development.	3	PO3, PO4
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	
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	

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, Aaron Courville, First Edition, MIT Press.
- 2 Neural Network Methods for Natural Language Processing, Yoav Goldberg, First Edition, Morgan & Claypool Publishers.
- 3 Foundations of Statistical Natural Language Processing, Christopher D. Manning, Hinrich Schütze, First Edition, MIT Press.
- 4 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, First Edition, MIT Press.
- 5 Natural Language Processing with Python, Steven Bird, Ewan Klein, Edward Loper, First Edition, O'Reilly Media.

- 6 Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Daniel Jurafsky, James H. Martin, 4th Edition, Pearson.

25ALT3303 - CONVERSATIONAL AI AND CHATBOT DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3303	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	CAICBD	R	3	0	0	2	3.5

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, PO8
CO2	Explain the basics of natural language processing (NLP). Understand the concepts of intent recognition and entity extraction in NLP.	2	PO1, PO2
CO3	Build text preprocessing techniques. Develop a simple chatbot using NLU(Natural Language Understanding) frameworks.	3	PO3, PO5
CO4	Examine different machine learning models for chatbots. Analyze dialog flows and state tracking mechanisms	4	
CO5	Determine the ethical implications of chatbot development. Assess the effectiveness of chatbot architectures in real-world scenarios.	5	
CO6	Design and develop a chatbot capable of context-aware responses in real-time scenarios.	6	
CO7	Evaluate the performance and ethical implications of chatbot applications in various domains.	5	

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.

Reference Books

- 1 Conversational Artificial Intelligence, Romil Rawat, Rajesh Kumar Chakrawarti, Sanjaya Kumar Sarangi, Anand Rajavat, Mary, First Edition, Scrivener Publishing.
- 2 Building Chatbots with Python: Using Natural Language Processing and Machine Learning, Sumit Raj, First Edition, Apress.
- 3 Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots (Synthesis Lectures on Human Language Technologies), Michael McTear, First Edition, Springer.
- 4 Building Chatbots with Microsoft Bot Framework and Azure, N. Masi, First Edition, Apress.
- 5 Deep Learning for NLP and Speech Recognition, Uday Kamath, John Liu, James (Jimmy) Whitaker, First Edition, Springer.

25ALT3303A - CONVERSATIONAL AI AND CHATBOT DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3303A	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	CAICBD	A	4	1	0	2	5.5

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, PO8
CO2	Explain the basics of natural language processing (NLP). Understand the concepts of intent recognition and entity extraction in NLP.	2	PO1, PO2
CO3	Build text preprocessing techniques. Develop a simple chatbot using NLU(Natural Language Understanding) frameworks.	3	PO3, PO5
CO4	Examine different machine learning models for chatbots. Analyze dialog flows and state tracking mechanisms.	4	
CO5	Determine the ethical implications of chatbot development. Assess the effectiveness of chatbot architectures in real-world scenarios.	5	
CO6	Design and develop a chatbot capable of context-aware responses in real-time scenarios.	6	
CO7	Evaluate the performance and ethical implications of chatbot applications in various domains.	5	

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, First Edition, Scrivener Publishing.
- 2 Building Chatbots with Python: Using Natural Language Processing and Machine Learning, Sumit Raj, First Edition, Apress.
- 3 Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots (Synthesis Lectures on Human Language Technologies), Michael McTear, First Edition, Springer.
- 4 Building Chatbots with Microsoft Bot Framework and Azure, N. Masi, First Edition, Apress.
- 5 Deep Learning for NLP and Speech Recognition, Uday Kamath, John Liu, James (Jimmy) Whitaker, First Edition, Springer.

25ALT3303E - CONVERSATIONAL AI AND CHATBOT DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3303E	CONVERSATIONAL AI AND CHATBOT DEVELOPMENT	CAICBD	E	4	1	0	2	5.5

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, PO8
CO2	Explain the basics of natural language processing (NLP). Understand the concepts of intent recognition and entity extraction in NLP.	2	PO1, PO2
CO3	Build text preprocessing techniques. Develop a simple chatbot using NLU(Natural Language Understanding) frameworks.	3	PO3, PO5
CO4	Examine different machine learning models for chatbots. Analyze dialog flows and state tracking mechanisms.	4	
CO5	Determine the ethical implications of chatbot development. Assess the effectiveness of chatbot architectures in real-world scenarios.	5	
CO6	Design and develop a chatbot capable of context-aware responses in real-time scenarios.	6	
CO7	Evaluate the performance and ethical implications of chatbot applications in various domains.	5	

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.

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- 4 Building Chatbots with Microsoft Bot Framework and Azure, N. Masi, First Edition, Apress.
- 5 Deep Learning for NLP and Speech Recognition, Uday Kamath, John Liu, James (Jimmy) Whitaker, First Edition, Springer.

25ALT3404 - TEXT UNDERSTANDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3404	TEXT UNDERSTANDING	TUS	R	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	
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	
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	
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	

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 Schotze, 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.
- 5 Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2009, O'Reilly media.
- 6 The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Ronen Feldman and James Sanger, 2017, Cambridge University Press.

25ALT3405 - NATURAL LANGUAGE PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3405	NATURAL LANGUAGE PROCESSING	NLP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of natural language processing, including text preprocessing and language modeling.	2	
CO2	Apply syntactic and semantic analysis techniques for linguistic structure and meaning representation	3	
CO3	Implement text classification, clustering, and information extraction methods for structured text analysis.	3	
CO4	Apply various NLP applications such as sentiment analysis, machine translation, and chatbots.	3	

Syllabus

Introduction to NLP: Definition, History, NLP Applications, Challenges in NLP, Approaches to NLP. Basic Text Processing: Tokens, Sentences, Paragraph Segmentation, Text Normalization (Lowercasing, Stemming, Lemmatization). Corpora Construction, Regular Expressions, Information Extraction using Regex. Named Entity Recognition (NER): Rule-Based and Statistical Approaches. Language Modelling: N-gram Models, Smoothing Techniques, Basic Probability in NLP.

Part-of-Speech (POS) Tagging: Rule-Based, Stochastic, and Transformation-Based Approaches. Hidden Markov Models (HMM) for POS Tagging, Viterbi Algorithm. Syntax Analysis: Constituency Parsing, Probabilistic Context-Free Grammars (PCFG), Dependency Parsing, Transition-Based Parsing. Semantic Processing: Word Sense Disambiguation, Computational Semantics, Lexical Semantics (WordNet, FrameNet). Spelling Correction and Language Modelling.

Vector Space Model for Text Representation: One-Hot Encoding, Bag of Words, TF-IDF. Document Similarity Measures: Cosine Similarity, Cluster-Based Measures. Text Classification: Naïve Bayes, Logistic Regression, Rule-Based Classifiers. Clustering & Topic Modeling: K-means Clustering, Latent Dirichlet Allocation (LDA), Latent Semantic Analysis (LSA). Information Extraction: Named Entity Recognition (NER), Relation Extraction, Event Detection.

Sentiment Analysis, Machine Translation (Statistical Approaches), Automated Speech Recognition. Question Answering Systems, Chatbots & Conversational AI (Rule-Based, Statistical Models). Text Summarization: Extractive & Abstractive Approaches.

Reference Books

- 1 Speech and Language Processing , Daniel Jurafsky and James H. Martin, 3rd edition, Pearson .
- 2 Neural Network Methods in Natural Language Processin, Yoav Goldberg, 1st edition, 2017, Morgan & Claypool Publishers.
- 3 Foundations of Statistical Natural Language Processing, Christopher D. Manning, Hinrich Schütze, 1 edition, MIT Press.
- 4 Natural Language Processing, J. Eisenstein, 1st ed, 2019, MIT Press.

25ALT3506 - LANGUAGE UNDERSTANDING WITH PRE-TRAINED MODELS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3506	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, PO2, PO5
CO2	Apply the Pre-trained Models- Transfer learning principles, Fine-tuning strategies, Domain adaptation techniques.	3	PO1, PO2, PO3, PO4, PO5
CO3	Develop a project that Popular pre-trained models: BERT, GPT, RoBERTa, etc.Masked language modeling (MLM) Next sentence prediction (NSP) .	4	PO1, PO4, PO5, PO10
CO4	Analyze and discuss the language generation tasks- Fine-tuning pre-trained models for language generation..	4	PO1, PO4, PO5, PO10

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

MODULE-3 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 in Action, Lane, Howard, and Hapke, 2019, Manning.
- 2 Transformers for Natural Language Processing, Shibamouli Lahiri and Anuj Gupta, 2024, O'Reilly Media.
- 3 Deep Learning for Natural Language Processing Creating Neural Networks with Python, , Palash Goyal, Sumit Pandey, and Karan Jain,, 2018, Packt.
- 4 Natural Language Processing with PyTorch Build Intelligent Language Applications Using Deep Learning, Delip Rao and Brian McMahan, , 2019, O'Reilly Media.

25ALT3507 - LARGE LANGUAGE MODEL FOR SPEECH PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ALT3507	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
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
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
CO4	Apply the text-to-speech synthesis methods (concatenative, waveform) and prosody for natural sounding speech its applications	3	PO1, PO5

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 The Scientist and Engineers Guide to Digital Signal Processing, Steven W. Smith, 2011, Technical Publishing.
- 2 Discrete-Time Speech Signal Processing Principles and Practice, , Thomas F Quatieri, 2006, Pearson.
- 3 Speech and audio signal processing, Ben gold and Nelson Morgan, 2006, Wiley.
- 4 Fundamentals of Speech Recognition, Lawrence Rabinerand Biing Hwang Juang, 2003, Pearson.
- 5 Speech and Language Processing An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, , Daniel Jurafsky and James H Martin, 2004, Pearson.
- 6 Mastering Large Language Models Advanced techniques, , Sanket Subhash Khandare , 2024, Kindle press.
- 7 Statistical Methods of Speech Recognition, , Frederick Jelinek, 2013, MIT Press.

25AVI3101 - DEEP LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3101	DEEP LEARNING	DL	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply various optimization algorithms to effectively solve neural network problems.	3	PO2, PO4
CO2	Able to apply various optimization algorithms to effectively solve neural network problems.	3	PO4
CO3	Able to Apply Recurrent Neural Networks (RNNs), Long Short- Term Memory (LSTM) networks, and autoencoders for sequence modeling and data reconstruction tasks.	3	PO3, PO4
CO4	Able to construct variational autoencoders and generative neural models for advanced data generation and representation learning.	3	PO2, PO4
CO5	Able to apply attention networks , transformers ,BERT, and vision transformers	3	
CO6	Construct, optimize, and fine-tune deep neural network including CNNs, RNNs, LSTMs, and autoencoders, for enhanced performance and accuracy.	5	
CO7	Design, implement, and deploy web applications for real-world case studies with deep learning models using PyTorch, flask etc	5	

Syllabus

Introduction to Deep Learning, History of Deep Learning, Types of Neural Networks, Backpropagation Algorithm, Loss Functions for Neural Networks, Challenges in Neural Network Optimization, Better Weight Initialization Methods, Optimization Techniques: Gradient Descent (GD), Momentum-based GD, Stochastic GD, Adam Optimizer, AdaGrad, RMSProp.

Bias-Variance Tradeoff, L1 and L2 Regularization, Batch Normalization, Early Stopping, Dataset Augmentation, Convolutional Neural Networks (CNNs), CNN Architectures: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing CNNs, Object Detection Models: RCNN, Fast RCNN, YOLO.

Recurrent Neural Networks (RNNs), Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients in RNNs, Loss Functions for RNNs and Sequence Prediction, Gated Recurrent Units (GRUs), Long Short-Term Memory (LSTM) Cells, Deep Dream and Deep Art, Encoder-Decoder Models, Regularization in Autoencoders, Denoising Autoencoders.

Markov Chain and Markov Models Restricted Boltzmann Machines Deep Belief Neural Networks Variational Autoencoders Autoregressive Models: NADE, MADE Generative Adversarial Networks (GANs)

Attention Networks Types of Attention: Self-Attention, Cross-Attention, Scaled Dot-Product Attention Multi-Head Attention Mechanism Transformer Architecture Transformer Models: BERT, GPT Large Language Models (LLMs) Vision Transformers (ViTs) Challenges in Transformer Training (Memory and Computation)

Reference Books

- 1 Deep Learning with PyTorch: A Practical Approach to Building Neural Network Models Using PyTorch, Vishnu Subramanian, 1st Edition, Packt Publishing.
- 2 Deep Learning with Python, Francois Chollet, 1st Edition, Manning Publications.
- 3 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 1st Edition, MIT Press.
- 4 Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal, 1st Edition, Springer.
- 5 Grokking Deep Learning, Andrew Trask, 1st Edition, Manning Publications.

- 6 Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal, 1st Edition, Springer.
- 7 Deep Learning with PyTorch, Luca Antiga, Eli Stevens, and Thomas Viehmann, 2nd Edition, Manning Publications.
- 8 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 1st Edition, MIT Press.

25AVI3101A - DEEP LEARNING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3101A	DEEP LEARNING	DL	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply various optimization algorithms to effectively solve neural network problems.	3	PO2, PO4
CO2	Able to Apply Convolutional Neural Network (CNN) models and their variants, such as LeNet, AlexNet, ZF-Net, and VGGNet, to real-world data.	3	PO4
CO3	Able to Apply Recurrent Neural Networks (RNNs), Long Short- Term Memory (LSTM) networks, and autoencoders for sequence modeling and data reconstruction tasks.	3	PO3
CO4	Able to construct variational autoencoders and generative neural models for advanced data generation and representation learning.	3	PO4
CO5	Able to apply attention networks , transformers ,BERT, and vision transformers	3	PO2, PO4
CO6	Construct, optimize, and fine-tune deep neural network including CNNs, RNNs, LSTMs, and autoencoders, for enhanced performance and accuracy. Construct, optimize, and fine-tune deep neural network including CNNs, RNNs, LSTMs, and autoencoders, for enhanced performance and accuracy.	5	
CO7	Design, implement, and deploy web applications for real-world case studies with deep learning models using PyTorch, flask etc	5	

Syllabus

Introduction to Deep Learning, History of Deep Learning, Types of Neural Networks, Backpropagation Algorithm, Loss Functions for Neural Networks, Challenges in Neural Network Optimization, Better Weight Initialization Methods, Optimization Techniques: Gradient Descent (GD), Momentum-based GD, Stochastic GD, Adam Optimizer, AdaGrad, RMSProp.

Bias-Variance Tradeoff, L1 and L2 Regularization, Batch Normalization, Early Stopping, Dataset Augmentation, Convolutional Neural Networks (CNNs), CNN Architectures: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing CNNs, Object Detection Models: RCNN, Fast RCNN, YOLO.

Recurrent Neural Networks (RNNs), Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients in RNNs, Loss Functions for RNNs and Sequence Prediction, Gated Recurrent Units (GRUs), Long Short-Term Memory (LSTM) Cells, Deep Dream and Deep Art, Encoder-Decoder Models, Regularization in Autoencoders, Denoising Autoencoders.

Markov Chain and Markov Models Restricted Boltzmann Machines Deep Belief Neural Networks Variational Autoencoders Autoregressive Models: NADE, MADE Generative Adversarial Networks (GANs)

Attention Networks Types of Attention: Self-Attention, Cross-Attention, Scaled Dot-Product Attention Multi-Head Attention Mechanism Transformer Architecture Transformer Models: BERT, GPT Large Language Models (LLMs) Vision Transformers (ViTs) Challenges in Transformer Training (Memory and Computation)

Construct, Optimize, and Fine-Tune Deep Neural Networks Integration of CNNs, RNNs, LSTMs, and Autoencoders Performance Tuning for Accuracy and Efficiency

Design and Implementation of Web Applications Integration of Deep Learning Models in Applications Tools and Frameworks: PyTorch, Flask: in lines not as points, mention only topics given

Reference Books

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- 8 Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 1st Edition, MIT Press.

25AVI3101E - DEEP LEARNING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3101E	DEEP LEARNING	DL	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to apply various optimization algorithms to effectively solve neural network problems.	3	PO2, PO4
CO2	Able to Apply Convolutional Neural Network (CNN) models and their variants, such as LeNet, AlexNet, ZF-Net, and VGGNet, to real-world data.	3	PO4
CO3	Able to Apply Recurrent Neural Networks (RNNs), Long Short- Term Memory (LSTM) networks, and autoencoders for sequence modeling and data reconstruction tasks.	3	PO4
CO4	Able to construct variational autoencoders and generative neural models for advanced data generation and representation learning.	3	PO4
CO5	Able to apply attention networks , transformers ,BERT, and vision transformers	3	PO2, PO4
CO6	Construct, optimize, and fine-tune deep neural network including CNNs, RNNs, LSTMs, and autoencoders, for enhanced performance and accuracy. Construct, optimize, and fine-tune deep neural network including CNNs, RNNs, LSTMs, and autoencoders, for enhanced performance and accuracy.	5	
CO7	Design, implement, and deploy web applications for real-world case studies with deep learning models using PyTorch, flask etc	5	

Syllabus

Introduction to Deep Learning, History of Deep Learning, Types of Neural Networks, Backpropagation Algorithm, Loss Functions for Neural Networks, Challenges in Neural Network Optimization, Better Weight Initialization Methods, Optimization Techniques: Gradient Descent (GD), Momentum-based GD, Stochastic GD, Adam Optimizer, AdaGrad, RMSProp.

Bias-Variance Tradeoff, L1 and L2 Regularization, Batch Normalization, Early Stopping, Dataset Augmentation, Convolutional Neural Networks (CNNs), CNN Architectures: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing CNNs, Object Detection Models: RCNN, Fast RCNN, YOLO.

Recurrent Neural Networks (RNNs), Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients in RNNs, Loss Functions for RNNs and Sequence Prediction, Gated Recurrent Units (GRUs), Long Short-Term Memory (LSTM) Cells, Deep Dream and Deep Art, Encoder-Decoder Models, Regularization in Autoencoders, Denoising Autoencoders.

Markov Chain and Markov Models Restricted Boltzmann Machines Deep Belief Neural Networks Variational Autoencoders Autoregressive Models: NADE, MADE Generative Adversarial Networks (GANs)

Attention Networks Types of Attention: Self-Attention, Cross-Attention, Scaled Dot-Product Attention Multi-Head Attention Mechanism Transformer Architecture Transformer Models: BERT, GPT Large Language Models (LLMs) Vision Transformers (ViTs) Challenges in Transformer Training (Memory and Computation)

Construct, Optimize, and Fine-Tune Deep Neural Networks Integration of CNNs, RNNs, LSTMs, and Autoencoders Performance Tuning for Accuracy and Efficiency

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- 5 Grokking Deep Learning, Grokking Deep Learning, 1st Edition, Manning Publications.
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- 7 Deep Learning with PyTorch, Second Edition, Luca Antiga, Eli Stevens, and Thomas Viehmann, 2nd Edition, Manning Publications.
- 8 Deep Learning, Deep Learning, 1st Edition, MIT Press.

25AVI3102 - AI DRIVEN VIDEO PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3102	AI DRIVEN VIDEO PROCESSING	AIDVP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of video processing and computer vision	2	
CO2	Explain AI and deep learning techniques applied to video analysis and interpretation	2	
CO3	Apply neural network models for tasks such as video classification detection and tracking	3	
CO4	Analyze temporal and spatial features for video understanding and summarization	4	

Syllabus

Introduction to video processing video representation frame extraction and motion analysis

Fundamentals of deep learning architectures CNN RNN and 3D CNN for video understanding

AI techniques for video classification object detection tracking and action recognition

Video summarization event detection and video captioning using AI models

Reference Books

- 1 Deep Learning for Video Analysis, Zhihua Zhang and M Bennamoun, 2021, Springer.
- 2 Computer Vision Models Learning and Inference, Simon J D Prince, 2012, Cambridge University Press.
- 3 Deep Learning with Python, Francois Chollet, Second Edition 2021, Manning Publications.

25AVI3102A - AI DRIVEN VIDEO PROCESSING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3102A	AI DRIVEN VIDEO PROCESSING	AIDVP	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of video processing and computer vision	2	
CO2	Explain AI and deep learning techniques applied to video analysis and interpretation	2	
CO3	Apply neural network models for tasks such as video classification detection and tracking	3	
CO4	Analyze temporal and spatial features for video understanding and summarization	4	
CO5	Evaluate the performance of AI driven video systems and explore real world applications	5	

Syllabus

Introduction to video processing video representation frame extraction and motion analysis

Fundamentals of deep learning architectures CNN RNN and 3D CNN for video understanding

AI techniques for video classification object detection tracking and action recognition

Video summarization event detection and video captioning using AI models

Applications of AI driven video analytics in surveillance sports entertainment and autonomous systems challenges and future directions

Reference Books

- 1 Deep Learning for Video Analysis, Zhihua Zhang and M Bennamoun, 2021, Springer.
- 2 Computer Vision Models Learning and Inference, Simon J D Prince, 2012, Cambridge University Press.
- 3 Deep Learning with Python, Francois Chollet, Second Edition 2021, Manning Publications.

25AVI3102E - AI DRIVEN VIDEO PROCESSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3102E	AI DRIVEN VIDEO PROCESSING	AIDVP	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of video processing and computer vision	2	
CO2	Explain AI and deep learning techniques applied to video analysis and interpretation	2	
CO3	Apply neural network models for tasks such as video classification detection and tracking	3	
CO4	Analyze temporal and spatial features for video understanding and summarization	4	
CO5	Evaluate the performance of AI driven video systems and explore real world applications	5	

Syllabus

Introduction to video processing video representation frame extraction and motion analysis

Fundamentals of deep learning architectures CNN RNN and 3D CNN for video understanding

AI techniques for video classification object detection tracking and action recognition

Video summarization event detection and video captioning using AI models

Applications of AI driven video analytics in surveillance sports entertainment and autonomous systems challenges and future directions

Reference Books

- 1 Deep Learning for Video Analysis, Zhihua Zhang and M Bennamoun, 2021, Springer.
- 2 Computer Vision Models Learning and Inference, Simon J D Prince, 2012, Cambridge University Press.
- 3 Deep Learning with Python, Francois Chollet, Second Edition 2021, Manning Publications.

25AVI3203 - COMPUTER VISION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3203	COMPUTER VISION	CV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals and mathematical foundations of computer vision	2	
CO2	Explain image processing techniques and feature extraction methods	2	
CO3	Apply machine learning and deep learning models to solve vision tasks	3	
CO4	Analyze computer vision algorithms for object recognition detection and tracking	4	

Syllabus

Introduction to computer vision history applications and challenges

Image processing fundamentals filtering edge detection morphology and transformations

Feature extraction and matching keypoints descriptors SIFT SURF ORB

Object recognition detection and tracking traditional methods and deep learning approaches

Reference Books

- 1 Computer Vision A Modern Approach, David A Forsyth and Jean Ponce, Second Edition 2011, Pearson.
- 2 Learning OpenCV Computer Vision with the OpenCV Library, Gary Bradski and Adrian Kaehler, Second Edition 2008, O Reilly Media.
- 3 Deep Learning for Computer Vision, Rajalingapuram R, 2020, Packt Publishing.

25AVI3304 - OBJECT DETECTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3304	OBJECT DETECTION	OD	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and techniques of object detection in images and videos	2	
CO2	Explain traditional and deep learning based object detection algorithms	2	
CO3	Apply object detection methods using popular frameworks and libraries	3	
CO4	Analyze the performance of object detection models on various datasets	4	

Syllabus

Introduction to object detection overview of applications and problem formulation

Traditional object detection methods Haar cascades HOG SVM and template matching

Deep learning based object detection CNN R CNN Fast R CNN Faster R CNN YOLO SSD and RetinaNet

Model training evaluation metrics mAP precision recall and dataset preparation

Reference Books

- 1 Deep Learning for Computer Vision, Rajalingapuram R, 2020, Packt Publishing.
- 2 Learning OpenCV Computer Vision with the OpenCV Library, Gary Bradski and Adrian Kaehler, Second Edition 2008, O Reilly Media.
- 3 Object Detection for Dummies, Prateek Joshi, 2021, Independently Published.

25AVI3304A - OBJECT DETECTION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3304A	OBJECT DETECTION	OD	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and techniques of object detection in images and videos	2	
CO2	Explain traditional and deep learning based object detection algorithms	2	
CO3	Apply object detection methods using popular frameworks and libraries	3	
CO4	Analyze the performance of object detection models on various datasets	4	
CO5	Evaluate optimization strategies and advanced techniques for real time and accurate detection	4	

Syllabus

Introduction to object detection overview of applications and problem formulation

Traditional object detection methods Haar cascades HOG SVM and template matching

Deep learning based object detection CNN R CNN Fast R CNN Faster R CNN YOLO SSD and RetinaNet

Model training evaluation metrics mAP precision recall and dataset preparation

Real time object detection optimization techniques deployment and challenges in practical scenarios

Reference Books

- 1 Deep Learning for Computer Vision, Rajalingapuram R, 2020, Packt Publishing.
- 2 Learning OpenCV Computer Vision with the OpenCV Library, Gary Bradski and Adrian Kaehler, Second Edition 2008, O Reilly Media.
- 3 Object Detection for Dummies, Prateek Joshi, 2021, Independently Published.

25AVI3304E - OBJECT DETECTION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3304E	OBJECT DETECTION	OD	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and techniques of object detection in images and videos	2	
CO2	Explain traditional and deep learning based object detection algorithms	2	
CO3	Apply object detection methods using popular frameworks and libraries	3	
CO4	Analyze the performance of object detection models on various datasets	4	
CO5	Evaluate optimization strategies and advanced techniques for real time and accurate detection	5	

Syllabus

Introduction to object detection overview of applications and problem formulation

Traditional object detection methods Haar cascades HOG SVM and template matching

Deep learning based object detection CNN R CNN Fast R CNN Faster R CNN YOLO SSD and RetinaNet

Model training evaluation metrics mAP precision recall and dataset preparation

Real time object detection optimization techniques deployment and challenges in practical scenarios

Reference Books

- 1 Deep Learning for Computer Vision, Rajalingapuram R, 2020, Packt Publishing.
- 2 Learning OpenCV Computer Vision with the OpenCV Library, Gary Bradski and Adrian Kaehler, Second Edition 2008, O Reilly Media.
- 3 Object Detection for Dummies, Prateek Joshi , 2021, independently published .

25AVI3405 - VISUAL RECOGNITION AND SCENE UNDERSTANDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3405	VISUAL RECOGNITION AND SCENE UNDERSTANDING	VRSU	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of visual recognition and scene understanding	2	
CO2	Explain image representation feature extraction and object detection techniques	2	
CO3	Apply machine learning and deep learning methods for image and video analysis	3	
CO4	Analyze visual recognition models and evaluate their performance on real world datasets	4	

Syllabus

Introduction to visual recognition and scene understanding image formation and representation

Feature extraction and description techniques SIFT SURF HOG and deep feature learning

Object detection and recognition traditional machine learning and CNN based approaches

Scene understanding semantic segmentation instance segmentation and context modeling

Reference Books

- 1 Computer Vision Algorithms and Applications, Richard Szeliski, 2010, Springer.
- 2 Deep Learning for Computer Vision, Rajalingapuram R, 2020, Packt Publishing.
- 3 Multiple View Geometry in Computer Vision, Richard Hartley and Andrew Zisserman, Second Edition 2003, Cambridge University Press.

25AVI3406 - DEEP REINFORCEMENT LEARNING FOR VISION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3406	DEEP REINFORCEMENT LEARNING FOR VISION	DRLV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of reinforcement learning and deep learning principles	2	
CO2	Explain various reinforcement learning algorithms and their applications to computer vision	2	
CO3	Apply deep reinforcement learning techniques to solve vision based tasks	3	
CO4	Analyze performance of deep reinforcement learning models in image and video processing	4	

Syllabus

Introduction to reinforcement learning RL basics Markov decision processes MDPs and reward functions

Deep learning fundamentals neural networks CNNs RNNs and architectures for vision

Deep reinforcement learning DRL algorithms Q learning deep Q networks policy gradient actor critic methods

Applications of DRL in computer vision image classification object detection tracking and segmentation

Reference Books

- 1 Reinforcement Learning An Introduction, Richard S Sutton and Andrew G Barto, Second Edition 2018, MIT Press.
- 2 Deep Reinforcement Learning Hands On Maxim, Lapan, 2018, Packt Publishing.
- 3 Deep Learning Ian Goodfellow, Yoshua Bengio and Aaron Courville, 2016, MIT Press.

25AVI3507 - HUMAN COMPUTER INTERACTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3507	HUMAN COMPUTER INTERACTION	HCI	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	PO1, PO2
CO2	Apply similarity learning and related algorithms for human face analysis working with semantic segmentation	3	PO1, PO3
CO3	Evaluate the performance of natural language and image processing Skills and working with generative adversarial networks	4	PO2, PO3
CO4	Classify the videos and image-based approaches for videos deployment in cloud and devices	2	PO2

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.
- 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 Generative Deep Learning Teaching Machines to Paint, Write, Compose and Play, David Foster, 2019, O'Reilly.
- 5 Multiple View Geometry in Computer Vision , Richard Hartley, 2011, Cambridge University Press.

25AVI3508 - OBJECT LOCALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3508	OBJECT LOCALIZATION	OL	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and apply advanced techniques for image enhancement, restoration, and filtering in spatial and frequency domains.	2	PO1, PO2
CO2	Implement segmentation and feature extraction methods to identify and analyze regions of interest in digital images.	3	PO1, PO2, PO3
CO3	Perform geometric and frequency domain transformations for image registration, object detection, and pattern recognition.	4	PO2, PO4
CO4	Design and develop machine learning and deep learning models for image classification and analysis using Python-based tools.	5	PO1, PO2, PO5

Syllabus

Fundamentals of Image Processing

Image Segmentation and Feature Extraction

Image Transformation and Analysis

Advanced Topics and Applications

Lab Program

Reference Books

- 1 Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, 2018, Pearson.
- 2 , Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac, and Roger Boyle, 2014, Cengage Learning.
- 3 Fundamentals of Digital Image Processing, Anil K. Jain, 1989, Prentice Hall.
- 4 Digital Image Processing, Bernd J?hne, 2005, Springer.

25AVI3509 - ADVANCED IMAGE PROCESSING AND ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25AVI3509	ADVANCED IMAGE PROCESSING AND ANALYSIS	AIPA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and techniques of advanced image processing and enhancement.	2	
CO2	Analyze images using spatial, frequency, and transform domain methods.	4	
CO3	Design and implement advanced image processing algorithms for feature extraction, segmentation, and recognition.	6	
CO4	Evaluate the performance of image processing and analysis techniques for real-world applications.	5	

Syllabus

This module covers techniques for improving image quality beyond basic processing. Topics include histogram equalization, contrast stretching, adaptive filtering, and noise reduction methods. Students will learn advanced restoration techniques such as inverse filtering, Wiener filtering, and motion blur compensation.

This module focuses on spatial and frequency domain transformations such as Fourier transform, Wavelet transform, and Discrete Cosine Transform. Students will study edge detection, corner detection, texture analysis, and feature descriptors for image understanding. Applications in pattern recognition and computer vision are discussed.

This module introduces advanced segmentation techniques including thresholding, region growing, clustering (K-means, Fuzzy C-means), and active contours. Students will learn object recognition, template matching, morphological operations, and machine learning-based approaches for automated image analysis.

This module emphasizes practical applications of advanced image processing. Students will explore medical imaging, remote sensing, surveillance, and industrial inspection. Techniques for performance evaluation, metrics such as PSNR, SSIM, and ROC analysis, and real-time implementation considerations are discussed. Emerging trends in deep learning-based image processing and analysis are also introduced.

Reference Books

- 1 Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, 4th Edition, Pearson.
- 2 Computer Vision: Algorithms and Applications, Richard Szeliski, 1st Edition, Springer.
- 3 Image Processing and Analysis: Variational, PDE, Wavelet, and Stochastic Methods, Tony F. Chan, Jianhong Shen, 1st Edition, SIAM.

25BEW3101 - INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3101	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	IBCTCCT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding or knowing the basic concepts of Cryptography for Blockchain	2	
CO2	Understand the basics of Blockchain and mining process	2	
CO3	Apply about the different types of Blockchain and consensus algorithms	3	
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	4	
CO5	Apply the different types of crypto currencies & its importance and Blockchain applications	4	
CO6	Apply and analyze basic cryptography concepts and smart contracts applications using soft wallet.	4	
CO7	Apply popular blockchain development platforms and tools for developing and testing smart contracts and tokens.	4	

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 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 Blockchain components

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 bitcoin anonymity

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, Pearson Education.
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction , Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, 2nd, Princeton University Press.
- 3 Blockchain: Blueprint for a New Economy , Melanie Swan, 2nd, 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, 2014, Paper EIP-150 REVISION .

25BEW3101A - INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3101A	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	IBCTCCT	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the basic concepts of Cryptography for Blockchain	2	
CO2	Understand the basics of Blockchain and mining process	2	
CO3	Apply about the different types of Blockchain and consensus algorithms	3	
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	4	
CO5	Analyze popular blockchain development platforms and tools for developing and testing smart contracts and tokens	4	
CO6	Apply and analyze basic cryptography concepts and smart contracts applications using soft wallet.	4	
CO7	Learn and use solidity programming language to build smart contracts	4	

Syllabus

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 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 properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoin anonymity.

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

Tokens, How Tokens Are Used , Tokens and Fungibility, Counterparty Risk ,Tokens and Intrinsicality, Using Tokens, Utility Tokens, Issues with ERC20 Tokens,ERC223: A Proposed Token Contract Interface Standard , ERC777: A Proposed Token Contract Interface Standard, ERC721: Non-fungible Token (Deed) Standard ,Using Token Standards, What Are Token Standards? What Is Their Purpose?, Should You Use These Standards?, Security by Maturity, Extensions to Token Interface Standards ,Tokens and ICOs.

Reference Books

- 1 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, 1st, Princeton University Press.
- 2 Blockchain: Blueprint for a New Economy, Melanie Swan, 1st, O Reilly Media.
- 3 Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos, Dr. Gavin Wood, 1st, O Reilly Media.
- 4 Cryptography and Network Security: Principles and Practice , William Stalling, 7th, Pearson.

25BEW3101E - INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3101E	INTRODUCTION TO BLOCKCHAIN TECHNOLOGY, CRYPTOCURRENCIES AND TOKENS	IBCTCCT	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Implement the basic concepts of Cryptography for Blockchain	3	
CO2	Demonstrate the basics of Blockchain and mining process	3	
CO3	Compare different types of crypto currencies & its importance and Blockchain applications	4	
CO4	Analyze popular blockchain development platforms and tools for developing and testing smart contracts and tokens	4	
CO5	Analyze Ethereum blockchain and using wallet for interacting with network	4	
CO6	Demonstrate different types of Blockchain and consensus algorithms	4	
CO7	Learn and use solidity programming language to build smart contracts	4	

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 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 RAFTconsensus Delayed Proof of Work dPoW Delegated Proof of Stake DPoS

Permissioned Blockchain Permissionless Blockchain Consortium Blockchain Cryptocurrencies Cryptocurrencies applications using Blockchain 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 FinancialServices Cross border payments KYC international trade Health Care Food safety Applications ofBlockchain 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 Ethers ProofofWork Algorithm Ethash Ethers ProofofStake Algorithm Casper Delegated Proof of Stake DPoS

Reference Books

- 1 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, 1st, Princeton University Press.
- 2 Blockchain: Blueprint for a New Economy, Melanie Swan, 1st, O Reilly Media.
- 3 Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos, Dr. Gavin Wood, 1st, O Reilly Media.
- 4 Cryptography and Network Security: Principles and Practice, William Stallings, 7th, Pearson Education .

25BEW3110 - SMART CONTRACT DEVELOPMENT & TESTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3110	SMART CONTRACT DEVELOPMENT & TESTING	SCDT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of smart contracts and their role in blockchain systems.	2	
CO2	Analyze smart contract requirements and design patterns for decentralized applications.	4	
CO3	Develop and deploy secure smart contracts using Solidity and related tools.	6	
CO4	Test and evaluate smart contracts for security, performance, and correctness.	5	

Syllabus

This module introduces smart contracts and their significance in blockchain ecosystems. Students will learn about the history and evolution of smart contracts, Ethereum virtual machine (EVM), and contract lifecycle. The module covers data types, state variables, functions, and modifiers, and explains how smart contracts automate decentralized processes.

This module focuses on the principles of smart contract design. Students will explore design patterns, inheritance, events, and error handling in Solidity. The module also covers integrating smart contracts with wallets and building small decentralized applications to interact with deployed contracts.

This module emphasizes practical testing and deployment strategies. Students will learn unit testing using frameworks like Hardhat and Truffle, testnet deployment, gas optimization techniques, and debugging contracts. Best practices for version control and deployment on public networks are discussed.

This module examines security challenges and evaluation techniques for smart contracts. Topics include common vulnerabilities such as reentrancy, integer overflow, and front-running attacks. Students will explore auditing tools, formal verification methods, and strategies to improve contract reliability and performance.

Reference Books

- 1 Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos, Gavin Wood, 1st Edition, O Reilly Media.
- 2 Ethereum Smart Contract Development, Mayukh Mukhopadhyay, 1st Edition, Packt Publishing.
- 3 Hands-On Smart Contract Development with Solidity and Ethereum, Kevin Solorio, Randall Kanna, David H. Hoover, 1st Edition, Addison-Wesley.

25BEW3202 - SMART CONTRACTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3202	SMART CONTRACTS	SC	R	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	PO3, PO7
CO2	Understand the basics of Blockchain and mining process	2	PO3, PO5, PO7
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO5, PO7, PO11
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	3	PO11

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 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 Crypto currencies applications using Blockchain Bitcoin Bitcoin Properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoin anonymity

Tangle IOTA Ether ETH Ether coin properties smart contract Applications Financial Services Cross border payments KYC international trade Health Care Food Safety Applications of Blockchain 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.

25BEW3211 - BLOCKCHAIN NETWORK ARCHITECTURE & CONSENSUS MECHANISMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3211	BLOCKCHAIN NETWORK ARCHITECTURE & CONSENSUS MECHANISMS	BNAC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental architecture of blockchain networks and their components.	2	
CO2	Analyze different consensus mechanisms and their applicability in various blockchain platforms.	4	
CO3	Design blockchain network solutions with appropriate consensus protocols for real-world applications.	6	
CO4	Evaluate the security, scalability, and performance trade-offs of different blockchain architectures and consensus mechanisms.	5	

Syllabus

This module introduces the key concepts of blockchain network architecture. It covers the structure of blocks, transactions, and ledgers, and explains how nodes communicate and maintain the distributed ledger. Students will learn about peer-to-peer networking, data propagation, and storage models in blockchain. The module also introduces blockchain types including public, private, and consortium networks, and discusses the role of cryptography in securing the network.

This module focuses on the various consensus algorithms used in blockchain networks. Students will study Proof of Work, Proof of Stake, Delegated Proof of Stake, Practical Byzantine Fault Tolerance, Proof of Authority, and hybrid consensus models. Each mechanism is analyzed in terms of performance, energy efficiency, scalability, and security. Case studies of blockchain platforms like Bitcoin, Ethereum, and Hyperledger are included to illustrate real-world implementations.

This module emphasizes the engineering of blockchain networks. Students will explore network topology, node roles, transaction validation, and block propagation strategies. They will learn how to select and implement suitable consensus mechanisms based on network requirements. The module includes practical aspects of designing private and consortium blockchains, configuring nodes, and deploying a basic blockchain network for simulation or enterprise use.

This module examines the challenges and solutions for securing blockchain networks and achieving scalability. Topics include fork management, double-spending attacks, Sybil attacks, and 51% attacks. Students will also explore Layer-2 scaling solutions, sharding, cross-chain interoperability, and sidechains. The module concludes with emerging trends in blockchain architectures and consensus mechanisms, including DAG-based systems, energy-efficient protocols, and enterprise adoption considerations.

Reference Books

- 1 Mastering Blockchain, Imran Bashir, 2nd Edition, Packt Publishing.
- 2 Blockchain Basics A Non-Technical Introduction in 25 Steps, Daniel Drescher, 1st Edition, Apress.
- 3 Blockchain Applications: A Hands-On Approach, Arshdeep Bahga, Vijay Madiseti, 1st Edition, VPT.

25BEW3303 - DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3303	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	DADW	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of decentralization and blockchain technology	1	
CO2	Develop proficiency in designing and implementing smart contracts using Solidity.	3	
CO3	Apply knowledge of decentralized application development principles and techniques to create a simple decentralized application	3	
CO4	Explore decentralized web technologies such as IPFS and their integration with dApps.	4	
CO5	Develop and deploy a decentralized application (dApp) using blockchain technology and decentralized web principles.	5	
CO6	Demonstrate proficiency in problem-solving and critical thinking skills through practical application of decentralized technologies	6	

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..

25BEW3303A - DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3303A	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	DADW	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of decentralization and blockchain technology.	2	
CO2	Develop proficiency in designing and implementing smart contracts using Solidity.	3	
CO3	Acquire knowledge of decentralized application development principles and techniques.	3	
CO4	Explore decentralized web technologies such as IPFS and their integration with dApps.	4	
CO5	Analyze advanced topics in decentralized applications and decentralized web and discuss their implications.	5	
CO6	Develop and deploy a decentralized application (dApp) using blockchain technology and decentralized web principles.	5	
CO7	Demonstrate proficiency in problem-solving and critical thinking skills through practical application of decentralized technologies.	5	

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.

25BEW3303E - DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3303E	DECENTRALIZED APPLICATIONS AND DECENTRALIZED WEB	DADW	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts of decentralized systems and blockchain technology	2	
CO2	Analyze various cryptographic techniques used in blockchain and their significance in securing decentralized applications.	4	
CO3	Evaluate the architecture and components of decentralized applications (DApps).	5	
CO4	Compare and contrast the Web2 and Web3 paradigms, focusing on their underlying technologies and protocols.	4	
CO5	Discuss the challenges and emerging trends in the field of decentralized systems, including scalability and governance issues.	2	
CO6	Develop a basic decentralized application using appropriate blockchain platforms and tools.	3	
CO7	Demonstrate problem-solving and critical thinking skills by addressing real-world issues through decentralized solutions.	3	

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
- 3 Decentralized Applications, Siraj Raval, First Edition, O'Reilly Media, Inc...
- 4 Ethereum: Building Decentralized Applications with Ethereum, Roberto Infante, First Edition, Packt Publishing..

25BEW3312 - WEB3 APPLICATION DEVELOPMENT & INTEGRATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3312	WEB3 APPLICATION DEVELOPMENT & INTEGRATION	WADI	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of Web3, blockchain interaction, and decentralized application architecture.	2	
CO2	Analyze and design decentralized applications (DApps) and their integration with blockchain networks.	4	
CO3	Develop smart contracts using Solidity and integrate them with frontend applications.	6	
CO4	Evaluate performance, security, and usability aspects of Web3 applications.	5	

Syllabus

This module introduces Web3 concepts and the fundamentals of decentralized applications. Students will learn how Web3 differs from traditional web applications, the role of blockchain as the backend, and key components of a DApp including smart contracts, wallets, and blockchain nodes. The module also explains Ethereum, Polygon, and other Web3-enabled platforms.

This module focuses on designing and implementing smart contracts using Solidity. Students will learn the structure of contracts, state variables, functions, events, modifiers, and error handling. Practical exercises include deploying contracts on Ethereum testnets and understanding gas optimization techniques.

Students will explore connecting decentralized applications with blockchain using Web3.js and Ethers.js. This module covers wallet integration, reading and writing on-chain data, and handling transactions. Topics also include building interactive user interfaces that reflect blockchain state changes in real-time.

This module emphasizes secure and reliable DApp deployment. Students will learn testing strategies using Hardhat and Truffle, debugging smart contracts, and auditing for vulnerabilities. Deployment to public networks and best practices for maintaining DApps are also covered.

Reference Books

- 1 Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos, Gavin Wood, 1st Edition, O Reilly Media.
- 2 Web3 Development with Ethereum and Solidity, Nitin Gaur, Luc Desrosiers, 1st Edition, Packt Publishing.
- 3 Building Ethereum DApps: Decentralized Applications on the Ethereum Blockchain, Roberto Infante, 1st Edition, Packt Publishing.

25BEW3312A - WEB3 APPLICATION DEVELOPMENT & INTEGRATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3312A	WEB3 APPLICATION DEVELOPMENT & INTEGRATION	WADI	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of Web3, blockchain interaction, and decentralized application architecture.	2	
CO2	Analyze and design decentralized applications (DApps) and their integration with blockchain networks.	4	
CO3	Develop smart contracts using Solidity and integrate them with frontend applications.	6	
CO4	Evaluate performance, security, and usability aspects of Web3 applications.	5	
CO5	Implement Web3 integrations with third-party services and APIs to enhance decentralized applications.	6	

Syllabus

This module introduces Web3 concepts and the fundamentals of decentralized applications. Students will learn how Web3 differs from traditional web applications, the role of blockchain as the backend, and key components of a DApp including smart contracts, wallets, and blockchain nodes. The module also explains Ethereum, Polygon, and other Web3-enabled platforms.

This module focuses on designing and implementing smart contracts using Solidity. Students will learn the structure of contracts, state variables, functions, events, modifiers, and error handling. Practical exercises include deploying contracts on Ethereum testnets and understanding gas optimization techniques.

Students will explore connecting decentralized applications with blockchain using Web3.js and Ethers.js. This module covers wallet integration, reading and writing on-chain data, and handling transactions. Topics also include building interactive user interfaces that reflect blockchain state changes in real-time.

This module emphasizes secure and reliable DApp deployment. Students will learn testing strategies using Hardhat and Truffle, debugging smart contracts, and auditing for vulnerabilities. Deployment to public networks and best practices for maintaining DApps are also covered.

This module covers integrating Web3 applications with third-party APIs, decentralized storage solutions like IPFS, and oracle services like Chainlink. Students will explore Layer-2 scaling solutions, cross-chain integrations, and NFT marketplaces. Emerging trends in Web3, such as DeFi, DAOs, and tokenized ecosystems, are also discussed.

Reference Books

- 1 Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos, Gavin Wood, 1st Edition, O Reilly Media.
- 2 Web3 Development with Ethereum and Solidity, Nitin Gaur, Luc Desrosiers, 1st Edition, Packt Publishing.
- 3 Building Ethereum DApps: Decentralized Applications on the Ethereum Blockchain, Roberto Infante, 1st Edition, Packt Publishing.

25BEW3312E - WEB3 APPLICATION DEVELOPMENT & INTEGRATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3312E	WEB3 APPLICATION DEVELOPMENT & INTEGRATION	WADI	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of Web3, blockchain interaction, and decentralized application architecture.	2	
CO2	Analyze and design decentralized applications (DApps) and their integration with blockchain networks.	4	
CO3	Develop smart contracts using Solidity and integrate them with frontend applications.	6	
CO4	Evaluate performance, security, and usability aspects of Web3 applications.	5	
CO5	Implement Web3 integrations with third-party services and APIs to enhance decentralized applications.	6	

Syllabus

This module introduces Web3 concepts and the fundamentals of decentralized applications. Students will learn how Web3 differs from traditional web applications, the role of blockchain as the backend, and key components of a DApp including smart contracts, wallets, and blockchain nodes. The module also explains Ethereum, Polygon, and other Web3-enabled platforms.

This module focuses on designing and implementing smart contracts using Solidity. Students will learn the structure of contracts, state variables, functions, events, modifiers, and error handling. Practical exercises include deploying contracts on Ethereum testnets and understanding gas optimization techniques.

Students will explore connecting decentralized applications with blockchain using Web3.js and Ethers.js. This module covers wallet integration, reading and writing on-chain data, and handling transactions. Topics also include building interactive user interfaces that reflect blockchain state changes in real-time.

This module emphasizes secure and reliable DApp deployment. Students will learn testing strategies using Hardhat and Truffle, debugging smart contracts, and auditing for vulnerabilities. Deployment to public networks and best practices for maintaining DApps are also covered.

This module covers integrating Web3 applications with third-party APIs, decentralized storage solutions like IPFS, and oracle services like Chainlink. Students will explore Layer-2 scaling solutions, cross-chain integrations, and NFT marketplaces. Emerging trends in Web3, such as DeFi, DAOs, and tokenized ecosystems, are also discussed.

Reference Books

- 1 Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos, Gavin Wood, 1st Edition, O Reilly Media.
- 2 Web3 Development with Ethereum and Solidity, Nitin Gaur, Luc Desrosiers, 1st Edition, Packt Publishing.
- 3 Building Ethereum DApps: Decentralized Applications on the Ethereum Blockchain, Roberto Infante, 1st Edition, Packt Publishing.

25BEW3404 - BLOCKCHAIN PLATFORMS AND PROTOCOLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3404	BLOCKCHAIN PLATFORMS AND PROTOCOLS	BCPFP	R	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	PO3, PO7
CO2	Understand the basics of Blockchain and mining process	2	PO3, PO5, PO7
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO5, PO7, PO11
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	3	PO11

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 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 Crypto currencies applications using Blockchain Bitcoin Bitcoin Properties Transaction life cycle creation of coin sending payments double spending using Blockchain bitcoin anonymity

Tangle IOTA Ether ETH Ether coin properties smart contract Applications Financial Services Cross border payments KYC international trade Health Care Food Safety Applications of Blockchain Blockchain based Internet of Things BloT Supply Chain Management and Healthcare etc

Reference Books

- 1 Blockchain: Blueprint for a New Economy, , Melanie Swan , 1st Edition, O'Reilly Media, Inc.
- 2 Bitcoin: A Peer-to-Peer Electronic Cash System, , Satoshi Nakamoto , 1st Edition, 2018 Annual Seminar Bitcoin Glossary.
- 3 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Imran Bashir, 4th Edition (2023), Packt Publishing.
- 4 Blockchain Basics: A Non-Technical Introduction in 25 Steps, Daniel Drescher, 1st Edition (2017), Apress.

25BEW3405 - BLOCKCHAIN SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3405	BLOCKCHAIN SECURITY	BCF	R	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
CO2	Understand the basics of Blockchain and mining process	2	PO1, PO3, PO5
CO3	Apply about the different types of Blockchain and consensus	3	PO1, PO3, PO5
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	3	PO1, PO5

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 Technology and Applications, , Pethuru Raj, Kavita Saini, Chellammal Surianarayanan, 1st Edition, Auerbach Publications (Routledge).
- 4 Blockchain: Blueprint for a New Economy, Melanie Swan , 1st Edition, O'Reilly Media, Inc.

25BEW3406 - ORACLES AND DATA FEEDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3406	ORACLES AND DATA FEEDS	ODF	R	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	
CO2	Able to integrate data from various sources using Oracle data feeds, understanding how to extract, transform, and load (ETL) data efficiently.	3	
CO3	3 Demonstrate proficiency in writing complex SQL queries to retrieve and manipulate data stored in Oracle databases, optimizing queries for performance and accuracy.	3	
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	

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 Golden Gate 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..

25BEW3413 - DECENTRALIZED FINANCE (DEFI) SYSTEMS ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3413	DECENTRALIZED FINANCE (DEFI) SYSTEMS ENGINEERING	DFSE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the core principles of blockchain and how they enable decentralized finance systems.	2	
CO2	Analyze and differentiate DeFi protocols, mechanisms, and architectures such as lending, staking, and liquidity pools.	4	
CO3	Design and develop smart contracts and decentralized applications (DApps) for DeFi use cases.	6	
CO4	Evaluate the security, scalability, and governance challenges in DeFi systems and propose engineering solutions.	5	

Syllabus

This module introduces the fundamental concepts of decentralized finance and its differences from traditional financial systems. It covers the core structure of blockchain technology, including blocks, consensus mechanisms, and cryptographic hashing. Students will learn about smart contracts and the Ethereum platform, which serve as the backbone for DeFi applications. The concept of tokenization is explored through fungible and non-fungible tokens, such as ERC-20, ERC-721, and ERC-1155 standards. The module also explains the role of stablecoins in maintaining stability within decentralized financial ecosystems.

This module focuses on the various decentralized finance protocols and mechanisms that power the DeFi ecosystem. It covers decentralized exchanges such as Uniswap and SushiSwap, explaining how automated market makers facilitate peer-to-peer trading. Students will explore lending and borrowing platforms like Compound and Aave to understand decentralized credit systems. The module also introduces yield farming, liquidity mining, and staking as core components of DeFi profitability. Additionally, it discusses derivatives, synthetic assets, and the importance of oracles like Chainlink in providing real-world data. The concept of cross-chain bridges and interoperability is included to highlight connectivity across blockchain networks.

This module emphasizes the practical aspects of designing and developing decentralized finance systems. It introduces DeFi architecture and design principles, focusing on the integration of blockchain and frontend technologies. Students will learn smart contract development using Solidity and explore how to connect decentralized applications to the blockchain using Web3.js or Ethers.js. The module includes testing, deployment, and gas optimization techniques with tools such as Truffle and Hardhat. A case study is provided to demonstrate the complete development of a simple DeFi decentralized application, such as a lending or swapping protocol.

This module examines the security challenges, governance models, and emerging trends within decentralized finance. It explains common DeFi vulnerabilities such as reentrancy attacks, flash loans, and oracle manipulation. Students will explore smart contract auditing methods and best practices to ensure secure deployment. The module discusses decentralized governance models, including decentralized autonomous organizations, voting systems, and tokenomics. It also addresses regulatory, ethical, and compliance aspects of DeFi. Finally, it introduces advanced topics like Layer-2 scaling, cross-chain DeFi, DeFi 2.0 protocols, and the integration of real-world assets into decentralized systems.

Reference Books

- 1 DeFi and the Future of Finance, Campbell R. Harvey, Ashwin Ramachandran, Joey Santoro, 1st Edition, Wiley.
- 2 Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos, Gavin Wood, 1st Edition, O Reilly Media.
- 3 Decentralized Finance (DeFi): The Future of Banking, Dr. S. Kannan, 2nd Edition, Springer.

25BEW3414 - POST-QUANTUM CRYPTOGRAPHY FOR BLOCKCHAIN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3414	POST-QUANTUM CRYPTOGRAPHY FOR BLOCKCHAIN	PQCB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25BEW3507 - BLOCKCHAIN SCALABILITY AND LAYER 2 SOLUTIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3507	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	3	PO3
CO2	Design and implement basic layer 2 solutions for improving the scalability of blockchain networks.	2	PO3
CO3	Determine the trade-offs involved in implementing different layer 2 solutions, considering factors such as security, decentralization,	3	PO4
CO4	Evaluate their knowledge of blockchain scalability and layer 2	4	PO4

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 Realworld 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, O'Reilly Media.
- 2 Scalability, Privacy, and Security in Blockchain Technologies", Jesus Diaz, Partha Dutta, et al, 1st Edition, Springer.
- 3 Mastering Ethereum: Building Smart Contracts and DApps, Andreas M. Antonopoulos, Gavin Wood , 1st Edition, O'Reilly Media.
- 4 Blockchain Scalability: Analysis and Solutions, Kartik Goyal , 1st Edition, CRC Press.

25BEW3508 - REGULATORY LANDSCAPE AND COMPLIANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3508	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	
CO2	Demonstrate knowledge of compliance practices and procedures to ensure adherence to regulatory standards.	3	
CO3	3 Analyze the impact of regulatory requirements on business operations and decisionmaking processes.	3	
CO4	Evaluate the role of regulatory bodies and agencies in enforcing compliance and maintaining industry standards.	4	

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.

25BEW3509 - FUTURE TRENDS IN BLOCKCHAIN AND WEB3 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3509	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	
CO2	Analyze current trends and emerging developments in blockchain and Web3 ecosystems.	3	
CO3	Demonstrate proficiency in utilizing blockchain platforms and protocols for decentralized applications (dApps) development.	3	
CO4	Evaluate the potential impact of blockchain and Web3 technologies on various industries and sectors.	3	

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 (NonFungible 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 toolkit

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.

25BEW3515 - DECENTRALIZED STORAGE, IDENTITY & MIDDLEWARE SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3515	DECENTRALIZED STORAGE, IDENTITY & MIDDLEWARE SYSTEMS	DSIM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25BEW3516 - QUANTUM ALGORITHMS FOR BLOCKCHAIN DATA ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BEW3516	QUANTUM ALGORITHMS FOR BLOCKCHAIN DATA ANALYSIS	QABA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe principles of quantum computing relevant to blockchain.	2	
CO2	Implement quantum search & optimization algorithms for blockchain analytics.	3	
CO3	Analyze blockchain cryptography under quantum attack models.	3	
CO4	Design hybrid quantum-classical approaches for blockchain scalability.	3	
CO5	Evaluate real-world blockchain datasets using quantum simulators.	3	

Syllabus

Quantum computing foundations (qubits, gates, superposition, entanglement). IBM Qiskit setup. Blockchain data structures overview.

Grover algorithm for blockchain search (transactions, fraud detection). Quantum Fourier Transform for consensus analysis.

Shor algorithm and threats to RSA/ECC-based blockchain systems. Post-quantum cryptographic alternatives.

Quantum machine learning for blockchain data classification. Variational Quantum Circuits. Hybrid QML pipelines with classical ML.

Applications: detecting anomalies in DeFi/NFT markets, quantum-accelerated consensus. Capstone: Quantum-based blockchain data analysis project.

Reference Books

- 1 Quantum Computation and Quantum Information, Michael Nielsen & Isaac Chuang, 2021, CUP.
- 2 Quantum Computing: An Applied Approach, Jack D. Hidary, 2022, Springer.
- 3 Mastering Blockchain, Imran Bashir, 2023, Packt.

25BIS3101 - MOLECULAR MODELLING AND DRUG DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3101	MOLECULAR MODELLING AND DRUG DESIGN	MMDD	R	3	0	2	0	4

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, PO4
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, 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.

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 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.

25BIS3101A - MOLECULAR MODELLING AND DRUG DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3101A	MOLECULAR MODELLING AND DRUG DESIGN	MMDD	A	4	1	2	0	6

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	PO2, 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.

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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, Molecular Modelling Principles and Applications, 2022, Pearson Publication.
- 4 Molecular Modelling: Computational Chemistry Demystified, Bladon P, 2018, , Rsc Publishing.

25BIS3101E - MOLECULAR MODELLING AND DRUG DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3101E	MOLECULAR MODELLING AND DRUG DESIGN	MMDD	E	4	1	2	0	6

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, 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, PO3, PO5
CO3	Demonstrate biomolecular interactions, such as protein-protein, protein-ligand, and protein-DNA/RNA interactions in biological systems	3	PO2, 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	PO2, PO3, 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	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	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	PO2, 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.

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- 3 Molecular Modeling: Basic Principles and Applications, Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers, 2021, John Wiley & Sons.
- 4 Molecular Modelling: Computational Chemistry Demystified, Bladon P, 2016, Rsc Publishing.

25BIS3202 - BIOMEDICAL INFORMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3202	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	PO3
CO2	Model computational analysis techniques and modeling approaches used in biomedical informatics to interpret complex biological data and derive meaningful insights.	3	PO4
CO3	Construct the principles of health information systems and interoperability standards to enhance the seamless exchange and integration of healthcare data.	3	PO1
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	PO5

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, Edward H. Shortliffe and James J. Cimino, 2014, Springer.
- 2 Health Informatics, Ramona Nelson and Nancy Staggers, 2017, Mosby.
- 3 Biomedical Informatics, David J. Lubliner, 2016, CRC Press.

25BIS3203 - PYTHON AND R PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3203	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
CO2	Utilize various R functions to analyze and interpret genomic sequences.	3	PO1, PO5
CO3	Apply R functions and libraries to analyze microarray gene expression datasets.	3	PO1
CO4	Apply R functions and libraries to analyze microarray gene expression datasets.	3	PO1, PO5

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.

25BIS3304 - STRUCTURAL BIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3304	STRUCTURAL BIOLOGY	SB	R	3	0	0	2	3.5

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, PO2
CO2	Understand the importance of techniques used in structural biology studies and secondary structure prediction methods and algorithms used in prediction	3	PO1, PO2
CO3	Understand the significance of Ramachandran Plot RMSD and concepts in 3D structure comparison	3	PO1, PO2
CO4	Apply the knowledge about the structural geometrical and dynamic interactions of nucleic acids with other molecules	3	PO1, PO2
CO5	Demonstrate the intricacy of protein protein interactions critical for cellular processes and with applications in drug discovery and disease understanding	3	PO1, PO2
CO6	Apply the understanding of structural biology techniques and secondary structure prediction methods to assess protein function and design novel biomolecules.	3	PO1, PO2

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, 2002, 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.

25BIS3304A - STRUCTURAL BIOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3304A	STRUCTURAL BIOLOGY	SB	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the protein dynamics and concepts of X-ray Diffraction Brags law electron density map	2	PO1, PO5
CO2	Understand the importance of techniques used in structural biology studies and secondary structure prediction methods and algorithms used in prediction	2	PO1, PO5
CO3	Understand the significance of Ramachandran Plot RMSD and concepts in 3D structure comparison	2	PO1, PO5
CO4	Apply the knowledge about the structural geometrical and dynamic interactions of nucleic acids with other molecules	3	PO1, PO5
CO5	Demonstrate the intricacy of protein protein interactions critical for cellular processes and with applications in drug discovery and disease understanding	3	PO1, PO5
CO6	Apply the understanding of structural biology techniques and secondary structure prediction methods to assess protein function and design novel biomolecules	3	PO1, PO5
CO7	Analyze macromolecular structures computational and experimental techniques in modeling and analyzing for biotechnology and medicine.	4	PO1, PO5

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...

25BIS3304E - STRUCTURAL BIOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3304E	STRUCTURAL BIOLOGY	SB	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the protein dynamics and concepts of X-ray Diffraction Brags law electron density map	2	PO1, PO5
CO2	Understand the importance of techniques used in structural biology studies and secondary structure prediction methods and algorithms used in prediction	2	PO1, PO5
CO3	Understand the significance of Ramachandran Plot RMSD and concepts in 3D structure comparison	2	PO1, PO5
CO4	Apply the knowledge about the structural geometrical and dynamic interactions of nucleic acids with other molecules	2	PO1, PO5
CO5	Demonstrate the intricacy of protein protein interactions critical for cellular processes and with applications in drug discovery and disease understanding	2	PO1, PO5
CO6	Apply the understanding of structural biology techniques and secondary structure prediction methods to assess protein function and design novel biomolecules	3	PO1, PO5
CO7	Analyze macromolecular structures computational and experimental techniques in modeling and analyzing for biotechnology and medicine	3	PO1, PO5

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.

25BIS3405 - APPLIED BIOINFORMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3405	APPLIED BIOINFORMATICS	ABI	R	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
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
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
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

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 Molecular Modelling : Principles & Applications, Andrew Leach, 2001, PEARSON.
- 2 Principles of Computational Cell Biology: From Protein Complexes to Cellular Networks, Volkhard Helms, 2019, Wiley.
- 3 Statistical analysis of gene expression microarray data, Terry Speed,, 2003, CRC.

25BIS3406 - NGS SEQUENCING AND DATA ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3406	NGS SEQUENCING AND DATA ANALYSIS	NGSDA	R	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	PO3, PO5
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, PO3
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, PO3, PO5
CO4	Interpret Transcriptomics and Differential Gene Expression: Engage in transcriptomic studies to explore gene expression levels under different conditions	3	PO2, PO3, 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. Cenik 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..

25BIS3507 - SYSTEMS BIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3507	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
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
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
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

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, Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, , 2016, Wiley-Blackwell.
- 2 Systems Biology, Andres Kriete, Roland Eils, 2013, Academic Press.
- 3 Foundations of Systems Biology, Hiroaki Kitano, 2020, MIT Press.

25BIS3508 - DATA BASE MANAGEMENT SYSTEM FOR BIOLOGIST (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BIS3508	DATA BASE 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

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.

25BMI3101 - BIOMEDICAL SIGNAL AND IMAGE PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BMI3101	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	BSIP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the basic concepts related to Biomedical signals and images.	2	PO1, PO2
CO2	Classify the Bio medical signal processing methods to eliminate the artefacts arise in biomedical signals.	2	PO1, PO2
CO3	Explain the Biomedical imaging and enhancement techniques.	2	PO1, PO2
CO4	Apply advanced signal processing approaches for biomedical signals and images.	3	PO1, PO2
CO5	Analyze and Implement appropriate signal/Image processing algorithms for practical problems involving biomedical signals and systems Using MATLAB.	4	PO1, PO2

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 , -, John Wiley and Sons .
- 2 Biomedical Signal and Image Processing , Kayvan Najarian, Robert Splinter , -, CRC Press Taylor & Francis Group .
- 3 Biomedical Image Analysis , Rangaraj M Rangayyan , -, CRC PRESS .
- 4 Practical Biomedical Signal Analysis Using MATLAB , K J Blinowska and J Zygiereicz , -, CRC Press .

25BMI3101A - BIOMEDICAL SIGNAL AND IMAGE PROCESSING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BMI3101A	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	BSIP	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the basic concepts related to Biomedical signals and images.	2	PO1, PO2
CO2	Classify the Bio medical signal processing methods to eliminate the artefacts arise in biomedical signals.	2	PO1, PO2
CO3	Explain the Biomedical imaging and enhancement techniques.	2	PO1, PO2
CO4	Apply advanced signal processing approaches for biomedical signals and images.	3	PO1, PO2
CO5	Analyze and Implement appropriate signal/Image processing algorithms for practical problems involving biomedical signals and systems Using MATLAB.	4	PO1, PO2
CO6	Case Study of the Bio medical Audio signal Analysis and Biomedical Image Analysis.	4	PO1, PO2

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.

Introduction to biomedical audio signals: heart sounds, lung sounds, speech. Pre-processing techniques for noise reduction and artifact removal. Feature extraction methods: time-domain and frequency-domain analysis. Image acquisition techniques and protocols. Pre-processing techniques: noise reduction, image enhancement, and normalization

Reference Books

- 1 Biomedical Signal Analysis, Rangaraj M Rangayyan, -, John Wiley and Sons.
- 2 Biomedical Signal and Image Processing, Kayvan Najarian, Robert Splinter, -, CRC Press Taylor & Francis Group.
- 3 Biomedical Image Analysis, Rangaraj M Rangayyan, -, CRC PRESS.
- 4 Practical Biomedical Signal Analysis Using MATLAB, K J Blinowska and J Zygiereicz, -, CRC Press.

25BM3101E - BIOMEDICAL SIGNAL AND IMAGE PROCESSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BM3101E	BIOMEDICAL SIGNAL AND IMAGE PROCESSING	BSIP	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the basic concepts related to Biomedical signals and images.	2	PO1, PO2
CO2	Classify the Bio medical signal processing methods to eliminate the artefacts arise in biomedical signals.	2	PO1, PO2
CO3	Explain the Biomedical imaging and enhancement techniques.	2	PO1, PO2
CO4	Apply advanced signal processing approaches for biomedical signals and images.	3	PO1, PO2
CO5	Analyze and Implement appropriate signal/Image processing algorithms for practical problems involving biomedical signals and systems Using MATLAB.	4	PO1, PO2
CO6	Case Study of the Bio medical Audio signal Analysis and Biomedical Image Analysis.	4	PO1, PO2

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.

Introduction to biomedical audio signals: heart sounds, lung sounds, speech. Pre-processing techniques for noise reduction and artifact removal. Feature extraction methods: time-domain and frequency-domain analysis. Image acquisition techniques and protocols. Pre-processing techniques: noise reduction, image enhancement, and normalization

Reference Books

- 1 Biomedical Signal Analysis, Rangaraj M Rangayyan, -, John Wiley and Sons.
- 2 Biomedical Signal and Image Processing, Kayvan Najarian, Robert Splinter, -, CRC Press Taylor & Francis Group.
- 3 Biomedical Image Analysis, Rangaraj M Rangayyan, -, CRC PRESS.
- 4 Practical Biomedical Signal Analysis Using MATLAB, K J Blinowska and J Zygiereicz, -, CRC PRESS.

25BMI3202 - ADVANCED BIOMEDICAL SIGNAL PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BMI3202	ADVANCED BIOMEDICAL SIGNAL PROCESSING	ABSP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the basic concepts of digital signal processing techniques and identify the nature of Biomedical signals.	3	PO2, PO3
CO2	Apply the Filtering Techniques.	3	PO2, PO3
CO3	Analyze the various Techniques for Detection of Events and Biosignals.	3	PO2, PO3
CO4	Analyze several circuits and systems for the application in medical instrumentation.	3	PO2, PO3

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 , USA, 2ed, 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 Biomedical Instrumentation and Measurements , Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer , 1990 , Prentice Hall Inc, New Jersey. .

25BMI3303 - MATERIALS FOR BIO-MEDICAL APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BMI3303	MATERIALS FOR BIO-MEDICAL APPLICATIONS	MBMA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the characteristics of biomaterials.	2	PO1
CO2	Apply surface modification for biomedical applications.	3	PO2
CO3	Apply Biocompatibility Testing and Response of Biomaterial to Human Body	3	PO3
CO4	Analyse Bio-implants & Surgical Aids for biomedical applications.	4	PO4
CO5	Design and evaluate a solution based on nanomaterial technology for a given need in the field of healthcare and biomedical Engineering using COMSOL/OFDTD	4	PO5

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

Module 2 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

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

Reference Books

- 1 Biomaterials , Sujata V. Bhatt , 2nd edition, 2005 , Alpha Science International Ltd .
- 2 Biomaterials Science , Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons , 3rd edition, 2014 , Elsevier.
- 3 Advanced Materials for Biomedical Applications , Advanced Materials for Biomedical Applications , 2023, Taylor & Francis Group.

25BMI3303A - MATERIALS FOR BIO-MEDICAL APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BMI3303A	MATERIALS FOR BIO-MEDICAL APPLICATIONS	MBMA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the characteristics of biomaterials	2	PO1
CO2	Apply surface modification for biomedical applications	3	PO2
CO3	Apply Biocompatibility Testing and Response of Biomaterial to Human Body	3	PO3
CO4	Analyse Bio-implants & Surgical Aids for biomedical applications	4	PO4
CO5	Design and evaluate a solution based on nanomaterial technology for a given need in the field of healthcare and biomedical Engineering using COMSOL/OFDTD	4	PO5
CO6	Evaluating and identify suitable biomaterials for biosensors	5	PO6

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.

Reference Books

- 1 Biomaterials , Sujata V. Bhatt , Alpha Science International Ltd , 2nd edition, 2005.
- 2 Biomaterials Science, Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons , Elsevier, 3rd edition, 2014 .
- 3 Advanced Materials for Biomedical Applications, Ashwani Kumar, Yatika Gori, Avinash Kumar, Chandan Swaroop Meena, Nitesh Dutt , Taylor & Francis Group , 2023 .

- 4 Medical Instrumentation Application and design , John Webster , Wiley , 5th Edition 2020 .

25BMI3303E - MATERIALS FOR BIO-MEDICAL APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BMI3303E	MATERIALS FOR BIO-MEDICAL APPLICATIONS	MBMA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the characteristics of biomaterials.	2	PO1
CO2	Apply surface modification for biomedical applications.	3	PO2
CO3	Apply Biocompatibility Testing and Response of Biomaterial to Human Body.	3	PO3
CO4	Analyse Bio-implants & Surgical Aids for biomedical applications.	4	PO4
CO5	CO5 Design and evaluate a solution based on nanomaterial technology for a given need in the field of healthcare and biomedical Engineering using COMSOL/OFDTD.	4	PO5
CO6	Evaluating and identify suitable biomaterials for biosensors	5	PO5

Syllabus

Module 1 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.

Module 2 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,

Module 3 Porous Composites, Fibrous & Particulate composites.

Module 4 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

Module 5 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.

Reference Books

- 1 Biomaterials , Sujata V. Bhatt , 2nd edition, 2005 , 1 Biomaterials Sujata V. Bhatt Alpha Science International Ltd 2nd edition, 2005 .
- 2 Biomaterials Science , Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons , Elsevier , 3rd edition, 2014 .

- Advanced Materials for Biomedical Applications , Ashwani Kumar, Yatika Gori, Avinash Kumar, Chandan Swaroop Meena, Nitesh Dutt , 2023, 3 Advanced Materials for Biomedical Applications Ashwani Kumar, Yatika Gori, Avinash Kumar, Chandan Swaroop Meena, Nitesh Dutt Taylor & Francis Group 2023 .
- 4 Medical Instrumentation Application and design , John Webster , 5th edition 2020, wiley.

25BMI3404 - NANOTECHNOLOGY AND NANOSENSORS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BMI3404	NANOTECHNOLOGY AND NANOSENSORS	NTN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the basic concepts of Nanosensors	2	PO2, PO3
CO2	CO2 Interpret the fabrication, characterization of nanosensors 2 PO2, PSO1	2	PO2, PO3
CO3	CO3 Apply nanomaterials to manipulate nanosensors 3 PO2 PSO1	3	PO2, PO3
CO4	Apply quantum dots in Sensing and Imaging Application.	3	PO2, PO3

Syllabus

Module 1 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

Module 3 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 .

25BMI3505 - BIOSENSING AND BIOELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25BMI3505	BIOSENSING AND BIOELECTRONICS	BSBE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the working principles of biosensors	2	PO1
CO2	Interpret characterization of optical and electrochemical sensors	3	PO2
CO3	Apply the response of biosensors	3	PO2
CO4	Analyse selective biomedical devices for future applications	4	PO2
CO5	Design and interfacing of Biological Systems with electronic systems, non-conventional bioelectronic devices using SPICE/OFDTD/COMSOL	4	PO2

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

Design and interfacing of Biological Systems with electronic systems, non-conventional bioelectronic devices using SPICE/OFDTD/COMSOL

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 Hand book of biosensor and biosensor kinetics, Ajit sadana, Neeti sadana, 2010, elsevier.

25CAC3101 - GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3101	GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC	GPAH	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain GPU architectures and their role in AI/HPC acceleration.	2	
CO2	Implement parallel programming using CUDA/OpenCL frameworks.	3	
CO3	Optimize ML/DL workloads using GPU acceleration libraries (TensorRT, cuDNN).	3	
CO4	Evaluate performance of GPU vs CPU for AI and HPC workloads.	3	
CO5	Design hybrid CPU-GPU solutions for large-scale AI/HPC applications.	3	

Syllabus

GPU architecture (SMs, warps, threads, memory hierarchy). Evolution from graphics to AI acceleration. CUDA basics, OpenCL. HPC clusters with GPUs.

Parallel programming paradigms: kernels, grid/thread/block model, shared vs global memory, synchronization. Performance pitfalls.

GPU libraries for AI: cuDNN, TensorRT, RAPIDS, PyTorch/TensorFlow GPU backends. Optimization (batching, memory pinning, mixed precision)

HPC applications: scientific simulations, molecular dynamics, weather forecasting. Profiling with NVIDIA Nsight, PyTorch Profiler. Case studies.

Emerging accelerators: TPUs, FPGAs, quantum co-processors. Hybrid CPU-GPU workloads. Capstone: Train deep learning model on GPU cluster

Reference Books

- 1 Programming Massively Parallel Processors, David Kirk & Wen-mei Hwu, 2022, Elsevier.
- 2 CUDA Handbook, Nicholas Wilt, 2021, Addison-Wesley.
- 3 Real-Time Rendering, Tomas Akenine-Möller et al, 2021, CRC Press.

25CAC3101A - GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3101A	GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC	GPAH	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain GPU architectures and their role in AI/HPC acceleration.	2	
CO2	Implement parallel programming using CUDA/OpenCL frameworks.	3	
CO3	Optimize ML/DL workloads using GPU acceleration libraries (TensorRT, cuDNN).	3	
CO4	Evaluate performance of GPU vs CPU for AI and HPC workloads.	3	
CO5	Design hybrid CPU-GPU solutions for large-scale AI/HPC applications.	3	

Syllabus

GPU architecture (SMs, warps, threads, memory hierarchy). Evolution from graphics to AI acceleration. CUDA basics, OpenCL. HPC clusters with GPUs.

Parallel programming paradigms: kernels, grid/thread/block model, shared vs global memory, synchronization. Performance pitfalls.

GPU libraries for AI: cuDNN, TensorRT, RAPIDS, PyTorch/TensorFlow GPU backends. Optimization (batching, memory pinning, mixed precision)

HPC applications: scientific simulations, molecular dynamics, weather forecasting. Profiling with NVIDIA Nsight, PyTorch Profiler. Case studies.

Emerging accelerators: TPUs, FPGAs, quantum co-processors. Hybrid CPU-GPU workloads. Capstone: Train deep learning model on GPU cluster

Reference Books

- 1 Programming Massively Parallel Processors, David Kirk & Wen-mei Hwu, 2022, Elsevier.
- 2 CUDA Handbook, Nicholas Wilt, 2021, Addison-Wesley.
- 3 Real-Time Rendering, Tomas Akenine-Möller et al, 2021, CRC Press.

25CAC3101E - GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3101E	GPU PROGRAMMING & HARDWARE ACCELERATION FOR AI & HPC	GPAH	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain GPU architectures and their role in AI/HPC acceleration.	2	
CO2	Implement parallel programming using CUDA/OpenCL frameworks.	3	
CO3	Optimize ML/DL workloads using GPU acceleration libraries (TensorRT, cuDNN).	3	
CO4	Evaluate performance of GPU vs CPU for AI and HPC workloads.	3	
CO5	Design hybrid CPU-GPU solutions for large-scale AI/HPC applications.	3	

Syllabus

GPU architecture (SMs, warps, threads, memory hierarchy). Evolution from graphics to AI acceleration. CUDA basics, OpenCL. HPC clusters with GPUs.

Parallel programming paradigms: kernels, grid/thread/block model, shared vs global memory, synchronization. Performance pitfalls.

GPU libraries for AI: cuDNN, TensorRT, RAPIDS, PyTorch/TensorFlow GPU backends. Optimization (batching, memory pinning, mixed precision)

HPC applications: scientific simulations, molecular dynamics, weather forecasting. Profiling with NVIDIA Nsight, PyTorch Profiler. Case studies.

Emerging accelerators: TPUs, FPGAs, quantum co-processors. Hybrid CPU-GPU workloads. Capstone: Train deep learning model on GPU cluster

Reference Books

- 1 Programming Massively Parallel Processors, David Kirk & Wen-mei Hwu, 2022, Elsevier.
- 2 CUDA Handbook, Nicholas Wilt, 2021, Addison-Wesley.
- 3 Real-Time Rendering, Tomas Akenine-Möller et al, 2021, CRC Press.

25CAC3202 - PARALLEL & FUNCTIONAL PROGRAMMING FOR SCIENTIFIC APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3202	PARALLEL & FUNCTIONAL PROGRAMMING FOR SCIENTIFIC APPLICATIONS	PFPS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply principles of parallel programming to design and implement concurrent scientific applications.	3	PO2, PO3
CO2	Analyze shared-memory and distributed-memory parallel models for scientific workloads.	4	PO2, PO3
CO3	Develop functional programming solutions for parallelizable scientific computations.	4	PO2, PO3
CO4	Evaluate hybrid parallel programming models for performance, scalability, and maintainability.	5	PO2, PO3

Syllabus

Parallelism vs. concurrency; data parallelism vs. task parallelism; identifying parallelizable components in scientific problems; parallel performance metrics (speedup, efficiency, scalability); introduction to OpenMP threading model.

Message Passing Interface basics; point-to-point communication; collective communication; process synchronization; load balancing in distributed systems; implementing scientific simulations across multiple nodes.

Concepts of immutability, higher-order functions, pure functions; functional constructs for parallelism; languages and libraries (Scala, Haskell, Python functional modules); using functional paradigms for mathematical modeling.

Combining MPI with OpenMP; MPI with CUDA; performance tuning of hybrid systems; case studies from climate modeling, molecular dynamics, and genomics; debugging and profiling hybrid parallel programs.

Reference Books

- 1 Parallel Programming in C with MPI and OpenMP, Michael J. Quinn, 1st Edition, McGraw-Hill, 2004.
- 2 Using MPI: Portable Programming with the Message Passing Interface, William Gropp, Ewing Lusk, Anthony Skjellum, 3rd Edition, MIT Press, 2014.
- 3 Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, 2nd Edition, Pearson, 2020.

25CAC3303 - ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3303	ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION	ACHA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply advanced architecture concepts to design hardware-accelerated computing solutions.	3	PO1, PO3
CO2	Analyze GPU, TPU, FPGA, and other accelerator architectures for performance trade-offs.	4	PO1, PO3
CO3	Develop workloads optimized for specialized hardware in AI and scientific computing.	4	PO1, PO3
CO4	Evaluate emerging hardware acceleration trends and their integration into cloud environments.	5	PO1, PO3

Syllabus

Multi-core and many-core processors; superscalar execution; instruction pipelining; out-of-order execution; vector processors and SIMD; NUMA architectures; cache coherence protocols; implications for HPC workloads.

GPU SM architecture and memory hierarchy; tensor processing units (TPUs) and systolic arrays; FPGA reconfigurable logic basics; hardware pipeline design; comparing latency, throughput, and energy efficiency of accelerators.

Mapping AI and HPC workloads to accelerators; hardware-aware algorithm design; optimizing data locality and memory usage; quantization and pruning for AI inference; FPGA acceleration using OpenCL and HLS tools.

Neuromorphic processors; photonic computing; quantum-inspired accelerators; integrating accelerators with cloud services (AWS Inferentia, Azure Brainwave, GCP TPUs); hybrid accelerator architectures for future workloads.

Reference Books

- 1 Computer Architecture: A Quantitative Approach, John L. Hennessy, David A. Patterson, 6th Edition, Morgan Kaufmann, 2017.
- 2 Digital Design and Computer Architecture, David Harris, Sarah Harris, 2nd Edition, Morgan Kaufmann, 2021.
- 3 GPU Architecture and Programming, Xavier Martorell, Eduard Ayguad?, 1st Edition, Springer, 2019.

25CAC3303A - ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3303A	ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION	ACHA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply advanced architecture concepts to design hardware-accelerated computing solutions.	3	PO1, PO3
CO2	Analyze GPU, TPU, FPGA, and other accelerator architectures for performance trade-offs.	4	PO1, PO3
CO3	Develop workloads optimized for specialized hardware in AI and scientific computing.	4	PO1, PO3
CO4	Evaluate emerging hardware acceleration trends and their integration into cloud environments.	5	PO1, PO3

Syllabus

Multi-core and many-core processors; superscalar execution; instruction pipelining; out-of-order execution; vector processors and SIMD; NUMA architectures; cache coherence protocols; implications for HPC workloads.

GPU SM architecture and memory hierarchy; tensor processing units (TPUs) and systolic arrays; FPGA reconfigurable logic basics; hardware pipeline design; comparing latency, throughput, and energy efficiency of accelerators.

Mapping AI and HPC workloads to accelerators; hardware-aware algorithm design; optimizing data locality and memory usage; quantization and pruning for AI inference; FPGA acceleration using OpenCL and HLS tools.

Neuromorphic processors; photonic computing; quantum-inspired accelerators; integrating accelerators with cloud services (AWS Inferentia, Azure Brainwave, GCP TPUs); hybrid accelerator architectures for future workloads.

Reference Books

- 1 Computer Architecture: A Quantitative Approach, John L. Hennessy, David A. Patterson, 6th Edition, Morgan Kaufmann, 2017.
- 2 Digital Design and Computer Architecture, David Harris, Sarah Harris, 2nd Edition, Morgan Kaufmann, 2021.
- 3 GPU Architecture and Programming, Xavier Martorell, Eduard Ayguad?, 1st Edition, Springer, 2019.

25CAC3303E - ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3303E	ADVANCED COMPUTER ARCHITECTURES FOR HARDWARE ACCELERATION	ACHA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply advanced architecture concepts to design hardware-accelerated computing solutions.	3	PO1, PO3
CO2	Analyze GPU, TPU, FPGA, and other accelerator architectures for performance trade-offs.	4	PO1, PO3
CO3	Develop workloads optimized for specialized hardware in AI and scientific computing.	4	PO1, PO3
CO4	Evaluate emerging hardware acceleration trends and their integration into cloud environments.	5	PO1, PO3

Syllabus

Multi-core and many-core processors; superscalar execution; instruction pipelining; out-of-order execution; vector processors and SIMD; NUMA architectures; cache coherence protocols; implications for HPC workloads.

GPU SM architecture and memory hierarchy; tensor processing units (TPUs) and systolic arrays; FPGA reconfigurable logic basics; hardware pipeline design; comparing latency, throughput, and energy efficiency of accelerators.

Mapping AI and HPC workloads to accelerators; hardware-aware algorithm design; optimizing data locality and memory usage; quantization and pruning for AI inference; FPGA acceleration using OpenCL and HLS tools.

Neuromorphic processors; photonic computing; quantum-inspired accelerators; integrating accelerators with cloud services (AWS Inferentia, Azure Brainwave, GCP TPUs); hybrid accelerator architectures for future workloads.

Reference Books

- 1 Computer Architecture: A Quantitative Approach, John L. Hennessy, David A. Patterson, 6th Edition, Morgan Kaufmann, 2017.
- 2 Digital Design and Computer Architecture, David Harris, Sarah Harris, 2nd Edition, Morgan Kaufmann, 2021.
- 3 GPU Architecture and Programming, Xavier Martorell, Eduard Ayguad?, 1st Edition, Springer, 2019.

25CAC3304 - QUANTUM PROGRAMMING FUNDAMENTALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3304	QUANTUM PROGRAMMING FUNDAMENTALS	QPF	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply core quantum-information concepts (states, measurement, superposition, entanglement) to build simple circuits and predict measurement distributions	3	PO2, PO3
CO2	Analyze multi-qubit circuits using linear-algebraic reasoning (tensor products, unitary evolution) and verify behavior via simulators	4	PO2, PO3
CO3	Analyze SDK workflows (Qiskit & Cirq): circuit construction, transpilation/optimization, backend configuration, and shot-based statistics on simulators and limited real hardware	4	PO2, PO3
CO4	Evaluate noise and error effects in NISQ devices; compare basic error-mitigation strategies (readout calibration, zero-noise extrapolation) and justify trade-offs	5	PO2, PO3

Syllabus

Quantum Information Basics & Single-Qubit Circuits: Classical vs quantum information; Dirac notation, state vectors; single-qubit gates (X, Z, H, S, T, Rx/Ry/Rz); measurement in computational basis; superposition creation & collapse; Bloch sphere intuition; probabilities & expectation values; first circuits in Qiskit and Cirq; sampling vs statevector simulation; reproducibility with random seeds

Two-Qubit & Entangling Circuits (Linear Algebra View): Tensor products & multi-qubit states; CNOT/controlled-U, SWAP, Toffoli (overview); Bell states, EPR pairs; basis changes (X/Z/H bases); interference; circuit depth & width; quantum teleportation & superdense coding (logic & circuit); amplitude vs phase manipulation; predicting outcomes with matrices and verifying numerically

Programming with Qiskit & Cirq (Simulators & Hardware Paths): Qiskit: QuantumCircuit API, transpiler passes, coupling maps, Aer simulators; Cirq: GridQubit, Moment, Simulator; shot counts & statistical error; backend selection (ideal vs noisy simulators, real devices); transpilation/optimization levels; mapping to device topology; measurement error calibration jobs; job submission, queueing & result parsing; experiment logging and plots

Noise, Error Models & Intro to Mitigation: NISQ reality: T1/T2, gate/measurement error, crosstalk, drift; noise channels (bit-flip, phase-flip, depolarizing, amplitude damping); custom noise models in Aer/Cirq; readout error calibration (confusion matrices); zero-noise extrapolation (gate folding); probabilistic error cancellation (conceptual); limitations & when mitigation hurts; designing fair experiments (shots, confidence intervals)

Reference Books

- 1 Quantum Computing: An Applied Approach, Jack D. Hidary, Springer, 2019.
- 2 Programming Quantum Computers, Eric R. Johnston, Nic Harrigan, Mercedes Gimeno-Segovia, O'Reilly, 2019.
- 3 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, MIT Press, 2017.

25CAC3304A - QUANTUM PROGRAMMING FUNDAMENTALS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3304A	QUANTUM PROGRAMMING FUNDAMENTALS	QPF	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply core quantum-information concepts (states, measurement, superposition, entanglement) to build simple circuits and predict measurement distributions	3	PO1, PO2
CO2	Analyze multi-qubit circuits using linear-algebraic reasoning (tensor products, unitary evolution) and verify behavior via simulators	4	PO1, PO2
CO3	Analyze SDK workflows (Qiskit & Cirq): circuit construction, transpilation/optimization, backend configuration, and shot-based statistics on simulators and limited real hardware	4	PO1, PO2
CO4	Evaluate noise and error effects in NISQ devices; compare basic error-mitigation strategies (readout calibration, zero-noise extrapolation) and justify trade-offs	5	PO1, PO2

Syllabus

Quantum Information Basics & Single-Qubit Circuits: Classical vs quantum information; Dirac notation, state vectors; single-qubit gates (X, Z, H, S, T, Rx/Ry/Rz); measurement in computational basis; superposition creation & collapse; Bloch sphere intuition; probabilities & expectation values; first circuits in Qiskit and Cirq; sampling vs statevector simulation; reproducibility with random seeds

Two-Qubit & Entangling Circuits (Linear Algebra View): Tensor products & multi-qubit states; CNOT/controlled-U, SWAP, Toffoli (overview); Bell states, EPR pairs; basis changes (X/Z/H bases); interference; circuit depth & width; quantum teleportation & superdense coding (logic & circuit); amplitude vs phase manipulation; predicting outcomes with matrices and verifying numerically

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Noise, Error Models & Intro to Mitigation: NISQ reality: T1/T2, gate/measurement error, crosstalk, drift; noise channels (bit-flip, phase-flip, depolarizing, amplitude damping); custom noise models in Aer/Cirq; readout error calibration (confusion matrices); zero-noise extrapolation (gate folding); probabilistic error cancellation (conceptual); limitations & when mitigation hurts; designing fair experiments (shots, confidence intervals)

Reference Books

- 1 Quantum Computation and Quantum Information, Michael A. Nielsen, Isaac L. Chuang, 2010, Cambridge Univ. Press.
- 2 Programming Quantum Computers, Eric R. Johnston, Nic Harrigan, Mercedes Gimeno-Segovia, 2019, O Reilly.
- 3 Learn Quantum Computing with Python and Qiskit, Robert Lored, 2020, Packt.

25CAC3304E - QUANTUM PROGRAMMING FUNDAMENTALS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3304E	QUANTUM PROGRAMMING FUNDAMENTALS	QPF	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply core quantum-information concepts (states, measurement, superposition, entanglement) to build simple circuits and predict measurement distributions	3	PO1, PO2
CO2	Analyze multi-qubit circuits using linear-algebraic reasoning (tensor products, unitary evolution) and verify behavior via simulators	4	PO1, PO2
CO3	Analyze SDK workflows (Qiskit & Cirq): circuit construction, transpilation/optimization, backend configuration, and shot-based statistics on simulators and limited real hardware	4	PO1, PO2
CO4	Evaluate noise and error effects in NISQ devices; compare basic error-mitigation strategies (readout calibration, zero-noise extrapolation) and justify trade-offs	5	PO1, PO2

Syllabus

Quantum Information Basics & Single-Qubit Circuits: Classical vs quantum information; Dirac notation, state vectors; single-qubit gates (X, Z, H, S, T, Rx/Ry/Rz); measurement in computational basis; superposition creation & collapse; Bloch sphere intuition; probabilities & expectation values; first circuits in Qiskit and Cirq; sampling vs statevector simulation; reproducibility with random seeds

Two-Qubit & Entangling Circuits (Linear Algebra View): Tensor products & multi-qubit states; CNOT/controlled-U, SWAP, Toffoli (overview); Bell states, EPR pairs; basis changes (X/Z/H bases); interference; circuit depth & width; quantum teleportation & superdense coding (logic & circuit); amplitude vs phase manipulation; predicting outcomes with matrices and verifying numerically

Programming with Qiskit & Cirq (Simulators & Hardware Paths): Qiskit: QuantumCircuit API, transpiler passes, coupling maps, Aer simulators; Cirq: GridQubit, Moment, Simulator; shot counts & statistical error; backend selection (ideal vs noisy simulators, real devices); transpilation/optimization levels; mapping to device topology; measurement error calibration jobs; job submission, queueing & result parsing; experiment logging and plots

Noise, Error Models & Intro to Mitigation: NISQ reality: T1/T2, gate/measurement error, crosstalk, drift; noise channels (bit-flip, phase-flip, depolarizing, amplitude damping); custom noise models in Aer/Cirq; readout error calibration (confusion matrices); zero-noise extrapolation (gate folding); probabilistic error cancellation (conceptual); limitations & when mitigation hurts; designing fair experiments (shots, confidence intervals)

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- 2 Programming Quantum Computers, Eric R. Johnston, Nic Harrigan, Mercedes Gimeno-Segovia, O'Reilly, 2019.
- 3 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, MIT Press, 2017.

25CAC3405 - CLOUD ARCHITECTURES FOR HPC & AI WORKLOADS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3405	CLOUD ARCHITECTURES FOR HPC & AI WORKLOADS	CHAW	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply cloud architecture principles to design scalable HPC and AI systems.	3	PO1, PO2
CO2	Analyze different cloud service models and architectures for scientific and AI workloads.	4	PO1, PO2
CO3	Develop end-to-end cloud-based HPC and AI deployment pipelines.	4	PO1, PO2
CO4	Evaluate cost, performance, and security trade-offs in deploying HPC and AI workloads in the cloud.	5	PO1, PO2

Syllabus

Cloud-native principles difference between HPC clusters and cloud HPC overview of IaaS, PaaS, and SaaS for scientific workloads; hybrid and multi cloud strategies virtualization vs. bare metal cloud nodes elasticity and auto scaling for HPC AI workloads.

AWS ParallelCluster, AWS Batch, EC2 P and G-series for GPUs, SageMaker for AI Azure CycleCloud, Azure Machine Learning; Google Cloud HPC Toolkit, Vertex AI specialized AI accelerators in cloud; cloud networking for HPC workloads.

CI/CD for scientific computing integrating version control (Git) with HPC workflows container orchestration (Kubernetes, KubeFlow, MLflow) workflow automation tools (Apache Airflow, Prefect) deployment of hybrid CPU GPU pipelines in the cloud.

Cloud benchmarking and monitoring; cost optimization strategies (spot instances, reserved instances, autoscaling policies); HPC security best practices (VPC isolation, encryption, IAM policies); disaster recovery and fault tolerance for HPC workloads.

Reference Books

- 1 Architecting Cloud Computing Solutions, Kevin L. Jackson, Scott Goessling, 1st Edition (2018), Packt.
- 2 Cloud Computing for Science and Engineering, Ian Foster, Dennis Gannon, 1st Edition (2017), MIT Press.
- 3 Kubernetes in Action, Marko Luksa, 2nd Edition (2018), Manning.

25CAC3406 - QUANTUM ALGORITHMS FOR AI & OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3406	QUANTUM ALGORITHMS FOR AI & OPTIMIZATION	QAAO	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply core quantum algorithm primitives (oracle-based, amplitude amplification, quantum Fourier transform) to small-scale problems.	3	PO2, PO4
CO2	Analyze variational quantum algorithms (VQE, QAOA) and map optimization problems into quantum formulations.	4	PO2, PO4
CO3	Analyze quantum machine learning approaches (quantum kernels, QSVM, quantum feature maps) and evaluate them against classical baselines.	4	PO2, PO4
CO4	Evaluate hybrid quantum classical AI pipelines, assess performance trade offs, and recommend integration patterns for NISQ era use.	5	PO2, PO4

Syllabus

Grovers search QFT Simons and Deutsch Jozsa algorithms algorithm complexity versus classical circuit depth and width considerations

Parameterized quantum circuits PQC VQE for ground states QAOA for Max Cut and portfolio optimization classical optimizers COBYLA SPSA barren plateaus problem encoding via Ising Hamiltonians

Quantum data encoding basis amplitude angle quantum feature maps QSVM quantum nearest neighbor hybrid neural networks benchmarking against classical models

Hybrid pipeline architecture workload split between CPU GPU and quantum use cases drug discovery finance logistics cost noise considerations cloud platforms IBM Qiskit Azure Quantum AWS Braket MLOps adaptation Hybrid pipeline architecture workload split between CPU GPU and quantum use cases drug discovery finance logistics cost noise considerations cloud platforms IBM Qiskit Azure Quantum AWS Braket MLOps adaptation

Reference Books

- 1 Quantum Computation and Quantum Information, Nielsen & Chuang, 2010, Cambridge University Press.
- 2 Learn Quantum Computing with Python and Qiskit, Robert Lored, 2020, Packt.
- 3 Dancing with Qubits, Robert Sutor, 2019, Packt.

25CAC3507 - MLOPS & SCIENTIFIC WORKFLOW AUTOMATION IN CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3507	MLOPS & SCIENTIFIC WORKFLOW AUTOMATION IN CLOUD	MSWC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply MLOps principles to manage AI/ML pipelines in cloud environments.	3	PO1, PO3
CO2	Analyze workflow orchestration strategies for scientific computing in the cloud.	4	PO1, PO3
CO3	Develop automated, reproducible, and scalable HPC/AI pipelines.	5	PO1, PO3
CO4	Evaluate performance, cost, and reliability trade-offs in workflow automation.	5	PO1, PO3

Syllabus

MLOps lifecycle model development, deployment, monitoring CI/CD for ML model registry and versioning reproducibility in ML pipelines MLOps vs traditional DevOps cloud-native MLOps tools (SageMaker Pipelines, Vertex AI Pipelines, Azure ML Pipelines).

Workflow automation needs in HPC DAG based workflow systems Apache Airflow, Prefect, Luigi parameter sweeps and batch job orchestration; integrating HPC schedulers (Slurm, PBS) with workflow systems.

Data ingestion automation feature engineering pipelines training pipeline automation automated hyperparameter tuning; reproducible results via containerization (Docker, Singularity) experiment tracking with MLflow and Weights & Biases.

Performance benchmarking for workflows cost optimization in automated pipelines checkpointing and job recovery fault tolerance strategies monitoring alerting for scientific workflows case studies in climate modeling, genomics, and drug discovery.

Reference Books

- 1 Practical MLOps, Noah Gift, Alfredo Deza, 1st Edition (2021), O Reilly.
- 2 Machine Learning Engineering, Andriy Burkov, 1st Edition (2020), True Positive Inc..
- 3 Data Science on the Google Cloud Platform, Valliappa Lakshmanan, 1st Edition (2022), O Reilly.

25CAC3508 - HYBRID QUANTUM-CLASSICAL CLOUD SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CAC3508	HYBRID QUANTUM-CLASSICAL CLOUD SYSTEMS	HQCC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply cloud-based quantum computing services to run quantum jobs and retrieve results programmatically.	3	PO2
CO2	Analyze orchestration workflows that integrate quantum computing into hybrid pipelines using classical and accelerated hardware.	4	PO3, PO4
CO3	Analyze DevOps/MLOps approaches for reproducible hybrid quantum classical deployments.	4	PO1, PO3
CO4	Evaluate hybrid system architectures for cost, performance, and scalability in production AI/optimization workloads.	5	PO1, PO4

Syllabus

Quantum Cloud Platforms Overview Managed quantum services (IBM Quantum Runtime, AWS Braket, Azure Quantum) account setup, authentication, and API usage job submission lifecycle simulators vs QPUs credit and quota systems quantum classical data exchange patterns

Orchestrating Hybrid Workflows Cloud orchestration basics; connecting classical preprocessing (CPU/GPU) with quantum post processing; building hybrid ML pipelines (e.g., feature extraction QPU classification); containerized quantum workloads (Docker images with SDKs); integration with Kubernetes for scalable orchestration

CI/CD & MLOps for Hybrid Systems CI/CD for quantum applications; automated testing of circuits; workflow automation (GitHub Actions, Azure DevOps, AWS Step Functions); dataset versioning (DVC); experiment tracking (MLflow with quantum extensions); reproducibility best practices

Architecture & Optimization Strategies Hybrid architecture patterns (client server, microservices, serverless triggers for quantum jobs); performance benchmarking; cost latency trade offs; error noise vs. cost analysis; scaling strategies; multi cloud quantum deployments (redundancy & performance); security considerations for quantum workflows

Reference Books

- 1 Quantum Computing: An Applied Approach, Jack D. Hidary, 2nd Edition, Springer.
- 2 Programming Quantum Computers, Eric R. Johnston, Nic Harrigan, Mercedes Gimeno-Segovia, 1st Edition, O'Reilly Media.
- 3 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, 1st Edition, MIT Press.

25CEC3101 - CLOUD INFRASTRUCTURE AND SERVICES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3101	CLOUD INFRASTRUCTURE AND SERVICES	CIS	R	3	0	2	0	4

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	
CO3	Understand load balancing, container services and Kubernetes	4	
CO4	Assess the security over the cloud through specific approaches	4	
CO5	Construct with Cloud infrastructure, virtualization, Load balancing and authentication, and security services with hands on lab	4	

Syllabus

Introduction to Cloud Technologies: Introduction to 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

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Zaigham Mahmood, Ricardo Puttini, Thomas Erl, 2013, Pearson.
- 2 Cloud Computing: Methodology, Systems, and Applications , Lizhe Wang, Rajiv Ranjan, Jinjun Chen, Boualem Benatallah , 2017, CRC Press .
- 3 Cloud Computing Bible , Barrie Sosinsky , 2011, John Wiley & Sons .

25CEC3202 - ADVANCED OPERATING SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3202	ADVANCED OPERATING SYSTEMS	AOS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply and design multiprocessors and distribute Operating Systems. Analyze distributed file system.	3	
CO2	Analyze the scheduling Real time and Parallel Applications on Heterogeneous Distributed Systems. Analyze three basic approaches for implementing distributed	4	
CO3	Analyze Deadlock detection in Distributed Systems. Understand Replication preventing and accepting divergence.	4	
CO4	Analyze the algorithms for Check pointing and rollback recovery, Consensus and agreement algorithms, and Failure detectors	4	

Syllabus

Types of Advanced Operating Systems, Problem of Multiprocessor Systems, Solutions with Master and Slave Processors, Solution with Semaphores. Distributed Unix Systems: Satellite Processors, The Newcastle Connection, Transparent Distributed File Systems

Scheduling: RTS, Reliability-Aware Fault-Tolerant Scheduling, Energy-Efficient Real-Time Scheduling, Scheduling Issues in load distributing, Components of load distributing algorithms, selecting a suitable load sharing Algorithm. Synchronization: Physical and logical clocks, Distributed Mutual Exclusion: Introduction, Classification of Mutual Exclusion algorithms

Distributed Deadlock: Introduction, deadlock handling strategies, Deadlock detection: Issues and resolution, Control Organizations, Centralized algorithms, Distributed algorithms, Hierarchical algorithms. Distributed Fault Handling: Agreement Protocol: System Model, Classification, Solution to Byzantine Agreement Problem, Partition tolerant consensus algorithms Paxos

Fault Recovery: Concepts, Classification of failures, Backward error recovery, 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, Voting protocols and Dynamic Voting Protocols. Distributed ledgers. Authentication in distributed systems, Blockchain, Decentralization, Symmetric and Public Key Cryptography.

Reference Books

- 1 Advanced concepts in operating systems, Mukesh Singhal, Niranjana G. Shivaratri, 7th, MC Graw Hill education.
- 2 Distributed Computing: Principles, Algorithms, and Systems, A.D. Kshemkalyani, M. Singhal, 2011, Cambridge University Press.
- 3 Modern Systems Principles and Paradigms, Andrew S.Tanenbaum,, 2, PHI.
- 4 Distributed Operating System Concepts and design., Pradeep K.Sinha, 1, PHI.
- 5 The design of the UNIX operating system, Maurice J.bach, 2nd, PHI.

25CEC3203 - FUNCTIONAL AND CONCURRENT PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3203	FUNCTIONAL AND 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	
CO2	Apply Functions and Lambdas on purely functional programs	3	
CO3	Apply Functional Infinite Data Structures and Monods	3	
CO4	Evaluate the functional design of concurrent systems	4	

Syllabus

Characteristics of Functional Programming Languages: The Basics of the Scala Language: Data Types, 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, 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

Reference Books

- 1 Scala From a Functional Programming Perspective_ An Introduction to the Programming Language, Vicen Torra , 2016, Springer.
- 2 Learning Concurrent Programming in Scala , Prokopec, Aleksandar , 2017, Packt Publishing.
- 3 Mastering Functional Programming: Functional techniques for sequential and parallel programming with Scala,, Anatolii Kmetiuk, 2018, Packt Publishing.
- 4 Scala for Data Science , Pascal Bugnion , 2016 , Packt Publishing.
- 5 Scala: Guide for Data Science , Pascal Bugnion, Arun Manivannan,, 2017 , Packt Publishing.
- 6 Learn Scala Programming , Slava Schmidt, 2018, Packet Publisher.

25CEC3204 - CLOUD DEVOPS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3204	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	
CO2	Inspect Configuration Management using Infrastructure as Code	4	
CO3	Analyze need of Containerization in SDLC and Examine the Kubernetes Pod Configuration.	4	
CO4	Analyze Continuous Integration and Continuous Deployment using Infrastructure as Code, Build in Cloud native Applications	4	

Syllabus

Networking Fundamentals: Network Fundamentals, Storage Fundamentals, Databases Fundamentals, Webserver (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

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, Hide to Saito, , Hui-Chuan Chloe Lee, Cheng-Yang,, 2019 , PACKT Publishing.
- 5 Complete DevOps Cookbook_ Build and manage your applications, orchestrate containers, and deploy cloud native services,, Murat Karslioglu, 2020, Packt Publishing.
- 6 Kubernetes A Complete DevOps Cookbook_ Build and manage your applications, orchestrate containers, and deploy cloud-native services, Murat Karslioglu, 2020, Packt Publishing.

25CEC3305 - CLOUD AND SERVERLESS COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3305	CLOUD AND SERVERLESS COMPUTING	CSC	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the foundation for cloud infrastructure	3	PO2, PO3
CO2	Analyze Virtualization, its levels, and some real time examples	4	PO3, PO4
CO3	Understand load balancing, container services and Kubernetes	4	PO1, PO4
CO4	Assess the security over the cloud through specific approaches	4	PO1, PO4
CO5	Construct with Cloud infrastructure, virtualization, Load balancing and authentication, and security services with hands on lab	4	PO2, PO3
CO6	Explore the Infrastructure related concepts as best practices	4	PO1, PO4

Syllabus

Introduction to Cloud Technologies Introduction to 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

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Zaigham Mahmood, Ricardo Puttini, Thomas Erl, 2013, Pearson.
- 2 Cloud Computing: Methodology, Systems, and Applications, Lizhe Wang, Rajiv Ranjan, Jinjun Chen, Boualem Benatallah, 2017, CRC Press.
- 3 Mastering Cloud Computing: Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, 2013, Morgan Kaufmann, Elsevier.
- 4 Cloud Computing Bible, Barrie Sosinsky, 2011, John Wiley & Sons.
- 5 Handbook of Cloud Computing, Borko Furht, Armando Escalante, 2010, Springer.

25CEC3305A - CLOUD AND SERVERLESS COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3305A	CLOUD AND SERVERLESS COMPUTING	CSC	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand advanced concepts of cloud computing serverless architecture and cloud native design principles	2	PO1, PO2, PO3, PO4, PO5, PSO1, PSO2
CO2	Analyze serverless platforms functions as a service event driven computing and cloud orchestration	4	PO1, PO2, PO3, PO4, PO5, PO6, PSO1, PSO2
CO3	Design and implement complex cloud native applications using serverless frameworks and cloud services	5	PO1, PO2, PO3, PO4, PO5, PO6, PSO1, PSO2
CO4	Evaluate scalability performance cost security and reliability of serverless applications in enterprise environments	6	PO1, PO2, PO3, PO4, PO5, PO6, PSO1, PSO2

Syllabus

Advanced Cloud Computing Concepts Deep dive into cloud models IaaS PaaS SaaS hybrid cloud multi cloud architectures cloud native design principles

Serverless Computing Platforms Advanced AWS Lambda Azure Functions Google Cloud Functions runtime environments triggers events integration with other cloud services

Monitoring Optimization and Security Logging monitoring observability cost optimization performance tuning security best practices and compliance in serverless deployments

Advanced Case Studies and Emerging Trends Real world enterprise serverless applications AI and IoT integration edge computing emerging trends and future directions

Reference Books

- 1 Serverless Architectures on AWS, Peter Sbarski, 1st, Manning Publications.
- 2 Cloud Computing Concepts Technology and Architecture, Thomas Erl, 1st, Prentice Hall.
- 3 Cloud Native Serverless Applications, John Arundel, 1st, O'Reilly.

25CEC3305E - CLOUD AND SERVERLESS COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3305E	CLOUD AND SERVERLESS COMPUTING	CSC	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of cloud computing serverless architecture and deployment models	2	PO1, PO2, PO3, PO4, PO5, PSO1, PSO2
CO2	Analyze serverless computing platforms functions as a service and event driven architectures	4	PO1, PO2, PO3, PO4, PO5, PO6, PSO1, PSO2
CO3	Design and implement cloud native applications using serverless frameworks and cloud services	5	PO1, PO2, PO3, PO4, PO5, PO6, PSO1, PSO2
CO4	Evaluate performance scalability security and cost efficiency of serverless applications in real scenarios	6	PO1, PO2, PO3, PO4, PO5, PO6, PSO1, PSO2

Syllabus

Introduction to Cloud and Serverless Computing Overview of cloud computing models SaaS PaaS IaaS comparison of cloud and traditional architectures basics of serverless computing and benefits

Serverless Platforms and Services AWS Lambda Azure Functions Google Cloud Functions runtime environments triggers events and integration with cloud services

Serverless Application Design Designing event driven applications microservices integration stateless computing data storage and API management

Deployment and Monitoring Deployment pipelines CI CD for serverless apps logging monitoring and observability using cloud native tools

Reference Books

- 1 Serverless Architectures on AWS, Peter Sbarski, 1st, Manning Publications.
- 2 Cloud Computing Concepts Technology and Architecture, Thomas Erl, 1st, Prentice Hall.
- 3 Serverless Computing Explained, Paul Johnston, 1st, Packt Publishing.

25CEC3406 - ADVANCED COMPUTER ARCHITECTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3406	ADVANCED COMPUTER ARCHITECTURE	ACA	R	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	PO1, PO2, PO3
CO2	Demonstrate an understanding of advanced pipelining techniques, including instruction-level parallelism (ILP) . and the concepts of superscalar execution.	2	PO1, 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	PO1, PO2
CO4	Analyze the performance of different computer architectures using metrics such as CPU performance, memory hierarchy, and system throughput.	4	PO1, PO3, PO5

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 Organization and Design: The Hardware/Software Interface. Morgan Kaufmann , David A. Patterson and John L. Hennessy,, 4th Edition .2011, Morgan Kaufmann.
- 3 Parallel Computer Architecture: A Hardware/Software Approach, David Culler, Jaswinder Pal Singh, and Anoop Gupta, 1st edition.2012, Elsevier.
- 4 Advanced Computer Architectures: A Design Space Approach, Sima D, Fountain T And Kacsuk P, 2000., Addison Wesley.

25CEC3407 - PARALLEL ALGORITHMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3407	PARALLEL ALGORITHMS	PA	R	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, PO3
CO2	Analyze and apply parallel algorithms for solving computational problems efficiently.	4	PO1, PO2, PO4
CO3	Evaluate the performance of parallel algorithms on different parallel architectures and environments	5	PO1, PO2, PO5
CO4	Summarize parallel algorithms using appropriate programming models and tools	3	PO3, PO4

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 Algorithms ., Henri Casanova, Arnaud Legrand, Yves Robert, 2008 , CRC Press..
- 3 Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers. , Barry Wilkinson, Michael Allen, 2005, Pearson..
- 4 Parallel Programming in C With MPI and OpenMP , Michael J. Quinn, 1st Edition (2003), McGraw-Hill Education.

25CEC3408 - CLOUD SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3408	CLOUD SECURITY	CS	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	PO1, PO4
CO2	Apply various security issues and system vulnerabilities in virtualization	3	PO2, PO6
CO3	Analyze the technologies for virtualization-based security enhancements	4	PO6, PO10
CO4	Implement legal & compliance issues and examine modern security standards	3	PO1, PO3

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, hyper jacking. 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, PCI DSS), 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 Mechanism1, Container Defense Mechanism2, SQL injection attacks in containers, Case Study SQL injection attacks in containers, malicious logs extraction.

Reference Books

- 1 Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz & Russell Dean Vines, 2010 , Wiley..
- 2 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance , Tim Mather, Subra Kumaraswamy, Shahed Latif, 2009, O'Reilly Media..
- 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, Packet Publishing.

25CEC3409 - ARCHITECTING CLOUD SOLUTIONS* (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3409	ARCHITECTING CLOUD SOLUTIONS*	ACS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design Resilient Architectures	3	PO1, PO2, PO3
CO2	Design High-Performing Architectures	3	PO1, PO2, PO4
CO3	Design Secure Applications and Architectures	3	PO2, PO3, PO4
CO4	Design Cost-Optimized Architectures, Designing solutions to the architecture of Cloud	3	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 Cloud Computing , Soumya Kanti Ghosh,, first edition, NPTEL.

25CEC3510 - EDGE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3510	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, PO3
CO2	Apply network slicing strategies with effective management techniques to optimize Resource allocation. Build network	3	PO2, PO3
CO3	Implement and evaluate middleware solutions for Fog and Edge Computing, Addressing security management.	4	PO1, PO3, PO4
CO4	Analyze the applicability and needs for Edge OR Fog Computing in various real time projects such as health monitoring, smart city management, and smart transportation	4	PO2, PO4, PO5

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 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, 2014, Springer. .

25CEC3511 - HIGH PERFORMANCE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3511	HIGH PERFORMANCE COMPUTING	HPC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand fundamental concepts of high performance computing parallel architectures and computing models	2	
CO2	Analyze performance of parallel algorithms and identify optimization opportunities	4	
CO3	Design and implement parallel programs using shared memory and distributed memory models	5	
CO4	Evaluate scalability fault tolerance and efficiency of HPC systems for real world applications	6	

Syllabus

Introduction to High Performance Computing: Overview of HPC need and applications supercomputers clusters grid computing types of parallelism Flynn taxonomy and performance metrics

Parallel Architectures and Programming Models: Shared memory architectures distributed memory architectures hybrid architectures parallel programming paradigms OpenMP MPI and GPU computing introduction

Performance Analysis and Optimization: Performance measurement profiling benchmarking load balancing memory hierarchy optimization techniques and algorithmic efficiency

HPC Applications and Case Studies: Scientific computing simulation modeling big data analytics machine learning and HPC applications in engineering finance and healthcare

Reference Books

- 1 Introduction to High Performance Computing, Hwang Feng, 1st, McGraw Hill.
- 2 Parallel Programming in C with MPI and OpenMP, Michael Quinn, 2nd, McGraw Hill.
- 3 GPU Computing Gems, Wen-mei Hwu, 1st, Morgan Kaufmann.

25CEC3512 - DESIGN OF DISTRIBUTED APPLICATIONS ON CLOUD (DDA) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3512	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	
CO2	Apply Distributed file systems and cache consistency	3	
CO3	Analyze Persistent cloud services, Failure models and failure detectors	4	
CO4	Analyze Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo	4	

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.

25CEC3513 - CLOUD NETWORKING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CEC3513	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	
CO2	Apply the basics and Identifying the architecture of Switch Fabric, Switch Fabric Topologies, Congestion Management, Flow Control and Traffic Management.	3	
CO3	Analyze the problems, and explain, analyze, and evaluate Ethernet Data Rate Standards, Virtual Local Area Networks, Data Center Bridging.	4	
CO4	Analyse Multi-tenant Environments, Traditional Network Tunneling Protocols, VXLAN, NVGRE, Tunnel Locations, Load Balancing Algorithms.	4	

Syllabus

Introduction to Cloud Networking: Networking Basics, The network stack, Packets and frames, Network equipment, Inter connect, 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.

25CID3101 - CLOUD INFRASTRUCTURE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3101	CLOUD INFRASTRUCTURE ENGINEERING	CIE	R	3	0	2	0	4

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	
CO2	Design and deploy scalable and resilient cloud architectures using virtualization, containerization, and cloud-native technologies.	3	
CO3	Utilize Infrastructure as Code (IaC) tools and best practices to automate the provisioning and management of cloud resources.	3	
CO4	Design and optimize cloud infrastructure for scalability, high availability, and cost efficiency.	3	
CO5	Monitor, troubleshoot, and optimize cloud infrastructure and applications using cloud native monitoring and logging tools	4	

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

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, Google Cloud Platform Team, 2018, Manning Publications.

25CID3101A - CLOUD INFRASTRUCTURE ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3101A	CLOUD INFRASTRUCTURE ENGINEERING	CIE	A	4	1	2	0	6

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	
CO2	Design and deploy scalable and resilient cloud architectures using virtualization, containerization, and cloud-native technologies.	3	
CO3	Utilize Infrastructure as Code (IaC) tools and best practices to automate the provisioning and management of cloud resources.	3	
CO4	Design and optimize cloud infrastructure for scalability, high availability, and cost efficiency.	3	
CO5	Monitor, troubleshoot, and optimize cloud infrastructure and applications using cloud native monitoring and logging tools	4	

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, Google Cloud Platform Team, 2018, Manning Publications.

25CID3101E - CLOUD INFRASTRUCTURE ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3101E	CLOUD INFRASTRUCTURE ENGINEERING	CIE	E	4	1	2	0	6

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	
CO2	Design and deploy scalable and resilient cloud architectures using virtualization, containerization, and cloud-native technologies.	3	
CO3	Utilize Infrastructure as Code (IaC) tools and best practices to automate the provisioning and management of cloud resources.	3	
CO4	Design and optimize cloud infrastructure for scalability, high availability, and cost efficiency.	3	
CO5	Monitor, troubleshoot, and optimize cloud infrastructure and applications using cloud native monitoring and logging tools	4	

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, Google Cloud Platform Team, 2018, Manning Publications.

25CID3202 - ENTERPRISE CLOUD COMPUTING: TECHNOLOGY, ARCHITECTURE, APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3202	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	
CO2	Analyze the evolution of Enterprise cloud computing	4	
CO3	Apply cloud-native principles and best practices in Devops	3	
CO4	Evaluate the Data encryption and compliance requirements related to ERP and CRM Applications	5	

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: A Hands-On Approach, Arshdeep Bahga and Vijay Madisetti, 2014, Arshdeep Bahga and Vijay Madisetti.
- 3 Cloud Computing: From Beginning to End, Ray J. Rafaels, revised, 2015, CreateSpace Independent Publishing Platform.

25CID3203 - ARCHITECTING HIGHLY AVAILABLE AND SCALABLE CLOUD ENVIRONMENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3203	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	
CO2	Design highly available and fault-tolerant cloud infrastructures	3	
CO3	Implement scalable solutions for handling variable workloads in the cloud	3	
CO4	Evaluate and Optimize the performance and cost-efficiency of cloud-based systems	5	

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 Application Architectures , George Reese , 2009, O'Reilly.
- 2 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, 2013, Prentice Hall.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 2014, Wiley.
- 4 Cloud Native Architectures: Design high-availability and cost-effective applications for the cloud, Tom Laszewski, Kamal Arora, and Erik Farr, 2018, Packt.
- 5 Scalability Rules: 50 Principles for Scaling Web Sites, Martin L. Abbott and Michael T. Fisher, 2011, Pearson.
- 6 Building Scalable Web Sites: Building, Scaling, and Optimizing the Next Generation of Web Applications, Cal Henderson , 2006, O'Reilly.
- 7 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 .

25CID3304 - CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3304	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	CIA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Cloud Computing Fundamentals	2	
CO2	Interpreting Cloud Infrastructure Components	2	
CO3	Designing Scalable and Resilient Cloud Architectures	3	
CO4	Applying Security and Compliance in the Cloud	3	
CO5	Automating Infrastructure Deployment and Management	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

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, 2013, Prentice Hall.
- 2 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison, Kris Nova, 2017, O'Reilly Media.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 2014, Wiley.
- 4 Practical Cloud Security A Guide for Secure Design and Deployment, Chris Dotson, 2nd edition, 2014, O'Reilly Media.
- 5 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, 2009, O'Reilly Media.
- 6 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej Goscinski, 2011, Wiley.

25CID3304A - CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3304A	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	CIA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Cloud Computing Fundamentals	2	
CO2	Interpreting Cloud Infrastructure Components	2	
CO3	Designing Scalable and Resilient Cloud Architectures	3	
CO4	Applying Security and Compliance in the Cloud	3	
CO5	Automating Infrastructure Deployment and Management	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

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, 2013, Prentice Hall..
- 2 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison, Kris Nova, 2017, O'Reilly Media.
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 2014, Wiley.
- 4 Practical Cloud Security A Guide for Secure Design and Deployment, Chris Dotson , 2nd Ed, 2024, O'Reilly Media .
- 5 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, 2009, O'Reilly Media.
- 6 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej Goscinski, 2011, Wiley.

25CID3304E - CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3304E	CLOUD INFRASTRUCTURE ARCHITECTURE AND ENGINEERING	CIA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Cloud Computing Fundamentals	2	
CO2	Interpreting Cloud Infrastructure Components	2	
CO3	Designing Scalable and Resilient Cloud Architectures	3	
CO4	Applying Security and Compliance in the Cloud	3	
CO5	Automating Infrastructure Deployment and Management	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

Reference Books

- 1 Cloud Computing: Concepts, Technology & Architecture, , Thomas Erl, Ricardo Puttini, Zaigham Mahmood, 2013, Prentice hall.
- 2 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison, Kris Nova, 2017, O'Reilly Media. .
- 3 Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Michael J. Kavis, 2014, Wiley.
- 4 Practical Cloud Security A Guide for Secure Design and Deployment, Chris Dotson , 2nd Ed, 2024, O'Reilly Media .
- 5 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, 2009, O'Reilly Media..
- 6 Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej Goscinski, 2011, Wiley.

25CID3405 - RELIABLE CLOUD INFRASTRUCTURE: DESIGN AND PROCESS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3405	RELIABLE CLOUD INFRASTRUCTURE: DESIGN AND PROCESS	RID	R	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	
CO2	Apply design patterns for building reliable and scalable cloud infrastructure on GCP.	3	
CO3	Apply the Design patterns to practical scenarios by designing and implementing secure, highly available, and cost-effective cloud deployments on GCP	3	
CO4	Analyze the trade-offs between different design choices considering factors like cost, performance, and security.	4	

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

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.
- 5 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.

25CID3406 - HYBRID CLOUD INTEGRATION AND MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3406	HYBRID CLOUD INTEGRATION AND MANAGEMENT	HCIM	R	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 advantage	2	
CO2	Apply different hybrid cloud deployment models and their suitability for various organizational needs	3	
CO3	Identify hybrid cloud monitoring and management tools, including cloud management platforms (CMPs) for monitoring cloud solutions	3	
CO4	Analyze the security risks and compliance issues associated with hybrid cloud environments and develop mitigation strategies.	4	

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.

25CID3507 - CLOUD ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3507	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	
CO2	Understand the fundamentals of cloud, cloud Architectures and types of services in cloud	2	
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	

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, one drive, drop box. 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.

25CID3508 - CLOUD DATA MANAGEMENT AND STORAGE SOLUTIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CID3508	CLOUD DATA MANAGEMENT AND STORAGE SOLUTIONS	CDMSS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain cloud storage concepts architectures and types of cloud data solutions	2	
CO2	Compare and evaluate different cloud storage systems and data management techniques	4	
CO3	Develop and implement cloud based storage solutions for enterprise applications	5	
CO4	Assess cloud data performance reliability security and compliance for real world use cases	6	

Syllabus

Introduction to Cloud Data Management: Overview of cloud computing models SaaS PaaS IaaS cloud storage concepts and deployment architectures

Cloud Storage Systems: Object storage block storage and file storage architectures cloud storage providers comparison AWS S3 Azure Blob Google Cloud Storage

Data Management Techniques: Data replication backup and recovery consistency and availability models metadata management and indexing techniques

Cloud Storage Security and Compliance: Security challenges encryption access control data privacy compliance standards and disaster recovery strategies

Reference Books

- 1 Cloud Data Management and Storage Solutions, Divyakant Agrawal, 1st, Springer.
- 2 Cloud Storage Concepts and Architecture, Thomas Erl, 1st, Prentice Hall.
- 3 Big Data and Cloud Storage, Rajkumar Buyya, 2nd, McGraw Hill.

25CND3101 - CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CND3101	CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION	CNAD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Helm to package Kubernetes manifests and manage multi environment deployments for a microservices app	3	PO1
CO2	Configure progressive delivery strategies blue green canary with probes rollout strategies and automated rollbacks	4	PO4
CO3	Build a complete CI CD pipeline integrating build test image scan Helm deploy and environment promotion	4	PO3
CO4	Architect external exposure using Ingress or API Gateway rate limiting and TLS and justify trade offs for scale and resilience	5	PO5

Syllabus

Helm fundamentals charts templates values yaml Chart yaml directory structure variable injection conditional templates chart dependencies Helm repos chart versioning managing dev stage prod overlays secret and config templating Helm linting and dry run upgrade rollback

Deployment strategies blue green canary rolling updates Kubernetes readiness liveness probes traffic splitting NGINX Ingress service mesh basics automated rollbacks kubectl rollout undo Helm atomic health testing PodDisruptionBudgets surge unavailable configurations

Pipeline design for microservices GitLab CI Jenkins GitHub Actions build test scan push deploy integrating image scans Trivy Helm deploy automation environment promotion dev staging prod secrets management vault basic GitOps Argo CD FluxCD

Ingress controllers NGINX Traefik TLS termination cert manager API Gateway rate limiting quotas JWT validation external DNS service discovery mTLS overview high availability gateway cost performance trade offs L4 L7 load balancing

Reference Books

- 1 Terraform: Up & Running, Yevgeniy Brikman, 3rd Edition, O'Reilly Media.
- 2 Serverless Architectures on AWS, Peter Sbarski, 2023, Manning Publications.
- 3 Architecting for Scale, Lee Atchison, 2020, O'Reilly Media.

25CND3101A - CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CND3101A	CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION	CNAD	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Helm to package Kubernetes manifests and manage multi environment deployments for a microservices app	3	PO1
CO2	Configure progressive delivery strategies blue green canary with probes rollout strategies and automated rollbacks	4	PO3
CO3	Build and automate CI CD pipelines integrating build test image scan Helm deploy and environment promotion	4	PO3
CO4	Implement GitOps and security practices for Kubernetes environments including vault integration Argo CD and FluxCD	5	PO2
CO5	Architect external exposure using Ingress API Gateway rate limiting and TLS and justify trade offs for scale and resilience	5	PO4

Syllabus

Helm fundamentals charts templates values yaml Chart yaml directory structure variable injection conditional templates chart dependencies Helm repos chart versioning managing dev stage prod overlays secret and config templating Helm linting and dry run upgrade rollback

Deployment strategies blue green canary rolling updates Kubernetes readiness liveness probes traffic splitting NGINX Ingress service mesh basics automated rollbacks kubectl rollout undo Helm atomic health testing PodDisruptionBudgets surge unavailable configurations

Pipeline design for microservices GitLab CI Jenkins GitHub Actions build test scan push deploy integrating image scans Trivy Helm deploy automation environment promotion dev staging prod

GitOps workflow using Argo CD FluxCD secrets management vault integration secure pipelines compliance observability automated testing integration deployment rollback strategies

Ingress controllers NGINX Traefik TLS termination cert manager API Gateway rate limiting quotas JWT validation external DNS service discovery mTLS overview high availability gateway cost performance trade offs L4 L7 load balancing

Reference Books

- 1 Architecting for Scale, Lee Atchison, 2020, O'Reilly Media.
- 2 Designing Data-Intensive Applications, Martin Kleppmann, 2017, O'Reilly Media.
- 3 Cloud Native Patterns, Cornelia Davis, 2019, Manning Publications.

25CND3101E - CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CND3101E	CLOUD-NATIVE APPLICATION DEVELOPMENT & CONTAINER ORCHESTRATION	CNAD	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Helm to package Kubernetes manifests and manage multi environment deployments for a microservices app	3	PO1
CO2	Configure progressive delivery strategies blue green canary with probes rollout strategies and automated rollbacks	4	PO3
CO3	Build and automate CI CD pipelines integrating build test image scan Helm deploy and environment promotion	4	PO3
CO4	Implement GitOps and security practices for Kubernetes environments including vault integration Argo CD and FluxCD	5	PO4
CO5	Architect external exposure using Ingress API Gateway rate limiting and TLS and justify trade offs for scale and resilience	5	PO4

Syllabus

Helm fundamentals charts templates values yaml Chart yaml directory structure variable injection conditional templates chart dependencies Helm repos chart versioning managing dev stage prod overlays secret and config templating Helm linting and dry run upgrade rollback

Deployment strategies blue green canary rolling updates Kubernetes readiness liveness probes traffic splitting NGINX Ingress service mesh basics automated rollbacks kubectl rollout undo Helm atomic health testing PodDisruptionBudgets surge unavailable configurations

Pipeline design for microservices GitLab CI Jenkins GitHub Actions build test scan push deploy integrating image scans Trivy Helm deploy automation environment promotion dev staging prod

GitOps workflow using Argo CD FluxCD secrets management vault integration secure pipelines compliance observability automated testing integration deployment rollback strategies

Ingress controllers NGINX Traefik TLS termination cert manager API Gateway rate limiting quotas JWT validation external DNS service discovery mTLS overview high availability gateway cost performance trade offs L4 L7 load balancing

Reference Books

- 1 Architecting for Scale, Lee Atchison, 2020, O'Reilly Media.
- 2 Designing Data-Intensive Applications, Martin Kleppmann, 2017, O'Reilly Media.
- 3 Cloud Native Patterns, Cornelia Davis, 2019, Manning Publications.

25CND3202 - CLOUD-NATIVE ARCHITECTURE & INFRASTRUCTURE AS CODE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CND3202	CLOUD-NATIVE ARCHITECTURE & INFRASTRUCTURE AS CODE	CNAI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply cloud native architectural patterns resilience scalability fault tolerance to design a distributed application	3	
CO2	Provision core cloud infrastructure using Infrastructure as Code Terraform or CloudFormation for a secure and scalable Kubernetes environment	4	
CO3	Implement event driven serverless components and integrate them with a cloud native microservices application	4	
CO4	Design a multi AZ or region resilient architecture with disaster recovery DR and evaluate trade offs in cost performance and reliability	5	

Syllabus

Principles of cloud native architecture decomposition strategies domain driven design bounded contexts resilience patterns circuit breaker bulkhead retry backoff scalability patterns sharding partitioning fault tolerance approaches service mesh basics for traffic control data management strategies CQRS eventual consistency

IaC concepts and benefits Terraform basics providers resources state management backends writing reusable modules provisioning VPC VNet subnets security groups managed Kubernetes EKS AKS GKE CloudFormation basics for AWS native IaC tagging and policy enforcement integrating IaC with CI CD pipelines

Event driven concepts and advantages event sources and sinks AWS SNS SQS Azure Service Bus GCP Pub Sub serverless computing basics AWS Lambda Azure Functions Google Cloud Functions integrating serverless with K8s microservices idempotency retries and event schema design

Understanding availability zones and regions designing active active and active passive topologies DR objectives RTO RPO automated failover patterns cross region replication for storage and databases backup strategies point in time restore snapshotting cost optimization for HA DR setups compliance considerations GDPR HIPAA

Reference Books

- 1 Cloud Native Patterns, Cornelia Davis, 2019, Manning Publications.
- 2 Terraform: Up Running, Yevgeniy Brikman, 2022, O'Reilly Media.
- 3 Designing Data-Intensive Applications, Martin Kleppmann, 2017, O'Reilly Media.

25CND3303 - ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CND3303	ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING	DORS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply infrastructure automation, configuration management, and policy-as-code to maintain consistent cloud-native environments.	3	PO1
CO2	Analyze CI CD pipelines to incorporate automated testing, quality gates, and secure software supply chain practices.	4	PO2
CO3	Implement distributed observability metrics, logs, traces for a multi-service Kubernetes deployment.	4	PO2
CO4	Evaluate and improve application reliability using SLOs, SLIs, error budgets, and chaos engineering experiments.	5	PO4

Syllabus

Infrastructure automation recap configuration management with Ansible and Pulumi managing secrets across environments policy as code with Open Policy Agent OPA GitOps for infra changes drift detection automated compliance scans

Pipeline optimization techniques parallelism caching matrix builds integrating static analysis SonarQube dependency scanning and container image signing cosign software bill of materials SBOM validation deployment promotion strategies automated rollback triggers canary pipeline integration

Metrics logs traces triad instrumentation with OpenTelemetry Prometheus data model and queries Grafana dashboards distributed tracing with Jaeger or Tempo log aggregation with ELK or EFK stack alerting rules and notification channel

SRE principles defining SLOs SLIs and error budgets incident response playbooks chaos engineering with LitmusChaos or Gremlin fault injection pod kill network latency analyzing results and iterating for higher resilience

Reference Books

- 1 Site Reliability Engineering, Niall Richard Murphy et al., 2016, O'Reilly Media.
- 2 Seeking SRE, David N. Blank-Edelman, 2018, O'Reilly Media.
- 3 Kubernetes Native Microservices with Quarkus and MicroProfile, John Clingan, Ken Finnigan, 2020, Packt Publishing.

25CND3303A - ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CND3303A	ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING	DORS	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply infrastructure automation configuration management and policy as code to maintain consistent cloud native environments	3	PO1
CO2	Analyze CI CD pipelines to incorporate automated testing quality gates and secure software supply chain practices	4	PO2
CO3	Implement observability practices including metrics logs and traces for cloud native microservices	4	PO2
CO4	Design distributed tracing and alerting systems to proactively identify bottlenecks and failures	4	PO3
CO5	Evaluate and improve application reliability using SLOs SLIs error budgets and chaos engineering experiments	5	PO3

Syllabus

Infrastructure automation recap configuration management with Ansible and Pulumi managing secrets across environments policy as code with Open Policy Agent OPA GitOps for infra changes drift detection automated compliance scans

Pipeline optimization techniques parallelism caching matrix builds integrating static analysis SonarQube dependency scanning and container image signing cosign software bill of materials SBOM validation deployment promotion strategies automated rollback triggers canary pipeline integration

Metrics logs traces triad instrumentation with OpenTelemetry Prometheus data model and queries Grafana dashboards basics of service level indicators and monitoring integrations

Distributed tracing with Jaeger or Tempo log aggregation with ELK or EFK stack advanced alerting rules and notification channels proactive monitoring for failure prediction

SRE principles defining SLOs SLIs and error budgets incident response playbooks chaos engineering with LitmusChaos or Gremlin fault injection pod kill network latency analyzing results and iterating for higher resilience

Reference Books

- 1 Site Reliability Engineering, Niall Richard Murphy et al., 2016, O'Reilly Media.
- 2 Seeking SRE, David N. Blank-Edelman, 2018, O'Reilly Media.
- 3 Observability Engineering, Charity Majors, Liz Fong Jones, George Miranda, 2022, O'Reilly Media.

25CND3303E - ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CND3303E	ADVANCED DEVOPS, OBSERVABILITY & RELIABILITY ENGINEERING	DORS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply infrastructure automation configuration management and policy as code to maintain consistent cloud native environments	3	PO1
CO2	Analyze CI CD pipelines to incorporate automated testing quality gates and secure software supply chain practices	4	PO2
CO3	Implement observability practices including metrics logs and traces for cloud native microservices	4	PO2
CO4	Design distributed tracing and alerting systems to proactively identify bottlenecks and failures	4	PO3
CO5	Evaluate and improve application reliability using SLOs SLIs error budgets and chaos engineering experiments	5	PO3

Syllabus

Infrastructure automation recap configuration management with Ansible and Pulumi managing secrets across environments policy as code with Open Policy Agent OPA GitOps for infra changes drift detection automated compliance scans

Pipeline optimization techniques parallelism caching matrix builds integrating static analysis SonarQube dependency scanning and container image signing cosign software bill of materials SBOM validation deployment promotion strategies automated rollback triggers canary pipeline integration

Metrics logs traces triad instrumentation with OpenTelemetry Prometheus data model and queries Grafana dashboards basics of service level indicators and monitoring integrations

Distributed tracing with Jaeger or Tempo log aggregation with ELK or EFK stack advanced alerting rules and notification channels proactive monitoring for failure prediction

SRE principles defining SLOs SLIs and error budgets incident response playbooks chaos engineering with LitmusChaos or Gremlin fault injection pod kill network latency analyzing results and iterating for higher resilience

Reference Books

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- 2 Seeking SRE, David N. Blank-Edelman, 2018, O'Reilly Media.
- 3 Observability Engineering, Charity Majors, Liz Fong Jones, George Miranda, 2022, O'Reilly Media.

25CND3404 - CLOUD-NATIVE MLOPS & A1-DRIVEN APPLICATION DEPLOYMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CND3404	CLOUD-NATIVE MLOPS & A1-DRIVEN APPLICATION DEPLOYMENT	CNMA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply containerization and orchestration principles to package and deploy ML models in a cloud-native environment.	3	PO1
CO2	Analyze and implement continuous training CT, continuous integration CI, and continuous delivery CD pipelines for ML workflows.	4	PO2
CO3	Deploy and monitor ML models using specialized MLOps frameworks and cloud-native observability tools.	4	PO3
CO4	Evaluate trade-offs between performance, cost, and accuracy for ML model deployment strategies in cloud-native systems.	5	PO3

Syllabus

Packaging ML models into Docker images dependency management conda, pipenv GPU-enabled container builds K8s deployments for inference services; scaling ML workloads with K8s HPA; integrating model APIs into existing microservices.

Overview of MLOps lifecycle CI CD adaptation for ML data validation, model validation continuous training triggers using GitHub Actions, Jenkins, or GitLab CI for ML pipelines integrating DVC Data Version Control for dataset management; model registry usage MLflow, SageMaker Model Registry.

Serving models with TensorFlow Serving, TorchServe, BentoML, or KFServing; setting up model monitoring with Prometheus metrics drift detection; A/B testing of models logging predictions and inference times; alerting on performance degradation.

Batch vs. real-time inference trade-offs cost-performance tuning CPU GPU autoscaling; quantization and pruning for performance spot instance usage multi-cloud deployment considerations ethical AI and governance compliance in deployment.

Reference Books

- 1 Practical MLOps, Noah Gift, Alfredo Deza, 2021, O'Reilly Media.
- 2 Kubernetes for Machine Learning, Andrei Torgashov, 2021, Packt Publishing.
- 3 Designing Machine Learning Systems, Chip Huyen, 2022, O'Reilly Media.

25CND3505 - HIGH-PERFORMANCE & SECURE CLOUD-NATIVE SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CND3505	HIGH-PERFORMANCE & SECURE CLOUD-NATIVE SYSTEMS	HPCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply performance profiling tools to identify bottlenecks in cloud-native applications.	3	PO1
CO2	Analyze and implement caching, concurrency, and load balancing strategies to improve scalability.	4	PO2
CO3	Design and implement security controls for containerized and microservices-based architectures.	4	PO3
CO4	Evaluate trade-offs between performance, cost, and security in production deployments and propose optimization strategies.	5	PO4

Syllabus

Fundamentals of performance testing load and stress testing concepts profiling applications using k6, Apache JMeter, and Kubernetes metrics; identifying CPU, memory, and I O bottlenecks; analyzing pod resource usage optimizing request/response cycles.

Horizontal and vertical scaling in Kubernetes caching strategies Redis, Memcached, CDN tuning optimizing concurrency in services API rate limiting advanced load balancing with Ingress, service mesh, and global load balancers; database optimization techniques indexing, query optimization

Zero-trust architecture for microservices container security best practices image scanning, signing Kubernetes RBAC, PodSecurityPolicy, and NetworkPolicy secrets management with Vault and KMS supply chain security; runtime protection with Falco security observability integration.

Cost-performance-security trade-offs autoscaling policies based on budgets FinOps basics regulatory compliance impacts on performance penetration testing for cloud-native apps security-performance balancing in multi-cloud/hybrid deployments.

Reference Books

- 1 Cloud Native Security, Chris Binnie, 2021, Packt Publishing.
- 2 Web Performance in Action, Jeremy Wagner, Manning Publications, 2016.
- 3 High Performance Browser Networking, Ilya Grigorik, 2013, O'Reilly Media.

25CNE3101 - FOUNDATIONS OF CLOUD NATIVE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3101	FOUNDATIONS OF CLOUD NATIVE COMPUTING	FCNC	R	3	0	2	0	4

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, PO2
CO2	Design and deploy scalable and resilient cloud architectures using virtualization, containerization, and cloud-native technologies.	3	PO1, PO2
CO3	Utilize Infrastructure as Code (IaC) tools and best practices to automate the provisioning and management of cloud resources.	3	PO1, PO2
CO4	Design and optimize cloud infrastructure for scalability, high availability, and cost efficiency.	3	PO2, PO4
CO5	Monitor, troubleshoot, and optimize cloud infrastructure and applications using cloud native monitoring and logging tools	4	PO2, PO7

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

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.

25CNE3101A - FOUNDATIONS OF CLOUD NATIVE COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3101A	FOUNDATIONS OF CLOUD NATIVE COMPUTING	FCNC	A	4	1	2	0	6

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, PO2
CO2	Design and deploy scalable and resilient cloud architectures using virtualization, containerization, and cloud-native technologies.	3	PO1, PO2
CO3	Utilize Infrastructure as Code (IaC) tools and best practices to automate the provisioning and management of cloud resources.	3	PO1, PO2
CO4	Design and optimize cloud infrastructure for scalability, high availability, and cost efficiency.	3	PO2, PO4
CO5	Monitor, troubleshoot, and optimize cloud infrastructure and applications using cloud native monitoring and logging tools	4	PO2, PO7

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

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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, Joe Beda, 2017, O Reilly Media.
- 5 Terraform: Up & Running, Yevgeniy Brikman, 2017, O Reilly Media.

25CNE3101E - FOUNDATIONS OF CLOUD NATIVE COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3101E	FOUNDATIONS OF CLOUD NATIVE COMPUTING	FCNC	E	4	1	2	0	6

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, PO2
CO2	Design and deploy scalable and resilient cloud architectures using virtualization, containerization, and cloud-native technologies.	4	PO1, PO2
CO3	Utilize Infrastructure as Code (IaC) tools and best practices to automate the provisioning and management of cloud resources.	3	PO1, PO2
CO4	Design and optimize cloud infrastructure for scalability, high availability, and cost efficiency.	3	PO2, PO4
CO5	Monitor, troubleshoot, and optimize cloud infrastructure and applications using cloud native monitoring and logging tools	4	PO2, PO7

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 Gorner, Google Cloud Platform Team, 2018, Manning Publications.
- 4 Kubernetes: Up and Running, Kelsey Hightower, Brendan Burns, Joe Beda, 2017, O'Reilly Media.
- 5 Terraform: Up & Running, Yevgeniy Brikman, 2017, O'Reilly Media.

25CNE3202 - CLOUD NATIVE APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3202	CLOUD NATIVE APPLICATION DEVELOPMENT	CNAD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Getting Started with IBM Cloud	3	PO3, PO4
CO2	IBM Cloud CLI and Tools	4	PO3, PO4
CO3	DevOps on IBM Cloud	4	PO3, PO4
CO4	REST Architecture and Watson APIs	4	PO3, PO4

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.

Reference Books

- 1 Essentials of Application Development on IBM Cloud, IBM, 1st Edition, IBM.
- 2 IBM Cloud Private Application Developer's Guide, Ahmed Azraq, 1st Edition, Apple.
- 3 Essentials of Application Development on IBM Cloud, IBM, 1st Edition, IBM.
- 4 IBM Cloud: A Complete Guide, IBM, 2019 Edition, IBM.

25CNE3203 - CLOUD NATIVE DESIGN PROCESS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3203	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
CO2	Analyse the Proficiency in cloud Native Technologies	4	PO1, PO9
CO3	Implement the Cloud Native Applications	4	PO1, PO4
CO4	Understanding of Devops and Continuous Delivery	2	PO4, PO9

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, First Edition, May 2019, Manning Publications.
- 2 Kubernetes Patterns: Reusable Elements for Designing Cloud-Native Applications, Bilgin Ibryam, Roland Hu?, First Edition, April 2019, O'Reilly Media.
- 3 Cloud Native Transformation: Practical Patterns for Innovation, Pini Reznik, Jamie Dobson, Michelle Gienow, First Edition, January 2020, O'Reilly Media.

25CNE3304 - SOFTWARE ENGINEERING FOR CLOUD COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3304	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	SEC	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Organize core concepts of cloud computing, including its history, characteristics, advantages, and challenges.	3	PO1, PO2
CO2	Identify the different cloud service models (IaaS, PaaS, SaaS) and discuss their suitability for various applications.	3	PO2, PO3
CO3	Analyze and apply cloud programming models to develop software solutions on the cloud.	4	PO2, PO3
CO4	Compare security risks in cloud computing environments and implement appropriate security measures.	4	PO2, PO4
CO5	Determine cloud platforms and services from major providers such as AWS, Azure, and Google Cloud,	5	
CO6	Compare software applications that leverage cloud resources for scalability, elasticity, and fault tolerance.	5	PO4, PO5
CO7	Distinguish various cloud infrastructures based on managing load balancing using cloud provider tools and APIs.	5	PO1, PO4

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

Reference Books

- 1 Cloud Native: Using Containers, Functions, and Data to Build Next-Generation Applications, Boris Scholl, Trent Swanson, Peter Jausovec, 2009, TMH.
- 2 The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations, Gene Kim, Patrick Debois, John Willis, Jez Humble, 2016, IT Revolution.

25CNE3304A - SOFTWARE ENGINEERING FOR CLOUD COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3304A	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	SEC	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Organize core concepts of cloud computing, including its history, characteristics, advantages, and challenges.	3	PO1, PO2
CO2	Identify the different cloud service models (IaaS, PaaS, SaaS) and discuss their suitability for various applications.	3	PO2, PO3
CO3	Analyze and apply cloud programming models to develop software solutions on the cloud.	4	PO2, PO3
CO4	Compare security risks in cloud computing environments and implement appropriate security measures.	4	PO2, PO4
CO5	Determine cloud platforms and services from major providers such as AWS, Azure, and Google Cloud,	5	
CO6	Compare software applications that leverage cloud resources for scalability, elasticity, and fault tolerance.	5	PO4, PO5
CO7	Distinguish various cloud infrastructures based on managing load balancing using cloud provider tools and APIs.	5	PO1, PO4

Syllabus

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- 2 The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations, Gene Kim, Patrick Debois, John Willis, Jez Humble, 2016, IT Revolution.

25CNE3304E - SOFTWARE ENGINEERING FOR CLOUD COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3304E	SOFTWARE ENGINEERING FOR CLOUD COMPUTING	SEC	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Organize core concepts of cloud computing, including its history, characteristics, advantages, and challenges.	3	PO1, PO2
CO2	Identify the different cloud service models (IaaS, PaaS, SaaS) and discuss their suitability for various applications.	3	PO2, PO3
CO3	Analyze and apply cloud programming models to develop software solutions on the cloud.	4	PO2, PO3
CO4	Compare security risks in cloud computing environments and implement appropriate security measures.	4	PO2
CO5	Determine cloud platforms and services from major providers such as AWS, Azure, and Google Cloud,	5	
CO6	Compare software applications that leverage cloud resources for scalability, elasticity, and fault tolerance	5	PO2, PO6
CO7	Distinguish various cloud infrastructures based on managing load balancing using cloud provider tools and APIs.	5	PO1, PO6

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)

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Reference Books

- 1 Cloud Native: Using Containers, Functions, and Data to Build Next-Generation Applications, Boris Scholl, Trent Swanson, Peter Jausovec, 2009, TMH.
- 2 The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations, Gene Kim, Patrick Debois, John Willis, Jez Humble, 2016, IT Revolution.

25CNE3405 - SERVERLESS COMPUTING AND EVENT-DRIVEN ARCHITECTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3405	SERVERLESS COMPUTING AND EVENT-DRIVEN ARCHITECTURES	SCEDA	R	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	PO1, PO2, PO4
CO2	Build Functions-as-a-Service (FaaS) and Event-driven programming. Evaluate the steps involved in developing scalable models using Serverless Architectures	3	PO1, PO3, PO5
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	4	PO4, PO5, PO6
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	4	PO4, PO6, PO7

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 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl et al., First Edition, 2013, Pearson.
- 2 Serverless Architectures on AWS, Peter Sbarski, First Edition, 2017, Manning.
- 3 AWS Certified Solutions Architect Study Guide, Ben Piper, Second Edition, 2019, Wiley.
- 4 Serverless Design Patterns and Best Practices: Build, Secure, and Deploy Enterprise-ready Serverless Applications with AWS Lambda, Brian Zambrano, 2023, Packt Publishing.

25CNE3406 - CLOUD NATIVE SOFTWARE ARCHITECTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3406	CLOUD NATIVE SOFTWARE ARCHITECTURES	CNSA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding of Cloud-Native Concepts	2	PO1, PO2, PO4
CO2	Proficiency in Cloud-Native Tools and Technologies	3	PO1, PO3, PO4
CO3	Ability to Design and Implement Cloud-Native Solutions	4	PO2, PO3, PO4
CO4	Critical Analysis of Cloud-Native Architectures	4	PO2, PO3, PO5

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 Native Patterns: Designing Change-Tolerant Software, Cornelia Davis, 1st Edition, Manning Publications.
- 2 Kubernetes: Up and Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, Joe Beda, 3rd Edition (or latest), O'Reilly Media.
- 3 Building Microservices: Designing Fine-Grained Systems, Sam Newman, 2nd Edition (2021), O'Reilly Media.
- 4 The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations, Gene Kim, Patrick Debois, John Willis, Jez Humble, 2nd Edition (2021), IT Revolution Press.
- 5 Kubernetes: Up and Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, Joe Beda, 1st Edition (2017), O'Reilly Media.
- 6 Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Jez Humble, David Farley, 1st Edition (2010), Addison-Wesley.
- 7 Infrastructure as Code: Dynamic Systems for the Cloud Age, Kief Morris, 2nd Edition (2020), O'Reilly Media.
- 8 Building Microservices: Designing Fine-Grained Systems, Sam Newman, 1st Edition (2015), O'Reilly Media.
- 9 Cloud Native Infrastructure: Patterns for Scalable Infrastructure and Applications in a Dynamic Environment, Justin Garrison, Kris Nova, 1st Edition (2017), O'Reilly Media.
- 10 Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Jez Humble, David Farley, 1st Edition (2010), Addison-Wesley.

25CNE3507 - CLOUD NATIVE NETWORKING AND STORAGE SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3507	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
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, PO5
CO3	Identify problems, and explain, analyze, and evaluate Ethernet Data Rate Standards, Virtual Local Area Networks, Data Center Bridging	3	PO1, PO2, PO5
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, PO5

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 Native Architecture and Design: A Handbook for Modern-Day Architecture and Design with Enterprise-Grade Examples, Goniwada S R, 1st Edition (2022), Apress.
- 2 Cloud Networking: Understanding Cloud-Based Data Center Networks, Gary Lee, 1st Edition (2014), Elsevier.
- 3 Cloud Native Data Center Networking: Architecture, Protocols, and Tools, Dinesh Dutt, 1st Edition, Shroff O'Reilly.
- 4 Cloud Networking: Understanding Cloud-Based Data Center Networks, Gary Lee, 1st Edition (2014) E, Elsevier.
- 5 Storage Systems: Organization, Performance, Coding, Reliability, and Their Data Processing, Alexander Thomasian, 1st Edition, Morgan Kaufmann.
- 6 Cloud Native Data Center Networking: Architecture, Protocols, and Tools, Dinesh Dutt, 1st Edition, Shroff o'Reilly.

25CNE3508 - CLOUD INFRASTRUCTURE AND VIRTUALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNE3508	CLOUD INFRASTRUCTURE AND VIRTUALIZATION	CIAV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Hypervisor and Virtualization. Analyze Virtualization on IT Assets and Resource Management in Cloud.	4	PO2, PO3, PO4
CO2	Building virtual infrastructure consisting of computers and networking	3	PO2, PO3, PO4
CO3	Adding Scalability and Elasticity to the Infrastructure	3	PO2, PO3, PO4
CO4	Apply Tools and techniques for infrastructure deployment	3	PO2, PO3, PO4
CO5	Hands-On Cloud Administration. Implement, monitor, and manage important cloud services and components including IaaS.	4	PO4

Syllabus

Introduction to Hypervisor: Types of hypervisors, Choosing the right hypervisor, Hypervisor Reference Model. Introduction to Virtualization: How does virtualization work, Virtualization structures/tools and mechanisms, Types of virtualization, Virtualization support and disaster recovery. Virtualization on IT Assets: Virtualization on compute, Virtualization on storage, Virtualization on network, Virtualization on desktop, user state, and application. Resource Management in Cloud: Virtual clusters and resource management, Resource provisioning and resource provisioning methods Transit Gateway using AWS Console, Terraform. Using AWS CloudFormation to start a virtual machine. Scalable Compute Capacity in the Cloud via EC2: Setting up EC2 instances, Creating an AWS billing alarms, AMI, EBS Volumes..

Cloud Service Models: Infrastructure as a Service (IaaS). Exploring Amazon Web Services, Interacting with AWS, A simple example: WordPress in 15 minutes, Creating your infrastructure, Exploring your infrastructure, Deleting your infrastructure, Using virtual machines EC2: Exploring a virtual machine, Monitoring and debugging a virtual machine, Starting a virtual machine in another data center, Allocating a public IP address, Adding an additional network interface to a virtual machine, Controlling network traffic to and from your virtual machine. Creating a Data Center in the Cloud Using VPC: Creating a private network in the cloud: Amazon Virtual Private Cloud (VPC). Setting up two VPCs, Creating AWS

Increasing an Application's Fault Tolerance with Elastic Load Balancing: Different load balancers offered by AWS, Setting up the application load balancer, Automating the application load balancer using Terraform. Increasing Application Performance Using AWS Auto Scaling: Understanding Auto Scaling policies, creating a launch template and AWS Auto Scaling group, Creating, Verifying and Testing an Auto Scaling group, Scaling an application based on demand. Creating a Relational Database in the Cloud using AWS Relational Database Service (RDS): The different database offerings in AWS RDS, Setting up AWS RDS in high availability mode, Setting up a MySQL read replica, Automating AWS RDS MySQL creation using Terraform

The challenges of managing infrastructure manually, Basic Infrastructure as Code project, Imperative approach, Deployment types, writing the code and deploying our infrastructure, performing Ansible, Terraform, An HCL example creating a resource group, deployment tasks, cloud init, preparing our cloud environment for deployment, Producing the low level design, Ansible playbook roles, Running the Ansible playbook, Walk through of Terraform files, Deploying the environment, Automating deployment, In place deployment with AWS CodeDeploy, Rolling update with AWS CloudFormation and user data

Reference Books

- 1 Amazon Web Services in Action: An In-Depth Guide to AWS, Andreas Wittig, Michael Wittig, 2023, Manning Publications.

- 2 Mastering AWS CloudFormation: Plan, Develop, and Deploy Your Cloud Infrastructure Effectively Using AWS CloudFormation, Karen Tovmasyan., 2023, Packt Publishing.
- 3 Infrastructure as Code for Beginners: Deploy and Manage Your Cloud-Based Services with Terraform and Ansible, Russ McKendrick, 2023, Packt Publishing.
- 4 Building Cloud and Virtualization Infrastructure: A Hands-on Approach to Virtualization and Implementation, Mrs. Lavanya S, Dr. Venkatachalam K, Dr. Saravanakumar N M, 2021, BPB Publications.
- 5 Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud, Mark Wilkins, 2019, Addison-Wesley Professional.
- 6 The Definitive Guide to AWS Infrastructure Automation: Craft Infrastructure-as-Code Solutions, Bradley Campbell, 2020, Apress.
- 7 AWS for System Administrators, Prashant Lakhera, 2021, Packt Publishing.
- 8 AWS SysOps Cookbook: Practical Recipes to Build, Automate, and Manage Your AWS-Based Cloud Environments, Lucas Chan, Rowan Udell, Eric Z. Beard, 2019, Packt Publishing.

25CNS3101 - INTRODUCTION TO CLOUD NATIVE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3101	INTRODUCTION TO CLOUD NATIVE COMPUTING	ITCNC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of cloud native computing architecture and its advantages over traditional systems	2	
CO2	Analyze containerization microservices and orchestration technologies used in cloud native systems	4	
CO3	Design cloud native applications using continuous integration continuous delivery and DevOps practices	5	
CO4	Evaluate scalability reliability fault tolerance and performance in cloud native environments	6	

Syllabus

Introduction to Cloud Native Computing: Overview of cloud computing concepts service models and deployment models understanding cloud native architecture principles benefits and challenges cloud native versus traditional applications introduction to microservices based systems and cloud platforms

Containerization and Microservices Architecture: Fundamentals of virtualization and containerization difference between virtual machines and containers introduction to Docker container images Dockerfile container lifecycle and networking design principles of microservices communication patterns service discovery API gateway and service mesh

Container Orchestration and Automation: Introduction to Kubernetes architecture components pods services deployments and namespaces Kubernetes control plane and node components managing scaling and updating applications Helm charts secrets and config maps introduction to orchestration in multi cloud environments

Cloud Native Application Development and Deployment: CI CD pipelines using Jenkins GitHub Actions or GitLab integration with Kubernetes DevOps practices for cloud native development monitoring logging and observability with Prometheus Grafana and ELK stack serverless computing using AWS Lambda or OpenFaaS security best practices in container and cluster management

Reference Books

- 1 Cloud Native Infrastructure Patterns, Justin Garrison, 1st, O'Reilly.
- 2 Kubernetes Up and Running, Kelsey Hightower, 3rd, O'Reilly.
- 3 Designing Cloud Native Applications, Cornelia Davis, 1st, Manning Publications.

25CNS3101A - INTRODUCTION TO CLOUD NATIVE COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3101A	INTRODUCTION TO CLOUD NATIVE COMPUTING	ITCNC	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Introduction to Cloud Native Computing	2	
CO2	Understand the concept of Containerization with Docker	2	
CO3	Apply Container Orchestration with Kubernetes	3	
CO4	Apply Microservices Architecture to container orchestration	3	
CO5	Integrating Cloud-Native Applications	3	
CO6	Analyzing and Mashing Cloud-Native Applications	4	
CO7	Analyzing DevOps Practices in Cloud-Native Environments	4	

Syllabus

Introduction to Cloud Native Computing Overview of cloud-native architecture Characteristics and benefits of cloudnative applications

Containerization with Docker Introduction to Docker containers Dockerfile and Docker images Docker Compose for multicontainer 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.

25CNS3101E - INTRODUCTION TO CLOUD NATIVE COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3101E	INTRODUCTION TO CLOUD NATIVE COMPUTING	ITCNC	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Introduction to Cloud Native Computing	2	
CO2	Understand the concept of Containerization with Docker	2	
CO3	Apply Container Orchestration with Kubernetes	3	
CO4	Apply Microservices Architecture to container orchestration	3	
CO5	Integrating Cloud-Native Applications	3	
CO6	Analyzing and Mashing Cloud-Native Applications	4	

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 Designing Change tolerant Software, Cornelia Davis, 2019, O Reilly Media..
- 3 Dive into the Future of Infrastructure, Joe Beda, 2022, O Reilly Media..
- 4 Essentials of Cloud Computing, Brendan Burns, 2023, O Reilly Media.
- 5 Kubernetes Up and Running Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, 2020, O Reilly Media..

25CNS3202 - FUNDAMENTALS OF CLOUD SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3202	FUNDAMENTALS OF CLOUD SECURITY	FOCS	R	2	0	2	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate compute services in cloud computing and its significance for security.	2	
CO2	Identify the security controls to implement IAM for monitoring and auditing cloud deployment.	3	
CO3	Examine the effectiveness of different security architectures	4	
CO4	Analyze about different compliance frameworks and their implications	4	

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.

Reference Books

- 1 Cloud Security A Comprehensive Guide to Secure Cloud Computing , Ronald L. Krutz and Russell Dean Vines, 2010, Wiley Publishing.
- 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.

25CNS3303 - CONTAINER SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3303	CONTAINER SECURITY	CTSY	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Containerization and Security	2	
CO2	Understand Container Image Security, Container Runtime Security	2	
CO3	Apply Container Orchestration Security	3	
CO4	Apply Network Security for Containers	3	
CO5	Apply the concept of Identity and Access Management, Monitoring and Logging	3	
CO6	Analyzing Security in Continuous Integration/Continuous Deployment (CI/CD)	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

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

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 (selfpublished).
- 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 (selfpublished).
- 5 Docker Security Quick Reference, Liz Rice, 2020, O'Reilly Media.

25CNS3303A - CONTAINER SECURITY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3303A	CONTAINER SECURITY	CTSY	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Containerization and Security	2	
CO2	Understand Container Image Security, Container Runtime Security	2	
CO3	Apply Container Orchestration Security	3	
CO4	Apply Network Security for Containers	3	
CO5	Analyzing Security in Continuous Integration/Continuous Deployment (CI/CD)	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, 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.

25CNS3303E - CONTAINER SECURITY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3303E	CONTAINER SECURITY	CTSY	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of Containerization and Security	2	
CO2	Understand Container Image Security, Container Runtime Security	2	
CO3	Apply Container Orchestration Security	3	
CO4	Apply Network Security for Containers	3	
CO5	Apply the concept of Identity and Access Management, Monitoring and Logging	3	
CO6	Analyzing Security in Continuous Integration/Continuous Deployment (CI/CD)	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, container) 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, SafelyLiz 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, SafelyLiz Rice, 2019, Nigel Poulton (self-published).
- 5 Docker Security Quick Reference, Liz Rice, 2018, O Reilly Media.

25CNS3404 - MICROSERVICES SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3404	MICROSERVICES SECURITY	MSS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying security challenges in various applications	3	
CO2	Apply authentications by implementing different mechanisms	3	
CO3	Applying protocols for microservices and various controls to be implemented for data encryption	3	
CO4	Analyzing various anomalies and incident responses in security monitoring	4	

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 Microservices Security in Action, Wajjakkara Kankanamge Anthony Nuwan Dias, Prabath Siriwardena, , 2020, Manning Publications.
- 4 Quantum Computing for Computer Scientists, Noson S. Yanofsky and Mirco A. Mannucci, 2008, UNIVERSITY PRESS..

25CNS3405 - INFRASTRUCTURE AS CODE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3405	INFRASTRUCTURE AS CODE SECURITY	ISACS	R	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	
CO2	Analyze and describe the various security vulnerabilities and threats specific to Infrastructure as Code.	4	
CO3	Analyze security best practices and methodologies for creating secure Infrastructure as Code deployments.	4	
CO4	Apply the governance security policy to ensure enterprise security in project management.	4	

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 , 2016, O'Reilly Media..
- 2 Terraform: Up & Running: Writing Infrastructure as Code , Yevgeniy Brikman , 2022, O'Reilly Media..
- 3 Infrastructure as Code (IAC) Cookbook , Stephane Jourdan and Pierre Pomes , 2020, Packt Publishing.
- 4 Continuous Delivery and DevOps: A Quickstart Guide , Paul Swartout , 2018, Packt Publishing.

25CNS3406 - IDENTITY AND ACCESS MANAGEMENT IN CLOUD NATIVE ENVIRONMENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3406	IDENTITY AND ACCESS MANAGEMENT IN CLOUD NATIVE ENVIRONMENTS	IAMCNE	R	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	
CO2	Understand IAM policies and role-based access control (RBAC) models.	2	
CO3	Understand and implement secure authentication and authorization mechanisms	3	
CO4	Manage identities across multiple platforms and services. Ensure compliance and security through logging, monitoring, and incident response.	4	

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, press,.
- 2 Active Directory Administration Cookbook: Proven solutions to everyday identity and authentication challenges for both on-premises and the cloud, Sander Berkouwer, 2 ND, 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 Vrie, 2022, Packt.
- 4 Practical Spring Cloud Function: Developing Cloud-Native Functions for Multi-Cloud and Hybrid-Cloud Environments , Banu Parasuraman,, 1 ST, Apress.

25CNS3407 - NETWORK SECURITY IN CLOUD NATIVE ARCHITECTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3407	NETWORK SECURITY IN CLOUD NATIVE ARCHITECTURES	NSCNA	R	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	
CO2	To implement security best practices specific to cloud native environments, ensuring the integrity, confidentiality, and availability of services	2	
CO3	Identify and mitigate common security threats and vulnerabilities in cloud native architectures, utilizing monitoring, logging, and alerting tools	3	
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	

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, 2018, O'Reilly.
- 2 Cloud Native Security: Patterns and Practices, , Chris Binnie, 2021, Wiley.
- 3 Kubernetes Up & Running: Dive into the Future of Infrastructure, Kelsey Hightower, Brendan Burns, and Joe Beda, , 2017, O'Reilly .
- 4 Practical Cloud Security: A Guide for Secure Design and Deployment, Chris Dots, 2023, O'Reilly.

25CNS3508 - MONITORING AND LOGGING FOR CLOUD NATIVE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3508	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	
CO2	Implement monitoring infrastructure using cloud-native tools and services	2	
CO3	Analyze log data to identify patterns, anomalies, and potential security threats	3	
CO4	Design comprehensive monitoring and logging architectures tailored to specific cloud native security requirements	4	

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,, 1 ST , O'Reilly Media..
- 2 Cloud Native Security Monitoring and Logging: A Practical Guide to Monitoring and Securing Cloud-Native Applications,, Abhay Bhargav, Rashmi Nanda, 1 ST, Packt Publishing.
- 3 Cloud Security Monitoring and Logging Handbook, Ankur Tyagi, Navneet Mehra,, 1 ST, Apress.
- 4 Monitoring and Logging Best Practices: A Comprehensive Guide for Cloud-Native Environments,, Mark Smith, 1 ST, Wiley.

25CNS3509 - COMPLIANCE AND GOVERNANCE IN CLOUD NATIVE ENVIRONMENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3509	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	
CO2	Apply Infrastructure as Code and Compliance as Code tools for automated governance.	3	
CO3	Demonstrate the effectiveness of different governance frameworks for a specific cloud-native project.	3	
CO4	Compare and contrast cloud provider tools for security and compliance automation.	4	

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, Shanling Shao and , 1 ST, Wiley publishing, Inc.
- 2 Compliance as Code: Infrastructure Automation for Security and Governance, Angie Chakravarty, 2 ND, O'Reilly Media, Inc..
- 3 Cloud Governance: Basics and practice , Meredith Stein, Steven Mezzio, 1 ST, De Gruyter.
- 4 Cloud Native Security , Chris Binnie, Rory McCune,, 1 ST, O'Reilly Media, Inc...
- 5 Cloud Native Patterns: Designing Change-tolerant Software,, Cornelia Davis, 1 ST, Manning, Inc..

25CNS3510 - SERVERLESS SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3510	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	
CO2	Identify common security risks and vulnerabilities in serverless architectures.	2	
CO3	Apply security best practices in designing, developing, and deploying serverless applications.	3	
CO4	Apply authentication, authorization, and data protection mechanisms in serverless environments	3	

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..

25CNS3512 - FUTURE TRENDS IN CLOUD NATIVE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CNS3512	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	
CO2	Analyze various security issues and system vulnerabilities in virtualization	3	
CO3	Apply the technologies for virtualization based security enhancements	3	
CO4	Analyze legal and Compliance issues and examine modern security standards	4	

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

- 1 Securing the Cloud, J.R. ("Vic") Winkler Ronald L. Krutz, Russell Dean Vines, 2011, Will Row..
- 2 Cloud Computing,, . John Rittinghouse, James Ransome, 4. J.R. ("Vic") Winkler, 2011, Will Row..
- 3 Cloud Security and Privacy: An EnterprisePerspective on Risks and Compliance",, Tim Mather, Subra Kumaraswamy, Shahed Latif,, 2009, O'Reilly Media Inc.,..
- 4 Securing the Cloud: Cloud Computer Security Techniques and Tactics, Tactics by Vic (J.R.) Winkler, Vic (J.R.) Winkler,, 2010, Syngress..

25CPD3101 - FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3101	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	FMAD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Kotlin programming constructs to develop robust application logic.	3	PO1, PO2
CO2	Set up Android development environments and explain Android architecture.	2	PO2
CO3	Design interactive Android UIs using widgets, views, and layouts.	3	PO2
CO4	Implement advanced Android features including Jetpack Compose, Room, and REST APIs.	3	PO1, PO3
CO5	Build and publish Android apps with data persistence and a capstone project.	3	PO3, PO5

Syllabus

Introduction to Kotlin, Annotations, Arrays, Basic Lambdas, Collections, Conditional Statements, Coroutines, Delegated Properties, Exceptions, Object-Oriented Programming Concepts (inheritance, polymorphism, encapsulation). Agile practices: Defining user stories with Jira.

Introduction to Android, Setting up Android Studio, Android Architecture (components, manifest), Core Building Blocks (Activity, Service, Broadcast Receiver, Content Provider), Android Emulator, Install Android, Setup of Android Studio, Android Widgets (TextView, EditText, Button), Git/GitHub for version control. Agile practices: Sprint planning.

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 Clocks, Progress Bar. Views and Layouts: Vertical Scroll View, Horizontal Scroll View, Image Switcher, Image Slider, View Stub, Tab Layout, Linear Layout, Relative Layout, Search View, Search View on Toolbar, Edit Text with Text Watcher. Activity Lifecycle, Implicit Intent, Explicit Intent, Start Activity for Result, Card View, Grid View, Navigation Drawer, Fragments, Android Service, Android Alarm Manager, Internal Storage, External Storage. Agile practices: Daily stand-ups, sprint reviews.

Jetpack Compose for modern UI development, Jetpack Libraries (ViewModel, LiveData, Navigation), Room Database for persistence, REST API integration with Retrofit, Dependency Injection with Hilt, Unit Testing with JUnit, UI Testing with Espresso, Debugging with Logcat and Android Profiler, Performance Optimization (memory management, lazy loading), Security Practices (secure storage, ProGuard, encryption). Agile practices: Feature tracking, sprint demos.

Android SQLite, SQLite Spinner, XML Parsing (SAX, DOM, Pull Parser), JSON Parsing, APK Generation, Publishing in Google Play Console. Capstone Project: Task Manager Android App integrating Kotlin, UI, Room, Retrofit, and testing. Agile practices: Project planning, final sprint presentation.

Reference Books

- 1 Android Programming with Kotlin for Beginners, John Horton, 2020, Packt Publishing.
- 2 Kotlin for Android App Development, Erik Hellman, 2019, Addison-Wesley.
- 3 The Busy Coder's Guide to Android Development, Mark L. Murphy, 2023, CommonsWare.
- 4 Android Programming: The Big Nerd Ranch Guide, Bill Phillips, Chris Stewart, 2021, Big Nerd Ranch.
- 5 Head First Kotlin, Dawn Griffiths, David Griffiths, 2019, O'Reilly Media.
- 6 Professional Android, Reto Meier, 2018, Wrox.

25CPD3101A - FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3101A	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	FMAD	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Kotlin programming constructs to develop robust application logic.	3	PO1, PO2
CO2	Set up Android development environments and explain Android architecture.	2	PO2
CO3	Design interactive Android UIs using widgets, views, and layouts.	3	PO2, PO3
CO4	Implement advanced Android features including Jetpack Compose, Room, and REST APIs.	3	PO1, PO3
CO5	Build and publish Android apps with data persistence and a capstone project.	3	PO3, PO5

Syllabus

Introduction to Kotlin, Annotations, Arrays, Basic Lambdas, Collections, Conditional Statements, Coroutines, Delegated Properties, Exceptions, Object-Oriented Programming Concepts (inheritance, polymorphism, encapsulation). Agile practices: Defining user stories with Jira.

Introduction to Android, Setting up Android Studio, Android Architecture (components, manifest), Core Building Blocks (Activity, Service, Broadcast Receiver, Content Provider), Android Emulator, Install Android, Setup of Android Studio, Android Widgets (TextView, EditText, Button), Git/GitHub for version control. Agile practices: Sprint planning.

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 Clocks, Progress Bar. Views and Layouts: Vertical Scroll View, Horizontal Scroll View, Image Switcher, Image Slider, View Stub, Tab Layout, Linear Layout, Relative Layout, Search View, Search View on Toolbar, Edit Text with Text Watcher. Activity Lifecycle, Implicit Intent, Explicit Intent, Start Activity for Result, Card View, Grid View, Navigation Drawer, Fragments, Android Service, Android Alarm Manager, Internal Storage, External Storage. Agile practices: Daily stand-ups, sprint reviews.

Jetpack Compose for modern UI development, Jetpack Libraries (ViewModel, LiveData, Navigation), Room Database for persistence, REST API integration with Retrofit, Dependency Injection with Hilt, Unit Testing with JUnit, UI Testing with Espresso, Debugging with Logcat and Android Profiler, Performance Optimization (memory management, lazy loading), Security Practices (secure storage, ProGuard, encryption). Agile practices: Feature tracking, sprint demos.

Android SQLite, SQLite Spinner, XML Parsing (SAX, DOM, Pull Parser), JSON Parsing, APK Generation, Publishing in Google Play Console. Capstone Project: Task Manager Android App integrating Kotlin, UI, Room, Retrofit, and testing. Agile practices: Project planning, final sprint presentation.

Reference Books

- 1 Android Programming with Kotlin for Beginners, John Horton, 2020, Packt Publishing.
- 2 Kotlin for Android App Development, Erik Hellman, 2019, Addison-Wesley.
- 3 The Busy Coder's Guide to Android Development, Mark L. Murphy, 2023, CommonsWare.
- 4 Android Programming: The Big Nerd Ranch Guide, Bill Phillips, Chris Stewart, 2021, Big Nerd Ranch.
- 5 Head First Kotlin, Dawn Griffiths, David Griffiths, 2019, O'Reilly Media.
- 6 Professional Android, Reto Meier, 2018, Wrox.

25CPD3101E - FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3101E	FUNDAMENTALS OF MOBILE APPLICATION DEVELOPMENT	FMAD	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Kotlin programming constructs to develop robust application logic.	3	PO1, PO2
CO2	Set up Android development environments and explain Android architecture.	2	PO2
CO3	Design interactive Android UIs using widgets, views, and layouts.	3	PO2, PO3
CO4	Implement advanced Android features including Jetpack Compose, Room, and REST APIs.	3	PO1, PO3
CO5	Build and publish Android apps with data persistence and a capstone project.	3	PO3, PO5

Syllabus

Introduction to Kotlin, Annotations, Arrays, Basic Lambdas, Collections, Conditional Statements, Coroutines, Delegated Properties, Exceptions, Object-Oriented Programming Concepts (inheritance, polymorphism, encapsulation). Agile practices: Defining user stories with Jira.

Introduction to Android, Setting up Android Studio, Android Architecture (components, manifest), Core Building Blocks (Activity, Service, Broadcast Receiver, Content Provider), Android Emulator, Install Android, Setup of Android Studio, Android Widgets (TextView, EditText, Button), Git/GitHub for version control. Agile practices: Sprint planning.

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 Clocks, Progress Bar. Views and Layouts: Vertical Scroll View, Horizontal Scroll View, Image Switcher, Image Slider, View Stub, Tab Layout, Linear Layout, Relative Layout, Search View, Search View on Toolbar, Edit Text with Text Watcher. Activity Lifecycle, Implicit Intent, Explicit Intent, Start Activity for Result, Card View, Grid View, Navigation Drawer, Fragments, Android Service, Android Alarm Manager, Internal Storage, External Storage. Agile practices: Daily stand-ups, sprint reviews.

Jetpack Compose for modern UI development, Jetpack Libraries (ViewModel, LiveData, Navigation), Room Database for persistence, REST API integration with Retrofit, Dependency Injection with Hilt, Unit Testing with JUnit, UI Testing with Espresso, Debugging with Logcat and Android Profiler, Performance Optimization (memory management, lazy loading), Security Practices (secure storage, ProGuard, encryption). Agile practices: Feature tracking, sprint demos.

Android SQLite, SQLite Spinner, XML Parsing (SAX, DOM, Pull Parser), JSON Parsing, APK Generation, Publishing in Google Play Console. Capstone Project: Task Manager Android App integrating Kotlin, UI, Room, Retrofit, and testing. Agile practices: Project planning, final sprint presentation.

Reference Books

- 1 Android Programming with Kotlin for Beginners, John Horton, 2020, Packt Publishing.
- 2 Kotlin for Android App Development, Erik Hellman, 2019, Addison-Wesley.
- 3 The Busy Coder's Guide to Android Development, Mark L. Murphy, 2023, CommonsWare.
- 4 Android Programming: The Big Nerd Ranch Guide, Bill Phillips, Chris Stewart, 2021, Big Nerd Ranch.
- 5 Head First Kotlin, Dawn Griffiths, David Griffiths, 2019, O'Reilly Media.
- 6 Professional Android, Reto Meier, 2018, Wrox.

25CPD3202 - REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3202	REACT NATIVE FOR ANDROID AND IOS DEVELOPMENT	RNA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain React Native fundamentals and build basic cross-platform apps.?	2	PO1, PO2
CO2	Develop interactive mobile apps with state management and navigation.?	3	PO2, PO3
CO3	Implement advanced features and testing in React Native apps.?	3	PO1, PO3
CO4	Secure, deploy, and deliver a capstone mobile app with Agile practices.?	3	PO2, PO4

Syllabus

Introduction to React Native: Features, benefits, comparison with Flutter/Ionic. Environment setup with Expo, Node.js, and Visual Studio Code. Core components: View, Text, Image. JSX and props. Styling: Flexbox, StyleSheet. Git/GitHub for version control. Debugging with React Developer Tools. Hands-on: Build a basic task list app with Expo. Agile practices: Sprint planning with Jira.

State management: useState, useEffect hooks. Event handling: Pressable, TextInput. Navigation with Expo Router: Stack, Tab navigation. UI/UX best practices: Responsive design, accessibility. Form handling with Formik and Yup. Hands-on: Enhance task list app with navigation and forms. Agile practices: Daily stand-ups.

REST API integration with fetch/axios. Community libraries: expo-camera, expo-notifications. Animations with React Native Reanimated. Unit testing with Jest. Native modules: Platform-specific configurations (Android permissions, iOS entitlements). Hands-on: Add API-based task syncing and notifications to the app. Agile practices: Sprint reviews.

Security: HTTPS, input validation, OWASP Mobile Top 10. Deployment: Publishing to Google Play Store and Apple App Store with Expo EAS. CI/CD with GitHub Actions. Testing on Android/iOS versions. Capstone project: Task manager app with CRUD, notifications, API integration, and deployment. Hands-on: Deploy and secure capstone app. Agile practices: Final sprint presentation.

Reference Books

- 1 React and React Native, Adam Boduch, 2020, Packt Publishing.
- 2 React Projects, Roy Derks, 2022, Packt Publishing.
- 3 Practical React Native, Frank Zammetti, 2018, Apress.
- 4 Learning React Native, Bonnie Eisenman, 2017, O Reilly Media.
- 5 The Ultimate React Native Series, Mosh Hamedani, 2021, CodeWithMosh.
- 6 React Native in Action, Nader Dabit, 2019, Manning Publications.

25CPD3203 - FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3203	FRAMEWORK BASED CROSS PLATFORM APP DEVELOPMENT	FBCPD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Dart programming to create secure Flutter UI components.	3	PO1, PO2
CO2	Develop cross-platform Flutter UIs with state management and testing.	3	PO2, PO3
CO3	CO-3 Design and integrate secure REST APIs with Flutter apps. PO1, PO3, PSO1 Applying	3	PO1, PO3
CO4	Build Flutter apps with device features, Firebase, and a capstone project.	3	PO2, PO4

Syllabus

Dart basics (variables, control flow, null safety, functions, OOP). Basic async/await and streams. Flutter setup (Android Studio, VS Code, DevTools, Pubspec.yaml). Flutter UI (widget tree, Material App, Text, Image). Customization (app icons, assets, fonts, hot reload). Secure coding (input validation, basic OWASP principles). Widget testing with Flutter Test. Git/GitHub for version control. Hands-on: Secure Flutter UI with custom widgets. Agile practices: Sprint planning with Jira

State management (stateful/stateless, Provider). Declarative UI (flexible layouts, mobile patterns). Basic UI animations (AnimatedContainer, FadeTransition). Accessibility (screen readers, basic i18n). Structuring apps (MVC, reusable widgets). Debugging (Flutter Inspector, Logcat, Dart DevTools). Unit/widget testing with Flutter Test. Cross-platform support (basic iOS configuration). Performance optimization (reducing widget rebuilds). Hands-on: Dynamic, accessible app with animations and MVC. Agile practices: Daily stand-ups, sprint reviews

REST API (Node.js, Express, MongoDB, Mongoose, schema design). Basic security (JWT, CORS, rate limiting). Swagger/OpenAPI documentation. Testing (Jest, Supertest). Firebase Functions for simple backend hosting. Integration with Flutter (HTTP package, Dio). Hands-on: Secure REST API integrated with Flutter. Agile practices: Feature tracking, sprint demos.

MODULE-4 Device access (camera, GPS, Google Maps). Secure permissions (runtime, storage). Firebase (Authentication, Firestore CRUD). Basic push notifications (FCM). Real-time data (Firestore updates). Integration testing for device features. App deployment to Google Play. Capstone project: Todo list app with Flutter, REST API, and Firebase. Agile practices: Project planning, final sprint presentation.

Reference Books

- 1 Programming Flutter: Native, Cross-Platform Apps the Easy Way, Carmine Zaccagnino, 2021, Pragmatic Bookshelf.
- 2 Practical Flutter, Frank Zammetti, 2020, Apress.
- 3 Pro Node.js for Developers, Adam Freeman, 2020, Apress.
- 4 Flutter in Action, Eric Windmill, 2020, Manning Publications.
- 5 Beginning Flutter: A Hands-On Guide to App Development, Marco L. Napoli, 2019, Wiley.
- 6 Node.js, MongoDB and Angular Web Development, Stephen J. Crichton, 2022, Addison-Wesley.

25CPD3304 - SECURE MOBILE APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3304	SECURE MOBILE APPLICATION DEVELOPMENT	SMAD	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Kotlin programming and Jetpack Compose to create secure UI components.	3	PO1, PO2
CO2	Develop cross-device compatible Flutter UIs with state management and testing.	3	PO2, PO3
CO3	Implement MVVM architecture with Room and Firebase for data persistence.	3	PO1, PO3
CO4	Integrate secure REST APIs and device permissions in Android apps.	3	PO2, PO4
CO5	Deploy Android apps with CI/CD, optimize performance, and build a capstone project.	3	PO3, PO5

Syllabus

Kotlin basics (variables, control flow, classes, objects, extension functions, sealed classes). Coroutines for asynchronous programming. Android environment (Android Studio, Gradle). Jetpack Compose setup for secure projects. Secure development (OWASP Mobile Top 10, input validation). Unit testing for Kotlin with JUnit. Git/GitHub for version control. Hands-on: Secure Compose app with coroutines. Agile practices: Sprint planning with Jira.

Composable functions (modifiers, Text, Buttons, LazyColumn, Surface). Layouts (Row, Column, Box, reusable composables). State management (State, recomposition, lifting state). Basic UI animations (AnimatedVisibility, transition). Accessibility (TalkBack, basic ARIA). Secure inputs (validation, anti-injection). Optimization (recompositions, lazy loading). Unit/widget testing with Espresso. Debugging (Logcat, Android Profiler). Cross-device compatibility (tablets). Hands-on: Dynamic, accessible UI with animations. Agile practices: Daily stand-ups, sprint MVVM architecture (View, ViewModel, Repository, Hilt). Room database (basic secure storage). Firebase Firestore (cloud storage, CRUD operations). Data flow (LiveData, coroutines). Offline sync (WorkManager). Testing (JUnit, Mockito for ViewModel/Repository). Hands-on: MVVM app with Room and Firestore. Agile practices: Feature tracking, sprint demos.

Networking (Retrofit for REST APIs). Security (HTTPS, Android Keystore). API integration (secure tokens, OAuth2, retries). API testing (OkHttp MockWebServer, Postman). Optimization (caching, pagination). Secure permissions (runtime, location, consent). Hands-on: Secure REST API integration with Flutter. Agile practices: Sprint planning, code reviews.

Reference Books

- 1 Android Programming with Kotlin for Beginners, John Horton, 1st Edition (2020), Packt Publishing.
- 2 Kotlin for Android App Development, Erik Hellman, 1st Edition (2019), Addison-Wesley.
- 3 Professional Android, Reto Meier, 4th Edition (2018), Wrox.
- 4 Android Programming: The Big Nerd Ranch Guide, Bill Phillips, Chris Stewart, 4th Edition (2021), Big Nerd Ranch.
- 5 Big Nerd Ranch, Dawn Griffiths, David Griffiths, 1st Edition (2019), O'Reilly Media.
- 6 Professional Android, Reto Meier, 4th Edition (2018), Wrox.

25CPD3304A - SECURE MOBILE APPLICATION DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3304A	SECURE MOBILE APPLICATION DEVELOPMENT	SMAD	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Kotlin programming and Jetpack Compose to create secure UI components.	3	PO1, PO2
CO2	Develop cross-device compatible Flutter UIs with state management and testing.	3	PO2, PO3
CO3	Implement MVVM architecture with Room and Firebase for data persistence.	3	PO1, PO3
CO4	Integrate secure REST APIs and device permissions in Android apps.	3	PO2, PO4
CO5	Deploy Android apps with CI/CD, optimize performance, and build a capstone project.	4	PO3, PO5

Syllabus

Kotlin basics (variables, control flow, classes, objects, extension functions, sealed classes). Coroutines for asynchronous programming. Android environment (Android Studio, Gradle). Jetpack Compose setup for secure projects. Secure development (OWASP Mobile Top 10, input validation). Unit testing for Kotlin with JUnit. Git/GitHub for version control. Hands-on: Secure Compose app with coroutines. Agile practices: Sprint planning with Jira.

Composable functions (modifiers, Text, Buttons, LazyColumn, Surface). Layouts (Row, Column, Box, reusable composables). State management (State, recomposition, lifting state). Basic UI animations (AnimatedVisibility, transition). Accessibility (TalkBack, basic ARIA). Secure inputs (validation, anti-injection). Optimization (recompositions, lazy loading). Unit/widget testing with Espresso. Debugging (Logcat, Android Profiler). Cross-device compatibility (tablets). Hands-on: Dynamic, accessible UI with animations. Agile practices: Daily stand-ups, sprint MVVM architecture (View, ViewModel, Repository, Hilt). Room database (basic secure storage). Firebase Firestore (cloud storage, CRUD operations). Data flow (LiveData, coroutines). Offline sync (WorkManager). Testing (JUnit, Mockito for ViewModel/Repository). Hands-on: MVVM app with Room and Firestore. Agile practices: Feature tracking, sprint demos.

Networking (Retrofit for REST APIs). Security (HTTPS, Android Keystore). API integration (secure tokens, OAuth2, retries). API testing (OkHttp MockWebServer, Postman). Optimization (caching, pagination). Secure permissions (runtime, location, consent). Hands-on: Secure REST API integration with Flutter. Agile practices: Sprint planning, code reviews.

Authentication (Firebase Authentication, JWT). Secure features (FCM push notifications, dynamic card layouts). Navigation (Navigation Compose, secure transitions). CI/CD (GitHub Actions, automated testing). Monitoring (Crashlytics). Google Play Store publishing. Performance optimization (APK size reduction, efficient networking). Capstone project: Todo list app with Compose, Room, REST API, and Firebase. Hands-on: Deploy capstone with monitoring. Agile practices: Project planning, final sprint presentation.

Reference Books

- 1 Android Programming with Kotlin for Beginners, John Horton, 1st Edition (2020), Packt Publishing.
- 2 Kotlin for Android App Development, Erik Hellman, 1st Edition (2019), Addison-Wesley.
- 3 Professional Android, Reto Meier, 4th Edition (2018), Wrox.
- 4 Android Programming: The Big Nerd Ranch Guide, Bill Phillips, Chris Stewart, 4th Edition (2021), Big Nerd Ranch.
- 5 Head First Kotlin, Dawn Griffiths, David Griffiths, 1st Edition (2019), O'Reilly Media.
- 6 Professional Android, Reto Meier, 4th Edition (2018), Wrox.

25CPD3304E - SECURE MOBILE APPLICATION DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3304E	SECURE MOBILE APPLICATION DEVELOPMENT	SMAD	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Kotlin programming and Jetpack Compose to create secure UI components.	3	PO1, PO2
CO2	Develop cross-device compatible Flutter UIs with state management and testing.	3	PO2, PO3
CO3	Implement MVVM architecture with Room and Firebase for data persistence.	3	PO1, PO3
CO4	Integrate secure REST APIs and device permissions in Android apps.	3	PO2, PO4
CO5	Deploy Android apps with CI/CD, optimize performance, and build a capstone project.	3	PO3, PO5

Syllabus

Kotlin basics (variables, control flow, classes, objects, extension functions, sealed classes). Coroutines for asynchronous programming. Android environment (Android Studio, Gradle). Jetpack Compose setup for secure projects. Secure development (OWASP Mobile Top 10, input validation). Unit testing for Kotlin with JUnit. Git/GitHub for version control. Hands-on: Secure Compose app with coroutines. Agile practices: Sprint planning with Jira.

Composable functions (modifiers, Text, Buttons, LazyColumn, Surface). Layouts (Row, Column, Box, reusable composables). State management (State, recomposition, lifting state). Basic UI animations (AnimatedVisibility, transition). Accessibility (TalkBack, basic ARIA). Secure inputs (validation, anti-injection). Optimization (recompositions, lazy loading). Unit/widget testing with Espresso. Debugging (Logcat, Android Profiler). Cross-device compatibility (tablets). Hands-on: Dynamic, accessible UI with animations. Agile practices: Daily stand-ups, sprint MVVM architecture (View, ViewModel, Repository, Hilt). Room database (basic secure storage). Firebase Firestore (cloud storage, CRUD operations). Data flow (LiveData, coroutines). Offline sync (WorkManager). Testing (JUnit, Mockito for ViewModel/Repository). Hands-on: MVVM app with Room and Firestore. Agile practices: Feature tracking, sprint demos.

Networking (Retrofit for REST APIs). Security (HTTPS, Android Keystore). API integration (secure tokens, OAuth2, retries). API testing (OkHttp MockWebServer, Postman). Optimization (caching, pagination). Secure permissions (runtime, location, consent). Hands-on: Secure REST API integration with Flutter. Agile practices: Sprint planning, code reviews.

Authentication (Firebase Authentication, JWT). Secure features (FCM push notifications, dynamic card layouts). Navigation (Navigation Compose, secure transitions). CI/CD (GitHub Actions, automated testing). Monitoring (Crashlytics). Google Play Store publishing. Performance optimization (APK size reduction, efficient networking). Capstone project: Todo list app with Compose, Room, REST API, and Firebase. Hands-on: Deploy capstone with monitoring. Agile practices: Project planning, final sprint presentation.

Reference Books

- 1 Android Programming with Kotlin for Beginners, John Horton, 1st Edition (2020), Packt Publishing.
- 2 Kotlin for Android App Development, Erik Hellman, 1st Edition (2019), Addison-Wesley.
- 3 Professional Android, Reto Meier, 4th Edition (2018), Wrox.
- 4 Android Programming: The Big Nerd Ranch Guide, Bill Phillips, Chris Stewart, 4th Edition (2021), Big Nerd Ranch.
- 5 Head First Kotlin, Dawn Griffiths, David Griffiths, 1st Edition (2019), O'Reilly Media.
- 6 Professional Android, Reto Meier, 4th Edition (2018), Wrox.

25CPD3405 - UX DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3405	UX DESIGN	UXD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and discuss about User Experience Design Process	2	
CO2	Apply User interface and differentiate from User Experience and principles of User Interface	3	
CO3	Analysing and distinguishing about components of UI Design process with interactive Devices	4	
CO4	Determine graphic design techniques and psychology principles of User Experience	4	

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

Reference Books

- 1 Designing the User Interface: Strategies for effective human Computer Interaction, Ben Schneiderman, 2009, Pearson.
- 2 The Elements of User Experience: User centered Design for the web, Jesse James garet, 2010, Peachpit..
- 3 Human Computer Interaction , Alan Dix janet Finlay , 2004, Pearson.
- 4 The UX Process and guidelines for Ensuring a quality User Experience , REX Hartson , 2012, Elsevier Science.

25CPD3406 - META REACT NATIVE SPECIALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3406	META REACT NATIVE SPECIALIZATION	MRNS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain React Native architecture and develop basic UI components.	2	PO1, PO2
CO2	Apply JavaScript ES6+ and React Native to create styled, interactive UIs.	3	PO2, PO3
CO3	Implement navigation and secure user input handling in React Native apps.	3	PO1, PO3
CO4	Manage state, integrate backend services, and deploy a capstone React Native app.	3	PO2, PO4

Syllabus

Mobile development landscape: Native vs Cross-platform. Introduction to React Native and its architecture (JavaScriptCore, Native Bridge). Setting up development environment (Expo & CLI, Node.js, Android Studio, Xcode). React Native components (View, Text, Image) and platform-specific code. Git/GitHub for version control. Hands-on: Basic React Native app with UI components. Agile practices: Sprint planning with Jira.

JavaScript ES6+ features (Arrow functions, Destructuring, Modules). Functional components and JSX. Props, State, and basic event handling (onPress, onChangeText). Styling in React Native using StyleSheet. Hands-on: Interactive UI with styled components. Agile practices: Daily stand-ups.

Introduction to react-navigation (Stack, Tab, Drawer navigation patterns). Handling user input with TextInput, TouchableOpacity, Pressable. Forms and validation (basic regex, preventing injection). REST API integration with fetch or Axios. Secure coding (input sanitization, secure API calls). Hands-on: Navigable app with secure forms and API calls. Agile practices: Sprint reviews.

Context API and state lifting. Introduction to Redux for state management. Managing side effects using useEffect. App architecture, folder structuring, and reusable components. Optimizing FlatList and ScrollView. Image lazy loading and caching. Debugging with Flipper, React DevTools, and console logging. Unit testing with Jest and React Native Testing Library. Firebase (Authentication, Firestore for storage). Building and signing release builds (Android & iOS, Google Play, App Store). Performance optimization (memoization, bundle size reduction). Capstone project: Task manager app with navigation, API, and Firebase. Hands-on: Deploy capstone app. Agile practices: Final sprint presentation.

Reference Books

- 1 Learning React Native, Bonnie Eisenman, 2017, O Reilly Media.
- 2 Learning React, Alex Banks, Eve Porcello, 2020, O Reilly Media.
- 3 React Native in Action, Nader Dabit, 2019, Manning Publications.
- 4 React and React Native, Adam Boduch, 2020, Packt Publishing.
- 5 Full-Stack React Projects, Roy Derks, 2020, Packt Publishing.
- 6 Practical React Native, Frank Zammetti, 2018, Apress.

25CPD3507 - ADVANCED MOBILE APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3507	ADVANCED MOBILE APPLICATION DEVELOPMENT	AMAD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop React Native apps with basic UI, navigation, and data persistence.	3	PO1, PO2
CO2	Create styled React Native UIs with state management and optimization.	3	PO2, PO3
CO3	Build Flutter apps with custom UIs, navigation, and state management.	3	PO1, PO3
CO4	Test, deploy, and monitor cross-platform apps with a capstone project.	3	PO2, PO4

Syllabus

React Native fundamentals: Environment setup (Expo CLI, React Native CLI, Node.js, Android Studio, Xcode). JSX syntax, functional components, props, and state via Hooks. Flexbox layout, scrollable (ScrollView) and touchable components (TouchableOpacity). Basic navigation with react-navigation (Stack, Tab). Data fetching with fetch. AsyncStorage for local persistence. List rendering with FlatList. Git/GitHub for version control. Hands-on: React Native app with navigation and data fetching. Agile practices: Sprint planning with Jira

Context API for state management. Basic animations with React Native Animated API. Performance optimization (memoization, virtualization with FlatList). Styling with StyleSheet. Debugging with Flipper and React DevTools. Unit testing with Jest. Hands-on: Styled, optimized React Native UI with animations. Agile practices: Daily stand-ups, sprint reviews.

Flutter advanced UI: Custom widgets, Stack, GridView, ListView. Basic navigation with Navigator 1.0. Dynamic theming and responsive design. Basic animations (Hero, AnimatedContainer). State management with Provider. Performance optimization (reducing widget rebuilds). Unit/widget testing with flutter_test. Debugging with Logcat and Dart DevTools. Secure coding (input validation, OWASP basics). Hands-on: Responsive Flutter app with navigation and state management. Agile practices: Feature tracking, sprint demos

Testing strategies: Jest for React Native, flutter_test for Flutter. Integration testing for UI and APIs. GitHub Actions for CI/CD pipelines. Environment and secret management. Android/iOS signing and build variants. Play Store and App Store publishing. Firebase (Authentication, Firestore for storage). Capstone project: Task manager app with React Native and Flutter, integrating navigation, state management, and Firebase. Hands-on: Deploy capstone app to app stores. Agile practices: Project planning, final sprint presentation.

Reference Books

- 1 React and React Native, Adam Boduch, 2nd Edition (2020), Packt Publishing.
- 2 Programming Flutter: Native, Cross-Platform Apps the Easy Way, Carmine Zaccagnino, 1st Edition (2021), Pragmatic Bookshelf.
- 3 Practical Flutter, Frank Zammetti, 1st Edition (2020), Apress.
- 4 Learning React Native, Bonnie Eisenman, 2nd Edition (2017), O'Reilly Media.
- 5 Flutter in Action, Eric Windmill, 1st Edition (2020), Manning Publications.
- 6 React Native in Action, Nader Dabit, 1st Edition (2019), Manning Publications.

25CPD3508 - CROSS PLATFORM USER INTERFACE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPD3508	CROSS PLATFORM USER INTERFACE DESIGN	CPED	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand principles of Cross-Platform Design and their importance across	2	PO2
CO2	Apply user-centered design concepts and create scenarios based on user behavior across platforms.	3	PO2
CO3	Design adaptive and responsive interfaces with enhanced navigation and usability.	3	PO1
CO4	Analyze usability and accessibility in cross-platform scenarios using modern design tools.	4	PO1

Syllabus

Understanding the Principles of Cross-Platform Design - Define cross-platform user experience and its significance, compare cross-platform and native platform design challenges, Explore the key pillars of user experience: usability, accessibility, and desirability, Introduction to Flutter framework: features, use cases, benefits for UI/UX, set up Flutter development environment integrated with design tools like Figma, Introduction to User-Centered Design (UCD) principles and methods.

User-Centered Design and Design Concept Translation - Conducting qualitative and quantitative user research for multiple platforms, creating user personas and empathy maps, defining user needs, behaviours, and pain points, Storyboarding and generating user scenarios, translating research into user flows and wireframes for web, mobile, and desktop, Using Flutter widgets and components to build these user flows effectively.

Designing for adaptivity and responsiveness, Explore responsive vs adaptive design strategies, Design for various screen sizes and device orientations, Best practices for layout design across platforms, Utilize Flutter layout and media query tools for responsiveness, Implement navigation patterns drawers tabs bottom navigation, Design and develop reusable UI components for consistent UX

Usability, Accessibility and Inclusive Design - Introduction to usability heuristics and evaluating user interfaces, conducting usability testing and analysing test results, Principles of accessible design: WCAG guidelines, implement accessibility features using Flutter widgets, Inclusive design principles: designing for diversity, Hands-on usage of Figma, Adobe XD, and Sketch for accessible UI design.

Reference Books

- 1 Building Cross-Platform Mobile and Web Apps for Engineers and Scientists: An Active Learning Approach, Pawan Lingras, Matt Triff, Rucha Lingras, 2016, Cengage Learning.
- 2 About Face: The Essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, 2014, Wiley.
- 3 The Design of Everyday Things, Don Norman, 2013, Basic Books.
- 4 Professional Cross-Platform Mobile Development in C, Scott Olson, John Hunter, Ben Horgen, Kenny Goers, 2012, Wrox.
- 5 The Elements of User Experience, Jesse James Garrett, 2010, New Riders.
- 6 Designing Interfaces: Patterns for Effective Interaction Design, Jenifer Tidwell, 2019, O Reilly Media.

25CPS3101 - IOT SENSING AND ACTUATING DEVICES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3101	IOT SENSING AND ACTUATING DEVICES	ISAD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the role and function of sensors and actuators in IoT systems	2	
CO2	Analyze sensing technologies and interfacing circuits used in IoT applications	4	
CO3	Apply hardware and software tools to design IoT solutions using sensing and actuating devices	5	
CO4	Evaluate and improve IoT device performance reliability and efficiency in real time environments	6	

Syllabus

Basics of IoT Devices: Overview of IoT device architecture sensors actuators and microcontrollers

Sensor Characteristics: Classification of sensors parameters sensitivity calibration and accuracy

Actuator Concepts: Types of actuators working principles and selection criteria

IoT Integration: Interfacing sensors and actuators with Arduino or NodeMCU basic IoT applications

Reference Books

- 1 IoT Sensors and Actuators Principles and Applications, Rajesh Singh, 1st, Pearson.
- 2 Fundamentals of IoT Sensors and Actuators, Nandhini P, 1st, McGraw Hill.
- 3 Smart Sensors and Systems for IoT, Sudip Misra, 1st, Springer.

25CPS3101A - IOT SENSING AND ACTUATING DEVICES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3101A	IOT SENSING AND ACTUATING DEVICES	ISAD	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles of IoT sensing and actuating devices and their roles in IoT systems	2	
CO2	Analyze various types of sensors and actuators and their interfacing techniques with IoT hardware	4	
CO3	Design and develop IoT applications integrating multiple sensors and actuators for automation	5	
CO4	Evaluate the performance and reliability of IoT sensing and actuating systems and apply optimization methods	6	

Syllabus

Advanced Sensing Systems: MEMS sensors smart sensors and biosensors

Intelligent Actuation :Adaptive control machine learning based actuation and feedback systems

Edge AI and IoT Integration: Edge computing and embedded intelligence for IoT devices

Advanced Case Studies: Industrial IoT applications predictive maintenance and robotics integration

Reference Books

- 1 IoT Sensors and Actuators Principles and Applications, Rajesh Singh, 1st, Pearson.
- 2 Fundamentals of IoT Sensors and Actuators, Nandhini P, 1st, McGraw Hill.
- 3 Smart Sensors and Systems for IoT, Sudip Misra, 1st, Sudip Misra.

25CPS3101E - IOT SENSING AND ACTUATING DEVICES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3101E	IOT SENSING AND ACTUATING DEVICES	ISAD	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the role and function of sensors and actuators in IoT systems	2	
CO2	Analyze sensing technologies and interfacing circuits used in IoT applications	4	
CO3	Apply hardware and software tools to design IoT solutions using sensing and actuating devices	5	
CO4	Evaluate and improve IoT device performance reliability and efficiency in real time environments	6	

Syllabus

Basics of IoT Devices: Overview of IoT device architecture sensors actuators and microcontrollers

Sensor Characteristics: Classification of sensors parameters sensitivity calibration and accuracy

Actuator Concepts: Types of actuators working principles and selection criteria

IoT Integration: Interfacing sensors and actuators with Arduino or NodeMCU basic IoT applications

Reference Books

- 1 IoT Sensors and Actuators Principles and Applications, Rajesh Singh, 1st, Pearson.
- 2 Fundamentals of IoT Sensors and Actuators, Nandhini P, 1st, McGraw Hill.
- 3 Smart Sensors and Systems for IoT, Sudip Misra, 1st , Springer.

25CPS3202 - INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3202	INTERNET OF THINGS ARCHITECTURES AND PROTOCOLS	IOTAP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of Internet of Things and its architecture	2	
CO2	Analyze various communication protocols and network layers used in IoT	4	
CO3	Design and develop IoT applications using different platforms and tools	5	
CO4	Evaluate IoT security issues and apply suitable protection mechanisms	6	

Syllabus

Introduction to Internet of Things: Concept and definition of IoT components architecture sensors actuators and embedded systems

IoT Communication Technologies: Overview of communication models IoT protocols such as MQTT CoAP and HTTP

IoT Architecture and Design: Layered architecture IoT device design data acquisition and edge computing

IoT Applications and Security: Applications in smart home healthcare agriculture and industrial IoT with security mechanisms

Reference Books

- 1 Internet of Things Principles and Paradigms, Rajkumar Buyya, 1st, Morgan Kaufmann.
- 2 Internet of Things A Hands On Approach, Arshdeep Bahga, 2nd, Universities Press.
- 3 Designing the Internet of Things, Adrian McEwen, 3rd, Wiley.

25CPS3303 - CYBER PHYSICAL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3303	CYBER PHYSICAL SYSTEMS	CPS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25CPS3303A - CYBER PHYSICAL SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3303A	CYBER PHYSICAL SYSTEMS	CPS	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals and architecture of cyber physical systems CPS	2	
CO2	Explain the interaction between computational and physical components in CPS	2	
CO3	Apply modeling simulation and control techniques for CPS applications	3	
CO4	Analyze system design issues including communication synchronization and safety in CPS	4	
CO5	Evaluate the performance security and reliability of CPS in real world scenarios	5	

Syllabus

Introduction to cyber physical systems CPS architecture components and design principles

Modeling of CPS continuous and discrete event systems hybrid systems and feedback control

Communication protocols and networking in CPS sensor networks and IoT integration

Real time computation scheduling synchronization and resource management in CPS

Applications of CPS in autonomous vehicles healthcare smart grids and industrial automation challenges and future trends

Reference Books

- 1 Introduction to Embedded Systems A Cyber Physical Systems Approach, Edward A Lee and Sanjit A Seshia, Second Edition 2017, MIT Press.
- 2 Cyber Physical Systems Design Modeling and Simulation, Rajeev Alur and Insup Lee, 2021, Cambridge University Press.

25CPS3303E - CYBER PHYSICAL SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3303E	CYBER PHYSICAL SYSTEMS	CPS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25CPS3404 - FOUNDATIONS OF HYBRID AND EMBEDDED SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3404	FOUNDATIONS OF HYBRID AND EMBEDDED SYSTEMS	DVP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of embedded systems architecture and design principles	2	
CO2	Explain the concepts of hybrid systems combining continuous and discrete dynamics	2	
CO3	Apply modeling and simulation techniques for hybrid and embedded system design	3	
CO4	Analyze real time operating systems scheduling and communication mechanisms in embedded systems	4	

Syllabus

Introduction to embedded systems hardware and software components design challenges and development lifecycle

Hybrid systems fundamentals continuous time systems discrete event systems and hybrid automata

Modeling and simulation of hybrid systems using state space models and tools such as MATLAB Simulink

Real time operating systems RTOS tasks scheduling synchronization and inter process communication

Reference Books

- 1 Embedded Systems Architecture A Comprehensive Guide for Engineers and Programmers, Tammy Noergaard, Second Edition 2013, Newnes.
- 2 Introduction to Embedded Systems A CyberPhysical Systems Approach Edward, A Lee and Sanjit A Seshia, Second Edition 2017, MIT Press.
- 3 Hybrid Systems Computation and Control Rajeev Alur Thomas, Henzinger and Eduardo D Sontag, 2000, Springer.

25CPS3505 - CLOUD COMPUTING FOR IOT ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3505	CLOUD COMPUTING FOR IOT ENGINEERS	CCIOTE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts, architecture, and service models of cloud computing relevant to IoT.	2	
CO2	Analyze and compare various cloud platforms, services, and deployment models for IoT applications.	3	
CO3	Design and demonstrate IoT data management and analytics using cloud services.	4	
CO4	Integrate IoT systems with cloud infrastructure ensuring scalability, security, and reliability.	5	

Syllabus

Introduction to cloud computing service models IaaS PaaS SaaS and deployment models public private hybrid and community clouds

Cloud architecture virtualization containers and resource management for IoT

Cloud platforms for IoT AWS IoT Core Azure IoT Hub Google Cloud IoT and IBM Watson IoT

Cloud based IoT data analytics real time streaming edge cloud integration and big data processing

Reference Books

- 1 Cloud Computing Concepts Technology and Architecture, Thomas Erl Ricardo Puttini and Zaigham Mahmood, 2013, Prentice Hall.
- 2 Internet of Things Principles and Paradigms, Rajkumar Buyya Amir Vahid Dastjerdi, 2016, Morgan Kaufmann.
- 3 Cloud Computing for IoT, Chandrakant D Patil, 2021, CRC Press.

25CPS3506 - WIRELESS SENSOR NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3506	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	
CO2	Apply WSNs Architectures, Energy consumption of Sensor nodes for the development of the IoT based Systems	3	
CO3	Apply different MAC protocols, Routing mechanism used for the development of WSNs Application	3	
CO4	Apply node and network management related concepts for real time application of WSNs	3	
CO5	Evaluate and analyse the programming & interfacing of WSNs using the hardware/software tool	5	

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

Reference Books

- 1 Fundamentals of Wireless sensor network, W.Dargie,C. Poellabaue, 2010, John Wiley & SonS.
- 2 Protocols And Architectures for Wireless Sensor Networks, Holger Karl & Andreas Willig, 2005, Jhon.
- 3 Networking Wireless Sensors , B. Krishnamachari, 2005, Cambridge University Press.

25CPS3507 - EDGE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CPS3507	EDGE COMPUTING	EC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts and architecture of edge computing	2	
CO2	Explain the relationship between cloud computing fog computing and edge computing	2	
CO3	Apply edge computing principles for data processing and real time analytics	3	
CO4	Analyze edge computing frameworks platforms and communication models	4	

Syllabus

Introduction to edge computing concepts architecture benefits and comparison with cloud computing

Edge and fog computing models edge nodes gateways and micro data centers

Communication and networking technologies for edge computing IoT protocols and data transmission

Edge analytics machine learning at the edge and data management techniques

Reference Books

- 1 Edge Computing A Primer, Niall Gallagher, 2020, Independently Published.
- 2 Fog and Edge Computing Principles and Paradigms, Rajkumar Buyya and Satish Narayana Srirama, 2019, Wiley.
- 3 Architecting the Internet of Things at the Edge, Debmalva Biswas, 2021, Springer.

25CSB3101 - CRYPT ANALYSIS & CYBER DEFENSE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3101	CRYPT ANALYSIS & CYBER DEFENSE	CACD	R	3	0	2	0	4

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.	2	PO1, PO2
CO2	Apply RC4 algorithm, Block Cipher Modes of Operation and Multiple Encryption for given plaintext.	2	PO1, PO2
CO3	Apply Public key Crypto Systems to ensure Secure communication of data	3	PO1, PO2
CO4	Apply Hash, MAC algorithms and Digital Signatures to achieve Message Authentication and Integrity.	3	PO1, PO2
CO5	Implement security goals like Confidentiality, Integrity, Authentication algorithms.	3	PO1, PO5

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

- 1 Cryptography and Network Security: Principles and Practice, William Stallings, 5th Edition (2011), Pearson.
- 2 Applied Cryptography: Protocols, Algorithms, and Source Code in C, Bruce Schneier, 2nd Edition (1996), John Wiley & Sons.
- 3 Cybersecurity Incident Management Guide, Gerard Johansen, 1st Edition (2017), Packt Publishing.
- 4 Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering, Hamid R. Nemati, Li Yang, 1st Edition (2011), IGI Global.
- 5 Cryptography and Network Security, Behrouz A. Forouzan, Indian Edition (2012), McGraw-Hill (TMH).

25CSB3101A - CRYPT ANALYSIS & CYBER DEFENSE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3101A	CRYPT ANALYSIS & CYBER DEFENSE	CACD	A	4	1	2	0	6

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.	2	PO1, PO2
CO2	Apply RC4 algorithm, Block Cipher Modes of Operation and Multiple Encryption for given plaintext.	2	PO1, PO2
CO3	Apply Public key Crypto Systems to ensure Secure communication of data	3	PO1, PO2
CO4	Apply Hash, MAC algorithms and Digital Signatures to achieve Message Authentication and Integrity.	3	PO1, PO2
CO5	Analyze the principles of Incident Response and Risk Management Processes.	4	PO1, PO3
CO6	Implement security goals like Confidentiality, Integrity, Authentication algorithms.	3	PO1, PO5

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 (2011), Pearson.
- 2 Applied Cryptography: Protocols, Algorithms, and Source Code in C, Bruce Schneier, 2nd Edition (1996), John Wiley & Sons.
- 3 Cybersecurity Incident Management Guide, Gerard Johansen, 1st Edition (2017), Packt Publishing.
- 4 Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering, Hamid R. Nemati, Li Yang, 1st Edition (2011), IGI Global.
- 5 Cryptography and Network Security, Behrouz A. Forouzan, Indian Edition (2012), McGraw-Hill (TMH).

25CSB3101E - CRYPT ANALYSIS & CYBER DEFENSE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3101E	CRYPT ANALYSIS & CYBER DEFENSE	CACD	E	4	1	2	0	6

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.	2	PO1, PO2
CO2	Apply RC4 algorithm, Block Cipher Modes of Operation and Multiple Encryption for given plaintext.	2	PO1, PO2
CO3	Apply Public key Crypto Systems to ensure Secure communication of data	3	PO1, PO2
CO4	Apply Hash, MAC algorithms and Digital Signatures to achieve Message Authentication and Integrity.	3	PO1, PO2
CO5	Analyze the principles of Incident Response and Risk Management Processes.	4	PO1, PO3
CO6	Implement security goals like Confidentiality, Integrity, Authentication algorithms.	3	PO1, PO5

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 (2011), Pearson.
- 2 Applied Cryptography: Protocols, Algorithms, and Source Code in C, Bruce Schneier, 2nd Edition (1996), John Wiley & Sons.
- 3 Cybersecurity Incident Management Guide, Gerard Johansen, 1st Edition (2017), Packt Publishing.
- 4 Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering, Hamid R. Nemati, Li Yang, 1st Edition (2011), IGI Global.
- 5 Cryptography and Network Security, Behrouz A. Forouzan, Indian Edition (2012), McGraw-Hill (TMH)q.

25CSB3202 - NETWORK AND INFRASTRUCTURE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3202	NETWORK AND INFRASTRUCTURE SECURITY	NS	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
CO2	Understand hardware procedures for digital certificate and techniques of user authentication.	2	PO3, PO5
CO3	Apply standardization schemes to maintain security in Web application and secured paymentsystem. Identify security vulnerability in the system.	3	PO3, PO5
CO4	Apply security concepts in Email and Internet Protocol. Understand and apply security principles offirewall, gateways and IDS.	3	PO3, PO5

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, 2017, Pearson.
- 2 Cryptography and Network Security, Behrouz A. Forouzan, Debdeep Mukhopadhyay, 4th Edition, 2015, Tata McGraw Hill Education Pvt. Ltd..
- 3 Network Security Essentials, William Stallings, 7th Edition, 2017, Pearson Education.
- 4 Network Security: A Practical Approach, Gopalakrishnan Sankaranarayanan, Chandan Mazumdar, 5th Edition, Pearson Education.
- 5 Wireless Network Security, Wolfgang Osterhage, 2nd Edition, Routledge / CRC Press.
- 6 Network Security, Charlie Kaufman, Radia Perlman, Mike Speciner, 2nd Edition, Prentice Hall.
- 7 Network Security Bible, Eric Cole, Ronald L. Krutz, James Conley, 2005, Wiley.
- 8 Guide to Wireless Network Security, Mark Ciampa, -, Springer.
- 9 NIST SP 800-97, National Institute of Standards and Technology (NIST), -, NIST Publication.

25CSB3203 - INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3203	INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES	IBCC	R	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, PO2
CO2	Understand the basics of Blockchain and mining process	2	PO2, PO3
CO3	Apply about the different types of Blockchain and consensus algorithms	3	PO4, PO5
CO4	Apply the different types of crypto currencies & its importance and Blockchain applications	4	PO11

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 BloT, Supply chain management, Healthcare

Reference Books

- 1 Cryptography and Network Security: Principles and Practice, William Stallings, 7th Edition, 2017, Pearson Education.
- 2 Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, 2016, Princeton University Press.
- 3 Blockchain: Blueprint for a New Economy, Melanie Swan, 2015, O Reilly Media.
- 4 Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhilash K A, Meena Karthikeyan, 2021, University Press (India) Private Limited.

25CSB3304 - DIGITAL FORENSICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3304	DIGITAL FORENSICS	DF	R	3	0	0	2	3.5

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
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
CO3	Analyze the fundamental concepts of digital evidence and its significance in forensic investigations.	4	PO1, PO2
CO4	Evaluate the value and admissibility of digital evidence and applying case study methodologies to analyze and link evidence to users.	5	PO1
CO5	Implement and Evaluating acquisition methods for digital evidence related to system security	5	PO5

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 growing challenge of evidence recovery from mobile phones and handheld devices, Case study: Mobile phone evidence in a bomb hoax. E-mails, Messaging Systems, and Mobile Phones: Locating evidence from Internet browsing, Messaging systems, Email analysis and the processing of large e-mail databases.

Reference Books

- 1 Practical Digital Forensics, Richard Boddington, 1st Edition (2016), Packt Publishing.
- 2 Digital Forensics, Andre Arnes, 1st Edition (2018), John Wiley & Sons.
- 3 Cisco CyberOps Associate (Chapters 15, 16 & 28), Cisco Networking Academy, Training Material, Cisco Press.
- 4 Fundamentals of Network Forensics: A Research Perspective, R. C. Joshi, Emmanuel S. Pilli, 1st Edition (2016), Springer.
- 5 Computer Forensics and Cyber Crime: An Introduction, Marjie T. Britz, 3rd Edition (2013), Prentice Hall.

- 6 MIT(CS)-202: Digital Forensics (Study Material), Dr. Jeetendra Pande, Dr. Ajay Prasad, Course Material (PDF), Uttarakhand Open University.

25CSB3304A - DIGITAL FORENSICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3304A	DIGITAL FORENSICS	DF	A	4	1	0	2	5.5

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.	2	PO1, PO2
CO2	Apply RC4 algorithm, Block Cipher Modes of Operation and Multiple Encryption for given plaintext.	2	PO1, PO2
CO3	Apply Public key Crypto Systems to ensure Secure communication of data	3	PO1, PO2
CO4	Apply Hash, MAC algorithms and Digital Signatures to achieve Message Authentication and Integrity.	3	PO1, PO2
CO5	Analyze the principles of Incident Response and Risk Management Processes.	4	PO1, PO3
CO6	Implement security goals like Confidentiality, Integrity, Authentication algorithms.	3	PO1, PO5

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.

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- 1 Practical Digital Forensics, Richard Boddington, 1st Edition (2016), Packt Publishing.
- 2 Digital Forensics, Andre Arnes, 1st Edition (2018), John Wiley & Sons.
- 3 Cisco CyberOps Associate (Chapters 15, 16 & 28), Cisco Networking Academy, Training Material (2019), Cisco Press.
- 4 Fundamentals of Network Forensics: A Research Perspective, R. C. Joshi, Emmanuel S. Pilli, 1st Edition (2016), Springer.
- 5 Computer Forensics and Cyber Crime: An Introduction, Marjie T. Britz, 3rd Edition (2013), Prentice Hall.
- 6 Digital Forensics (MIT(CS)-202 Study Material), Dr. Jeetendra Pande, Dr. Ajay Prasad, Course Material (2018), Uttarakhand Open University.

25CSB3304E - DIGITAL FORENSICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3304E	DIGITAL FORENSICS	DF	E	4	1	0	2	5.5

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.	2	PO1, PO2
CO2	Apply RC4 algorithm, Block Cipher Modes of Operation and Multiple Encryption for given plaintext.	2	PO1, PO2
CO3	Apply Public key Crypto Systems to ensure Secure communication of data	3	PO1, PO2
CO4	Apply Hash, MAC algorithms and Digital Signatures to achieve Message Authentication and Integrity.	3	PO1, PO2
CO5	Analyze the principles of Incident Response and Risk Management Processes.	4	PO1, PO3
CO6	Implement security goals like Confidentiality, Integrity, Authentication algorithms.	3	PO1, PO5

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.

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- 5 Computer Forensics and Cyber Crime: An Introduction, Marjie T. Britz, 3rd Edition (2013), Prentice Hall.
- 6 Digital Forensics (MIT(CS)-202 Study Material), Dr. Jeetendra Pande, Dr. Ajay Prasad, Course Material (2018), Uttarakhand Open University.

25CSB3405 - DATABASE SYSTEM AND SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3405	DATABASE SYSTEM AND SECURITY	DSS	R	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	PO3
CO2	Apply Data Encryption and Database Vaults	3	PO5
CO3	Apply secret password Encryption & Decryption.	3	PO2
CO4	Apply Data Encryption for the Data in Transit.	3	PO5

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 , 1st Edition,2011, Apress.

- 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, 1st Edition, 2010 , Tata McGraw Hill.
- 3 Database Security and Auditing, Hassan A. Afyouni, 2005, Cengage Learning.

25CSB3406 - PROGRAMMING FOR SMART CONTRACTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3406	PROGRAMMING FOR SMART CONTRACTS	PSC	R	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
CO3	Evaluating advanced smart contracts with various test setups and trycatch assertions.	5	PO4
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 (Ethereum), 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 self-destruct, Adding a Constructor and self-destruct, 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 Create-React app, Web3 setup, deploying contracts, local contracts instances, rendering contract data, Form setup, Contracts Design Patterns Contract self destruction pattern, Factory contract pattern, Name Registry pattern, Mapping iterator pattern Setting up private blockchain network, Boot node tool peer 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, Gavin Zheng, Longxiang Gao, Liqun Huang, Jian Guan, -, -.
- 2 Beginning Ethereum and Solidity with React, Greg Lim, -, -.
- 3 Mastering Bitcoin: Programming the Open Blockchain, Andreas M. Antonopoulos, -, -.
- 4 Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications, Lorne Lantz, Daniel Cawrey, -, -.
- 5 Smart Contract Development with Solidity and Ethereum: Building Smart Contracts with the Azure Blockchain, Akhil Mittal, -, -.
- 6 Building on Ethereum with Solidity and React, Cliff Hall, -, -.

25CSB3407 - CLOUD SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3407	CLOUD SECURITY	CS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basic security principles such as confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defense in depth, least privilege, and the importance of security in cloud services like PaaS, IaaS, and SaaS.	1	PO1
CO2	Apply cryptographic methods like symmetric and public-key encryption, ciphers, hashing, digital signatures, key management, and tools like X.509 certificates and OpenSSL to protect information.	3	PO2
CO3	Analyze security issues by examining how VMs are separated, identifying weaknesses in systems like ESX/ESXi, and recognizing attacks like guest hopping, VM migration, and hyperjacking.	4	PO2
CO4	Analyze storage security, including HIDPS, log management, and data loss prevention, and examine legal issues like data ownership, penetration testing rights, and compliance responsibilities for cloud providers and customers.	4	PO2

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 Intro to stream ciphers (Random number generators (RNGs, One-Time Pad (OTP), Linear feedback shift registers (LFSRs) , Trivium: a modern stream cipher), block ciphers, modes of operation (DES, TDES, AES), Symmetric and Asymmetric Encryption, public-key cryptography (RSA Algorithm), hashing (MD5, SHA-512), 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.

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, Wiley (John Wiley & Sons).
- 3 Cloud Computing: Implementation, Management, and Security, John Rittinghouse, James Ransome, 2009, CRC Press.
- 4 Developing and Securing the Cloud, B. Thuraisingham, 2012, CRC Press.
- 5 Securing the Cloud: Cloud Computer Security Techniques and Tactics, V.J.R. Winkler, 2011, Syngress.

- 6 Securing the Cloud, J.R. Vic Winkler, 2011, Syngress.

25CSB3508 - SECURE SOFTWARE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3508	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 illustrate the resources that addresses these	2	PO1, PO2
CO2	Interpret the process of analysing and validating security requirements.	2	PO1, PO2
CO3	Apply software testing methods to analyse the software code to improve the quality and describe the assembly changes for system design.	3	PO3
CO4	Apply the governance security policy to ensure enterprise	3	PO5, PO6

Syllabus

Security is a Software Issue Introduction, The Problem, Software Assurance and Software Security, Sources of Software Insecurity, Benefits of detecting software security defects early, Managing Secure Software Development. What makes Software Secure Defining Properties of Secure Software, how to influence the security properties of software, How to Assert and Specify Desired Security Properties.

Secure Software Specifications and Requirements Introduction, Requirements Engineering for Secure Software Misuse and Abuse Cases, The SQUARE Process Model, Requirements Elicitation and Prioritization

Secure Software Architecture and Design Software Security Practices for Architecture and Design, Architectural Risk Analysis, Software Security Knowledge for Architecture and Design Security Principles, Security Guidelines and Attack Patterns. Secure Coding and Testing Code Analysis, Coding Practices, Testing Considerations throughout the SDLC, Security and Complexity Security Failures and Attacker Perspectives for Security Analysis, System Complexity Drivers and Security.

Governance and Security Role of governance in software security life cycle, 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, May 2008, Addison Wesley.
- 2 Software Security: Building Security In, Gary McGraw, July 2017, Addison Wesley.
- 3 Secure Coding in C and C++, Robert C. Seacord , Edition, March 2013, Addison Wesley.
- 4 Governing for Enterprise Security (GES) Implementation Guide, Jody R. Westby , 2007, Software Engineering Institute.
- 5 Building Secure Software, John Viega, Gary McGraw, September 2001, Addison Wesley.

25CSB3509 - WEB SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3509	WEB SECURITY	WS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and discuss Web Security Concepts.	2	PO1, PO2, PO4
CO2	Identify different techniques involved in protecting privacy and the principles of Web Security.	2	PO1, PO2, PO4
CO3	Deploy SSL server Certificates clientside digital certificates and Microsofts Authenticode	3	PO2, PO3, PO4
CO4	Apply ethical hacking techniques to identify and exploit security vulnerabilities in web applications.	3	PO2, PO3, PO5

Syllabus

Introduction: Introduction to 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.

Web Server Security The Webs War on Your Privacy PrivacyProtecting 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 ClientSide Digital Certificates Code Signing and Microsofts Authenticode Security for Content Providers Pornography Filtering Software and Censorship

Hacking Web Applications: Introduction, Cross-site scripting, Cross-Site Request Forgery, Broken Authentication and Session Management, SQL Injection, Code Injection, Client-side attacks

Reference Books

- 1 Web Application Security Exploitation and Countermeasures for Modern Web Applications Second Edition, Andrew Hoffman, 2024, O Reilly Media, Inc..
- 2 Web Application Security: A Beginner's Guide, Bryan Sullivan, Vincent Liu, 2012, The McGraw Hill Companies.
- 3 Web Security, Privacy & Commerce, Garfinkel S, Spafford G., 2002, O Reilly Media, Inc..
- 4 Developers Guide to Web Application Security, Michael Cross, 2007, Syngress Publishing, Inc..
- 5 Web Security for Developers, Malcom McDonald, 2020, No Starch Press, Inc..
- 6 Web Security for Developers: Real Threats, Practical Defense, McDonald M., 2020, No Starch Press.

25CSB3510 - SECURITY GOVERNANCE & MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSB3510	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	
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	
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	
CO4	Applying Incident Management and Response Metrics to various organizations	3	

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, 2012, Auerbach,.
- 4 Principles of Information Security,, Michael E. Whitman,, 2015, Cengage Learning India Private Limited.
- 5 Fundamental of Information Security, Sanil Nadkarni , 2020, bpb.

25CSC3101 - FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3101	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	FCS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	CO-1 Understand the principles of Cloud Computing, Cloud Economics, DevOps & cloud platforms. PO3, PO4, PSO2 2	2	PO2, PO3
CO2	Apply the appropriate Cloud Services to various scenarios	3	PO2, PO3
CO3	Deploy, manage and operate applications on scalable, highly available and fault-tolerant Cloud Platforms. PO3, PO4, PSO2 4	4	PO3, PO4
CO4	Develop skills for implementing cloud solutions for various scenarios	4	PO3, PO4
CO5	Develop skills in containerization, orchestration, and reproducible research practices	4	PO4

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.

MODULE-2 Cloud storage Landscape Storage as a service ,Using cloud storage services ,Distributed Databases: Cosmos DB, using Amazon cloud storage services, using Azure cloud storage services, using google cloud storage services, using open stack cloud storage services

MODULE-3 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.

Streaming data to the cloud, Scientific streaming examples, basic design challenges of streaming systems, amazon knesis and fire house, streaming data with azure, google dataflow, knesis, 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 Scientific Cloud Computing (in Encyclopedia of Cloud Computing), Kyle Chard, Ian Foster, 2016, Wiley.
- 4 Cloud Computing for Scientific Research, Benjamin Disraeli, 2020, Kindly.
- 5 Fundamentals of Cloud Computing, A. Kannammal, 2020, Cengage.
- 6 High Performance Computing: Modern Systems and Practices, Thomas Sterling, Matthew Anderson, Maciej Brodowicz, 2017, Morgan Kaufmann.

25CSC3101A - FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3101A	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	FCS	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles of Cloud Computing, Cloud Economics, DevOps & cloud platforms.	2	
CO2	Apply the appropriate Cloud Services to various scenarios	3	
CO3	Deploy, manage and operate applications on scalable, highly available and fault-tolerant Cloud Platforms.	4	
CO4	Develop skills for implementing cloud solutions for various scenarios.	4	
CO5	Develop skills in containerization, orchestration, and reproducible research practices	4	

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.

MODULE-2 Cloud storage Landscape Storage as a service ,Using cloud storage services ,Distributed Databases: Cosmos DB, using Amazon cloud storage services, using Azure cloud storage services, using google cloud storage services, using open stack 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.

MODULE-4 Streaming data to the cloud, Scientific streaming examples, basic design challenges of streaming systems, amazon knesis and fire house, streaming data with azure, google dataflow, knesis, 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 Scientific Cloud Computing (in Encyclopedia of Cloud Computing), Kyle Chard, Ian Foster, 2016, Wiley.
- 4 Cloud Computing for Scientific Research, Benjamin Disraeli, 2020, Kindly.
- 5 Fundamentals of Cloud Computing, A. Kannammal, 2020, Cengage.
- 6 High Performance Computing: Modern Systems and Practices, Thomas Sterling, Matthew Anderson, Maciej Brodowicz, 2017, Morgan Kaufmann.

25CSC3101E - FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3101E	FUNDAMENTALS OF CLOUD-BASED SCIENTIFIC COMPUTING	FCS	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	CO-1 Understand the principles of Cloud Computing, Cloud Economics, DevOps & cloud platforms. PO3, PO4, PSO2 2	2	PO3, PO4
CO2	Apply the appropriate Cloud Services to various scenarios.	3	PO5, PO6
CO3	CO-3 Deploy, manage and operate applications on scalable, highly available and fault-tolerant Cloud Platforms. PO3, PO4, PSO2 4	4	PO3, PO4
CO4	Develop skills for implementing cloud solutions for various scenarios	4	PO3, PO4
CO5	Develop skills in containerization, orchestration, and reproducible research practices	4	PO3, PO4

Syllabus

MODULE-1 Fundamentals of Cloud Computing, Architecture Layers of Cloud Computing, Scientific Service on the Cloud, Scientific Programming Paradigms, Delivering Scientific Computing Services on the Cloud.

MODULE-2 Cloud storage Landscape Storage as a service ,Using cloud storage services ,Distributed Databases: Cosmos DB, using Amazon cloud storage services, using Azure cloud storage services, using google cloud storage services, using open stack cloud storage services

MODULE-3 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.

Streaming data to the cloud, Scientific streaming examples, basic design challenges of streaming systems, amazon knesis and fire house, streaming data with azure, google dataflow, knesis, spark and array of things

MODULE-5 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 Scientific Cloud Computing (in Encyclopedia of Cloud Computing), Kyle Chard, Ian Foster, 2016, Wiley.
- 4 Cloud Computing for Scientific Research, Benjamin Disraeli, 2020, Kindly.
- 5 Fundamentals of Cloud Computing, A. Kannammal, 2020, Cengage.
- 6 High Performance Computing: Modern Systems and Practices , Thomas Sterling, Matthew Anderson, Maciej Brodowicz , 2017, Morgan Kaufmann.

25CSC3202 - DEVELOPMENT OF SCIENTIFIC APPLICATIONS USING CLOUD-BASED TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3202	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
CO2	Proficiently use major cloud platforms and tools for managing scientific data and performing analytics.	3	PO1, PO3, PO5
CO3	Develop scalable scientific applications using parallel and distributed computing principles.	3	PO1, PO2, PO5
CO4	Effectively deploy, monitor, and manage scientific applications in the cloud, ensuring performance	4	PO1, PO2

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: Realworld examples of scientific applications developed using cloud-based technology

Reference Books

- 1 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, 1st Edition (2017), MIT Press.
- 2 Cloud Computing Technology, Thomas Erl, Zaigham Mahmood (commonly associated with Erls cloud books), 1st Edition (2014), Prentice Hall.
- 3 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Ricardo Puttini, Zaigham Mahmood, 1st Edition (2013), Prentice Hall.
- 4 Mastering Cloud Computing: Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, 1st Edition (2019), Morgan Kaufmann.
- 5 Cloud Computing: Principles, Systems and Applications, Nick Antonopoulos, Lee Gillam, 1st Edition (2010), Springer.
- 6 Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis, 1st Edition (2014), Wiley.

25CSC3203 - DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3203	DISTRIBUTED SCIENTIFIC COMPUTING IN THE CLOUD	DSCC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the core principles of distributed and cloud computing in the context of scientific problems.	3	PO1, PO2
CO2	Analyze different cloud service models (IaaS, PaaS, SaaS) for deploying scientific applications.	3	PO2, PO3
CO3	Implement distributed scientific applications using frameworks like MPI, Spark, or Dask.	3	PO1, PO3
CO4	Design and automate scalable scientific workflows using tools such as Nextflow, Snakemake, or Airflow.	4	PO1, PO2

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

Reference Books

- 1 Distributed Systems: Principles and Paradigms, Andrew S. Tanenbaum, Maarten van Steen, 2nd Edition, 2007, Pearson Prentice Hall.
- 2 Cloud Computing: Theory and Practice, Dan C. Marinescu, 2nd Edition, 2017, Morgan Kaufmann (Elsevier).
- 3 Parallel Scientific Computing in C++ and MPI, George Karniadakis, Robert M. Kirby II, 2003, Cambridge University Press.

25CSC3304 - CLOUD BASED HIGH PERFORMANCE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3304	CLOUD BASED HIGH PERFORMANCE COMPUTING	CHC	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamentals of Cloud Computing and HPC	3	PO1, PO2
CO2	Analyze Cloud Infrastructure and Resource Management	4	PO2, PO3, PO5
CO3	Analyze Programming Models for Cloud-based HPC	4	PO2, PO3, PO5
CO4	Analyze HPC Applications on the Cloud	4	PO1, PO2, PO3
CO5	Analyze Advanced Cloud-based HPC Technique, and future trends	4	PO3, PO11

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 Cloud Computing: Theory and Practice, Dan C. Marinescu, 2nd Edition (2017), Morgan Kaufmann.
- 2 High Performance Computing: Modern Systems and Practices, Thomas Sterling, Matthew Anderson, Maciej Brodowicz, 1st Edition (2018), Morgan Kaufmann.
- 3 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, 1st Edition (2017), MIT Press.
- 4 High Performance Computing for Dummies, Jack Dongarra, Sun Microsystems, AMD, 1st Edition (2005), Wiley.
- 5 Introduction to High Performance Computing for Scientists and Engineers, Georg Hager, Gerhard Wellein, 1st Edition (2011), Chapman & Hall / CRC.
- 6 High Performance Heterogeneous Computing, Jack Dongarra, Alexey L. Lastovetsky, 1st Edition (2009), Wiley.
- 7 HPC for the Age of AI and Cloud Computing, NVIDIA Corporation, 1st Edition (2024), NVIDIA.

25CSC3304A - CLOUD BASED HIGH PERFORMANCE COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3304A	CLOUD BASED HIGH PERFORMANCE COMPUTING	CHC	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamentals of Cloud Computing and HPC	3	PO1, PO2
CO2	Analyze Cloud Infrastructure and Resource Management	4	PO2, PO3, PO5
CO3	Analyze Programming Models for Cloud-based HPC	4	PO2, PO3, PO5
CO4	Analyze HPC Applications on the Cloud	4	PO1, PO2, PO3
CO5	Analyze Advanced Cloud-based HPC Technique, and future trends	4	PO3, PO11

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 Cloud Computing: Theory and Practice, Dan C. Marinescu, 2nd Edition (2017), Morgan Kaufmann.
- 2 High Performance Computing: Modern Systems and Practices, Thomas Sterling, Matthew Anderson, Maciej Brodowicz, 1st Edition (2018), Morgan Kaufmann.
- 3 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, 1st Edition (2017), MIT Press.
- 4 High Performance Computing for Dummies, Jack Dongarra, Sun Microsystems, AMD, 1st Edition (2005), Wiley.
- 5 Introduction to High Performance Computing for Scientists and Engineers, Georg Hager, Gerhard Wellein, 1st Edition (2011), Chapman & Hall / CRC.
- 6 High Performance Heterogeneous Computing, Jack Dongarra, Alexey L. Lastovetsky, 1st Edition (2009), Wiley.
- 7 HPC for the Age of AI and Cloud Computing, NVIDIA Corporation, 1st Edition (2024), NVIDIA Press.

25CSC3304E - CLOUD BASED HIGH PERFORMANCE COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3304E	CLOUD BASED HIGH PERFORMANCE COMPUTING	CHC	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamentals of Cloud Computing and HPC	3	PO1, PO2
CO2	Analyze Cloud Infrastructure and Resource Management	4	PO2, PO3, PO5
CO3	Analyze Programming Models for Cloud-based HPC	4	PO2, PO3, PO5
CO4	Analyze HPC Applications on the Cloud	4	PO1, PO2, PO3
CO5	Analyze Advanced Cloud-based HPC Technique, and future trends	4	PO3, PO11

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 Cloud Computing: Theory and Practice, Dan C. Marinescu, 2nd Edition (2017), Morgan Kaufmann.
- 2 High Performance Computing: Modern Systems and Practices, Thomas Sterling, Matthew Anderson, Maciej Brodowicz, 1st Edition (2018), Morgan Kaufmann.
- 3 Cloud Computing for Science and Engineering, Ian Foster, Dennis B. Gannon, 1st Edition (2017), MIT Press.
- 4 High Performance Computing for Dummies, Jack Dongarra, Sun Microsystems, AMD, 1st Edition (2005), Wiley.
- 5 Introduction to High Performance Computing for Scientists and Engineers, Georg Hager, Gerhard Wellein, 1st Edition (2011), Chapman & Hall / CRC.
- 6 High Performance Heterogeneous Computing, Jack Dongarra, Alexey L. Lastovetsky, 1st Edition (2009), Wiley.
- 7 HPC for the Age of AI and Cloud Computing, NVIDIA Corporation, 1st Edition (2024), NVIDIA Press.

25CSC3405 - CLOUD-BASED GRID COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3405	CLOUD-BASED GRID COMPUTING	CGC	R	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.	2	PO1, PO2, PO4
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	3	PO1, PO2, PO5
CO3	Evaluate various cloud deployment models and computing categories, assess the pros and cons of cloud computing, and analyze virtualization	3	PO1, PO3, PO4
CO4	Analyze and apply security models, methods, and practices to ensure robust security across grid and cloud computing	4	PO1, PO2, PO3

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 Systems: Principles and Paradigms, Andrew S. Tanenbaum, Maarten van Steen, -, Pearson Education.
- 2 Service-Oriented Architecture: Concepts, Technology, and Design, Thomas Erl, -, Prentice Hall.
- 3 Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Zaigham Mahmood, Ricardo Puttini, -, Prentice Hall.
- 4 The Grid: Blueprint for a New Computing Infrastructure, Ian Foster, Carl Kesselman, -, Morgan Kaufmann.
- 5 Virtualization Essentials, Matthew Portnoy, -, Wiley.
- 6 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, -, O Reilly Media.
- 7 Cloud Computing for Business (The Open Group Series), Christian Baun, Marcel Kunze, Jens Nimis, Stefan Tai, 2011, Springer.
- 8 Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, 2009, O Reilly Media.
- 9 Mastering Cloud Computing: Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, 2013, Morgan Kaufmann.

25CSC3406 - CLOUD COMPUTING FOR SCIENTIFIC DISCOVERY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3406	CLOUD COMPUTING FOR SCIENTIFIC DISCOVERY	CCFSD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Harness cloud computing resources to accelerate scientific data analysis	3	PO1, PO2, PO5
CO2	Implement cloud-based collaboration tools for interdisciplinary scientific projects	3	PO3, PO4, PO9
CO3	Optimize scientific workflows using cloud computing architectures	4	PO3, PO4, PO5
CO4	Evaluate the impact of cloud computing on scientific innovation and discovery	5	PO4, PO5, 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 Collaboration for Science: A Guide to Collaborative Research in the Cloud, John Goodhue, Bruce Segee, 1st Edition, 2013, CRC Press.
- 2 Architecting for Scale: High Availability for Your Growing Applications, Lee Atchison, 1st Edition, 2016, O Reilly Media.
- 3 Cloud Native Patterns: Designing Change-Tolerant Software, Cornelia Davis, 1st Edition, 2019, O Reilly Media.
- 4 Cloud Computing for Data Analysis, Yanpei Chen, Sara Alspaugh, Randy Katz, 1st Edition, 2014, O Reilly Media.
- 5 Data Science in the Cloud: Tools, Techniques, and Applications, David Langer, Soledad Galli, 1st Edition, 2017, Apress.
- 6 Collaborative Research in the Cloud: Understanding and Managing the Risks, Elizabeth Cummings, Anne Fitzgerald, 1st Edition, 2014, Edward Elgar Publishing.

25CSC3507 - CLOUD-BASED SCALABLE COMPUTING AND BIG DATA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3507	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	PO2, PO4
CO2	Outline scalable computing techniques for handling big data in cloud environments.	2	PO2
CO3	Demonstrate distributed computing paradigms and their applications in big data analytics	3	PO2
CO4	Develop hands-on experience with popular big data analytics tools and platforms.	4	PO1

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, Zaigham Mahmood, 2013, Pearson.
- 2 Data Science for Business: What You Need to Know about Data Mining and Data-Analytic, Michael Minelli, Jamie Andrews, Murex D. Flanagan, 2019, O Reilly Media.
- 3 Hands-On Serverless Computing, Kuldeep Chowhan, 2018, Packt Publishing Ltd.
- 4 Big Data and Analytics, Seema Acharya, 2019, Wiley.

25CSC3508 - PARALLEL COMPUTING FOR SCIENTISTS USING CLOUD PLATFORMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CSC3508	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	PO1, PO4
CO2	Develop parallel algorithms and applications using popular programming paradigms	2	PO3
CO3	Utilize cloud computing platforms for deploying and scaling applications	3	PO2, PO4
CO4	Apply parallel computing techniques to real-world scientific problems	3	PO3

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

MODULE-2 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

MODULE-2 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

MODULE-4 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, McGraw-Hill Education.
- 2 Patterns for Parallel Programming, Timothy G. Mattson, Beverly A. Sanders, 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, Jim Jeffers, 2023, Morgan Kaufmann.
- 5 Parallel Programming in C with MPI and OpenMP, Michael J. Quinn, 2004, McGraw-Hill Education.
- 6 Parallel and High Performance Computing, Robert Robey, Yuliana Zamora, 2021, Manning Publications.

25CTI3101 - DIGITAL FORENSICS & INCIDENT RESPONSE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3101	DIGITAL FORENSICS & INCIDENT RESPONSE	DFIR	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply forensic principles for acquiring and preserving digital evidence in a forensically sound manner	3	PO2, PO4
CO2	Analyze disk images, memory dumps, and logs to reconstruct security incidents	4	PO2, PO3
CO3	Evaluate incident response strategies and align them with real-world scenarios	5	PO1, PO2
CO4	Document and present digital evidence that is admissible in a legal environment	5	PO1, PO2

Syllabus

Introduction to digital forensics & IR, evidence types (volatile, non-volatile, transient), chain of custody, legal admissibility, order of volatility, forensic methodology (Identification, Acquisition, Analysis, Reporting).

Imaging tools (dd, FTK Imager, Guymager), file systems (FAT32, NTFS, EXT4), file carving & metadata, deleted file recovery, partition & boot sectors, timeline analysis using MAC timestamps.

Capturing volatile memory (DumpIt, FTK Imager), process & DLL injection analysis, registry hives, malware in memory, Volatility plugins (pslist, netscan, hivelist, malfind), host indicator correlation.

Incident categories & playbooks, first responder actions, log forensics (Windows, Syslog, Web logs), timeline reconstruction, legal/organizational report writing, courtroom evidence presentation.

Reference Books

- 1 Incident Response & Computer Forensics, Jason T. Luttgens, Matthew Pepe, Kevin Mandia, 2014, McGraw Hill.
- 2 Digital Forensics and Incident Response, Gerard Johansen, 2022, Packt Publishing.
- 3 Practical Forensic Imaging, Bruce Nikkel, 2016, No Starch Press.

25CTI3101A - DIGITAL FORENSICS & INCIDENT RESPONSE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3101A	DIGITAL FORENSICS & INCIDENT RESPONSE	DFIR	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply forensic principles for acquiring and preserving digital evidence in a forensically sound manner	3	PO2, PO3
CO2	Analyze disk images, memory dumps, and logs to reconstruct security incidents	4	PO2, PO3
CO3	Evaluate incident response strategies and align them with real-world scenarios	5	PO1, PO3
CO4	Document and present digital evidence that is admissible in a legal environment	5	PO1, PO3

Syllabus

Introduction to digital forensics & IR, evidence types (volatile, non-volatile, transient), chain of custody, legal admissibility, order of volatility, forensic methodology (Identification, Acquisition, Analysis, Reporting).

Imaging tools (dd, FTK Imager, Guymager), file systems (FAT32, NTFS, EXT4), file carving & metadata, deleted file recovery, partition & boot sectors, timeline analysis using MAC timestamps.

Capturing volatile memory (DumpIt, FTK Imager), process & DLL injection analysis, registry hives, malware in memory, Volatility plugins (pslist, netscan, hivelist, malfind), host indicator correlation.

Incident categories & playbooks, first responder actions, log forensics (Windows, Syslog, Web logs), timeline reconstruction, legal/organizational report writing, courtroom evidence presentation.

Reference Books

- 1 Incident Response & Computer Forensics, Jason T. Luttgens, Matthew Pepe, Kevin Mandia, 2014, McGraw Hill.
- 2 Digital Forensics and Incident Response, Gerard Johansen, 2022, Packt Publishing.
- 3 Practical Forensic Imaging, Bruce Nikkel, 2016, No Starch Press.

25CTI3101E - DIGITAL FORENSICS & INCIDENT RESPONSE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3101E	DIGITAL FORENSICS & INCIDENT RESPONSE	DFIR	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply forensic principles for acquiring and preserving digital evidence in a forensically sound manner	3	PO2, PO3
CO2	Analyze disk images, memory dumps, and logs to reconstruct security incidents	4	PO2, PO3
CO3	Evaluate incident response strategies and align them with real-world scenarios	5	PO1, PO3
CO4	Document and present digital evidence that is admissible in a legal environment	5	PO2, PO4

Syllabus

Introduction to digital forensics & IR, evidence types (volatile, non-volatile, transient), chain of custody, legal admissibility, order of volatility, forensic methodology (Identification, Acquisition, Analysis, Reporting).

Imaging tools (dd, FTK Imager, Guymager), file systems (FAT32, NTFS, EXT4), file carving & metadata, deleted file recovery, partition & boot sectors, timeline analysis using MAC timestamps.

Capturing volatile memory (DumpIt, FTK Imager), process & DLL injection analysis, registry hives, malware in memory, Volatility plugins (pslist, netscan, hivelist, malfind), host indicator correlation.

Incident categories & playbooks, first responder actions, log forensics (Windows, Syslog, Web logs), timeline reconstruction, legal/organizational report writing, courtroom evidence presentation.

Reference Books

- 1 Incident Response & Computer Forensics, Jason T. Luttgens, Matthew Pepe, Kevin Mandia, 2014, McGraw Hill.
- 2 Digital Forensics and Incident Response, Gerard Johansen, 2022, Packt Publishing.
- 3 Practical Forensic Imaging, Bruce Nikkel, 2016, No Starch Press.

25CTI3102 - MALWARE ANALYSIS & REVERSE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3102	MALWARE ANALYSIS & REVERSE ENGINEERING	MARE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply static and dynamic analysis techniques to investigate the behavior of malicious software	3	PO1, PO3
CO2	Analyze malware samples using sandboxing and behavioral monitoring tools	4	PO2, PO4
CO3	Evaluate obfuscation, packing, and anti-analysis techniques used by advanced malware	5	PO1, PO3
CO4	Reverse engineer binary executables using disassemblers and debuggers	5	PO2, PO4

Syllabus

Introduction to Malware & Analysis Types Malware types (viruses, worms, trojans, spyware, ransomware, rootkits), malware lifecycle, indicators of compromise (IOCs), analysis types (Static, Dynamic, Hybrid), malware infection vectors, legal and ethical considerations in malware handling

Static Analysis Techniques File signature analysis, PE file structure and headers (Win32), hashing and strings extraction (Strings, FLOSS), basic assembly (x86) for malware understanding, identifying function calls/imports/syscalls, anti-virus evasion basics, obfuscation techniques

Dynamic Analysis & Behavioral Analysis Controlled environment setup (VM, sandbox), system behavior logging (filesystem, registry, network), tools (Procmon, Process Explorer, Wireshark), malware sandboxing (Cuckoo Sandbox), anti-debugging and anti-VM detection, persistence mechanisms

Reverse Engineering & Code Disassembly Disassemblers and debuggers (Ghidra, x64dbg, IDA Free), static code navigation, breakpoints, stepping, register monitoring, shellcode analysis, unpacking techniques, reverse engineering simple keygens/droppers, writing basic malware analysis reports

Reference Books

- 1 Practical Malware Analysis, Michael Sikorski, Andrew Honig, 1st Edition, No Starch Press.
- 2 Malware Analysts Cookbook, Michael Hale Ligh, Steven Adair, Blake Hartstein, Matthew Richard, 1st Edition, Wiley.
- 3 The IDA Pro Book, Chris Eagle, 2nd Edition, No Starch Press.

25CTI3102A - MALWARE ANALYSIS & REVERSE ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3102A	MALWARE ANALYSIS & REVERSE ENGINEERING	MARE	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply static and dynamic analysis techniques to investigate the behavior of malicious software	3	PO2, PO4
CO2	Analyze malware samples using sandboxing and behavioral monitoring tools	4	PO1, PO3
CO3	Evaluate obfuscation, packing, and anti-analysis techniques used by advanced malware	5	PO2, PO4
CO4	Reverse engineer binary executables using disassemblers and debuggers	5	PO1, PO3

Syllabus

Introduction to Malware & Analysis Types Malware types (viruses, worms, trojans, spyware, ransomware, rootkits), malware lifecycle, indicators of compromise (IOCs), analysis types (Static, Dynamic, Hybrid), malware infection vectors, legal and ethical considerations in malware handling

Static Analysis Techniques File signature analysis, PE file structure and headers (Win32), hashing and strings extraction (Strings, FLOSS), basic assembly (x86) for malware understanding, identifying function calls/imports/syscalls, anti-virus evasion basics, obfuscation techniques

Dynamic Analysis & Behavioral Analysis Controlled environment setup (VM, sandbox), system behavior logging (filesystem, registry, network), tools (Procmon, Process Explorer, Wireshark), malware sandboxing (Cuckoo Sandbox), anti-debugging and anti-VM detection, persistence mechanisms

Reverse Engineering & Code Disassembly Disassemblers and debuggers (Ghidra, x64dbg, IDA Free), static code navigation, breakpoints, stepping, register monitoring, shellcode analysis, unpacking techniques, reverse engineering simple keygens/droppers, writing basic malware analysis reports

Reference Books

- 1 Practical Malware Analysis, Michael Sikorski, Andrew Honig, 1st Edition, No Starch Press.
- 2 Malware Analysts Cookbook, Michael Hale Ligh, Steven Adair, Blake Hartstein, Matthew Richard, 1st Edition, Wiley.
- 3 The IDA Pro Book, Chris Eagle, 2nd Edition, No Starch Press.

25CTI3102E - MALWARE ANALYSIS & REVERSE ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3102E	MALWARE ANALYSIS & REVERSE ENGINEERING	MARE	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply static and dynamic analysis techniques to investigate the behavior of malicious software	3	PO2, PO4
CO2	Analyze malware samples using sandboxing and behavioral monitoring tools	4	PO1, PO3
CO3	Evaluate obfuscation, packing, and anti-analysis techniques used by advanced malware	5	PO2, PO4
CO4	Reverse engineer binary executables using disassemblers and debuggers	5	PO1, PO3

Syllabus

Introduction to Malware & Analysis Types Malware types (viruses, worms, trojans, spyware, ransomware, rootkits), malware lifecycle, indicators of compromise (IOCs), analysis types (Static, Dynamic, Hybrid), malware infection vectors, legal and ethical considerations in malware handling

Static Analysis Techniques File signature analysis, PE file structure and headers (Win32), hashing and strings extraction (Strings, FLOSS), basic assembly (x86) for malware understanding, identifying function calls/imports/syscalls, anti-virus evasion basics, obfuscation techniques

Dynamic Analysis & Behavioral Analysis Controlled environment setup (VM, sandbox), system behavior logging (filesystem, registry, network), tools (Procmon, Process Explorer, Wireshark), malware sandboxing (Cuckoo Sandbox), anti-debugging and anti-VM detection, persistence mechanisms

Reverse Engineering & Code Disassembly Disassemblers and debuggers (Ghidra, x64dbg, IDA Free), static code navigation, breakpoints, stepping, register monitoring, shellcode analysis, unpacking techniques, reverse engineering simple keygens/droppers, writing basic malware analysis reports

Reference Books

- 1 Practical Malware Analysis, Michael Sikorski, Andrew Honig, 1st Edition, No Starch Press.
- 2 Malware Analysts Cookbook, Michael Hale Ligh, Steven Adair, Blake Hartstein, Matthew Richard, 1st Edition, Wiley.
- 3 The IDA Pro Book, Chris Eagle, 2nd Edition, No Starch Press.

25CTI3203 - ETHICAL HACKING & OFFENSIVE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3203	ETHICAL HACKING & OFFENSIVE SECURITY	EHOS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply ethical hacking methodologies to simulate real-world attacks within legal boundaries	3	PO1, PO2
CO2	Analyze system and network vulnerabilities using open-source attack frameworks	4	PO2, PO3
CO3	Evaluate exploitation techniques across different platforms and services	5	PO1, PO4
CO4	Design an end-to-end ethical hacking exercise and report findings to stakeholders	5	PO2, PO3

Syllabus

Ethical Hacking Fundamentals Introduction to offensive security, legal and ethical hacking boundaries, vulnerability vs. exploit vs. payload, hacking phases (Recon, Scanning, Gaining Access, Maintaining Access, Covering Tracks), rules of engagement and authorization, bug bounty and red teaming ethics

Reconnaissance & Scanning Passive vs. active reconnaissance, DNS enumeration, WHOIS, Google dorking, subdomain enumeration (Sublist3r, Amass), port scanning and fingerprinting using Nmap, banner grabbing and service enumeration, OS and version detection, vulnerability identification (CVE scanning)

Exploitation Techniques Exploiting web applications (SQLi, XSS, LFI, Command Injection), network attacks (SMB, RDP, FTP, SNMP, etc.), exploiting misconfigurations, password attacks (brute force, dictionary, Hydra, John the Ripper), client side attacks (phishing, payload delivery), exploit frameworks (Metasploit basics)

Post Exploitation & Reporting Privilege escalation (Windows/Linux), maintaining access (persistence), cleaning logs and anti-forensics, reverse shell handling, capturing flags/credentials/tokens, reporting vulnerabilities (templates and formats), ethical hacking report writing and presentation

Reference Books

- 1 The Web Application Hackers Handbook, Dafydd Stuttard, Marcus Pinto, 2nd Edition, Wiley.
- 2 Penetration Testing: A Hands-On Introduction, Georgia Weidman, 1st Edition, No Starch Press.
- 3 Hacking: The Art of Exploitation, Jon Erickson, 2nd Edition, No Starch Press.
- 4 Ethical Hacking and Penetration Testing Guide, Rafay Baloch, 1st Edition, CRC Press.
- 5 Metasploit: The Penetration Testers Guide, David Kennedy, Jim OGorman, Devon Kearns, Mati Aharoni, 1st Edition, No Starch Press.

25CTI3204 - VULNERABILITY ASSESSMENT & PENETRATION TESTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3204	VULNERABILITY ASSESSMENT & PENETRATION TESTING	VAPT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply industry-standard tools and techniques for vulnerability scanning and risk assessment	3	PO1, PO3
CO2	Analyze and prioritize discovered vulnerabilities using CVSS and contextual information	4	PO2, PO3
CO3	Evaluate penetration testing techniques across system layers and technologies	5	PO2, PO3
CO4	Design VAPT reports and mitigation plans aligned with compliance frameworks	5	PO1, PO3

Syllabus

VA vs PT overview, VAPT life cycle, scoping & RoE, OWASP & PTES, NIST 800-115, legal & compliance (PCI-DSS, ISO 27001).

Nessus, OpenVAS, Nikto, ZAP, Burp Suite, Nmap, CVE & CVSS scoring, auth/unauth scans, false positives.

Manual/automated testing, privilege escalation (Linux/Windows), web flaws (IDOR, deserialization, SSRF), SMB/SNMP/FTP, Exploit-DB.

Executive/technical reports, MITRE ATT&CK mapping, remediation, severity scoring, compliance (PCI, GDPR), validation & retesting.

Reference Books

- 1 The Basics of Hacking and Penetration Testing, Patrick Engebretson, 2013, Syngress.
- 2 Web Application Vulnerabilities & Prevention, Dafydd Stuttard, Marcus Pinto, 2011, Wiley.
- 3 Penetration Testing Essentials, Sean-Philip Oriyano, 2016, Sybex.
- 4 Advanced Penetration Testing, Wil Allsopp, 2017, Wiley.
- 5 Hands-On Vulnerability Management with Nessus, Himanshu Kumar, 2020, Packt.

25CTI3305 - BLUE TEAM OPERATIONS & SIEM (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3305	BLUE TEAM OPERATIONS & SIEM	BTOS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply threat detection techniques using real-time log sources and correlation rules	3	PO2, PO3
CO2	Analyze suspicious activities using SIEM dashboards and investigation workflows	4	PO2, PO3
CO3	Evaluate and tune detection rules and alerts to reduce false positives and alert fatigue	5	PO2, PO3
CO4	Design threat hunting strategies and incident detection playbooks for known attack patterns	5	PO2, PO3

Syllabus

Introduction to Blue Team Operations Security operations, MITRE ATT&CK, SOC roles, incident categories, detection engineering, false positive triage.

Log Sources & Data Normalization Syslog, Windows Event Logs, centralized logging, parsing, normalization, event correlation, telemetry ingestion.

Security Information & Event Management (SIEM) SIEM architecture, rule types, SPL, ELK, Sigma rules, custom detection use cases.

Threat Hunting & Playbook Engineering IOC/TTP-based hunting, hypothesis models, playbook design, YARA, Sigma, threat intel, purple teaming.

Reference Books

- 1 Blue Team Handbook Incident Response Edition, Don Murdoch, 1st Edition (2014), CreateSpace.
- 2 Applied SIEM Threat Detection Using ELK & Splunk, Wouter Hindriks, Steve Anson, 1st Edition (2021), Packt.
- 3 Cybersecurity Blue Team Toolkit, Nadean H. Tanner, 1st Edition (2019), Wiley.
- 4 The Practice of Network Security Monitoring, Richard Bejtlich, 1st Edition (2013), No Starch Press.

25CTI3305A - BLUE TEAM OPERATIONS & SIEM (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3305A	BLUE TEAM OPERATIONS & SIEM	BTOS	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply threat detection techniques using real-time log sources and correlation rules	3	PO2, PO3
CO2	Analyze suspicious activities using SIEM dashboards and investigation workflows	4	PO2, PO3
CO3	Evaluate and tune detection rules and alerts to reduce false positives and alert fatigue	5	PO2, PO3
CO4	Design threat hunting strategies and incident detection playbooks for known attack patterns	5	PO2, PO4

Syllabus

Introduction to Blue Team Operations Security operations, MITRE ATT&CK, SOC roles, incident categories, detection engineering, false positive triage.

Log Sources Data Normalization Syslog, Windows Event Logs, centralized logging, parsing, normalization, event correlation, telemetry ingestion

Security Information Event Management (SIEM) SIEM architecture, rule types, SPL, ELK, Sigma rules, custom detection use cases

Threat Hunting Playbook Engineering IOC/TTP based hunting, hypothesis models, playbook design, YARA, Sigma, threat intel, purple teaming.

Reference Books

- 1 Blue Team Handbook Incident Response Edition, Don Murdoch, 1st Edition (2014), CreateSpace.
- 2 Applied SIEM Threat Detection Using ELK Splunk, Wouter Hindriks, Steve Anson, 1st Edition (2021), Packt.
- 3 Cybersecurity Blue Team Toolkit, Nadean H. Tanner, 1st Edition (2019), Wiley.
- 4 The Practice of Network Security Monitoring, Richard Bejtlich, 1st Edition (2013), No Starch Press.
- 5 Enterprise SIEM Deployment Guide, Arun E Thomas, 1st Edition (2020), BPB Publications.

25CTI3305E - BLUE TEAM OPERATIONS & SIEM (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3305E	BLUE TEAM OPERATIONS & SIEM	BTOS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply threat detection techniques using real-time log sources and correlation rules	3	PO2, PO3
CO2	Analyze suspicious activities using SIEM dashboards and investigation workflows	4	PO2, PO3
CO3	Evaluate and tune detection rules and alerts to reduce false positives and alert fatigue	5	PO4, PO5
CO4	Design threat hunting strategies and incident detection playbooks for known attack patterns	5	PO2, PO4

Syllabus

Introduction to Blue Team Operations Security operations, MITRE ATT&CK, SOC roles, incident categories, detection engineering, false positive triage.

Log Sources Data Normalization Syslog, Windows Event Logs, centralized logging, parsing, normalization, event correlation, telemetry ingestion.

Security Information Event Management (SIEM) SIEM architecture, rule types, SPL, ELK, Sigma rules, custom detection use cases.

Threat Hunting Playbook Engineering IOC/TTP-based hunting, hypothesis models, playbook design, YARA, Sigma, threat intel, purple teaming.

Reference Books

- 1 Blue Team Handbook: Incident Response Edition, Don Murdoch, 1st Edition (2014), CreateSpace.
- 2 Applied SIEM Threat Detection Using ELK Splunk, Wouter Hindriks, Steve Anson, 1st Edition (2021), Packt.
- 3 Cybersecurity Blue Team Toolkit, Nadean H. Tanner, 1st Edition (2019), Wiley.

25CTI3306 - SOC MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3306	SOC MANAGEMENT	SOC	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply SOC organizational models and workflows to structure team roles and responsibilities	3	
CO2	Analyze alert management workflows, escalation processes, and response prioritization	4	
CO3	Evaluate the effectiveness of SOC operations using SLAs, KPIs, and detection metrics	5	
CO4	Design a functional SOC blueprint with shift models, tiered response, and playbook integration	5	

Syllabus

M1 SOC Structure, Roles & Responsibilities - SOC models: In-house, MSSP, Hybrid - Analyst tiers: Tier 1, 2, 3, and Incident Manager - Responsibilities per role (L1 triage, L2 validation, L3 containment) - Typical 24x7 shift models (Follow-the-sun, On-call) - SOC staffing and shift scheduling - Coordination with Red Team, IR, and CTI

M2 Alert Triage, Escalation & Workflow Management - L1 > L2 > L3 alert handoff workflow - Playbook-based triage and escalation logic - Ticketing systems: TheHive, ServiceNow, JIRA - Alert enrichment: asset context, threat intel, historical patterns - Common false positives and alert fatigue handling - Analyst decision-making in real-time

M3 SOC Metrics, SLAs & Reporting - Key metrics: MTTR, MTTD, false positive rate, analyst fatigue index - SLA definition per alert type (e.g., phishing vs. privilege misuse) - KPI dashboards and shift performance metrics - Analyst productivity tracking - Daily SOC reports: handover logs, incident summaries - Compliance & audit readiness reporting

M4 SOC Design, Playbooks & Automation - SOC architecture: SIEM, SOAR, log pipeline, endpoints, case management - Designing Tier 1 and Tier 2 playbooks - Use case lifecycle: idea > rule > tuning > suppression - Automation examples: phishing triage, alert enrichment - Tools for workflow automation (SOAR platforms) - SOC blueprints and maturity models (NIST, MITRE D3FEND)

Reference Books

- 1 Designing and Building a Security Operations Center , David Nathans , 2014, Syngress .
- 2 Security Operations Center: Building, Operating, and Maintaining , Joseph Muniz et al. , 2021, Cisco Press.
- 3 Cybersecurity Operations Handbook John Rittinghouse, , William Hancock , 2016, CRC Press.
- 4 The Blue Team Field Manual (BTFM) , Alan J. White, 2017, Independently Published .
- 5 The SOC Analyst Mindset , Tyler Hudak , No Starch (Coming soon) , Pre-release notes.

25CTI3306A - SOC MANAGEMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3306A	SOC MANAGEMENT	SOC	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply SOC organizational models and workflows to structure team roles and responsibilities	3	
CO2	Analyze alert management workflows, escalation processes, and response prioritization	4	
CO3	Evaluate the effectiveness of SOC operations using SLAs, KPIs, and detection metrics	5	
CO4	Design a functional SOC blueprint with shift models, tiered response, and playbook integration	5	

Syllabus

M1 SOC Structure, Roles & Responsibilities - SOC models: In-house, MSSP, Hybrid - Analyst tiers: Tier 1, 2, 3, and Incident Manager - Responsibilities per role (L1 triage, L2 validation, L3 containment) - Typical 24x7 shift models (Follow-the-sun, On-call) - SOC staffing and shift scheduling - Coordination with Red Team, IR, and CTI

M2 Alert Triage, Escalation & Workflow Management - L1 > L2 > L3 alert handoff workflow - Playbook-based triage and escalation logic - Ticketing systems: TheHive, ServiceNow, JIRA - Alert enrichment: asset context, threat intel, historical patterns - Common false positives and alert fatigue handling - Analyst decision-making in real-time

M3 SOC Metrics, SLAs & Reporting - Key metrics: MTTR, MTTD, false positive rate, analyst fatigue index - SLA definition per alert type (e.g., phishing vs. privilege misuse) - KPI dashboards and shift performance metrics - Analyst productivity tracking - Daily SOC reports: handover logs, incident summaries - Compliance & audit readiness reporting

M4 SOC Design, Playbooks & Automation - SOC architecture: SIEM, SOAR, log pipeline, endpoints, case management - Designing Tier 1 and Tier 2 playbooks - Use case lifecycle: idea > rule > tuning > suppression - Automation examples: phishing triage, alert enrichment - Tools for workflow automation (SOAR platforms) - SOC blueprints and maturity models (NIST, MITRE D3FEND)

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- 1 Designing and Building a Security Operations Center , David Nathans , 2014, Syngress.
- 2 Security Operations Center: Building, Operating, and Maintaining , Joseph Muniz et al., 2021, Cisco Press .
- 3 Cybersecurity Operations Handbook , John Rittinghouse, William Hancock, 2016, CRC Press .
- 4 The Blue Team Field Manual (BTFM) , Alan J. White , 2017, Independently Published .
- 5 The SOC Analyst Mindset , Tyler Hudak , No Starch (Coming soon) , Pre-release notes.

25CTI3306E - SOC MANAGEMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3306E	SOC MANAGEMENT	SOC	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	CO1 Apply SOC organizational models and workflows to structure team roles and responsibilities	3	
CO2	Analyze alert management workflows, escalation processes, and response prioritization	4	
CO3	Evaluate the effectiveness of SOC operations using SLAs, KPIs, and detection metrics	5	
CO4	Design a functional SOC blueprint with shift models, tiered response, and playbook integration	5	

Syllabus

M1 SOC Structure, Roles & Responsibilities - SOC models: In-house, MSSP, Hybrid - Analyst tiers: Tier 1, 2, 3, and Incident Manager - Responsibilities per role (L1 triage, L2 validation, L3 containment) - Typical 24x7 shift models (Follow-the-sun, On-call) - SOC staffing and shift scheduling - Coordination with Red Team, IR, and CTI

M2 Alert Triage, Escalation & Workflow Management - L1 > L2 > L3 alert handoff workflow - Playbook-based triage and escalation logic - Ticketing systems: TheHive, ServiceNow, JIRA - Alert enrichment: asset context, threat intel, historical patterns - Common false positives and alert fatigue handling - Analyst decision-making in real-time

M3 SOC Metrics, SLAs & Reporting - Key metrics: MTTR, MTTD, false positive rate, analyst fatigue index - SLA definition per alert type (e.g., phishing vs. privilege misuse) - KPI dashboards and shift performance metrics - Analyst productivity tracking - Daily SOC reports: handover logs, incident summaries - Compliance & audit readiness reporting

M4 SOC Design, Playbooks & Automation - SOC architecture: SIEM, SOAR, log pipeline, endpoints, case management - Designing Tier 1 and Tier 2 playbooks - Use case lifecycle: idea > rule > tuning > suppression - Automation examples: phishing triage, alert enrichment - Tools for workflow automation (SOAR platforms) - SOC blueprints and maturity models (NIST, MITRE D3FEND)

Reference Books

- 1 Designing and Building a Security Operations Center , David Nathans , 2014, Syngress.
- 2 Security Operations Center: Building, Operating, and Maintaining, Joseph Muniz et al., 2021, Cisco Press.
- 3 Cybersecurity Operations Handbook , John Rittinghouse, William Hancock , 2016, CRC Press.
- 4 The Blue Team Field Manual (BTFM) , Alan J. White, 2017, Independently Published.
- 5 The SOC Analyst Mindset, Tyler Hudak , No Starch (Coming soon) , Pre-release notes.

25CTI3407 - CLOUD SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3407	CLOUD SECURITY	CS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply cloud security frameworks to design secure identity, network, and storage services	3	PO1, PO3
CO2	Analyze configuration vulnerabilities in cloud-native services across public cloud platforms	4	PO2, PO3
CO3	Evaluate cloud provider security features for IAM, encryption, logging, and threat detection	5	PO1, PO3
CO4	Design cloud security incident response and compliance strategies aligned with standards	5	PO1, PO3

Syllabus

Cloud Security Architecture & Governance

Identity, Network & Infrastructure Security

Monitoring, Logging & Threat Detection in Cloud

Cloud Incident Response & Compliance

Reference Books

- 1 AWS Certified Security Specialty Guide, Stuart Scott, 2021, Packt.
- 2 Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif, 2009, O Reilly.
- 3 Architecting Cloud Computing Solutions, Kevin L. Jackson, Scott Goessling, 2018, Packt.
- 4 Cloud Security Handbook, E. Rose, 2022, Independently Published.
- 5 Cloud Security and Compliance Controls, Ben Potter, Josh Armitage (AWS Whitepaper), Ongoing, AWS.

25CTI3408 - DEVSECOPS & INFRASTRUCTURE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3408	DEVSECOPS & INFRASTRUCTURE SECURITY	DSI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply DevSecOps principles to integrate security across the software development lifecycle	3	PO1, PO2
CO2	Analyze CI/CD pipelines for potential misconfigurations and vulnerabilities	4	PO2
CO3	Evaluate container and infrastructure security practices using industry tools and frameworks	5	PO1, PO2
CO4	Design automated security policies, compliance gates, and runtime defenses in production pipelines	5	PO1, PO2

Syllabus

DevSecOps vs. DevOps, shift-left testing, secure SDLC, SAST, threat modeling, secrets detection, Security as Code

Jenkins/GitHub Actions/GitLab CI, build test deploy security checks, SCA tools, secret management, git secrets, pipeline misconfigurations.

IaC (Terraform, Ansible), IaC scanning (tfsec, Checkov), Dockerfile/image hardening, Kubernetes security, runtime threat defense.

SOAR in CI/CD, policy-as-code (OPA, Sentinel), compliance frameworks, audit logging, canary releases, DevSecOps metrics.

Reference Books

- 1 DevSecOps A Leaders Guide to Producing Secure Software, Jim Bird, 1st Edition (2023), O Reilly.
- 2 Practical DevSecOps, Tony Hsiang Chih Hsu, 1st Edition (2021), Packt.
- 3 Infrastructure as Code: Dynamic Systems, Kief Morris, 2nd Edition (2020), O Reilly.
- 4 Kubernetes Security and Observability, Brendan Creane, Amit Gupta, 1st Edition (2021), O Reilly.
- 5 Pipeline Security, Ahmed Raza, Kevin T. Smith, 1st Edition (2022), Apress.

25CTI3509 - QUANTUM CRYPTOGRAPHY & POST-QUANTUM SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3509	QUANTUM CRYPTOGRAPHY & POST-QUANTUM	QCPS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of quantum computing and its implications on security	3	PO1, PO2
CO2	Analyze classical cryptographic systems vulnerable to quantum attacks	4	PO2, PO3
CO3	Evaluate post-quantum cryptographic schemes and their trade-offs	5	PO1, PO2
CO4	Design secure communication protocols using quantum and post-quantum cryptography	5	PO1, PO2

Syllabus

Basics of quantum computing, Shors and Grovers algorithms, impact on classical cryptography, and quantum safe design overview.

Quantum Cryptography & QKD QKD protocols (BB84, E91), entanglement-based key generation, security proofs, and real world deployment challenges.

Post Quantum Cryptography Algorithms Lattice based, code based, multivariate, and hash based schemes with focus on NIST PQC standardization.

Implementation, Migration & System Design Hybrid cryptosystems, migration strategies, OQS tools, PQC use cases, and hardware software integration challenges

Reference Books

- 1 Quantum Computation and Quantum Information, Michael Nielsen, Isaac Chuang, 10th Anniversary Edition (2011), Cambridge University.
- 2 Post-Quantum Cryptography, Daniel J. Bernstein et al, 1st Edition (2009), Springer.
- 3 Quantum Cryptography and Secret-Key Distillation, Gilles van Assche, 1st Edition (2006), Cambridge University.
- 4 Quantum Cryptography and Secure Communications, Marco Lucamarini, 1st Edition (2022), Wiley.
- 5 Post-Quantum Cryptography: Algorithms and Applications, Nicolas Sendrier (ed.), 1st Edition (2022), Springer.

25CTI3510 - APPLIED CRYPTOGRAPHY FOR CYBERSECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CTI3510	APPLIED CRYPTOGRAPHY FOR CYBERSECURITY	ACC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply core cryptographic primitives (symmetric, asymmetric, hash functions, MACs)	3	PO1, PO3
CO2	Analyze secure protocols like TLS, SSH, PGP, and digital signatures	4	PO1, PO2
CO3	Evaluate the security and efficiency of cryptographic systems used in enterprise systems	5	PO1, PO2
CO4	Implement secure data storage and communication using cryptographic APIs and libraries	5	PO1, PO2

Syllabus

Symmetric and asymmetric encryption, hashing, MACs, KDFs, and random number generation.

Digital signatures, certificate authorities, PKI setup, and secure key exchange methods.

TLS, SSH, email security (S/MIME, PGP), and secure API communication (JWT, OAuth2).

Cryptographic libraries, file encryption, E2EE systems, key management, and avoiding common failures.

Reference Books

- 1 Cryptography and Network Security, William Stallings, 7th Edition, 2020, Pearson.
- 2 Applied Cryptography, Bruce Schneier, 2nd Edition, 2015, Wiley.
- 3 Serious Cryptography, Jean-Philippe Aumasson, 1st Edition, 2017, No Starch Press.
- 4 Practical Cryptography in Python, Seth Nielson, Christopher Monson, 1st Edition, 2019, Apress.
- 5 Understanding Cryptography, Christof Paar, Jan Pelzl, 1st Edition, 2010, Springer.

25DCM3101 - TCP/IP AND OTHER PROTOCOL SUITE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DCM3101	TCP/IP AND OTHER PROTOCOL SUITE	TCP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	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	Analysis of DHCP Theory and Operation, DHCP Architecture, DHCP Auto-Configuration: Network Address Translation	3	PO2, PO3, PSO2
CO3	Analysis of TCP: DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM	3	PO2, PO3, PSO2
CO4	Advancement In Other Protocol Suites: ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12]	4	PO2, PO3, PSO2
CO5	Advanced features in protocols suites and their applications	4	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 WAN ATM 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.

TCP DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM TCP Principal, operational , Segment Structure of simplified TCP, TCP Connection Management Connection Establishment, Transfer, Termination and Reset, Time out and Data flow, Congestion control, DNS Distribution of Name Space and Defined Zones, DNS in Internet.

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)

Reference Books

- 1 TCP/IP Protocol Suite , Behrouz A. Ferouzan , 3rd , Mc-Graw Hill .
- 2 The DHCP Handbook , Ralph Droms, and Ted Lemon , Second Edition, Pearson .
Enabling Enterprise Multi homing With Cisco IOS Network Address Translation (NAT), , Praveen Akkiraju,
- 3 Cisco Consulting Engineering Kevin Delgadillo, Cisco IOS Product Marketing Yakov Rekhter, Cisco Fellow , 3rd, Mc-Graw Hill.
- 4 PRO DNS and Bind , Ronald G.F. Aitchison , Second Edition, Pearson.
- 5 Data and Computer Communications , William Stallings, , 1st, Pearson.

25DCM3101A - TCP/IP AND OTHER PROTOCOL SUITE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DCM3101A	TCP/IP AND OTHER PROTOCOL SUITE	TCP	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	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	Analysis of DHCP Theory and Operation, DHCP Architecture, DHCP Auto-Configuration: Network Address Translation	3	PO2, PO3, PSO2
CO3	Analysis of TCP: DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM	3	PO2, PO3, PSO2
CO4	Advancement In Other Protocol Suites: ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12]	4	PO2, PO3, PSO2
CO5	Advanced features in protocols suites and ther applications	4	PO2, PO3, PSO2
CO6	Simualte and analyse different protocols suites using Cisco packet tracer	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 WAN ATM 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.

TCP 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, Muti 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 , 3rd , Mc-Graw Hill .
- 2 The DHCP Handbook , Ralph Droms, and Ted Lemon , Second Edition, Pearson .
Enabling Enterprise Multi homing With Cisco IOS Network Address Translation (NAT), , Praveen Akkiraju,
- 3 Cisco Consulting Engineering Kevin Delgadillo, Cisco IOS Product Marketing Yakov Rekhter, Cisco Fellow , 3rd, Mc-Graw Hill.
- 4 PRO DNS and Bind , Ronald G.F.Aitchison , 1st, Pearson.
- 5 Data and Computer Communications , William Stallings , 10th , Pearson .

25DCM3101E - TCP/IP AND OTHER PROTOCOL SUITE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DCM3101E	TCP/IP AND OTHER PROTOCOL SUITE	TCP	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Architectural Evolution of TCP/IP, standards, Comparisons between OSI/ISO & TCP/IP Protocol Suite, different Addressing systems, ATM ARP ARP and their analysis	3	
CO2	Analysis of DHCP Theory and Operation, DHCP Architecture, DHCP Auto-Configuration: Network Address Translation	3	
CO3	Analysis of TCP: DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM	3	
CO4	Advancement In Other Protocol Suites: ICMPv4/v6, IGMP, MLD, UDP, IP Fragmentation, IP Sec, EAP][10-12]	4	
CO5	Advanced features in protocols suites and their applications	4	
CO6	Simualte and analyse different protocols suites using Cisco packet tracer	4	

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 WAN ATM 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.

TCP DNS, Connection Mgt, Time-out, Data Flow, Congestion Cont., TLS, DNSSEC, DKIM TCP Principal, operational , Segment Structure of simplified TCP, TCP Connection Management Connection Establishment, Transfer, Termination and Reset, Time out and Data flow, Congestion control, DNS Distribution of Name Space and Defined Zones, DNS in Internet.

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, Muti 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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- 1 TCP/IP Protocol Suite , Behrouz A.Ferouzan , 3rd , Mc-Graw Hill .

- 2 The DHCP Handbook , Ralph Droms, and Ted Lemon , Second Edition, Pearson .
Enabling Enterprise Multi homing With Cisco IOS Network Address Translation (NAT), , Praveen Akkiraju,
- 3 Cisco Consulting Engineering Kevin Delgadillo, Cisco IOS Product Marketing Yakov Rekhter, Cisco Fellow ,
Second Edition, Pearson .
- 4 certification Provider , Ronald G.F.Aitchison , Second Edition, Mc-Graw Hill .
- 5 Data and Computer Communications , William Stallings , Tenth Edition, Pearson .

25DCM3202 - CLOUD COMPUTING AND NETWORKS SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DCM3202	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	"Identify different Topologies and apply various Architecture standards "	3	PO2, PO3, PSO2
CO3	"Apply security concepts in cloud computing "	3	PO2, PO3, PSO2
CO4	"Examine and analyze various Network Security issues "	4	PO2, PO3, PSO2

Syllabus

Introduction to Cloud Networking: Computer Networks, Cloud Networks, Cloud Data Centers, Virtualization: Cloud computing at a glance, Historical developments, Building cloud computing environments, Principals 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 Center 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, Rouge 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

Reference Books

- "Cloud Computing: Concepts, Technology, and Architecture" , Thomas Erl, Ricardo Puttini, and Zaigham Mahmood. , 2, Pearson .
- "Computer Networking: A Top-Down Approach" 2. "Computer Networking: A Top-Down Approach" by James F. Kurose and Keith W. Ross. 2. "Computer Networking: A Top-Down Approach" by James F. Kurose and Keith W. Ross., James F. Kurose and Keith W. Ross. , 8, PEARSON .
- "Cloud Data Centers and Cost Modeling: A Complete Guide To Planning, Designing and Building a Cloud Data Center" 3. "Cloud Data Centers and Cost Modeling: A Complete Guide To Planning, Designing and Building a Cloud Data Center" by Caesar Wu and Rajkumar Buyya. 3. "Cloud Data Centers and Cost Modeling: A Complete Guide To Planning, Designing and Building a Cloud Data Center" by Caesar Wu and Rajkumar Buyya., Caesar Wu and Rajkumar Buyya , 2, Pearson.
- "Virtualization: A Manager's Guide" , Dan Kusnetzky , 2, Pearson.
- "Network Security Essentials: Applications and Standards" 6. "Network Security Essentials: Applications and Standards" by William Stallings. 6. "Network Security Essentials: Applications and Standards" by William Stallings., William Stallings , 6, Pearson.

25DCM3303 - VOIP AND BROADBAND NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DCM3303	VOIP AND BROADBAND NETWORKS	VOIP	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Classical Telephony, IP Networking and SS7 signalling	3	
CO2	Analyze different VoIP Architectures and Protocols	4	
CO3	Analyze Broadband Wireless, Access Technologies, Passive Optical Networks and Fiber-to-the-Home in real time scenario	4	
CO4	Analyze Broadband Optical NWs and Multimedia Network-Connection	4	
CO5	Analyze the signalling and calling procedures for VoIP protocols. Apply the advanced broadband access technologies in real time scenario	4	

Syllabus

Classical Telephony: Line Side/Trunk Side switching, Isochronous Transport, PSTN Signaling, 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): 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)

Broadband Optical NWs and Broadband and Multimedia: Broadband optical Access Introduction, Evolution of optical technology, Trends in Broadband Services, Optical Broad band services, Fiber to neighborhood (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 , Henry Sinnreich and Alan Johnston , 2, Wiley .
- 2 IP Telephony , Oliver Hersent, Jean-Pierre Petit, and David Gurle , 1, Wiley .
- 3 Understanding Session Internet Protocol(SIP) , Alan.B. Johnston , 2, Artech House .
- 4 BROADBAND OPTICAL ACCESS NETWORKS, LEONID G. KAZOVSKY, NING CHENG, WEI-TAO SHAW , 1, Wiley .

- 5 Broadband Optical Access Networks and Fiber-to-the-Home , Chinton Lin , 1, Willey .
- 6 VoIP Technology: Applications and Challenges , Tamal Chakraborty , Iti Saha Misra, Ramjee Prasad , 2, Springer Series in Wireless Technology .
- 7 VoIP - Wireless P2P and New Enterprise Voice Over IP?Hardcover , S Ganguly , 1, John Willey and Sons .

25DCM3303A - VOIP AND BROADBAND NETWORKS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DCM3303A	VOIP AND BROADBAND NETWORKS	VOIP	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Classical Telephony, IP Networking and SS7 signalling	3	
CO2	Analyze different VoIP Architectures and Protocols	4	
CO3	Analyze Broadband Wireless, Access Technologies, Passive Optical Networks and Fiber-to-the-Home in real time scenario	4	
CO4	Analyze Broadband Optical NWs and Multimedia Network-Connection	4	
CO5	Analyze the signalling and calling procedures for VoIP protocols. Apply the advanced broadband access technologies in real time scenario	4	
CO6	Analysis of VoIP Protocols using Cisco packet tracer	4	

Syllabus

Classical Telephony: Line Side/Trunk Side switching, Isochronous Transport, PSTN Signaling, 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): 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,

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- 1 Internet Communications Using SIP , Henry Sinnreich and Alan Johnston , 2, Willey .
- 2 IP Telephony , Oliver Hersent, Jean-Pierre Petit, and David Gurle , 1, Willey .

- 3 Understanding Session Internet Protocol(SIP) , Alan.B. Jhonston , 2, Artech House .
- 4 BROADBAND OPTICALACCESS NETWORKS, LEONID G. KAZOVSKY,NING CHENG,WEI-TAO SHAW , 1, Willey .
- 5 Broadband Optical Access Networks and Fiber-to-the-Home , Chinton Lin , 1, Willey .
- 6 VoIP Technology: Applications and Challenges , Tamal Chakraborty , Iti Saha Misra, Ramjee Prasad , 1, Springer Series in Wireless Technology .
- 7 VoIP - Wireless P2P and New Enterprise Voice Over IP?Hardcover , S Ganguly , 1, John willey and Sons .

25DCM3303E - VOIP AND BROADBAND NETWORKS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DCM3303E	VOIP AND BROADBAND NETWORKS	VOIP	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic concepts of Classical Telephony, IP Networking and SS7 signalling	3	
CO2	Analyze different VoIP Architectures and Protocols	4	
CO3	Analyze Broadband Wireless, Access Technologies, Passive Optical Networks and Fiber-to-the-Home in real time scenario	4	
CO4	Analyze Broadband Optical NWs and Multimedia Network-Connection	4	

Syllabus

Classical Telephony: Line Side/Trunk Side switching, Isochronous Transport, PSTN Signaling ,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): 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),

Broadband Optical NWs and Broadband and Multimedia: Broadband optical Access Introduction, Evolution of optical technology, Trends in Broadband Services, Optical Broad band services, Fiber to neighborhood (FTTX) Architecture, ITU-T PON standards, PON Technology background, Multimedia Network-Connection and Communication Mechanism.

Reference Books

- 1 Internet Communications Using SIP , Henry Sinnreich and Alan Johnston, 2, Willey .
- 2 IP Telephony , Oliver Hersent, Jean-Pierre Petit, and David Gurle , 1, Willey .
- 3 Understanding Session Internet Protocol(SIP) , Alan.B. Jhonston , 2, Artech House .
- 4 BROADBAND OPTICALACCESS NETWORKS, LEONID G. KAZOVSKY,NING CHENG,WEI-TAO SHAW , 1, Willey .
- 5 Broadband Optical Access Networks and Fiber-to-the-Home , Chinton Lin , 1, Willey .

25DCM3404 - 5G MOBILE AND IEEE STANDARDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DCM3404	5G MOBILE AND IEEE STANDARDS	5GMI	R	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	
CO2	Apply the principles of advanced waveforms and air interfaces, 5G Waveforms, Channels, Millimeter wave technology, 5G Radio Access Technologies.	3	
CO3	Apply 5G Evaluation & Applications: MTC, D2D Communication, Multi-hop D2D, Multi-carrier D2D	3	
CO4	Analyze IEEE802Std: 802.11 (WiFi), 802.15.1 (Bluetooth), 802.15.4 (Zigbee), 802.16 (WiMax), 4G/5G	4	
CO5	Analyze IEEE802Std: 802.11 (WiFi), 802.15.1 (Bluetooth), 802.15.4 (Zigbee), 802.16 (WiMax), 4G/5G Analysis and study of networking with 5G and Cloud platforms	4	

Syllabus

Intro. 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 Pillers of 5G, IoT relation to 5G, From ICT to the whole economy, Rationale of 5G: 5G system concept. The 5G Architecture IoT relation to 5G. 5G Radio Access Technologies Design principles Multi-carrier with filtering Nonorthogonal Multiple Access Radio access for dense deployments Radio Access for V2X Communication High data volume, twenty five billion connected devices and wide requirements, Global initiatives, Standardization activities,

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.

5G Evaluation & Applications MTC, D2D Communication, Multi-hop D2D, Multi-carrier D2D Machine-type communications Fundamental techniques for MTC - Massive MTC - Ultra-reliable low latency MTC Device to device (D2D) communications Multi-hop D2D communications Multi operator D2D communication Simulation methodology Evaluation methodology Calibration New challenges in the 5G modeling

IEEE802Std 802.11 (WiFi), 802.15.1 (Bluetooth), 802.15.4 (Zigbee), 802.16 (WiMax), 4G/5G Frame Structures and applications.

Architecture Deployment models Virtualization Introduction to MapReduce Open Stack Opensource cloud Openstack demo, Cloud Computing Case Study with a Google Cloud Platform (GCP) DOCKER Container impact and challenges of 5g on cloud computing.

Reference Books

- 1 Fundamentals of 5G Mobile Networks, , Jonathan Rodriguez, 1st Eidtion. , 1st Eidtion., SPRINGER .
- 2 5G Mobile Communications, , Xiang, Kan Zheng, Xuemin (Sherman) Shen , 1ST Eidtion., SPRINGER .
- 3 5G Mobile and Wireless Communications Technology, , Afif Osseiran, Jose F. Monserrat and Patrick Marsch , 1ST Eidtion., Cambridge University Press, 2016. .
- 4 Cloud Computing: Theory and Practice , Dan C. Marinescu , 1st Eidtion., ELSEVIER .

- 5 "All reference books must be in the format: ""Title"", ""Authors list"", ""Edition"", ""Publisher"" Atleast two internationally reputed authors to be included for Ref. 1 and Ref. 2 Refer to Statutory Body recommendations for the reference books and include them" , Sanjai Sharma , 1st Eidtion., SK Kataria and Sons .

25DCM3505 - IP MULTIMEDIA SUB-SYSTEM AND EMERGING TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DCM3505	IP MULTIMEDIA SUB-SYSTEM AND EMERGING TECHNOLOGIES	IMSET	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret Next-Gen NWs, IMS Standards, Models, IMS Architectures and IMS Core NW	3	PO1, PO2, PO4
CO2	Interpret IMS Protocol Stacks & IMS Operation: H248, Magcao, RTP, RTCP, IMS to IMS Call/Flow Operation	3	PO1, PO2, PO4
CO3	Interpret IMS-PSTN, IMS Services: Comparison of GSM, IMS, PSTN, Web-Msg, Voice Video, VoLTE, RCS	3	PO1, PO2, PO4
CO4	Inspect Emerging Tech. of IMS & Appn: Cloud, IoT Applications, NFV, SDN, PDAS, DSL, Cable-Set-Top Box	4	PO1, PO2, PO4
CO5	Inspect the knowledge of IP Multimedia Subsystems and Emerging Technologies to solve real world problems	4	PO1, PO2, PO4

Syllabus

Introduction. to IMS & IMS Architectures: Next-Gen NWs, IMS Standards, IMS Architectures, IMS Core NW: The History of the IMS Standardization-Trends for telephony services, Evolution of mobile networks, Next Generation Networks, IMS,, IMS service examples. Origin of IMS,IMS Standards, IMS concepts, IMS Architecture, Core network and Access network Architecture reference models, Components and functions, Control Plane and Data plane in IMS, IMS Interface reference points, User identities

IMS Protocol Stacks & IMS Operation: H248, Magcao, RTP, RTCP, IMS to IMS Call/Flow Operation: Session Initiation Protocol, DIAMETER and H.248/Megaco, RTP and RTCP, IMS service path. IMS Layer mapping. IMS and the DNS, IMS session setup, IMS registration, IMS call flow examples, IMS to IMS call, IMS Charging, IMS Security, IMS Scenarios, Role of application servers, Examples

IMS-PSTN, IMS Services: Comparison of GSM, IMS, PSTN, Web-Msg, Voice Video, VoLTE, RCS: Interoperability between PSTN and IMS, Comparison of PSTN, GSM and IMS networks, Establishing a call with the PSTN.Layer 2 and 3 Messages for call flow. Web Messaging-Voice-Video-VoLTE-Rich Communication Services (RCS) Access Network: Fixed Access Mobile access Wireless access

Web Messaging-Voice-Video-VoLTE-Rich Communication Services (RCS) Access Network: Fixed Access Mobile access Wireless accessEmerging Tech. of IMS & Applications: Cloud, IoT Applications, NFV, SDN, PDAS, DSL, Cable-Set-Top Box, Trends of IPM based Mobile Phones- Personal Digital Assistants (PDAS)-Desktops/Laptops Digital Subscriber Line (DSL)-Cable Set-Top Box

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 , 2nd, Elsevier Science .
- 4 Convergence Through All-IP Networks, Asoke K. Talukder, Jayateertha G. M., Nuno M. Garcia, 5th, Pan Stanford.

25DEA3101 - FUNDAMENTALS OF DATA ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DEA3101	FUNDAMENTALS OF DATA ENGINEERING	FDE	R	3	0	2	0	4

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	Build & Evaluate common practical applications	5	PO1, PO2

Syllabus

Introduction to DataEngineering,Data Engineering Lifecycle, Evolution of the Data Engineer, Skills and Activities of Data Engineer, Generation: Source Systems.

Good DataArchitecture, Principles ofGood Data Architecture,Major Architecture Concepts, Examples andTypes 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, 1st Edition, OReilly Media, Inc..
- 2 Data Engineering with Python, Paul Crickard, 1st Edition, Packt Publishing.
- 3 Data Engineering with Apache Spark, Delta Lake, and Lakehouse, Manoj Kukreja, Danil Zburivsky, 1st Edition, Packt Publishing.
- 4 Data, Engineering and Applications, Geetam Singh Tomer, Jitendra Agrawal, Rajesh Kumar Shukla, Sanjeev Sharma, 1st Edition, Springer.
- 5 Data Science: Theory, Analysis and Applications, Qurban A. Memon, Shakeel Ahmed Khoja, 1st Edition, CRC Press.
- 6 Data Engineering Fundamentals: Building Scalable Data Solutions with ETL Pipelines and Strategic Data Architecture Design, Zhaolong Liu, 1st Edition (English Edition), BPB Publications.

25DEA3101A - FUNDAMENTALS OF DATA ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DEA3101A	FUNDAMENTALS OF DATA ENGINEERING	FDE	A	4	1	2	0	6

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 DataEngineering,Data Engineering Lifecycle, Evolution of the Data Engineer, Skills and Activities of Data Engineer, Generation: Source Systems.

Good DataArchitecture, Principles ofGood Data Architecture,Major Architecture Concepts, Examples andTypes 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.

DevelopDatamodelsfordatalakesforstoring,organizingandanalysingvolumesofdata

Reference Books

- 1 Fundamentals of Data Engineering, Joe Reis, Matt Housley, 1st Edition, OReilly Media, Inc..
- 2 Data Engineering with Python, Paul Crickard, 1st Edition, Packt Publishing.
- 3 Data Engineering with Apache Spark, Delta Lake, and Lakehouse, Manoj Kukreja, Danil Zburivsky, 1st Edition, Packt Publishing.
- 4 Data, Engineering and Applications, Geetam Singh Tomer, Jitendra Agrawal, Rajesh Kumar Shukla, Sanjeev Sharma, 1st Edition, Springer.
- 5 Data Science: Theory, Analysis and Applications, Qurban A. Memon, Shakeel Ahmed Khoja, 1st Edition, CRC Press.
- 6 Data Engineering Fundamentals: Building Scalable Data Solutions with ETL Pipelines and Strategic Data Architecture Design, Zhaolong Liu, 1st Edition (English Edition), BPB Publications.

25DEA3101E - FUNDAMENTALS OF DATA ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DEA3101E	FUNDAMENTALS OF DATA ENGINEERING	FDE	E	4	1	2	0	6

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 DataEngineering,Data Engineering Lifecycle, Evolution of the Data Engineer, Skills and Activities of Data Engineer, Generation: Source Systems.

Good DataArchitecture, Principles ofGood Data Architecture,Major Architecture Concepts, Examples andTypes 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.

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- 6 Data Engineering Fundamentals: Building Scalable Data Solutions with ETL Pipelines and Strategic Data Architecture Design, Zhaolong Liu, 1st Edition (English Edition), BPB Publications.

25DEA3202 - DATA EXPLORATION AND PREPARATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DEA3202	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
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
CO3	Analyze dimensionality reduction methods such as PCA and t-SNE to extract meaningful patterns from high-dimensional data.	4	PO3
CO4	Explore advanced topics including text data preprocessing, handling imbalanced datasets, and managing streaming data to address complex data challenges effectively.	3	PO2

Syllabus

Apply Python/R programming for exploratory analysis, evaluate data lifecycle concepts, and apply practical data preprocessing techniques.

Utilize data visualization principles and tools like Matplotlib, Seaborn, or ggplot2 to create both basic and advanced plots for insightful data representation.

Analyze dimensionality reduction methods such as PCA and t-SNE to extract meaningful patterns from high-dimensional data.

Explore advanced topics including text data preprocessing, handling imbalanced datasets, and managing streaming data to address complex data challenges effectively.

Reference Books

- 1 Data Wrangling with pandas, Jacqueline Kazil, Katharine Jarmul, 2016, O Reilly Media.
- 2 Practical Statistics for Data Scientists, Peter Bruce, Andrew Bruce, Peter Gedeck, 2nd Edition, 2020, O Reilly Media.
- 3 NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pramod J. Sadalage, Martin Fowler, 1st Edition, 2012, Addison-Wesley Professional.
- 4 Hadoop: The Definitive Guide, Tom White, 4th Edition, 2015, O Reilly Media.
- 5 Spark: The Definitive Guide: Big Data Processing Made Simple, Bill Chambers, Matei Zaharia, 1st Edition, 2018, O Reilly Media.
- 6 Data Wrangling with Python, Jacqueline Kazil, Katharine Jarmul, 1st Edition, 2016, O Reilly Media.

25DEA3303 - BIG DATA TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DEA3303	BIG DATA TECHNOLOGIES	BDT	R	3	0	0	2	3.5

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
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, PO3, PO4
CO3	Design and implement data models for storing and managing large-scale datasets.	3	PO1, PO3, PO4
CO4	Utilize Big Data processing frameworks like Apache Hadoop and Apache Spark for processing and analyzing large datasets.	3	PO1, PO3, PO4
CO5	Develop and optimize MapReduce programs to perform distributed data processing tasks.	3	PO4
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	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.

Reference Books

- 1 Big Data: A Revolution That Will Transform How We Live, Work, and Think, Viktor Mayer-Schönberger, Kenneth Cukier, 1st Edition, Eamon Dolan/Mariner Books.
- 2 Big Data: Concepts, Technology, and Architecture, Balamarugan Balusamy, Nandhini Abirami R, Seifedine Kadry, Amir Gandomi, 1st Edition, Wiley.
- 3 MapReduce Design Patterns, Donald Miner, Adam Shook, 1st Edition, O'Reilly Media.
- 4 Spark: The Definitive Guide: Big Data Processing Made Simple, Bill Chambers, Matei Zaharia, 1st Edition, O'Reilly Media.
- 5 Hadoop: The Definitive Guide, Tom White, 4th Edition, O'Reilly Media.
- 6 NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pramod J. Sadalage, Martin Fowler, 1st Edition, Addison-Wesley Professional.

25DEA3303A - BIG DATA TECHNOLOGIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DEA3303A	BIG DATA TECHNOLOGIES	BDT	A	4	1	0	2	5.5

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
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
CO4	Utilize Big Data processing frameworks like Apache Hadoop and Apache Spark for processing and analyzing large datasets.	3	PO1
CO5	Develop and optimize Map Reduce programs to perform distributed data processing tasks.	3	PO4
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 Big Data: A Revolution That Will Transform How We Live, Work, and Think, Viktor Mayer-Schönberger, Kenneth Cukier, 1st Edition, Eamon Dolan/Mariner Books.
- 2 Big Data: Concepts, Technology, and Architecture, Balamarugan Balusamy, Nandhini Abirami R, Seifedine Kadry, Amir Gandomi, 1st Edition, Wiley.
- 3 MapReduce Design Patterns, Donald Miner, Adam Shook, 1st Edition, O'Reilly Media.
- 4 Spark: The Definitive Guide: Big Data Processing Made Simple, Bill Chambers, Matei Zaharia, 1st Edition, O'Reilly Media.
- 5 Hadoop: The Definitive Guide, Tom White, 4th Edition, O'Reilly Media.
- 6 NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pramod J. Sadalage, Martin Fowler, 1st Edition, Addison-Wesley Professional.

25DEA3303E - BIG DATA TECHNOLOGIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DEA3303E	BIG DATA TECHNOLOGIES	BDT	E	4	1	0	2	5.5

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
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
CO4	Utilize Big Data processing frameworks like Apache Hadoop and Apache Spark for processing and analyzing large datasets.	3	PO1
CO5	Develop and optimize Map Reduce programs to perform distributed data processing tasks.	3	PO4
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 Big Data: A Revolution That Will Transform How We Live, Work, and Think, Viktor Mayer-Schönberger, Kenneth Cukier, 1st Edition, Eamon Dolan/Mariner Books.
- 2 Big Data: Concepts, Technology, and Architecture, Balamarugan Balusamy, Nandhini Abirami R, Seifedine Kadry, Amir Gandomi, 1st Edition, Wiley.
- 3 MapReduce Design Patterns, Donald Miner, Adam Shook, 1st Edition, O'Reilly Media.
- 4 Spark: The Definitive Guide: Big Data Processing Made Simple, Bill Chambers, Matei Zaharia, 1st Edition, O'Reilly Media.
- 5 Hadoop: The Definitive Guide, Tom White, 4th Edition, O'Reilly Media.
- 6 NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pramod J. Sadalage, Martin Fowler, 1st Edition, Addison-Wesley Professional.

25DEA3404 - DATA WAREHOUSING AND BUSINESS INTELLIGENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DEA3404	DATA WAREHOUSING AND BUSINESS INTELLIGENCE	DWBI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of data warehousing	2	PO1, PO2
CO2	Apply data modeling techniques to design a data warehouse	3	PO1, PO2
CO3	Implement ETL processes to populate a data warehouse	3	PO2, PO3
CO4	Analyze data trends and patterns to identify business opportunities	4	PO4

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

Reference Books

- 1 Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber, 3rd Edition, Elsevier.
- 2 Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Vipin Kumar, 2008, Pearson Education.
- 3 Data Mining, Vikram Pudi, P. Radha Krishna, -, Oxford University Press.
- 4 The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, Ralph Kimball, Margy Ross, 3rd Edition, Wiley.
- 5 Business Intelligence Guidebook: From Data Integration to Analytics, Rick Sherman, 2nd Edition, Morgan Kaufmann.
- 6 Data Warehouse Design: Modern Principles and Methodologies, Matteo Golfarelli, Stefano Rizzi, Alberto Sacc?, 1st Edition , McGraw-Hill Education.
- 7 Business Intelligence Roadmap: The Complete Project Lifecycle for Decision-Support Applications, Larissa T. Moss, Shaku Atre, 2nd Edition, Addison-Wesley Professional.

25DEA3505 - MACHINE LEARNING ENGINEERING FOR BIG DATA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DEA3505	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
CO2	Analyze and address key technical issues in developing ML systems through various real-world case studies.	2	PO1, PO3, PO4
CO3	Apply machine learning techniques in big data analytics, including learning theory, association rule learning, clustering, and classification.	3	PO1, PO3, PO5
CO4	Utilize open-source tools for data analytics to perform basic and advanced analysis of big data.	3	PO1, PO4, PO5

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 Big Data: Principles and Best Practices of Scalable Real-Time Data Systems, Nathan Marz, James Warren, 1st Edition, 2015, Manning.
- 2 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurelien Geron, 2nd Edition, 2019, O Reilly Media.
- 3 Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas M?ller, Sarah Guido, 1st Edition, 2016, O Reilly Media.
- 4 Pattern Recognition and Machine Learning, Christopher M. Bishop, 1st Edition, 2006, Springer.
- 5 Learning Spark: Lightning-Fast Big Data Analysis, Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, 1st Edition, 2015, O Reilly Media.
- 6 Machine Learning for Big Data: Hands-On for Developers and Technical Professionals, Jason Bell, 2014, Wiley.

25DLA3101 - BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3101	BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS	SNTSA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain core blockchain data structures and transaction lifecycle in public and permissioned blockchains	3	PO1, PO2
CO2	Apply cryptographic principles (hashing, digital signatures, wallets) in blockchain systems	3	PO1, PO2
CO3	Analyze consensus protocols and compare fault-tolerance in PoW, PoS, PBFT, and Raft	4	PO2
CO4	Evaluate blockchain architectures across scalability, decentralization, and enterprise-readiness	5	PO2

Syllabus

Blockchain Structures & Architectures

Cryptographic Primitives & Wallet Infrastructure

Consensus Algorithms & Forks

Blockchain Trilemma, Platforms & Deployment Models

Reference Books

- 1 Mastering Blockchain, Imran Bashir, 4th Edition, 2023, Packt Publishing.
- 2 Blockchain Science, Tomaso Aste, 2022, Springer.
- 3 Designing Blockchain Systems, Sara Rouhani, 2024, Springer.
- 4 Hyperledger Fabric Developer Guide, Hyperledger Documentation Team, 2024 Edition, Hyperledger Foundation.
- 5 Ethereum Book, Andreas M. Antonopoulos, 2023 Revision, O Reilly Media.

25DLA3101A - BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3101A	BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS	SNTSA	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain core blockchain data structures and transaction lifecycle in public and permissioned blockchains	3	PO1, PO2
CO2	Apply cryptographic principles (hashing, digital signatures, wallets) in blockchain systems	3	PO1, PO2
CO3	Analyze consensus protocols and compare fault-tolerance in PoW, PoS, PBFT, and Raft	4	PO2
CO4	Evaluate blockchain architectures across scalability, decentralization, and enterprise-readiness	5	PO2

Syllabus

Ledger structure, transaction lifecycle, block validation, Ethereum and Fabric architectures, public vs private vs consortium chains.

Hash functions, Merkle trees, digital signatures, wallet generation, Fabric CA & MSPs, key management and identity binding.

Consensus properties, PoW, PoS, Raft, Kafka, PBFT, forks, reorganizations, and blockchain attack scenarios.

Trilemma (scalability, security, decentralization), Layer 1 & Layer 2 scaling, comparative platform analysis, deployment considerations, and use case suitability.

Reference Books

- 1 Mastering Blockchain, Imran Bashir, 4th Edition, 2023, Packt Publishing.
- 2 Blockchain Science, Tomaso Aste, 2022, Springer.
- 3 Designing Blockchain Systems, Sara Rouhani, 2024, Springer.
- 4 Hyperledger Fabric Developer Guide, Hyperledger Documentation Team, 2024 Edition, Hyperledger Foundation.
- 5 Ethereum Book, Andreas M. Antonopoulos, 2023 Revision, O Reilly Media.

25DLA3101E - BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3101E	BLOCKCHAIN SYSTEMS AND DISTRIBUTED LEDGER FOUNDATIONS	SNTSA	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain core blockchain data structures and transaction lifecycle in public and permissioned blockchains	3	PO1, PO2
CO2	Apply cryptographic principles (hashing, digital signatures, wallets) in blockchain systems	3	PO1, PO2
CO3	Analyze consensus protocols and compare fault-tolerance in PoW, PoS, PBFT, and Raft	4	PO2, PO3
CO4	Evaluate blockchain architectures across scalability, decentralization, and enterprise-readiness	5	PO2, PO3

Syllabus

Ledger structure, transaction lifecycle, block validation, Ethereum and Fabric architectures, public vs private vs consortium chains.

Hash functions, Merkle trees, digital signatures, wallet generation, Fabric CA & MSPs, key management and identity binding.

Consensus properties, PoW, PoS, Raft, Kafka, PBFT, forks, reorganizations, and blockchain attack scenarios.

Trilemma (scalability, security, decentralization), Layer 1 & Layer 2 scaling, comparative platform analysis, deployment considerations, and use case suitability.

Reference Books

- 1 Mastering Blockchain, Imran Bashir, 4th Edition, 2023, Packt Publishing.
- 2 Blockchain Science, Tomaso Aste, 2022, Springer.
- 3 Designing Blockchain Systems, Sara Rouhani, 2024, Springer.
- 4 Hyperledger Fabric Developer Guide, Hyperledger Documentation Team, 2024 Edition, Hyperledger Foundation.
- 5 Ethereum Book, Andreas M. Antonopoulos, 2023 Revision, O Reilly Media.

25DLA3202 - MACHINE LEARNING FOR FINANCIAL RISK & BEHAVIORAL INTELLIGENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3202	MACHINE LEARNING FOR FINANCIAL RISK & BEHAVIORAL INTELLIGENCE	MLFRBI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply supervised and unsupervised ML techniques to structured financial data	3	PO1, PO2
CO2	Design models for credit scoring, fraud detection, and behavioral intelligence in FinTech systems	4	PO2, PO3
CO3	Evaluate ML models using finance-specific metrics and explain model decisions	5	PO2, PO3
CO4	Deploy lightweight predictive pipelines for both enterprise and on-chain data	5	PO2, PO3

Syllabus

Financial Data Preprocessing & Feature Engineering

Supervised & Unsupervised ML in Finance

Model Evaluation, Explainability & Ethics

Building & Deploying Predictive Pipelines

Reference Books

- 1 Machine Learning for Financial Risk Management, Svetlozar Rachev, 2023, Springer.
- 2 Applied Machine Learning for Finance, Patrick McKeown, 2022, -.
- 3 Interpretable Machine Learning, Christoph Molnar, -, -.
- 4 Hands-On ML with Scikit-Learn, Keras, and TensorFlow, Aurélien Geron, -, -.
- 5 The Ethical Algorithm, Michael Kearns & Aaron Roth, -, -.

25DLA3203 - BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3203	BLOCKCHAIN TECHNOLOGY FOR DIGITAL TRANSFORMATION	BTDT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamentals of blockchain technology its architecture and key components	2	
CO2	Analyze how consensus mechanisms ensure trust and integrity in decentralized systems	4	
CO3	Apply blockchain concepts to develop and evaluate smart contracts and decentralized applications DApps	3	
CO4	Examine blockchain use cases across industries for digital transformation such as finance supply chain and healthcare	4	

Syllabus

Introduction to blockchain technology fundamentals structure blocks hash functions cryptography and distributed ledger technology

Consensus mechanisms proof of work proof of stake delegated proof of stake and practical Byzantine fault tolerance

Smart contracts introduction structure deployment Ethereum and Hyperledger Fabric platforms

Blockchain applications in finance supply chain healthcare e governance and IoT

Reference Books

- 1 Blockchain Basics A NonTechnical Introduction in 25 Steps, Daniel Drescher, 2017, Apress.
- 2 Mastering Blockchain , Imran Bashir, Third Edition, Packt Publishing.
- 3 Blockchain Revolution, Don Tapscott and Alex Tapscott, 2018, Penguin.

25DLA3303 - SMART CONTRACTS & WEB3 APPLICATION ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3303	SMART CONTRACTS & WEB3 APPLICATION ENGINEERING	SCW3	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design and implement smart contracts using Solidity and Chaincode for public and permissioned blockchains	3	PO1, PO4
CO2	Build and integrate dApps with backend APIs and wallet systems	4	PO1, PO4
CO3	Analyze and resolve smart contract security vulnerabilities	4	PO1, PO4
CO4	Deploy smart contracts to Ethereum testnets and Hyperledger networks with event tracking and off-chain integrations	5	PO1, PO4

Syllabus

Smart Contract Fundamentals (Solidity + Chaincode)

Smart Contract Interaction, Front-End & Wallet Integration

Secure Contract Development & Testing

Deployment & Integration in DeFi & Enterprise Systems

Reference Books

- 1 Mastering Ethereum, Andreas Antonopoulos, Updated 2023, -.
- 2 Solidity Programming Essentials, Ritesh Modi, -, Packt.
- 3 Hyperledger Fabric Developer Guide, Hyperledger Documentation, -, Hyperledger Foundation.
- 4 Ethereum Smart Contract Development, Mayukh Mukhopadhyay, -, Packt.
- 5 Design Patterns for Smart Contracts, Chainlink Labs & Trail of Bits, -, Whitepaper.

25DLA3303A - SMART CONTRACTS & WEB3 APPLICATION ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3303A	SMART CONTRACTS & WEB3 APPLICATION ENGINEERING	SCW3	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design and implement smart contracts using Solidity and Chaincode for public and permissioned blockchains	3	PO1, PO5
CO2	Build and integrate dApps with backend APIs and wallet systems	4	PO1, PO5
CO3	Analyze and resolve smart contract security vulnerabilities	4	PO1, PO5
CO4	Deploy smart contracts to Ethereum testnets and Hyperledger networks with event tracking and off-chain integrations	5	PO1, PO5

Syllabus

Smart Contract Fundamentals (Solidity + Chaincode)

Smart Contract Interaction, Front-End & Wallet Integration

Secure Contract Development & Testing

Deployment & Integration in DeFi & Enterprise Systems

Reference Books

- 1 Mastering Ethereum, Andreas Antonopoulos, Updated 2023, -.
- 2 Solidity Programming Essentials, Ritesh Modi, -, Packt.
- 3 Hyperledger Fabric Developer Guide, Hyperledger Documentation, -, Hyperledger Foundation.
- 4 Ethereum Smart Contract Development, Mayukh Mukhopadhyay, -, Packt.
- 5 Design Patterns for Smart Contracts, Chainlink Labs & Trail of Bits, -, Whitepaper.

25DLA3303E - SMART CONTRACTS & WEB3 APPLICATION ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3303E	SMART CONTRACTS & WEB3 APPLICATION ENGINEERING	SCW3	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design and implement smart contracts using Solidity and Chaincode for public and permissioned blockchains	3	
CO2	Build and integrate dApps with backend APIs and wallet systems	4	
CO3	Analyze and resolve smart contract security vulnerabilities	4	
CO4	Deploy smart contracts to Ethereum testnets and Hyperledger networks with event tracking and off-chain integrations	5	

Syllabus

Smart Contract Fundamentals (Solidity + Chaincode)

Smart Contract Interaction, Front-End & Wallet Integration

Secure Contract Development & Testing

Deployment & Integration in DeFi & Enterprise Systems

Reference Books

- 1 Mastering Ethereum, Andreas Antonopoulos, Updated 2023, -.
- 2 Solidity Programming Essentials, Ritesh Modi, -, Packt.
- 3 Hyperledger Fabric Developer Guide, Hyperledger Documentation, -, Hyperledger Foundation.
- 4 Ethereum Smart Contract Development, Mayukh Mukhopadhyay, -, Packt.
- 5 Design Patterns for Smart Contracts, Chainlink Labs & Trail of Bits, -, Whitepaper.

25DLA3304 - MULTI AGENT SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3304	MULTI AGENT SYSTEMS	MAS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25DLA3304A - MULTI AGENT SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3304A	MULTI AGENT SYSTEMS	MAS	A	4	1	0	2	5.5

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) ,apply the characteristics of applications that lend themselves to an agent-oriented solution	2	
CO2	Analyze the key issues associated with constructing agents capable of intelligent autonomous action, and the main approaches taken to developing such agents	3	
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	
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	
CO5	Implement and analyze the algorithm of agents interaction and communication each other using JADE	4	
CO6	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

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.

25DLA3304E - MULTI AGENT SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3304E	MULTI AGENT SYSTEMS	MAS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25DLA3404 - TOKENOMICS, DIGITAL ASSETS & CRYPTO INFRASTRUCTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3404	TOKENOMICS, DIGITAL ASSETS & CRYPTO INFRASTRUCTURE	TDCI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of tokenomics, crypto-economics, and digital asset frameworks	3	PO1, PO3
CO2	Design and implement fungible, non-fungible, and governance tokens on public and enterprise platforms	4	PO2, PO4
CO3	Evaluate the technical and financial models behind DeFi protocols, DAOs, and liquidity mechanisms	4	PO1, PO3
CO4	Integrate crypto infrastructure APIs and develop token-based services with security and compliance considerations	5	PO1, PO4

Syllabus

Foundations of Tokenomics & Digital Asset Models

Token Design & Smart Contract Engineering

DeFi Systems, DAO Infrastructure & Liquidity Models

Crypto Infrastructure APIs & Token-Based Service Integration

Reference Books

- 1 Token Economy: How the Web3 Reinvents the Internet, Shermin Voshmgir, -, -.
- 2 Mastering DeFi, Kris Bennett, -, -.
- 3 Decentralized Finance: On Blockchain- and Smart Contract-based Financial Markets, Fabian Sch?r, -, -.
- 4 Ethereum Smart Contract Development, Mayukh Mukhopadhyay, -, -.
- 5 Enterprise Blockchain for Dummies, Hyperledger Foundation, -, Wiley.

25DLA3405 - BLOCKCHAIN ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3405	BLOCKCHAIN ANALYTICS	BCA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25DLA3406 - CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3406	CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGY	CBT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25DLA3505 - PRIVACY, COMPLIANCE & DECENTRALIZED SECURITY ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3505	PRIVACY, COMPLIANCE & DECENTRALIZED SECURITY ENGINEERING	PCDS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain core principles of decentralized privacy, cryptographic enforcement, and compliance in financial systems	3	PO1, PO2
CO2	Implement privacy-preserving mechanisms (ZKPs, mixers, private transactions) across blockchain networks	4	PO2, PO3
CO3	Develop and integrate decentralized identity (DID/SSI) and audit-ready compliance components	4	PO3
CO4	Evaluate and mitigate security vulnerabilities in DeFi, DAO, and enterprise blockchain infrastructure	5	PO3

Syllabus

Decentralized Privacy Cryptographic Foundations On chain/off chain privacy, ZKPs, mixers, zk rollups, and enterprise privacy models

Regulatory Frameworks Compliance for Blockchain Systems KYC/AML, GDPR, smart contract compliance, transaction screening, and CBDC regulations

Decentralized Identity Secure Authentication DIDs, verifiable credentials, wallet-based login, privacy preserving authentication, and enterprise identity solutions

Smart Contract & Protocol Security for DeFi and Enterprise Vulnerabilities, DAO/flash loan attacks, secure oracles, auditing tools, and enterprise security enforcement

Reference Books

- 1 Zero Knowledge Proofs: Building Blockchain Privacy, Matthew Green, 2023, MIT Press.
- 2 Blockchain and GDPR, Michèle Finck, 2019, Oxford University Press.
- 3 Blockchain and the Law: The Rule of Code, Primavera De Filippi, 2018, Harvard University Press.
- 4 Self-Sovereign Identity, Drummond Reed, 2021, Manning Publications.
- 5 The DeFi Security Handbook, LlamaRisk Collective, 2024, Independently Published.

25DLA3507 - DISTRIBUTED LEDGER ARCHITECTURE FOR AUTOMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3507	DISTRIBUTED LEDGER ARCHITECTURE FOR AUTOMATION	DLAA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25DLA3508 - PERMISSIONED DISTRIBUTED LEDGER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLA3508	PERMISSIONED DISTRIBUTED LEDGER	PDL	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25DLS3101 - STREAMING DATA ARCHITECTURES & FRAMEWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLS3101	STREAMING DATA ARCHITECTURES & FRAMEWORKS	SDAF	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain streaming analytics concepts such as event vs. processing time, watermarks, windows, late data, and stream SQL.	2	PO1, PO2
CO2	Design and implement event processing, enrichment, and multi-stream joins using CEP and stateful operators.	6	PO2, PO3
CO3	Build and evaluate online ML techniques for anomaly detection and forecasting on data streams with feature pipelines.	5	PO2, PO3
CO4	Serve real-time insights via OLAP-on-streams, dashboards, and alerts, ensuring low-latency decisioning with SLOs/SLAs.	5	PO2, PO3

Syllabus

Stream vs. batch analytics; event time vs. processing time; watermarks and out-of-order handling; lateness strategies; windowing (tumbling, sliding, session); state & state backends (concepts only); approximations & sketches (HyperLogLog, Count-Min, Bloom) for high-velocity metrics; Flink SQL/Table API and ksqldb/Materialize concepts; stream-time joins vs. table-time joins; real-time KPIs (conversions, DAU/MAU, CTR) computed via windows.

CEP patterns (sequences, absence, time-bounded patterns); Flink CEP/Kafka Streams DSL; campaign funnels & fraud sequences; enrichment from reference tables/caches; sessionization; temporal table joins; watermark-aware stream-stream and stream-table joins; deduplication & idempotence at the analytics layer; topology design for correctness and low latency.

Online learning vs. offline; model families for streams: incremental linear models, Hoeffding trees, adaptive drift detectors (ADWIN); streaming anomaly detection (z-score with sliding statistics, EWMA, robust MAD, Isolation Forest variants); short-horizon forecasting (incremental AR/ES, Prophet-lite with recency weighting); feature pipelines & real-time feature stores (intro to Feast streaming ingestion); concept drift monitoring, backtesting with rolling windows; model evaluation on streams (prequential metrics).

OLAP on streams: Apache Pinot / Druid for sub-second analytics; star-tree/segment basics; ingestion from Kafka; real-time dashboards (Apache Superset, Grafana); alerting (rule-based & anomaly-driven) with Alertmanager; A/B and multi-armed bandit basics for streaming experiments; SLOs/SLAs for latency, freshness, availability; cost/perf trade-offs; operational playbooks for hot fixes and metric sanity checks.

Reference Books

- 1 Streaming Systems, Tyler Akidau, Latest, O Reilly.
- 2 Stream Processing with Apache Flink, Fabian Hueske, Latest, O Reilly.
- 3 Mastering Kafka Streams and ksqldb, Mitch Seymour, Latest, O Reilly.

25DLS3101A - STREAMING DATA ARCHITECTURES & FRAMEWORKS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLS3101A	STREAMING DATA ARCHITECTURES & FRAMEWORKS	SDAF	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain streaming analytics primitives including event/processing time, watermarks, windows, late data, and sketches.	2	PO1, PO2
CO2	Apply stream SQL and joins to compute real-time KPIs and enable stateful stream processing.	3	PO2, PO3
CO3	Design and implement CEP, multi-stream joins, and enrichment pipelines ensuring correctness and low latency.	6	PO2, PO3
CO4	Build and evaluate incremental/online ML models for anomaly detection and forecasting on streaming data.	5	PO2, PO3
CO5	Serve and operationalize real-time insights (OLAP-on-streams, dashboards, alerts, A/B decisioning) with SLOs/SLAs.	5	PO2, PO3

Syllabus

Stream vs. batch analytics; event time vs. processing time; watermarks and out-of-order handling; lateness strategies; windowing (tumbling, sliding, session); state & state backends (concepts only); approximations & sketches (HyperLogLog, Count-Min, Bloom) for high-velocity metrics.

Flink SQL/Table API and ksqldb/ksqlDB/Materialize basics; stream-time joins vs. table-time joins; real-time KPIs (CTR, DAU/MAU, conversions) computed via windows; case studies of materialized views and stream-table duality.

CEP patterns (sequences, absence, time-bounded patterns); Flink CEP/Kafka Streams DSL; campaign funnels & fraud sequences; enrichment from reference tables/caches; sessionization; temporal table joins; watermark-aware stream-stream and stream-table joins; deduplication & idempotence at the analytics layer; topology design for correctness and low latency.

Online learning vs. offline; model families for streams: incremental linear models, Hoeffding trees, adaptive drift detectors (ADWIN); streaming anomaly detection (z-score with sliding statistics, EWMA, robust MAD, Isolation Forest variants); short-horizon forecasting (incremental AR/ES, Prophet-lite with recency weighting); feature pipelines & real-time feature stores (intro to Feast streaming ingestion); concept drift monitoring, backtesting with rolling windows; model evaluation on streams (prequential metrics).

OLAP on streams: Apache Pinot / Druid for sub-second analytics; star-tree/segment basics; ingestion from Kafka; real-time dashboards (Apache Superset, Grafana); alerting (rule-based & anomaly-driven) with Alertmanager; A/B and multi-armed bandit basics for streaming experiments; SLOs/SLAs for latency, freshness, availability; cost/perf trade-offs; operational playbooks for hot fixes and metric sanity checks.

Reference Books

- 1 Streaming Systems, Tyler Akidau, Latest, O Reilly.
- 2 Stream Processing with Apache Flink, Fabian Hueske, Latest, O Reilly.
- 3 Mastering Kafka Streams and ksqldb, Mitch Seymour, Latest, O Reilly.

25DLS3101E - STREAMING DATA ARCHITECTURES & FRAMEWORKS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLS3101E	STREAMING DATA ARCHITECTURES & FRAMEWORKS	SDAF	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain streaming analytics primitives including event/processing time, watermarks, windows, late data, and sketches.	2	PO1, PO2
CO2	Apply stream SQL and joins to compute real-time KPIs and enable stateful stream processing.	3	PO2, PO3
CO3	Design and implement CEP, multi-stream joins, and enrichment pipelines ensuring correctness and low latency.	6	PO2, PO3
CO4	Build and evaluate incremental/online ML models for anomaly detection and forecasting on streaming data.	5	PO2, PO3
CO5	Serve and operationalize real-time insights (OLAP-on-streams, dashboards, alerts, A/B decisioning) with SLOs/SLAs.	6	PO3

Syllabus

Stream vs. batch analytics; event time vs. processing time; watermarks and out-of-order handling; lateness strategies; windowing (tumbling, sliding, session); state & state backends (concepts only); approximations & sketches (HyperLogLog, Count-Min, Bloom) for high-velocity metrics; Flink SQL/Table API and ksQLDB/Materialize concepts; stream-time joins vs. table-time joins; real-time KPIs (conversions, DAU/MAU, CTR) computed via windows.

CEP patterns (sequences, absence, time-bounded patterns); Flink CEP/Kafka Streams DSL; campaign funnels & fraud sequences; enrichment from reference tables/caches; sessionization; temporal table joins; watermark-aware stream-stream and stream-table joins; deduplication & idempotence at the analytics layer; topology design for correctness and low latency.

Online learning vs. offline; model families for streams: incremental linear models, Hoeffding trees, adaptive drift detectors (ADWIN); streaming anomaly detection (z-score with sliding statistics, EWMA, robust MAD, Isolation Forest variants); short-horizon forecasting (incremental AR/ES, Prophet-lite with recency weighting); feature pipelines & real-time feature stores (intro to Feast streaming ingestion); concept drift monitoring, backtesting with rolling windows; model evaluation on streams (prequential metrics).

OLAP on streams: Apache Pinot / Druid for sub-second analytics; star-tree/segment basics; ingestion from Kafka; real-time dashboards (Apache Superset, Grafana); alerting (rule-based & anomaly-driven) with Alertmanager; A/B and multi-armed bandit basics for streaming experiments; SLOs/SLAs for latency, freshness, availability; cost/perf trade-offs; operational playbooks for hot fixes and metric sanity checks.

Reference Books

- 1 Streaming Systems, Tyler Akidau, Latest, O Reilly.
- 2 Stream Processing with Apache Flink, Vasiliki Kalavri, Latest, O Reilly.
- 3 Mastering Kafka Streams and ksQLDB, Mitch Seymour, Latest, O Reilly.

25DLS3202 - DESIGNING REAL-TIME DATA PIPELINES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLS3202	DESIGNING REAL-TIME DATA PIPELINES	RTDP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply ethical, reliable acquisition of social and web data streams using APIs, webhooks, websockets, and SDKs.	3	PO1, PO3
CO2	Analyze and implement real-time enrichment of text and metadata including language ID, tagging, and sentiment analysis.	4	PO3, PO5
CO3	Design and evaluate domain-specific analytics such as trend detection, burst analysis, cascades, and bot/abuse heuristics.	5	PO4, PO5
CO4	Deliver real-time insights with OLAP systems, dashboards, and alerts while meeting SLOs for latency, freshness, and quality.	5	PO4

Syllabus

Platform APIs, SSE, websockets, webhooks, clickstream SDKs; rate limits, retries, backpressure; schema design; ethics: robots.txt, ToS, PII minimization, consent; deduplication & idempotence at ingest.

Language ID, transliteration; normalization (case, emoji, punctuation); hashtag/URL processing; tokenization & NER; lightweight transformers for sentiment/toxicity; throughput & schema evolution.

Trend detection (Count-Min + heap), burst detection (Kleinberg), cascade approximations, influence proxies, bot/abuse heuristics (posting rate, entropy, link ratio); cohort splits; rule-based streaming.

OLAP ingestion with Pinot/Druid; denormalized star schema; Superset/Grafana dashboards; rule-based & anomaly alerts; SLOs for latency, freshness, correctness; data quality monitoring; ops playbooks.

Reference Books

- 1 Streaming Systems, Tyler Akidau, Latest, O Reilly.
- 2 Mining of Massive Datasets (3e), Jure Leskovec, Latest, Cambridge Univ Press.
- 3 Social Media Mining: An Introduction, Reza Zafarani, Latest, Cambridge Univ Press.

25DLS3303 - DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLS3303	DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS	DLSS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply lake and lakehouse principles to design layered storage layouts on object stores with efficient data organization.	3	PO1
CO2	Analyze and model datasets with open table formats (Delta/Iceberg/Hudi) supporting ACID transactions and schema evolution.	4	PO2, PO3
CO3	Evaluate and optimize query performance and cost across engines (Spark/Trino/Presto) using partitioning, clustering, and indexing.	5	PO2, PO3
CO4	Evaluate and implement unified batch + streaming lakehouse pipelines with quality gates, time-travel, and maintenance SLOs.	5	PO2, PO3

Syllabus

Object storage (S3/ADLS/GCS) as system of record; Parquet/ORC formats; compression & file sizing; partitioning & directory conventions; medallion layering (Bronze/Silver/Gold); catalogs (Hive/Glue/Nessie); governance touchpoints; anti-patterns (small files, over-partitioning).

Delta, Iceberg, Hudi: metadata, manifests, ACID on object storage; snapshot isolation & time-travel; MERGE/UPSERT/DELETE; CDC ingestion & deduplication; schema evolution; copy-on-write vs merge-on-read; compaction & clustering; retention/vacuum policies.

Spark SQL vs Trino/Presto; partition pruning, column stats, predicate pushdown; clustering (Z-ORDER, Iceberg sort order); Bloom filters; vectorized reads; mitigating small files; caching layers; benchmarking (bytes scanned, latency, cost).

Streaming writes into tables Spark Structured Streaming to Delta, Flink to Iceberg or Hudi. Exactly once at table level, idempotent merges. Bronze to Silver to Gold promotion jobs. Quality gates using Great Expectations and dbt tests on schemas and distributions. Rollback using time travel. SLOs for freshness and latency. Housekeeping optimize, compact, snapshot expiration, manifest rewrite. Reproducibility and audit trails.

Reference Books

- 1 Designing Data-Intensive Applications, Martin Kleppmann, Latest, O Reilly.
- 2 Streaming Systems, Tyler Akidau, Latest, O Reilly.
- 3 Spark The Definitive Guide, Bill Chambers, Latest, O Reilly.

25DLS3303A - DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLS3303A	DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS	DLSS	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply lake and lakehouse principles to design layered storage layouts on object stores with sound partitioning and file strategies	3	PO1
CO2	Analyze and model datasets using open table formats (Delta/Iceberg/Hudi) supporting ACID transactions, CDC, and schema evolution.	4	PO2, PO3
CO3	Evaluate and optimize query performance and cost across multiple engines (Spark/Trino/Presto) with partitioning, clustering, and indexes.	5	PO2, PO3
CO4	Design and implement unified ingestion pipelines combining batch and streaming into Delta/Iceberg/Hudi with exactly-once guarantees.	6	PO2, PO3
CO5	Evaluate data quality, lineage, and maintenance in lakehouse pipelines with rollback, time-travel, and SLOs for freshness and latency.	5	PO2, PO3

Syllabus

Object storage (S3/ADLS/GCS); Parquet/ORC formats; compression & file sizing; partitioning & directory design; medallion layering; external vs managed tables; catalogs (Hive/Glue/Nessie); governance constraints; anti-patterns.

Delta, Iceberg, Hudi: ACID metadata, snapshot isolation; MERGE/UPSERT/DELETE; CDC ingestion with dedup; schema evolution (column add/rename, type widening); compaction & clustering; retention & vacuum.

Spark SQL vs Trino/Presto; partition pruning & stats; clustering/sorting (Z-ORDER, Iceberg sort); Bloom filters & predicate pushdown; small-file mitigation; caching layers; benchmarking methodology (scan size, wall time, cost).

Streaming writes into tables Spark Structured Streaming to Delta, Flink to Iceberg or Hudi. Exactly once at table level, idempotent merges. Bronze to Silver to Gold promotion jobs. Quality gates using Great Expectations and dbt tests on schemas and distributions. Rollback using time travel. SLOs for freshness and latency. Housekeeping optimize, compact, snapshot expiration, manifest rewrite. Reproducibility and audit trails

Quality gates (Great Expectations/dbt); rollback with time-travel; lineage and audit trails; freshness & latency SLOs; housekeeping jobs (optimize, compact, snapshot expiration); reproducibility & ops playbooks.

Reference Books

- 1 Designing Data-Intensive Applications, Martin Kleppmann, Latest, O Reilly.
- 2 Streaming Systems, Tyler Akidau, Latest, O Reilly.
- 3 Spark The Definitive Guide, Bill Chambers, Latest, O Reilly.

25DLS3303E - DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLS3303E	DATA LAKES & STREAM-ORIENTED STORAGE SYSTEMS	DLSS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply lake and lakehouse principles to design layered storage layouts on object stores with sound partitioning and file strategies.	3	PO1
CO2	Analyze and model datasets using open table formats (Delta/Iceberg/Hudi) supporting ACID transactions, CDC, and schema evolution.	4	PO2, PO3
CO3	Evaluate and optimize query performance and cost across multiple engines (Spark/Trino/Presto) with partitioning, clustering, and indexes.	5	PO2, PO3
CO4	Design and implement unified ingestion pipelines combining batch and streaming into Delta/Iceberg/Hudi with exactly-once guarantees.	6	PO2, PO3
CO5	Evaluate data quality, lineage, and maintenance in lakehouse pipelines with rollback, time-travel, and SLOs for freshness and latency.	5	PO2, PO3

Syllabus

Object storage (S3/ADLS/GCS); Parquet/ORC formats; compression & file sizing; partitioning & directory design; medallion layering; external vs managed tables; catalogs (Hive/Glue/Nessie); governance constraints; anti-patterns.

Delta, Iceberg, Hudi: ACID metadata, snapshot isolation; MERGE/UPSERT/DELETE; CDC ingestion with dedup; schema evolution (column add/rename, type widening); compaction & clustering; retention & vacuum.

Spark SQL vs Trino/Presto; partition pruning & stats; clustering/sorting (Z-ORDER, Iceberg sort); Bloom filters & predicate pushdown; small-file mitigation; caching layers; benchmarking methodology (scan size, wall time, cost).

Streaming writes into tables Spark Structured Streaming to Delta, Flink to Iceberg or Hudi. Exactly once at table level, idempotent merges. Bronze to Silver to Gold promotion jobs. Quality gates using Great Expectations and dbt tests on schemas and distributions. Rollback using time travel. SLOs for freshness and latency. Housekeeping optimize, compact, snapshot expiration, manifest rewrite. Reproducibility and audit trails.

Quality gates (Great Expectations/dbt); rollback with time-travel; lineage and audit trails; freshness & latency SLOs; housekeeping jobs (optimize, compact, snapshot expiration); reproducibility & ops playbooks.

Reference Books

- 1 Designing Data-Intensive Applications, Martin Kleppmann, Latest, O Reilly.
- 2 Streaming Systems, Tyler Akidau, Latest, O Reilly.
- 3 Spark The Definitive Guide, Bill Chambers, Latest, O Reilly.

25DLS3404 - REAL-TIME ANALYTICS & COMPLEX EVENT PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLS3404	REAL-TIME ANALYTICS & COMPLEX EVENT PROCESSING	RTAC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply stream-time semantics and stateful operators such as event time, watermarks, windows, state and timers in modern frameworks	3	PO1
CO2	Design and implement Complex Event Processing patterns and multi-stream joins ensuring correctness under out-of-order data	4	PO2, PO3
CO3	Build production-grade reliability with exactly-once and effectively-once guarantees, transactional sinks, schema evolution, rollouts and rescaling	5	PO2, PO3
CO4	Evaluate and tune performance and operability including backpressure, state backends, memory, observability, benchmarking and cost	5	PO2, PO3

Syllabus

Time Semantics, Windows and Stateful Processing: Event time vs processing time; watermarks, late data policies, side outputs; window types and triggers; stateful operators and timers; state backends, checkpointing and savepoints; connectors overview; framework focus Flink API and SQL, parallels in Kafka Streams and Spark Structured Streaming.

Complex Event Processing and Multi-Stream Correlation: CEP theory and patterns, Flink CEP advanced patterns, deduplication and idempotence; interval joins, temporal joins, stream-table enrichment; handling out-of-order data and retractions; correctness proofs and test harnesses.

Reliability, Transactions and Safe Delivery: Delivery semantics at-most, at-least, exactly-once; Flink two-phase commit sinks; Kafka EOS v2 and idempotent producers; transactional outbox and inbox; CDC sources and ordering; schema registry compatibility; rolling upgrades, state migration, savepoints and rescaling; dead-letter topics and retry policies.

Performance, Observability and Benchmarking: Backpressure mechanics, watermark lag analysis; RocksDB tuning, memory and GC tuning; task slots and parallelism; checkpoint interval sizing; producer and consumer tuning; metrics and tracing with Prometheus and Grafana; chaos testing and failure drills; cross-framework benchmarking of Flink, Kafka Streams and Spark Structured Streaming.

Reference Books

- 1 Streaming Systems, Tyler Akidau, Latest, O Reilly.
- 2 Stream Processing with Apache Flink, Fabian Hueske, Latest, O Reilly.
- 3 Mastering Kafka Streams and ksqlDB, Mitch Seymour, Latest, O Reilly.

25DLS3505 - STREAMING ANALYTICS FOR IOT AND EDGE ENVIRONMENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DLS3505	STREAMING ANALYTICS FOR IOT AND EDGE ENVIRONMENTS	SAIE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design streaming pipelines for high-frequency IoT sensor data acquisition, pre-processing, and metadata management	3	PO1, PO2
CO2	Implement advanced time-series analytics, anomaly detection, and predictive maintenance on live sensor streams	4	PO2, PO3
CO3	Integrate multi-protocol IoT gateways with streaming frameworks, ensuring security, scalability, and fault tolerance	5	PO2, PO3
CO4	Optimize IoT streaming systems for performance energy efficiency and edge cloud hybrid processing	5	PO2, PO3

Syllabus

IoT Data Acquisition and Stream Pre Processing: IoT pipeline architecture; sensor data characteristics; ingestion via MQTT, CoAP, OPC UA; metadata tagging; calibration in stream; edge vs cloud ingestion; tools Apache NiFi, Kafka Connect.

Real time Analytics for IoT Streams: Time series modeling; anomaly detection methods Z score, ESD, STL, ML; predictive maintenance pipelines; CEP triggers; sliding window telemetry analytics.

IoT Gateway Integration and Security: Multi protocol gateways; bridging OT to IT; serialization formats Avro, Protobuf, JSON; secure transport TLS, DTLS; device authentication; gateway clustering for fault tolerance.

Performance Optimization and Edge Cloud Hybrid: Edge analytics vs centralized; partitioning and parallelism; low latency routing; hybrid batch stream for archival; energy aware computation; Kubernetes KEDA scaling for IoT workloads.

Reference Books

- 1 Streaming Data Understanding the Real-Time Pipeline, Andrew G. Psaltis, Latest, Manning.
- 2 Architecting the Internet of Things, Dieter Uckelmann et al., Latest, Springer.
- 3 Designing Connected Products, Claire Rowland et al., Latest, O Reilly.

25DSB3101 - DATA ANALYTICS AND VISUALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3101	DATA ANALYTICS AND VISUALIZATION	DAV	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of Data Science and its application	2	PO1, PO2, PO3, PSO1, PSO2
CO2	Apply various statistical tools for testing hypotheses	3	PO1, PO2, PO3, PSO1, PSO2
CO3	Apply python tool for handling Data Science.	3	PO1, PO2, PO3, PSO1, PSO2
CO4	Apply data visualization for different types of data.	3	PO1, PO2, PO3, PO4, PSO1, PSO2
CO5	Analyze Data through Visualization in Python.	4	PO3, PO5, 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 Pre Processing 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, What is 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, 2017, Wiley.
- 2 Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, Wes McKinney, 2nd Edition, 2017, O Reilly Media.
- 3 Statistical Inference for Data Science, Brian Caffo, Global Edition, 2015, Leanpub.
- 4 Doing Data Science: Straight Talk from the Frontline, Rachel Schutt, Cathy O Neil, 2013, O Reilly Media.
- 5 Probability and Statistics for Data Science, Carlos Fernandez-Granda, 2022, Cambridge University Press.
- 6 Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing, and Presenting Data, EMC Education Services, 1st Edition, 2015, Wiley.

25DSB3101A - DATA ANALYTICS AND VISUALIZATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3101A	DATA ANALYTICS AND VISUALIZATION	DAV	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of Data Science and its application	2	PO1, PO2, PO3, PSO1, PSO2
CO2	Apply various statistical tools for testing hypotheses	3	PO1, PO2, PO3, PSO1, PSO2
CO3	Apply python tool for handling Data Science.	3	PO1, PO2, PO3, PSO1, PSO2
CO4	Apply data visualization for different types of data.	3	PO1, PO2, PO3, PO4, PSO1, PSO2
CO5	Analyze Enhanced concepts for Data Visualization.	4	PO3, PO5, PSO1
CO6	Apply data visualization for different types of data.	4	PO1, PO2, PO3, PO4, PSO1, PSO2

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 Pre Processing 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 metrices, 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 Color Bars, Multiple Subplots, Text and Annotation, Customizing Ticks

Reference Books

- 1 The Data Science Handbook, Field Cady, 2017, Wiley.
- 2 Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, Wes McKinney, 2nd Edition, 2017, O Reilly Media.
- 3 Statistical Inference for Data Science, Brian Caffo, Global Edition, 2015, Leanpub.

- 4 Doing Data Science: Straight Talk from the Frontline, Rachel Schutt, Cathy O Neil, 2013, O Reilly Media.
- 5 Probability and Statistics for Data Science, Carlos Fernandez-Granda, 2025, Cambridge University Press.
- 6 Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing, and Presenting Data, EMC Education Services, 1st Edition, 2015, Wiley.

25DSB3101E - DATA ANALYTICS AND VISUALIZATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3101E	DATA ANALYTICS AND VISUALIZATION	DAV	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of Data Science and its application	2	PO1, PO2, PO3, PSO1, PSO2
CO2	Apply various statistical tools for testing hypotheses	3	PO1, PO2, PO3, PSO1, PSO2
CO3	Apply python tool for handling Data Science.	3	PO1, PO2, PO3, PSO1, PSO2
CO4	Analyze Enhanced concepts for Data Visualization.	4	PO3, PO5, PSO1
CO5	Apply data visualization for different types of data.	4	PO1, PO2, PO3, PO4, PSO1, PSO2

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 Pre Processing 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 metrices, 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 Color Bars, Multiple Subplots, Text and Annotation, Customizing Ticks

Reference Books

- 1 The Data Science Handbook, Field Cady, 2017, Wiley.
- 2 Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, Wes McKinney, 2nd Edition, 2017, O Reilly Media.
- 3 Statistical Inference for Data Science, Brian Caffo, Global Edition, 2015, Leanpub.
- 4 Doing Data Science: Straight Talk from the Frontline, Rachel Schutt, Cathy O Neil, 2013, O Reilly Media.
- 5 Probability and Statistics for Data Science, Carlos Fernandez-Granda, 2025, Cambridge University Press.

- 6 Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing, and Presenting Data, EMC Education Services, 1st Edition, 2015, Wiley.

25DSB3202 - DATA WAREHOUSING AND MINING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3202	DATA WAREHOUSING AND MINING	DWHM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of Data Warehousing and Data Mining and describe their importance in business intelligence. Discuss the main functions of Data Mining and outline a suitable schema for a real-time data warehousing application.	2	PO2, PSO1
CO2	Demonstrate different data preprocessing methods, including data cleaning, integration, transformation, and reduction, to prepare raw data for data mining algorithms.	2	PO1, PO2, PSO1
CO3	Identify and apply classification algorithms to categorize data and use Apriori and FP-Growth for association rule mining to find hidden patterns. Build and evaluate classification models.	3	PO2, PSO1
CO4	Identify and apply different clustering algorithms, build clustering models, analyze the results, and explain the findings based on the performance and characteristics of each algorithm	3	PO2

Syllabus

Data Warehouse: Driving Forces, Fundamental Concepts, including Data Cube and OLAP modeling, design, usage, and implementation. Data Mining: introduction, Types of data and patterns mined, the technologies involved, and the targeted applications, issues of Data Mining.

Data Preprocessing: This includes techniques such as data cleaning, integration, reduction, transformation, and discretization to prepare raw data for analysis

Association Analysis: Importance of Association Rules, frequent itemset generation, pruning, Apriori, and FP-Growth algorithms. Single and Multi Level Association Rule Mining

Classification: Decision tree induction, Bayesian Classification and Networks, Neural networks, Back Propagation. Cluster Analysis: Overview, Basics and Importance of Cluster Analysis, Clustering techniques, Different Types of Clusters; K-means: The Basic K-means Algorithm, K-means Additional Issues, Bi-securing K Means.

Reference Books

- 1 Data Mining: Concepts and Techniques, Jiawei Han, Micheline Kamber 3rd Edition, 2011, 3rd Edition, 2011, Elsevier.
- 2 Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, Vipin Kumar, 2008, Pearson Education.
- 3 Data Mining, Vikram Pudi, P. Radha Krishna, -, Oxford University Press.
- 4 Data Mining and Analysis: Fundamental Concepts and Algorithms, Mohammed J. Zaki, Wagner Meira Jr., -, Oxford University Press.
- 5 Data Mining Techniques and Applications: An Introduction, Hongbo Du, -, Cengage Learning.
- 6 Data Warehousing, Data Mining & OLAP, Alex Berson, Stephen J. Smith, -, Tata McGraw-Hill (TMH).

25DSB3303 - BIG DATA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3303	BIG DATA ANALYTICS	BDA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of big data and Big data analytics life cycle.	2	PO3, PO5, PO6, PSO2
CO2	Understand Initial exploration of data and advanced data analytics by using R.	2	PO3, PO5, PO6, PSO2
CO3	Apply advanced analytical methods & algorithms for big data.	3	PO3, PO5, PO6, PSO2
CO4	Build and Evaluate the Text Analytical problems using Hadoop.	3	PO3, PO5, PO6, PSO2
CO5	Build and Evaluate the Big Data Analytical problems using R Programming concepts.	4	PO3, PO5, PO6, PSO2

Syllabus

Introduction to Big Data Analytics: Big Data Overview, State of the Practice of Analytics, Key Roles for the New Big Data Ecosystem, Examples of Big Data Analytics. Data Analytics Lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalizing.

Basic Data Analytic Methods Using R: Introduction to R, Exploratory Data Analysis, Statistical Methods for Evaluation. Advanced Analytical Theory and Methods: Clustering, K-means, Additional Algorithms. Advanced Analytical Theory and Methods: Association Rules, Apriori Algorithm, Evaluation of Candidate Rules, Applications of Association Rules, Transactions in a Grocery Store, Validation and Testing, Diagnostics.

Advanced Analytical Theory and Methods: Regression, Linear Regression, Logistic Regression, Reasons to Choose and Cautions, Additional Regression Models. Classification: Decision Trees, Naïve Bayes, Diagnostics of Classifiers, Additional Classification Methods. Time Series Analysis.

Text Analysis: A Text Analysis Steps, Collecting Raw Text, Representing Text, Term FrequencyInverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments, Gaining Insights. Advanced AnalyticsTechnology and Tools: Map Reduce and Hadoop

Reference Books

- 1 Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, 1st Edition, Wiley.
- 2 Big Data: Principles and Best Practices of Scalable Realtime Data Systems, Nathan Marz, James Warren, 1st Edition, Manning Publications.
- 3 Hadoop: The Definitive Guide, Tom White, 4th Edition, O'Reilly Media.
- 4 R for Data Science, Hadley Wickham, Garrett Golemund, 1st Edition, O'Reilly Media.
- 5 Advanced Analytics with R and Hadoop, Vignesh Prajapati, 1st Edition, Packt Publishing.

25DSB3303A - BIG DATA ANALYTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3303A	BIG DATA ANALYTICS	BDA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of big data and Big data analytics life cycle.	2	PO3, PO5, PO6, PSO2
CO2	Understand Initial exploration of data and advanced data analytics by using R.	2	PO3, PO5, PO6, PSO2
CO3	Apply advanced analytical methods & algorithms for big data.	3	PO3, PO5, PO6, PSO2
CO4	Build and Evaluate the Text Analytical problems using Hadoop.	3	PO3, PO5, PO6, PSO2
CO5	Build and Evaluate the Big Data Analytical problems using R Programming concepts.	4	PO3, PO5, PO6, PSO2

Syllabus

Introduction to Big Data Analytics: Big Data Overview, State of the Practice of Analytics, Key Roles for the New Big Data Ecosystem, Examples of Big Data Analytics. Data Analytics Lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalizing.

Basic Data Analytic Methods Using R: Introduction to R, Exploratory Data Analysis, Statistical Methods for Evaluation. Advanced Analytical Theory and Methods: Clustering, K-means, Additional Algorithms. Advanced Analytical Theory and Methods: Association Rules, Apriori Algorithm, Evaluation of Candidate Rules, Applications of Association Rules, Transactions in a Grocery Store, Validation and Testing, Diagnostics.

Advanced Analytical Theory and Methods: Regression, Linear Regression, Logistic Regression, Reasons to Choose and Cautions, Additional Regression Models. Classification: Decision Trees, Naïve Bayes, Diagnostics of Classifiers, Additional Classification Methods. Time Series Analysis.

Text Analysis: A Text Analysis Steps, Collecting Raw Text, Representing Text, Term Frequency Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments, Gaining Insights. Advanced Analytics Technology and Tools: Map Reduce and Hadoop

Reference Books

- 1 Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, 1st Edition, Wiley.
- 2 Big Data: Principles and Best Practices of Scalable Realtime Data Systems, Nathan Marz, James Warren, 1st Edition, Manning Publications.
- 3 Hadoop: The Definitive Guide, Tom White, 4th Edition, OReilly Media.
- 4 R for Data Science, Hadley Wickham, Garrett Grolemund, 1st Edition, OReilly Media.
- 5 Advanced Analytics with R and Hadoop, Vignesh Prajapati, 1st Edition, Packt Publishing.

25DSB3303E - BIG DATA ANALYTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3303E	BIG DATA ANALYTICS	BDA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of big data and Big data analytics life cycle.	2	PO3, PO5, PO6, PSO2
CO2	Understand Initial exploration of data and advanced data analytics by using R.	2	PO3, PO5, PO6, PSO2
CO3	Apply advanced analytical methods & algorithms for big data.	3	PO3, PO5, PO6, PSO2
CO4	Build and Evaluate the Text Analytical problems using Hadoop.	3	PO3, PO5, PO6, PSO2
CO5	Build and Evaluate the Big Data Analytical problems using R Programming concepts.	4	PO3, PO5, PO6, PSO2

Syllabus

Introduction to Big Data Analytics: Big Data Overview, State of the Practice of Analytics, Key Roles for the New Big Data Ecosystem, Examples of Big Data Analytics. Data Analytics Lifecycle: Discovery, Data Preparation, Model Planning, Model Building, Communicating Results, Operationalizing.

Basic Data Analytic Methods Using R: Introduction to R, Exploratory Data Analysis, Statistical Methods for Evaluation. Advanced Analytical Theory and Methods: Clustering, K-means, Additional Algorithms. Advanced Analytical Theory and Methods: Association Rules, Apriori Algorithm, Evaluation of Candidate Rules, Applications of Association Rules, Transactions in a Grocery Store, Validation and Testing, Diagnostics.

Advanced Analytical Theory and Methods: Regression, Linear Regression, Logistic Regression, Reasons to Choose and Cautions, Additional Regression Models. Classification: Decision Trees, Naïve Bayes, Diagnostics of Classifiers, Additional Classification Methods. Time Series Analysis.

Text Analysis: A Text Analysis Steps, Collecting Raw Text, Representing Text, Term Frequency Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments, Gaining Insights. Advanced Analytics Technology and Tools: Map Reduce and Hadoop

Reference Books

- 1 Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, 1st Edition, Wiley.
- 2 Big Data: Principles and Best Practices of Scalable Realtime Data Systems, Nathan Marz, James Warren, 1st Edition, Manning Publications.
- 3 Hadoop: The Definitive Guide, Tom White, 4th Edition, O'Reilly Media.
- 4 R for Data Science, Hadley Wickham, Garrett Grolemund, 1st Edition, O'Reilly Media.
- 5 Advanced Analytics with R and Hadoop, Vignesh Prajapati, 1st Edition, Packt Publishing.

25DSB3404 - BIG DATA OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3404	BIG DATA OPTIMIZATION	BDO	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Optimization methods and analytics using R	2	
CO2	Apply blind search and local search methods for solving optimization problems	3	
CO3	Analyze and compare population-based search methods for solving real world problems	4	
CO4	Examine the applications of genetic programming to solve problems like Travelling Salesman Problem and advanced Nature inspired	4	

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, Swarm intelligence algorithms: Ant Colony Optimization, Blue Whale Optimization, Grey Wolf Optimization.

Reference Books

- 1 Modern Optimization with R, Paulo Cortez, , 3 RD, Springer.
- 2 Using R and R Studio for Data Management, Statistical Analysis, and Graphics, , Nicholas J. Horton & Ken Klein man, 2 ND, CRC PRESS.
- 3 Nature-Inspired Computation and Swarm Intelligence, , Xin-She Yang, 1 ST, Elsevier .
- 4 Nature-Inspired Algorithms and Applications, nupriya Jain, Dinesh Goyal, S. Balamurugan, Seema Sharma, Sonia Duggal, 2 ND, Wiley.
- 5 OPTIMIZATION Algorithms and Applications, Rajesh Kumar Arora, 2 ND, Taylor & Francis GROUP LLC.

25DSB3407 - DATA ANALYTICS ON CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3407	DATA ANALYTICS ON CLOUD	DAC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the Introduction to Data Analytics: Data Analytics Overview, Importance of Data Analytics.	2	PO1, PSO2
CO2	Apply Data Analytics Tools and programming language.	3	PO1, PO2, PO4, PSO2
CO3	Analyzing data analytics on google cloud. GCP Console.	4	PO1, PO2, PO3, PO4, PSO2
CO4	Explore data and extract insights by using Bigquery. Make data-driven decisions by using Looker.	4	PO2, PO3, PO4, PSO2

Syllabus

Introduction to Data Analytics: Data Analytics Overview, Importance of Data Analytics. Types of Data Analytics, Descriptive Analytics, Diagnostic Analytics, Predictive Analytics, Prescriptive Analytics. Benefits of Data Analytics. Data Visualization for Decision Making, Data Types, Measure Of central tendency. Measures of Dispersion, Graphical Techniques, Skewness & Kurtosis, Box Plot. Descriptive Stats, Sampling Funnel, Sampling Variation, Central Limit Theorem, Confidence interval.

Data Analytics Tools: Spreadsheets (Microsoft Excel, Google Sheets)- Business Intelligence platforms (Tableau, Power BI). Programming Languages (Python, R), SQL. Data Visualization Tools(Google Data Studio). Cloud-based Analytics platforms (Looker, Sisense).

Introduction to Cloud Computing, Fundamentals of the cloud computing ecosystem. Cloud Computing characteristics/ Cloud deployment models, Cloud Service models. Cloud Infrastructure Mechanisms, Cloud Computing Life Cycle. Cloud-Specific Tools and Platforms: GCP (Google Cloud Platforms): data analytics on google cloud. GCP Console, Application Engine.

Explore data and extract insights by using Bigquery. Make data-driven decisions by using Looker. Google Data Studio - Amazon Web Services (AWS): Explore services like S3, Redshift, and QuickSight for data analytics on AWS. Microsoft Azure: Learn about services like Azure Blob Storage, Azure Synapse Analytics, and Power BI for data analytics on Azure.

Reference Books

- 1 Data Analytics with Google Cloud Platform, Murari Ramuka, 2019, Walter de Gruyter GmbH.
- 2 Designing Cloud Data Platforms, Danil Zburivsky, Lynda Partner, 2021, Manning Publications.
- 3 Google BigQuery: The Definitive Guide, Valliappa Lakshmanan, Jordan Tigani, 2019, O Reilly Media, Inc..
- 4 Data Engineering with Google Cloud Platform: A Practical Guide to Operationalizing Scalable Data Analytics Systems on GCP, Adi Polak, Lakshmanan, 2024, Packt Publishing Limited.
- 5 Data Analytics with AWS: Unlocking the Value of Your Data, Roger Barga, 2024, Orange Education Pvt Ltd.
- 6 Data Science on the Google Cloud Platform: Implementing End to End RealTime Data Pipelines: From Ingest to Machine Learning, Valliappa Lakshmanan, 2018, O Reilly Media Inc.

25DSB3408 - DIGITAL MEDIA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3408	DIGITAL MEDIA ANALYTICS	DMA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To develop an understanding of data ethics, privacy concerns, and the basic concepts of algorithm-driven media environments.	2	PO4
CO2	To develop an understanding of key metrics and tools for analyzing digital media performance.	3	PO1, PO2, PO3
CO3	To apply digital data analysis techniques to support strategic decision-making.	3	PO2, PO5, PSO1, PSO2
CO4	To gain hands-on experience with tools like Google Analytics and social media dashboards.	3	PO3, PO5, PSO2

Syllabus

Marketing & Digital Marketing Fundamentals :Introduction to Marketing, Digital Channels Overview, Customer Journey and Persona Building, Digital Marketing Fundamentals and Strategies Content Creation Using AI Tools: Introduction to AI in Content Marketing, Introduction to AI in Content Marketing, Content Ideation and Copywriting, AI-Powered Content Creation, Content Optimization, AI Content Development.

Social Media and Influencer Marketing :Social Media Landscape, Content Strategies for Social Media, Influencer Marketing, Social Media Advertising, Monitoring Social Media Performance, Workshop: Planning a Social Media Campaign.

SEO and SEM: Introduction to SEO, On-Page and Off-Page SEO, Technical SEO, Introduction to SEM, Performance Metrics for SEO and SEM.

Data Analytics in Marketing, Introduction to Marketing Analytics, Google Analytics Basics, Advanced Analytics Tools, A/B Testing and Experimentation, Attribution Models and ROI Calculation. Campaign Management and Automation: Introduction to Campaign Management, Marketing Automation Tools, AI in Campaign Management, Programmatic Advertising.

Reference Books

- 1 Digital Marketing Analytics: Making Sense of Consumer Data in a Digital World (2nd Edition), Chuck Hemann & Ken Burbar, 2018, Que Publishing (Pearson).
- 2 Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics (1st Edition), Marshall Sponder, 2012, Pearson Education.
- 3 Digital Analytics 101: Your Shortcut to Marketing Analytics, Kevin Hartman, 2020, Independently Published.
- 4 Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, Avinash Kaushik, 2009, Wiley.
- 5 Marketing Analytics: A Practical Guide to Real Marketing Science, Mike Grigsby, 2015, Kogan Page.
- 6 Advanced Web Metrics with Google Analytics (3rd Edition), Brian Clifton, 2012, Wiley.

25DSB3509 - ADVANCED DATABASES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3509	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
CO2	Advanced Database Models and applications, Apply emerging database technologies	3	PO1, PO2, PO5
CO3	Distributed database, Analyze and Discriminate object oriented relational database system	3	PO1, PO3, PO5
CO4	Analyze multimedia databases for various aspects including data types, SQL operations, architecture and handling of text, images, and video, Querying Techniques	4	PO2, PO3, PO5

Syllabus

Query optimization, Heuristic in query optimization, selectivity and cost estimates in query optimization. Database tuning: An overview of databases Tuning in relational systems. Database Recovery Protocols: Recovery concepts, NO-UNDO/REDO Recovery Based on Deferred Update, Recovery techniques Based on Immediate Update, Shadow Paging, ARIES Recovery Algorithm.

Advanced Database Models and Applications: Active Database Concepts, Temporal Database Concepts, Spatial Database Concepts, Deductive Databases. Emerging Database Technologies and Applications: Mobile Data Management, Geographical Information Systems (GIS), Genomic Databases.

Distributed Databases: distributed database concepts, Types of Distributed database systems, Distributed database Architecture, Data Fragmentation, Allocation Techniques for Distributed Database Design, Data Replication. Transaction Management, concurrency control and recovery in distributed databases. Explores strength of object-oriented and object-relational DBMS, adhering to standards like ODMG 3.0

Multimedia Databases: Multimedia databases encompass managing diverse data types (text, image, video) using SQL for large objects. Manipulating multimedia data, Multimedia Database Architecture and performance. Modeling effective querying techniques.

Reference Books

- 1 Fundamentals of Database Systems, Ramez Elmasri, Shamkanth B. Navathe, 5th Edition, Pearson.
- 2 Database Systems, Thomas Connolly, Carolyn Begg, 6th Edition, 2019, Pearson.
- 3 Principles of Distributed Database Systems, M. Tamer ?zsu, Patrick Valduriez, 4th Edition, 2020, Springer.
- 4 Database System Concepts, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, 7th Edition, 2019, McGraw-Hill Education.
- 5 Multimedia Databases: An Object Relational Approach, Dunckley, Lynne, 1st Edition, 2002, Pearson Education.
- 6 Database Systems-Design, Implementation and Management, Peter Rob and Corlos coronel, 5th Edition, 2009, Thompson Learning, Course Technology.

25DSB3510 - BUSINESS ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3510	BUSINESS ANALYTICS	BA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and concepts of Business analytics including the types of data used	3	PO3, PSO1
CO2	Identify and analyze business problems, formulate appropriate solutions and present findings to stakeholders.	3	PO4, PSO1
CO3	Formulate statistical and machine learning techniques to analyse the data including exploratory data analysis hypothesis testing regression	4	PO3, PSO1
CO4	Analyse the ethical and legal issues related to data analytics, including data privacy and security.	4	PO1, PO3, PO4, PSO1

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, Data Quality Issues and Remedies

Descriptive Statistics: Measures of Central Tendency and Dispersion, Data visualization principles and tools, Communicating insights through visualizations. 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), 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.

Big Data Analytics: Introduction to big data technologies (e.g., Hadoop, Spark), Processing and analyzing large-scale data sets, Distributed computing and parallel processing, Ethical and Legal Issues in Business Analytics: Privacy and security considerations, Ethical guidelines for data handling and analysis, Compliance with relevant regulations (e.g., GDPR, HIPAA)

Reference Books

- 1 Data Mining and Predictive Analytics (Wiley Series on Methods and Applications in Data Mining), Daniel T. Larose, 2nd Edition, Wiley.
- 2 Statistical Methods for Survival Data Analysis (Wiley Series in Probability and Statistics), Elisa T. Lee, John Wenyu Wang, and Lawrence J. Wei, 4th Edition, Wiley.
- 3 Business Analytics Principles, Concepts, and Applications: What, Why, and How, Marc J. Schniederjans, Dara G. Schniederjans, and Christopher M. Starkey, 1st Edition, Cengage Learning.
- 4 Business Analytics Principles, Concepts, and Applications: What, Why, and How, Marc J. Schniederjans, Dara G. Schniederjans, and Christopher M. Starkey, 1st Edition, Cengage Learning.

25DSB3511 - GRAPH & WEB ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3511	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, PO3, PO4, PSO2
CO3	Analyzing Web Analytics Strategy : website traffic analysis, audience identification and segmentation analysis, Emerging Analytics	4	PO1, PO2, PO3, PO4
CO4	Compare Email Testing Analysis, competitive Intelligence Analysis, and Social, Mobile, Video Analysis	4	PO2, PO3, PO4, PSO2

Syllabus

Graph Analytics Origin of Graph Theory Graph Basics types of Graphs Finding the best path Dijkstras Algorithm operation on graphs Network Basics Types of Social Networks properties of Social Networks Scale free Networks Small world Networks Network navigation Node Level analysis Degree Centrality closeness centrality betweenness centrality Eigen vector centrality PageRank Community Detection Graph Portioning Hierarchical Clustering

Web Analytics Introduction- State of the analytics union, state of the industry, Rethinking imperative, tactical shift. Strategy for choosing the optimal analytics tool- vendor selection analysis, running an effective tool pilot, checking SLA's for web-analytics vendor engagement, attributes of great metrics, strategically aligned tactics for impactful web metrics.

Web Traffic Data Practical solutions- Sources of traffic, outcomes, foundations of measuring the search quality, search engine optimization analysis, google example, content coverage, indexing by search engines, paid search analysis, direct traffic analysis Testing, actionable testing ideas.

Component of Web Analytics Strategy Competitive Intelligence Analysis- Data Sources, website traffic analysis, search and keyword ana 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, Willey publisher.
- 3 Practical Web Analytics for User Experience: How Analyticscan help you Understand your Users, Michael Beasley, 1st Edition, 2013, Morgan Kaufmann.
- 4 Practical Web Analytics for User Experience: How Analytics Can Help You Understand Your Users, Thomas (Tom) Dinsmore, 1st Edition (2010), Morgan Kaufmann.

25DSB3512 - DATA GOVERNANCE ON CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSB3512	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, PO3, PO4, PO5
CO2	Demonstrate the fundamental principles and components of data governance	3	PO1, PO3, PO4
CO3	Apply various data governance frameworks and best practices.	3	PO1, PO3, PO4
CO4	Apply hands-on experience in implementing data governance in cloud environments	3	PO1, PO3, PO4

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.

25DSE3101 - DATA ANALYTICS & VISUALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3101	DATA ANALYTICS & VISUALIZATION	DAV	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply analytic framing to translate business questions into KPIs, metric trees, and SQL/Python queries on curated datasets.	3	PO1
CO2	Analyze data and select effective visual encodings, chart types, and narratives using visual perception principles.	4	PO2, PO3
CO3	Build interactive dashboards (filters, drill-downs, alerts) and perform product analytics (funnels, cohorts) for decision support.	4	PO2, PO3
CO4	Evaluate dashboards and reports for accuracy, usability, and impact; run A/B readouts and anomaly reviews with statistical rigor.	5	PO2, PO3

Syllabus

KPI trees, metric specifications (owner, grain, formula, caveats), leading vs lagging indicators, querying curated datasets, SQL joins, aggregations, window functions, time/date handling, pandas basics for light wrangling.

Visual perception principles, encoding hierarchy, chart selection (comparison, composition, distribution, relationship), color theory & accessibility, small multiples, annotations, time-series narratives, geospatial visualization basics.

Dashboard types (operational vs analytical), interactivity (filters, parameters, drill-downs), product funnels, conversion rates, retention and cohort analysis, segmentation pitfalls, real-time KPI monitoring, geospatial layers.

Metric validation, reproducibility, statistical readouts (CIs, p-values, power), A/B testing interpretation, anomaly detection, dashboard QA (performance, accessibility, documentation), stakeholder presentation techniques.

Reference Books

- 1 Storytelling with Data, Cole Nussbaumer Knaflic, 1st Edition 2015, Wiley.
- 2 The Visual Display of Quantitative Information (2e), Edward R. Tufte, Second Edition 2001, Graphics Press.
- 3 Data Science for Business, Foster Provost & Tom Fawcett, First Edition 2013, O Reilly.

25DSE3101A - DATA ANALYTICS & VISUALIZATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3101A	DATA ANALYTICS & VISUALIZATION	DAV	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply analytic framing to translate business questions into KPIs, metric trees, and SQL/Python queries on curated datasets.	3	PO1, PO2
CO2	Perform essential data wrangling, cleaning, and preprocessing using SQL and Python (pandas, time/date handling).	3	PO2, PO3
CO3	Analyze data and select effective visual encodings, chart types, and narratives using visual perception principles.	4	PO2, PO3
CO4	Build interactive dashboards (filters, drill-downs, alerts) and perform product analytics (funnels, cohorts) for decision support.	4	PO2, PO3
CO5	Evaluate dashboards and reports for accuracy, usability, and impact; run A/B readouts and anomaly reviews with statistical rigor.	5	PO2, PO3

Syllabus

KPI trees, metric specifications (owner, grain, formula, caveats), leading vs lagging indicators, querying curated datasets.

SQL joins, aggregations, window functions, time/date handling, pandas basics for data wrangling and preprocessing.

Visual perception principles, encoding hierarchy, chart selection (comparison, composition, distribution, relationship), color theory & accessibility, small multiples, annotations, time-series narratives, geospatial visualization basics.

Dashboard types (operational vs analytical), interactivity (filters, parameters, drill-downs), product funnels, conversion rates, retention and cohort analysis, segmentation pitfalls, real-time KPI monitoring, geospatial layers.

Metric validation, reproducibility, statistical readouts (CIs, p-values, power), A/B testing interpretation, anomaly detection, dashboard QA (performance, accessibility, documentation), stakeholder presentation techniques.

Reference Books

- 1 Storytelling with Data, Cole Nussbaumer Knaflic, First Edition 2015, Wiley.
- 2 The Visual Display of Quantitative Information (2e), Edward R. Tufte, Second Edition 2001, Graphics Press.
- 3 Data Science for Business, Foster Provost & Tom Fawcett, First Edition 2013, O Reilly.

25DSE3101E - DATA ANALYTICS & VISUALIZATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3101E	DATA ANALYTICS & VISUALIZATION	DAV	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply analytic framing to translate business questions into KPIs, metric trees, and SQL/Python queries on curated datasets.	3	PO1
CO2	Perform essential data wrangling, cleaning, and preprocessing using SQL and Python (pandas, time/date handling).	3	PO2, PO3
CO3	Analyze data and select effective visual encodings, chart types, and narratives using visual perception principles.	4	PO2
CO4	Build interactive dashboards (filters, drill-downs, alerts) and perform product analytics (funnels, cohorts) for decision support.	4	PO2
CO5	Evaluate dashboards and reports for accuracy, usability, and impact; run A/B readouts and anomaly reviews with statistical rigor.	5	PO2

Syllabus

KPI trees, metric specifications (owner, grain, formula, caveats), leading vs lagging indicators, querying curated datasets.

SQL joins, aggregations, window functions, time/date handling, pandas basics for data wrangling and preprocessing.

Visual perception principles, encoding hierarchy, chart selection (comparison, composition, distribution, relationship), color theory & accessibility, small multiples, annotations, time-series narratives, geospatial visualization basics.

Dashboard types (operational vs analytical), interactivity (filters, parameters, drill-downs), product funnels, conversion rates, retention and cohort analysis, segmentation pitfalls, real-time KPI monitoring, geospatial layers.

Metric validation, reproducibility, statistical readouts (CIs, p-values, power), A/B testing interpretation, anomaly detection, dashboard QA (performance, accessibility, documentation), stakeholder presentation techniques.

Reference Books

- 1 Storytelling with Data, Cole Nussbaumer Knaflic, First Edition 2015, Wiley.
- 2 Fundamentals of Data Visualization, Claus O. Wilke, First Edition 2019, O Reilly.
- 3 Information Dashboard Design (2e), Stephen Few, Second Edition 2013, Analytics Press.

25DSE3202 - DATA EXPLORATION & PREPARATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3202	DATA EXPLORATION & PREPARATION	DEP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Perform comprehensive exploratory data analysis (EDA) to uncover data distributions, patterns, correlations, and anomalies.	3	PO1
CO2	Apply advanced data cleaning, missing value imputation, and outlier treatment techniques for model readiness.	4	PO2, PO3
CO3	Engineer meaningful features, encode categorical variables, and transform data for optimal ML/AI performance.	4	PO2, PO3
CO4	Evaluate the impact of preprocessing and feature engineering choices on downstream ML/AI models.	5	PO2, PO3

Syllabus

Role of EDA in ML/AI pipelines, univariate/bivariate/multivariate analysis, statistical summaries, data visualization for EDA (pair plots, correlation heatmaps), distribution fitting, detecting anomalies and skewness, hypothesis generation from EDA findings.

Handling missing data (mean/median/mode imputation, KNN imputation, MICE), outlier detection and treatment (IQR, Z-score, isolation forests), handling inconsistent formats, text normalization, deduplication, scaling/standardization of numeric values, type casting, sanity checks.

One-hot encoding, label encoding, ordinal encoding, target encoding; interaction features, polynomial features, domain-specific features; date/time feature extraction; frequency encoding; normalization and transformations (log, Box-Cox, Yeo-Johnson).

rain-test leakage prevention, evaluating preprocessing with cross-validation, impact of feature scaling/encoding on model performance, pipeline automation with scikit-learn Pipelines, feature importance ranking, iterative feature selection/removal, documenting data preparation workflows.

Reference Books

- 1 Feature Engineering for Machine Learning, Alice Zheng, Amanda Casari, 1st Edition 2018, O Reilly.
- 2 Data Preparation for Analytics Using SAS, Gerhard Svolba, 1st Edition 2006, SAS Press.
- 3 Data Wrangling with Python, Jacqueline Kazil, Katharine Jarmul, 1st Edition 2016, O Reilly.

25DSE3203 - DATA WAREHOUSING& BUSINESS INTELLIGENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3203	DATA WAREHOUSING& BUSINESS INTELLIGENCE	DWBI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Design conceptual, logical, and physical data warehouse models based on enterprise requirements.	3	PO1
CO2	Implement ETL/ELT processes for populating a data warehouse using industry-standard tools.	4	PO2, PO3
CO3	Apply OLAP operations and dimensional modeling for complex analytical queries.	4	PO2, PO3
CO4	Utilize BI platforms to create interactive dashboards and generate actionable business insights.	5	PO2, PO3

Syllabus

Introduction to data warehouses; difference between OLTP and OLAP; data warehouse architecture (single-tier, two-tier, three-tier); data marts; data lakes vs. data warehouses; role in decision support systems.

Star, snowflake, and galaxy schemas; fact and dimension tables; surrogate keys; slowly changing dimensions (SCDs); ETL vs. ELT approaches; scheduling & orchestration tools; incremental loading strategies.

OLAP operations (roll-up, drill-down, slice, dice, pivot); materialized views; aggregation strategies; query optimization in warehouses; partitioning and indexing strategies.

BI concepts and lifecycle; KPIs and metrics; self-service BI; dashboard design principles; BI tools (Power BI, Tableau, Looker); integrating BI with data warehouses; real-time BI pipelines.

Reference Books

- 1 Data Warehousing in the Age of Big Data, Krish Krishnan, 1st Edition 2013, Morgan Kaufmann.
- 2 Learning Microsoft Power BI, Brett Powell, 2nd Edition 2022, Packt Publishing.
- 3 The Data Warehouse Toolkit, Ralph Kimball, Margy Ross, 3rd Edition 2013, Wiley.

25DSE3304 - BIG DATA ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3304	BIG DATA ENGINEERING	BDE	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain big data characteristics, architectures, and distributed computing principles.	3	
CO2	Design and implement scalable batch and streaming data processing pipelines using industry-standard frameworks.	4	
CO3	Optimize distributed processing jobs for performance, cost, and fault tolerance.	4	
CO4	Integrate big data systems with downstream analytics and AI/ML workflows.	5	

Syllabus

Definition of big data (Volume, Velocity, Variety, Veracity, Value); Lambda and Kappa architectures; distributed storage systems (HDFS, object storage); scalability and fault tolerance principles; trade-offs in consistency, availability, and partition tolerance (CAP theorem).

Apache Hadoop ecosystem; MapReduce programming model; Apache Spark core concepts (RDDs, DataFrames, Datasets); data partitioning and shuffling; resource management (YARN, Kubernetes); job orchestration.

Stream processing concepts; Apache Kafka fundamentals; Spark Structured Streaming; Apache Flink basics; event time vs. processing time; windowed operations; exactly-once processing guarantees.

Performance tuning in Spark and Flink; memory vs. disk usage trade-offs; data locality; schema evolution handling; integration with ML pipelines (Spark MLlib, TensorFlow on Spark); cloud-native big data services (EMR, Dataproc, Databricks).

Reference Books

- 1 Learning Spark, Tom White, 4th Edition 2015, O Reilly Media.
- 2 Streaming Systems, Tyler Akidau et al, 1st Edition 2018, O Reilly Media.
- 3 Designing Data-Intensive Applications, Martin Kleppmann, 1st Edition 2017, O Reilly Media.

25DSE3304A - BIG DATA ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3304A	BIG DATA ENGINEERING	BDE	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain big data characteristics and distributed computing principles.	3	PO1, PO2, PO3
CO2	Design scalable batch data processing pipelines using Hadoop and Spark.	4	PO3, PO5
CO3	Design scalable streaming data pipelines using Kafka, Spark Streaming, and Flink.	4	PO3, PO5
CO4	Optimize distributed processing jobs for performance, cost, and fault tolerance.	4	PO3, PO5
CO5	Integrate big data systems with downstream analytics and AI/ML workflows.	5	PO3, PO5

Syllabus

Definition of big data (Volume, Velocity, Variety, Veracity, Value); Lambda and Kappa architectures; distributed storage systems (HDFS, object storage); scalability and fault tolerance principles; trade-offs in consistency, availability, and partition tolerance (CAP theorem).

Apache Hadoop ecosystem; MapReduce programming model; Apache Spark core concepts (RDDs, DataFrames, Datasets); data partitioning and shuffling; resource management (YARN, Kubernetes); job orchestration.

Stream processing concepts; Apache Kafka fundamentals; Spark Structured Streaming; Apache Flink basics; event time vs. processing time; windowed operations; exactly-once processing guarantees.

Performance tuning in Spark and Flink; memory vs. disk usage trade-offs; data locality; schema evolution handling.

Integration with ML pipelines (Spark MLlib, TensorFlow on Spark); cloud-native big data services (EMR, Dataproc, Databricks); downstream analytics integration.

Reference Books

- 1 Learning Spark, Jules Damji et al., 2nd Edition 2020, O Reilly Media.
- 2 Streaming Systems, Tyler Akidau et al, 1st Edition 2018, O Reilly Media.
- 3 Designing Data-Intensive Applications, Martin Kleppmann, 1st Edition 2017 , O Reilly Media.

25DSE3304E - BIG DATA ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3304E	BIG DATA ENGINEERING	BDE	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain big data characteristics and distributed computing principles.	3	PO1, PO2, PO4
CO2	Design scalable batch data processing pipelines using Hadoop and Spark.	4	PO2, PO4
CO3	Design scalable streaming data pipelines using Kafka, Spark Streaming, and Flink.	4	PO2, PO4
CO4	Optimize distributed processing jobs for performance, cost, and fault tolerance.	4	PO2, PO4
CO5	Integrate big data systems with downstream analytics and AI/ML workflows.	5	PO2, PO4

Syllabus

Definition of big data (Volume, Velocity, Variety, Veracity, Value); Lambda and Kappa architectures; distributed storage systems (HDFS, object storage); scalability and fault tolerance principles; trade-offs in consistency, availability, and partition tolerance (CAP theorem).

Apache Hadoop ecosystem; MapReduce programming model; Apache Spark core concepts (RDDs, DataFrames, Datasets); data partitioning and shuffling; resource management (YARN, Kubernetes); job orchestration.

Stream processing concepts; Apache Kafka fundamentals; Spark Structured Streaming; Apache Flink basics; event time vs. processing time; windowed operations; exactly-once processing guarantees.

Performance tuning in Spark and Flink; memory vs. disk usage trade-offs; data locality; schema evolution handling.

Integration with ML pipelines (Spark MLlib, TensorFlow on Spark); cloud-native big data services (EMR, Dataproc, Databricks); downstream analytics integration.

Reference Books

- 1 Learning Spark, Jules Damji et al, 2nd 2020, O Reilly Media.
- 2 Streaming Systems, Tyler Akidau et al., 1st Edition 2018 , O Reilly Media.
- 3 Designing Data-Intensive Applications, Martin Kleppmann, 1st Edition 2017, O Reilly Media.

25DSE3305 - BUSINESS ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3305	BUSINESS ANALYTICS	BA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the role of analytics in business decision-making and competitive strategy.	3	PO1, PO4
CO2	Apply descriptive and diagnostic analytics techniques to extract actionable insights from business data.	4	PO4, PO5, PO8
CO3	Build predictive and prescriptive analytics models for solving real-world business problems.	4	PO3, PO4, PO8
CO4	Evaluate and communicate business analytics results to stakeholders for strategic impact.	5	PO8

Syllabus

Overview of business analytics types (descriptive, diagnostic, predictive, prescriptive); role in business strategy; key industries using analytics (finance, retail, healthcare, manufacturing); analytics lifecycle; KPIs & metrics; linking analytics to ROI.

Data summarization techniques; KPI dashboards; slicing/dicing; cohort analysis; funnel analysis; root cause analysis; hypothesis testing; association rules for business intelligence; business storytelling with data.

Regression (linear, logistic); time-series forecasting (ARIMA, Prophet); churn prediction; demand forecasting; customer lifetime value modeling; model evaluation metrics (RMSE, ROC-AUC).

Optimization models (linear, integer programming); simulation modeling; scenario analysis; Monte Carlo simulations; reinforcement learning for decision-making; communicating recommendations; ethical considerations in business analytics.

Reference Books

- 1 Competing on Analytics, Thomas H. Davenport, Jeanne G. Harris, 1st 2019, Harvard Business Review Press.
- 2 Data Science for Business, Foster Provost, Tom Fawcett, 1st Edition 2020, O Reilly Media.
- 3 Prescriptive Analytics, Patrick Bangert, 1st Edition 2021, Wiley.

25DSE3305A - BUSINESS ANALYTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3305A	BUSINESS ANALYTICS	BA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the role of analytics in business decision-making and competitive strategy.	3	PO1
CO2	Apply descriptive analytics techniques to summarize and visualize business data.	4	PO3, PO4
CO3	Apply diagnostic analytics methods to identify patterns, root causes, and business insights	4	PO4
CO4	Build predictive and prescriptive analytics models for real-world applications.	4	PO9, PO10
CO5	Evaluate and communicate business analytics results to stakeholders for strategic impact.	5	PO9, PO10

Syllabus

Overview of business analytics types (descriptive, diagnostic, predictive, prescriptive); role in business strategy; key industries using analytics (finance, retail, healthcare, manufacturing); analytics lifecycle; KPIs & metrics; linking analytics to ROI.

Data summarization techniques; KPI dashboards; slicing/dicing; cohort analysis; funnel analysis; business storytelling with data.

Root cause analysis; hypothesis testing; association rules for business intelligence.

Regression (linear, logistic); time-series forecasting (ARIMA, Prophet); churn prediction; demand forecasting; customer lifetime value modeling; model evaluation metrics (RMSE, ROC-AUC).

Optimization models (linear, integer programming); simulation modeling; scenario analysis; Monte Carlo simulations; reinforcement learning for decision-making; communicating recommendations; ethical considerations in business analytics.

Reference Books

- 1 Competing on Analytics, Thomas H. Davenport, Jeanne G. Harris, 3rd Edition 2017, Jeanne G. Harris Harvard Business Review Press.
- 2 Data Science for Business, Foster Provost, Tom Fawcett, 1st Edition 2013, O Reilly Media.
- 3 Prescriptive Analytics, Patrick Bangert, 1st Edition 2021, Wiley.

25DSE3305E - BUSINESS ANALYTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3305E	BUSINESS ANALYTICS	BA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the role of analytics in business decision-making and competitive strategy.	3	PO1
CO2	Apply descriptive analytics techniques to summarize and visualize business data.	4	PO3, PO8, PO9
CO3	Apply diagnostic analytics methods to identify patterns, root causes, and business insights.	4	PO8, PO9
CO4	Build predictive and prescriptive analytics models for real-world applications.	4	PO8, PO9
CO5	Evaluate and communicate business analytics results to stakeholders for strategic impact.	5	PO8, PO9

Syllabus

Overview of business analytics types (descriptive, diagnostic, predictive, prescriptive); role in business strategy; key industries using analytics (finance, retail, healthcare, manufacturing); analytics lifecycle; KPIs & metrics; linking analytics to ROI.

Data summarization techniques; KPI dashboards; slicing/dicing; cohort analysis; funnel analysis; business storytelling with data.

Root cause analysis; hypothesis testing; association rules for business intelligence.

Regression (linear, logistic); time-series forecasting (ARIMA, Prophet); churn prediction; demand forecasting; customer lifetime value modeling; model evaluation metrics (RMSE, ROC-AUC).

Optimization models (linear, integer programming); simulation modeling; scenario analysis; Monte Carlo simulations; reinforcement learning for decision-making; communicating recommendations; ethical considerations in business analytics.

Reference Books

- 1 Prescriptive Analytics, Patrick Bangert, 1st Edition 2021, Wiley.
- 2 Predictive Analytics, Eric Siegel, 3rd Edition 2017, Wiley.
- 3 Data Science for Business, Foster Provost, Tom Fawcett, 1st Edition 2013, O Reilly Media.

25DSE3406 - AI-DRIVEN DATA ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3406	AI-DRIVEN DATA ENGINEERING	AIDE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply metadata-/contract-driven design for reliable, discoverable data products with SLAs/SLOs, lineage, and observability hooks.	3	PO1
CO2	Analyze and implement ML-assisted data quality, drift/anomaly detection, and entity resolution for production datasets.	4	PO2, PO3, PO8
CO3	Build feature store centric ML data products ensuring point in time correctness, training serving consistency, and version control.	4	PO8
CO4	Evaluate cost, performance, and reliability via intelligent orchestration (canary/shadow runs, auto-tuning, CI/CD for data) and recommend operations runbooks	5	PO8

Syllabus

Data as a product; data contracts (schema, semantics, freshness/volume SLAs); contract change management; metadata catalogs (ownership, lineage, usage stats); OpenLineage/OpenMetadata/DataHub concepts; data observability pillars (freshness, volume, distribution, schema, lineage); SLOs & runbooks; event logging for pipelines.

Time-series anomaly detection for KPIs (ESD/Prophet/ADTK); schema & distribution drift (KS test, PSI, JS divergence); missingness patterns; entity resolution/dedup with ML; automated tests (expectations) vs learned monitors; synthetic data for test fixtures; alerting severity and ticket routing.

Offline/online feature stores; point-in-time correctness & backfill; feature definitions, owners, SLAs; training-serving skew detection; validation (schema & stats) with TFDV/Evidently; feature reuse/versioning; real-time vs batch feature pipelines; integration with model serving.

Orchestrators with lineage/metrics (Airflow/Dagster); canary/shadow pipelines & output diffs; auto-tuning Spark/Flink jobs; cache/materialization strategies; cost-aware scheduling & FinOps basics; CI/CD for data (dbt tests, expectations in PRs, environment promotions), rollback & blast-radius control; SRE for data (SLOs, error budgets, on-call playbooks).

Reference Books

- 1 Fundamentals of Data Engineering, Joe Reis, Matt Housley, 1st Edition 2022, O Reilly.
- 2 Designing Data-Intensive Applications, Martin Kleppmann, 1st Edition 2017, O Reilly.
- 3 Practical MLOps, Noah Gift, Alfredo Deza, 1st Edition 2021, O Reilly.

25DSE3407 - DATA GOVERNANCE ON CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3407	DATA GOVERNANCE ON CLOUD	DGC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply a cloud data-governance framework (policies, roles, classifications, access models) and map it to provider services.	3	PO1
CO2	Analyze and implement privacy protection (masking, tokenization, encryption, KMS), DLP scanning, consent & retention controls to meet compliance needs.	4	PO3
CO3	Build metadata, catalog, and lineage capabilities; define domain ownership and SLAs for data-mesh style governance.	4	PO3
CO4	Evaluate and enforce governance via policy-as-code, audit/monitoring, and cost guardrails (FinOps) with measurable SLOs and runbooks.	5	PO3

Syllabus

Governance principles accountability stewardship least privilege segregation of duties, data policy stack enterprise policy standards controls, classification tagging Public Internal Confidential Restricted and mapping to controls, identity access models RBAC ABAC tag based access, row column level security dynamic masking, platform mappings AWS IAM Lake Formation, Azure Entra AD Purview RBAC, GCP IAM BigQuery policies, roles RACI Owner Steward Custodian Consumer, landing zone basics org units accounts projects guardrails

PII/PHI/PCI data types; encryption (at rest, in transit, client-side), KMS & key rotation, HSM basics; masking/pseudonymization/tokenization patterns; DLP scanning approaches and triage; consent & purpose limitation modeling; data lifecycle & retention/legal hold; geo-residency & cross-border transfers; mapping to standards (GDPR, HIPAA, ISO-27001, SOC 2); change management & DPIA templates.

Business glossary, technical metadata, usage metadata, catalog services crowd sourcing descriptions, lineage capture OpenLineage events pipeline integration, data quality from a governance lens rules owners thresholds not ML monitors, data mesh concepts domain ownership data products SLAs SLOs discoverability access delegation, publishing agreements consumer contracts, onboarding workflows for new products

Policy as code OPA Rego Azure Policy AWS Config GCP Org Policy for preventive detective controls, CI CD gates for schema policy changes, audit monitoring access logs query logs anomaly review, incident response runbooks, FinOps for data tagging standards budgets alerts storage class lifecycle hot warm cold cost showback chargeback, SLOs for freshness availability error budgets, governance scorecards

Reference Books

- 1 DAMA-DMBOK2: Data Management Body of Knowledge, DAMA International, 2017, Technics Publications.
- 2 Non-Invasive Data Governance, Robert S. Seiner, 2014, Technics Publications.
- 3 Data Governance: How to Design, John Ladley, 2020, Academic / Elsevier.

25DSE3508 - DATA ANALYTICS ON CLOUD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3508	DATA ANALYTICS ON CLOUD	DAC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply cloud lake/lakehouse patterns: object storage, open formats, external/federated tables, and managed query engines.	3	PO1
CO2	Analyze and implement advanced cloud SQL/ELT (nested data, partitioning, clustering, materialized views) with cost-aware design.	4	PO2
CO3	Build near real time analytics using fully managed streaming warehouse paths with minimal ops burden	4	PO2
CO4	Evaluate & operate cloud analytics workloads for performance, reliability, and cost (plans, quotas, reservations, monitoring).	5	PO2

Syllabus

Lake vs lakehouse, object storage Cloud Storage as system of record, open columnar formats Parquet ORC compression, external tables over files, federated queries Cloud SQL Sheets BigQuery, partitioning strategies ingestion time vs column, clustering, metadata layouts, managed engines BigQuery Athena Synapse serverless vs provisioned warehouses, data transfer services public datasets, cost surface overview bytes scanned slots storage classes

ARRAY STRUCT UNNEST, semi structured JSON ingestion, window analytic functions, approximate aggregations, materialized views and table decorators, scheduling dbt Dataform ELT flow staging marts, partition pruning and cluster filtering, cache BI Engine, cost aware SQL avoid SELECT predicate pushdown bytes processed limits, on demand vs slot reservations high level

Streaming options Pub Sub BigQuery streaming buffer, Dataflow SQL or templates for transforms, event time vs processing time windows, late data watermarks managed, deduplication keys, building sliding window aggregates for ops KPIs, near real time freshness SLIs, minimal visualization handoff connector only

Query plan EXPLAIN and common bottlenecks, pre aggregation tables, multi table materialization, workload management reservations quotas concurrency controls, INFORMATION_SCHEMA for usage cost telemetry, scheduled queries with failure alerts, failure modes quota exceeded lock contention, FinOps for analytics storage lifecycle standard nearline archive cost budget alerts showback by project user, runbooks and SLOs freshness fail

Reference Books

- 1 Google BigQuery: The Definitive Guide (2e), Lakshmanan, Tigani, 2021, O Reilly.
- 2 Designing Cloud Data Platforms, Danil Zburivsky, L. Mou, 2021, Wiley.
- 3 Streaming Systems, Akidau et al., 2018, O Reilly.

25DSE3509 - GRAPH & WEB ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25DSE3509	GRAPH & WEB ANALYTICS	GWA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain fundamental concepts of graph theory and web analytics.	2	PO1
CO2	Apply graph algorithms and web analytics techniques to real-world datasets.	3	PO2
CO3	Analyze patterns, communities, and relationships in complex networks.	4	PO2
CO4	Design scalable pipelines for graph and web data ingestion, processing, and analysis.	5	PO2

Syllabus

Graph basics (vertices, edges, weighted/unweighted, directed/undirected); Graph representation; BFS, DFS, shortest path algorithms; Real-world graph datasets (social networks, citation graphs, knowledge graphs).

Community detection (Louvain, Girvan-Newman); Graph clustering & modularity; Graph embeddings (Node2Vec, DeepWalk); Centrality measures; Link prediction fundamentals.

Web traffic metrics; User behavior analysis; Clickstream analysis; Conversion funnels; A/B testing design & interpretation.

Session graph modeling; Navigation loop detection; Dead-end detection; Recommendation systems using graph

Distributed graph processing (GraphX, GraphFrames); Large-scale clickstream handling; Streaming analytics for real-time behavior tracking.

End-to-end project integrating graph & web analytics; Real-world datasets; Deployment and dashboard creation.

Reference Books

- 1 Graph Databases, Ian Robinson, Jim Webber, Emil Eifrem, 2020, O Reilly Media.
- 2 Network Science, Albert-L?szl? Barab?si, 2016, Cambridge University Press.
- 3 Learning Neo4j, Rik Van Bruggen, 2015, Packt Publishing.

25EDS3101 - ADVANCED EMBEDDED SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EDS3101	ADVANCED EMBEDDED SYSTEMS	AES	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of embedded systems to understand about multicore System on chip.	3	
CO2	Apply the interconnection networks, designs and routing algorithms for Network- On Chip (NoC)	3	
CO3	Development of Software Tools and Debugging Techniques	3	
CO4	Analyze the concept of multicore SoC in building real time applications for health monitoring	4	
CO5	Analyze the programming of LPC2148 and LPC1768 microcontroller and also interface various peripheral devices to these micro controllers.	4	
CO6	Analyze the simulation of LPC2148 and LPC1768 microcontrollers	4	
CO7	Analyze the simulation of LPC2148 and LPC1768 microcontrollers	4	

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, Photonic on chip Interconnect

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

Reference Books

- 1 Advanced Multicore system on chip- Architecture, On-chip Network, design, Abderazek Ben Abdallah, ISBN 978-981-10-6091-5, Springer.
- 2 Computers as components-Principles of embedded computing system design, Wayne Wolf, 2nd edition. , elsevier,.
- 3 An embedded software primer, David. E. Simon, ISBN 020161569X, 2005.
- 4 Embedded systems: Architecture, Programming and design, Raj Kamal, 2nd edition., elsevier,.

25EDS3101A - ADVANCED EMBEDDED SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EDS3101A	ADVANCED EMBEDDED SYSTEMS	AES	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of embedded systems to understand about multicore System on chip.	3	
CO2	Identify the interconnection networks, designs and routing algorithms for Network-On Chip (NoC)	3	
CO3	Development of Software Tools and Debugging Techniques	3	
CO4	Analyze the concept of multicore SoC in building real time applications for health monitoring	4	
CO5	Analyze various advanced embedded systems with Installation and understanding of Keil, and execution of various programs on LPC1768	4	
CO6	Analyze the programming of LPC2148 and LPC1768 microcontroller and also interface various peripheral devices to these micro controllers.	4	
CO7	Analyze the simulation of LPC2148 and LPC1768 microcontrollers	4	

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, Photonic on chip Interconnect

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

Reference Books

- 1 Advanced Multicore system on chip- Architecture, On-chipNetwork, design, Abderazek Ben Abdallah, ISBN 978-981-10-6091-5, Springer.
- 2 Computers as components-Principles of embedded computing system design, Wayne Wolf, 2nd edition, elseiver.
- 3 Anembedded software primer, David. E. Simon, ISBN 020161569X, 2005., elseiver.
- 4 Embedded systems: Architecture, Programming and design, Raj Kamal, 2nd edition, Springer.

25EDS3101E - ADVANCED EMBEDDED SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EDS3101E	ADVANCED EMBEDDED SYSTEMS	AES	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concept of embedded systems to understand about multicore System on chip.	3	
CO2	Apply the interconnection networks, designs and routing algorithms for Network- On Chip (NoC)	3	
CO3	Development of Software Tools and Debugging Techniques	3	
CO4	Analyze the concept of multicore SoC in building real time applications for health monitoring	4	
CO5	Analyze the programming of LPC2148 and LPC1768 microcontroller and also interface various peripheral devices to these micro controllers.	4	
CO6	Analyze the simulation of LPC2148 and LPC1768 microcontrollers	4	

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, Photonic on chip Interconnect.

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.

Reference Books

- 1 Advanced Multicore system on chip- Architecture, On-chip Network, design, Abderazek Ben Abdallah, 2, springer.
- 2 Computers as components-Principles of embedded computing system design, Wayne Wolf, 2, Elsevier.

25EDS3202 - EMBEDDED SYSTEMS FOR IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EDS3202	EMBEDDED SYSTEMS FOR IOT	ESIOT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to Understand and apply the requirements of functional blocks and functioning of IoT devices	3	PO2, PSO2
CO2	To apply the Communication models that are used for the development of the IoT based Systems	3	PO2, PSO2
CO3	To apply different networking topologies and protocols used for the development of IoT based Networks	3	PO5, PO10, PSO2
CO4	To analyze the IoT Application in different Case studies	4	PO5, PO10, PSO2

Syllabus

Embedded Systems and IoT Architecture: 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 Enabling Technologies-WSN, WSN architectures, embedded systems, IoT Levels and deployment

IoT Communication Models and Protocols: IoT communication Models, 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 & LoRA

IoT Communication Protocols and Cloud IoT 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

IoT Case Studies 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, 1st edition, 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, 1st edition 2019, British Columbia Institute of Technology.

25EDS3303 - EMBEDDED AND REAL-TIME SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EDS3303	EMBEDDED AND REAL-TIME SYSTEMS	ERTS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the different task-scheduling algorithms for real-time systems application	3	PO1
CO2	Apply Multiprocessor scheduling and real-time communication, databases, and synchronization in Real-time Systems	3	PO2
CO3	Analyse an RTOS and be able to interpret the feasibility of a task set to accomplish and Timers.	4	PO3
CO4	Analyse model-driven development approaches to construct an execution environment with case studies.	4	PO4
CO5	Analyse to design a real-time application and different task-scheduling algorithms in real-time systems using modern tool.	4	PO5

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.

a single, self-contained that covers Introduction ,Two Periodic Tasks ,Main Loop Task all in one place

Reference Books

- 1 Real-Time Embedded Systems, Xiaocong Fan, 1, Elsevier Inc.,.
- 2 Real Time Systems, C.M. Krishna & Kang G. Shin, 1, McGraw Hill.
- 3 Embedded Real Time Systems, KVKK Prasad, 1, Dreamtech Press.
- 4 Real Time Systems Design and Analysis-An Engineers Handbook, Philip A.Laplante, 4, IEEE Computer Society Press.
- 5 Embedded System Design A Unified Hardware/Software Introduction, Frank Vahid, Tony D. Givargis, 1, John Wiley.

25EDS3303A - EMBEDDED AND REAL-TIME SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EDS3303A	EMBEDDED AND REAL-TIME SYSTEMS	ERTS	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the different task-scheduling algorithms for real-time systems application	3	PO1
CO2	Apply Multiprocessor scheduling and real-time communication, databases, and synchronization in Real-time System	3	PO2
CO3	Analyse an RTOS and be able to interpret the feasibility of a task set to accomplish and Timers.	4	PO2, PO3
CO4	Analyze to develop model-driven development approaches to construct an execution environment with case studies.	4	PO3
CO5	Analyze the performance of real-time application and different task scheduling algorithms in real-time systems	4	PO4
CO6	Analyze to develop a real-time application and different task-scheduling algorithms in real-time systems	4	PO5

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

multitasking creates two timer-waiting tasks while the main task continuously loops performing background operations

Reference Books

- 1 Real-Time Embedded Systems, Xiaocong Fan, 1, Elsevier Inc.,.
- 2 Real Time Systems, C.M. Krishna & Kang G. Shin, 1, McGraw Hill.
- 3 Embedded / Real Time Systems, KVKK Prasad, 1, Dreamtech Press.
- 4 Real Time Systems Design and Analysis-An Engineers Handbook, Philip A.Laplante, 4, IEEE Computer Society Press.

- 5 Embedded System Design A Unified Hardware/Software Introduction, Frank Vahid, Tony D. Givargis, 1, John Wiley.

25EDS3303E - EMBEDDED AND REAL-TIME SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EDS3303E	EMBEDDED AND REAL-TIME SYSTEMS	ERTS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the different task-scheduling algorithms for real-time systems application	3	PO1
CO2	Apply Multiprocessor scheduling and real-time communication, databases, and synchronization in Real-time System	3	PO2
CO3	Analyse an RTOS and be able to interpret the feasibility of a task set to accomplish and Timers.	4	PO2, PO3
CO4	Analyze to develop model-driven development approaches to construct an execution environment with case studies.	4	PO3
CO5	Analyze the performance of real-time application and different task scheduling algorithms in real-time systems	4	PO3
CO6	Analyze to develop a real-time application and different task-scheduling algorithms in real-time systems	4	PO3

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

FreeRTOS application with two tasks triggered by a timer while the main task loops continuously in the background.

Reference Books

- 1 Real-Time Embedded Systems, Xiaocong Fan, 1, Elsevier Inc.,.
- 2 Real Time Systems, C.M. Krishna & Kang G. Shin, 1, McGraw Hill.
- 3 Embedded Real Time Systems, KVKK Prasad, 1, Dreamtech Press.

- 4 Real Time Systems Design and Analysis-An Engineers Handbook, Philip A.Laplante, 4, IEEE Computer Society Press.
- 5 Embedded System Design A Unified Hardware/Software Introduction, Frank Vahid, Tony D. Givargis, 1, John Wiley.

25EDS3404 - CLOUD ARCHITECTURE IN IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EDS3404	CLOUD ARCHITECTURE IN IOT	CAIOT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the process involved in sensing and moving data across the network to be stored in the clouds and extract the same for conducting the analytics.	2	
CO2	Understand the fundamentals related to cloud computing especially relating to data storage into cloud and retrieval of the same from the clouds.	2	
CO3	Ability to develop application for storing the sensed data on to the clouds	3	
CO4	Ability to deploy IoT device into cloud, Able to implement the communication between IoT device and cloud (Thingspeak, Azure and AWS)	4	

Syllabus

Introduction to Cloud Computing: Devices, Data flow, data 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. Cloud Computing (NIST Model): Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers; Properties, Characteristics & Disadvantages: Pros and Cons of Cloud Computing, Benefits of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing; Role of Open Standards.

Computing Architecture: Cloud computing stack, Comparison with traditional computing architecture (client/server), Services provided at various levels, Role of Networks in Cloud computing, Protocols used, 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.

Embellishing and using a private cloud: Network topology, HW-SE specification, installing open stack, configuring open stack availing services through open stacks, establishing virtual networks. Infrastructure as a Service (IaaS): Introduction to IaaS, IaaS definition, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, and Virtual Machine (VM).

Resource Virtualization: Server, Storage, Network, Virtual Machine (resource) provisioning and manageability, Storage as a service Case studies: Amazon EC2, Google Drive, one drive, drop box. Developing applications that use IaaS. Data capturing through IOT devices: Transmission of the data through different stages, and storage of the same in Clouds. Case Studies: Thing speak cloud, AWS IoT, Microsoft Azure IBM Watson IoT.

Reference Books

- 1 Parallel Processing to the Internet of Things, Kai Hwang Geoffrey C. Fox. Jack J. Dongarra, 1st Edition 2012, Morgan Kaufmann Publishers.
- 2 Cloud Computing, A Practical Approach, Toby Velte, Anthony Velte, Robert Elsenpeter, 1st Edition 2009, TMH.
- 3 Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, 1st Edition 2009, O'Reilly publishers.
- 4 Internet of Things Programming Projects_ Build modern IoT solutions with the Raspberry Pi 3 and Python, Colin Dow , 1st Edition 2012, Packt Publishing.

25EDS3505 - EDGE COMPUTING AND DATA ANALYTICS IN IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EDS3505	EDGE COMPUTING AND DATA ANALYTICS IN IOT	ECDAI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25EGD3101 - ADVANCED STRENGTH OF MATERIALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3101	ADVANCED STRENGTH OF MATERIALS	ASM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO2	Analyze the behaviour of curved beams and determine the shear centre for various cross sections of beams	4	PO1, PO2, PSO1
CO3	Apply unit load method to find deflections in beams and structures	3	PO1, PO2, PSO1
CO4	Analyze the various stresses in rotating members and thick cylinders	4	PO1, PO2, PSO1
CO5	Conduct simulations to determine the behavior of different beams and structures using software tool.	4	PO5, PSO1

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 J. M., & Timoshenko S. P., 2nd Edition, CBS publishers.
- 2 Strength of Materials, Dr. Sadhu Singh, 10th edition, Khanna Publishers.
- 3 Mechanics of Materials, Beer P F and Johnston (Jr) E R, 4th Edition, McGraw Hill.

25EGD3101A - ADVANCED STRENGTH OF MATERIALS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3101A	ADVANCED STRENGTH OF MATERIALS	ASM	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO2	Analyze the behaviour of curved beams and determine the shear centre for various cross sections of beams	4	PO1, PO2, PSO1
CO3	Apply unit load method to find deflections in beams and structures	3	PO1, PO2, PSO1
CO4	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO5	Analyze torsion in non-circular sections and determine stresses considering warping effects using Prandtl's stress function.	4	PO1, PO2, PSO1
CO6	Conduct simulations to determine the behavior of different beams and structures using software tool	4	PO5, PSO1

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.

Torsion of Non-Circular Sections: Introduction, warping of cross-sections, Prandtl's stress function approach.

Reference Books

- 1 Mechanics of Materials, Gere, J. M., & Timoshenko, 2nd Edition, CBS Publishers.
- 2 Strength of materials , Dr. Sadhu Singh, 10th Edition, Khanna Publishers.
- 3 Strength of Materials, A. Pytel, F. L. Singer, 3rd Edition, Harper Collins.

25EGD3101E - ADVANCED STRENGTH OF MATERIALS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3101E	ADVANCED STRENGTH OF MATERIALS	ASM	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the behaviour of statically indeterminate beams for different loading conditions	4	PO1, PO2, PSO1
CO2	Analyze the behaviour of curved beams and determine the shear centre for various cross sections of beams	4	PO1, PO2, PSO1
CO3	Apply unit load method to find deflections in beams and structures	3	PO1, PO2, PSO1
CO4	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO5	Analyze torsion in non-circular sections and determine stresses considering warping effects using Prandtl's stress function	4	PO1, PO2, PSO1
CO6	Conduct simulations to determine the behavior of different beams and structures using software tool.	4	PO5, PSO1

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.

Torsion of Non-Circular Sections: Introduction, warping of cross-sections, Prandtl's stress function approach.

Reference Books

- 1 Mechanics of Materials, J. M. Gere, S. P. Timoshenko, 2nd Edition, CBS Publishers.
- 2 Strength of Materials, S. Singh, 10th Edition, Khanna Publishers.
- 3 Strength of Materials, A. Pytel, F. L. Singer, 3rd Edition, Harper Collins.

25EGD3202 - CREEP, FATIGUE AND FRACTURE MECHANICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3202	CREEP, FATIGUE AND FRACTURE MECHANICS	CFFM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	?Analyse the life of structural components under creep?	4	PO2, PSO2
CO2	Analyse the fatigue life of structural components under the specified load spectrum?	4	PO2, PSO2
CO3	Apply linear elastic fracture mechanisms to predict material failure?	3	PO2, PO3
CO4	Analyse the fracture toughness and assess the life of flawed structural components?	4	PO2, PO3

Syllabus

Creep behaviour of metals: Plastic deformation and characteristics of dislocations, Mechanisms of creep, Creep testing methods, modelling the useful creep life of materials, Creep stress time temperature relations, strain-hardening effects on creep, creep buckling, members subjected to combined stresses and creep.?

Fatigue: Repeated stresses, S N curves, endurance limit, Fatigue life prediction finite, infinite, Factors influencing fatigue behaviour of metals, cyclic Strain hardening and softening, Modified Goodman diagram and examples, Coffin Mansons relation.?

Fracture Mechanics: Modes of fracture failures, Energy release rate Griffiths theory Irwin extension of Griffiths theory to ductile materials, Effect of thickness on fracture toughness, stress intensity factors; critical SIF, Paris Law and Sigmoidal curve.?

Fracture toughness testing : Plane stress and plane strain fracture toughness testing, General considerations for metallic specimens, Specimen configuration, Stress intensity factors, Precracking ,Grooving , ASTM E 399? standard, K R curve.?

Reference Books

- 1 Elements of Fracture Mechanics, Prashant Kumar, 2009, Tata McGraw-Hill Education.
- 2 Mechanical Metallurgy, George E. Dieter, 1986, McGraw Hill.
- 3 Creep in Metallic Materials, Josef Cadek, 1988, Elsevier.

25EGD3203 - THEORY OF ELASTICITY AND PLASTICITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3203	THEORY OF ELASTICITY AND PLASTICITY	KDARS	R	3	0	0	0	3

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 criterions 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.

25EGD3304 - MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3304	MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS	MADRS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO2	Analyze the behaviour of curved beams and determine the shear centre for various cross sections of beams	4	PO1, PO2, PSO1
CO3	Apply unit load method to find deflections in beams and structures	3	PO1, PO2, PSO1
CO4	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO5	Conduct simulations to determine the behavior of different beams under different loading	4	PO1, PO2, PSO1

Syllabus

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.

Introduction, Principles of virtual work, Apply Unit load Method to determine displacements and slope in Beams and to analyze simple structures and trusses.

: 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 Strength of Materials, S. Singh, 10th, Khanna Publishers (2013).
- 2 Mechanics of Materials , F. P. Beer, E. R. Johnston, 4th, McGraw Hill (2003).
- 3 Engineering Mechanics of Solids, E. P. Popov, 4th, Prentice Hall (1998).

25EGD3304A - MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3304A	MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS	MADRS	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO2	Analyze the behaviour of curved beams and determine the shear centre for various cross sections of beams	4	PO1, PO2, PSO1
CO3	Apply unit load method to find deflections in beams and structures	3	PO1, PO2, PSO1
CO4	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO5	Conduct simulations to determine the behavior of different beams under different loading	4	PO1, PO2, PSO1

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, J. M. Gere, S. P. Timoshenko, 2nd, CBS Publishers (1999).
- 2 Strength of Materials, S. Singh, 10th, Khanna Publishers (2013).
- 3 Strength of Materials, A. Pytel, F. L. Singer, 3rd, HarperCollins (1987).
- 4 Mechanics of Materials, F. P. Beer, E. R. Johnston, 4th, McGraw Hill (2003).
- 5 Engineering Mechanics of Solids, E. P. Popov, 4th, Prentice Hall (1998).

25EGD3304E - MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3304E	MODELING, ANALYSIS AND DESIGN OF ROBOTIC SYSTEMS	MADRS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO2	Analyze the behaviour of curved beams and determine the shear centre for various cross sections of beams	4	PO1, PO2, PSO1
CO3	Apply unit load method to find deflections in beams and structures	3	PO1, PO2, PSO1
CO4	Analyze the behaviour of statically indeterminate beams for different loading	4	PO1, PO2, PSO1
CO5	Conduct simulations to determine the behavior of different beams under different loading	4	PO1, PO2, PSO1

Syllabus

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.

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.

Introduction, Principles of virtual work, Apply Unit load Method to determine displacements and slope in Beams and to analyze simple structures and trusses.

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 Strength of Materials, S. Singh, 10th, Khanna Publishers (2013).
- 2 Mechanics of Materials, F. P. Beer, E. R. Johnston, 4th, McGraw Hill (2003).
- 3 Engineering Mechanics of Solids, E. P. Popov, 4th, Prentice Hall (1998).

25EGD3405 - SUSTAINABLE DESIGN AND SOCIAL INNOVATION IN ENGINEERING DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3405	SUSTAINABLE DESIGN AND SOCIAL INNOVATION IN ENGINEERING DESIGN	SDSIED	R	3	0	0	0	3

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

Syllabus

Introduction to Robotics : Definition and scope of robotics, evolution and history, Types of, Coordinate frames and classification based on geometry and motion, Introduction to robot anatomy: links, joints, actuators, and end effectors
 Kinematics of Robots : Coordinate transformations using homogeneous transformation matrices, Forward and inverse kinematics using Denavit-Hartenberg (D-H) parameters, Example: 2R and 3R manipulators; Planar vs. spatial kinematics

Sensors and Actuators: Introduction to joint sensors: potentiometers, encoders, proximity sensors, End effector sensors: force, torque, tactile, Actuators: electrical (DC, servo), pneumatic, hydraulic.

Robot Control and Trajectory Planning: Basics of feedback and open-loop control, Joint space and task space trajectory planning, Control system examples (PD/PI control, velocity control).

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.

Robot Simulation and Application : Introduction to ABB IRB 1600 industrial robot configuration, Programming in ABB RobotStudio or MATLAB Robotics Toolbox, Simulating pick and place operations and basic motion plans, Case studies: spot welding, painting, assembly. Design a pick-and-place task using ABB RobotStudio or any open-source platform (V-REP, Webots)

Reference Books

- 1 Robotics Engineering An Integrated Approach, R. D. Klafter, T. A. Chmielewski, M. Negin, 1989, Prentice Hall.
- 2 Industrial Robotics Technology Programming and Applications, M. P. Groover, 2017, McGraw-Hill.
- 3 Robotics Control Sensing Vision and Intelligence, K. S. Fu, R. C. Gonzalez, C. S. G. Lee, 1987, McGraw-Hill.

25EGD3406 - ADVANCED VIBRATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3406	ADVANCED VIBRATIONS	AV	R	3	0	0	0	3

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	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

Syllabus

Introduction to Sustainable Design Principles of sustainable design and social innovation Overview of engineering design process based on Dieter's approach Sustainable design methodologies and frameworks Design Thinking and Needs Analysis Fundamentals of social innovation and design thinking Problem identification in societal and environmental contexts Needs analysis and user centered design considerations

Concept Development Techniques for concept generation and ideation Methods for concept screening and selection Decision making under sustainability and impact criteria

Concept Development Techniques for concept generation and ideation Methods for concept screening and selection Decision making under sustainability and impact criteria

Implementation and Sustainability Review Developing a manufacturing and assembly plan for the prototype Cost material and process selection considerations Sustainability audit and innovation refinement of the prototype

Reference Books

- 1 Sustainability in Engineering Design, Anthony Johnson & Andy Gibson, 1st Edition, Elsevier Publications. .
- 2 Design for Sustainability: A Practical Approach, Tracy Bhamra and Vicky Lofthouse, 1st, Gower Publishing Limited.
- 3 Engineering Design, George Dieter and Linda Schmidt, 4th Edition, , McGraw Hill.

25EGD3507 - MECHANICS OF COMPOSITE MATERIALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3507	MECHANICS OF COMPOSITE MATERIALS	MOCM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	?Understand the basic concepts of vibrations and the types of systems.?	2	PO1, PO3
CO2	Model vibrating systems and analyze their behavior under harmonic and transient excitation	3	PO2, PSO1
CO3	Analyze vibrations of continuous systems and apply vibration control techniques.	4	PO1, PO3, PSO1
CO4	?Apply vibration analysis techniques to real-world problems in engineering.?	3	PO1, PO3, PSO1

Syllabus

Introduction to Vibrations: Single degree offreedom 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 Newtons 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, 2019, Pearson Education India.
- 2 Fundamentals of Mechanical Vibrations, S. Graham Kelly, 2000, McGraw-Hill Education.
- 3 Mechanical Vibrations: Theory and Applications, S. Graham Kelly, 2011, Cengage Learning.

25EGD3508 - HYBRID AND ELECTRIC VEHICLE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EGD3508	HYBRID AND ELECTRIC VEHICLE DESIGN	HEVD	R	3	0	0	0	3

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, 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. Integration of AI and machine learning in electric vehicle systems enables real-time power management, predictive maintenance, intelligent fault diagnosis, and advanced autonomous control, enhancing efficiency, safety, and driving experience.

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 Hybrid/EV Vehicle Architecture , Chris Mi , 2021, Wiley.

25EME3101 - POWER TRAIN DESIGN FOR ELECTRIC VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3101	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	PTDEV	R	3	0	2	0	4

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, PO2
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, PO2, PO3
CO3	Analyze new technologies or improvements in electric vehicle powertrain design, fostering creativity and forward-thinking in the field.	4	PO1, PO2, PO3
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, PO2, PO3

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 Vehicle Technology , James Larminie and John Lowry, First,2012, Jhon Wiley-Blackwell..
- 3 Electric and Hybrid Vehicles, Iqbal Husain, Second,2018, CRC PRESS..

25EME3101A - POWER TRAIN DESIGN FOR ELECTRIC VEHICLE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3101A	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	PTDEV	A	4	1	2	0	6

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, PO2
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, PO2, PO3
CO3	Analyze new technologies or improvements in electric vehicle powertrain design, fostering creativity and forward-thinking in the field.	4	PO1, PO2, PO3
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, PO2, PO3
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, PO2, PO3

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..

25EME3101E - POWER TRAIN DESIGN FOR ELECTRIC VEHICLE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3101E	POWER TRAIN DESIGN FOR ELECTRIC VEHICLE	PTDEV	E	4	1	2	0	6

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, PO2
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, PO2, PO3
CO3	Analyze new technologies or improvements in electric vehicle powertrain design, fostering creativity and forward-thinking in the field.	4	PO1, PO2, PO3
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, PO2, PO3
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, PO2, PO3

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.

25EME3202 - COMMUNICATION PROTOCOLS AND TESTING OF ELECTRIC VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3202	COMMUNICATION PROTOCOLS AND 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, PO2
CO2	To Apply knowledge of communication protocols and fault diagnostics various components in Electric Vehicles	3	PO2, PO3
CO3	To analyze the intricacies of integrating HV and LV components of vehicle.	4	PO2, PO3
CO4	To demonstrate system engineering and system validation.	3	PO2, PO3

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, Taylor and Francis, 1, -.
- 2 Electric Vehicle Technology Explained, James Larminie and John Lowry, 1, Wiley.
- 3 Bosch Automotive Electrics and Automotive Electronics, Bosch Team, 1, Springer.

25EME3203 - AUTONOMOUS VEHICLES AND AUTOMOTIVE ELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3203	AUTONOMOUS VEHICLES AND 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	
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	
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	
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	

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.

25EME3304 - CHARGING STATIONS FOR ELECTRIC VEHICLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3304	CHARGING STATIONS FOR ELECTRIC VEHICLES	CSEV	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop control algorithms for various electric vehicle charging modes and various chargers.	3	PO1, PO6
CO2	Analyze the design, operation, and integration of power electronic converters in electric vehicle charging systems.	4	PO1, PO6
CO3	Analyze the optimization of diverse EV charging infrastructures through critical evaluation and innovative problem-solving for enhanced efficiency.	4	PO1, PO6
CO4	Outline strategies for the effective installation and management of EV charging stations, incorporating regulatory compliance, site assessment, installation procedures.	2	PO1, PO6

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, 2nd Edition 2014, John Wiley & Sons, Ltd..
- 2 Power Electronics, Daniel W. Hart, 3rd Edition 2011, McGraw Hill.
- 3 AIS 138 Part 1 and Part 2, Automotive Research Association of India, 2nd Edition 2010, ARAI India.

25EME3304A - CHARGING STATIONS FOR ELECTRIC VEHICLES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3304A	CHARGING STATIONS FOR ELECTRIC VEHICLES	CSEV	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop control algorithms for various electric vehicle charging modes and various chargers.	3	PO1, PO6
CO2	Analyze the design, operation, and integration of power electronic converters in electric vehicle charging systems.	4	PO1, PO6
CO3	Analyze the optimization of diverse EV charging infrastructures through critical evaluation and innovative problem-solving for enhanced efficiency.	4	PO1, PO6
CO4	Outline strategies for the effective installation and management of EV charging stations, incorporating regulatory compliance, site assessment, installation procedures.	2	PO1, PO6
CO5	Develop and implement electric vehicle (EV) charging stations by integrating knowledge of electrical systems,	4	PO1, PO6

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 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 Guidelines on Public Charging Stations. IEC Standards 60068-2 1, 2, 14, 30, 61683, 60227, 60502, 60947 Part I, II, III, 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, 2nd Edition 2014, John Wiley & Sons, Ltd..
- 2 Power Electronics, Daniel W. Hart, 3rd Edition 2011, McGraw Hill.
- 3 AIS 138 Part 1 and Part 2, Automotive Research Association of India, 2nd Edition 2010, ARAI India.

25EME3304E - CHARGING STATIONS FOR ELECTRIC VEHICLES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3304E	CHARGING STATIONS FOR ELECTRIC VEHICLES	CSEV	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop control algorithms for various electric vehicle charging modes and various chargers.	3	PO1, PO6
CO2	Analyze the design, operation, and integration of power electronic converters in electric vehicle charging systems.	4	PO1, PO6
CO3	Analyze the optimization of diverse EV charging infrastructures through critical evaluation and innovative problem-solving for enhanced efficiency.	4	PO1, PO6
CO4	Outline strategies for the effective installation and management of EV charging stations, incorporating regulatory compliance, site assessment, installation procedures.	2	PO1, PO6
CO5	Develop and implement electric vehicle (EV) charging stations by integrating knowledge of electrical systems,	4	PO1, PO6

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 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 Guidelines on Public Charging Stations. IEC Standards 60068-2 1, 2, 14, 30, 61683, 60227, 60502, 60947 Part I, II, III, 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, 2nd Edition 2014, John Wiley & Sons, Ltd..
- 2 Power Electronics, Daniel W. Hart, 3rd Edition 2011, McGraw Hill.
- 3 AIS 138 Part 1 and Part 2, Automotive Research Association of India, 2nd Edition 2010, ARAI India.

25EME3405 - INTRODUCTION TO BATTERY-MANAGEMENT SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3405	INTRODUCTION TO BATTERY-MANAGEMENT SYSTEMS	IBMS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25EME3406 - BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3406	BATTERY STATE ESTIMATION ALGORITHMS FOR ELECTRIC VEHICLE	BSAEV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select suitable battery for electric vehicle.	3	PO1, PO6
CO2	Analyze the key functions of Battery management systems.	4	PO1, PO6
CO3	Analyze various mathematical models of battery.	4	PO1, PO6
CO4	Analyze the Algorithms for SOC estimation of battery	4	PO1, PO6

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, 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: Battery Modeling, Gregory L. Plett, 2nd Edition , Artech House.
- 2 Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market, Gianfranco Pistoia, 1st Edition, Elsevier.
- 3 Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussain, 3rd Edition , CRC Press.

25EME3507 - AI AND IOT FOR ELECTRIC VEHICLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3507	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, PO6
CO2	Operate the cloud system Environment.	3	PO1, PO6
CO3	Applying ML Techniques for Electric Vehicles.	3	PO1, PO6
CO4	Applying AI techniques for EV Applications.	3	PO1, PO6

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 preprocessing 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, 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, David Wenzhong Gao, 1st Edition 2011, Apress.

25EME3508 - EV SYSTEM AND WIRING DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25EME3508	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, PO3
CO2	Understand the wiring routing and optimal weights of wiring.	2	PO1, PO3
CO3	Understand the electrical connections and safety consideration for EV.	2	PO1, PO3
CO4	Apply the concept of BMS and thermal management of EV	3	PO1, PO3

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, 1, SDC Publications.
- 2 AutoCAD Electrical Essential Training, Shaun Bryant, 2, linkedin.
- 3 Automotive Wiring and Electrical Systems, Tony Candela, 2, CarTech Inc.
- 4 Wireless Power Transfer for Electric Vehicles Foundations and Design Approach, , Alicia Trivino-Cabrera, Jose M. Gonzalez-Gonzalez, Jose A. Aguado, 1, Springer Cham.

25GAM3101 - NATURAL LANGUAGE PROCESSING AND APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GAM3101	NATURAL LANGUAGE PROCESSING AND APPLICATIONS	NLPA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the fundamental concepts in NLP and review different NLP applications.	3	PO1, PO3, PSO2
CO2	Illustrate and summarize the basic structure of NLP Pipelines.	3	PO2, PO3, PSO2
CO3	Apply and Analyze the performance of algorithms for semantics in NLP and prioritize them for the existing applications.	3	PO2, PO3, PSO2
CO4	Apply machine learning models for finding solutions for problems in NLP and judge their performance.	4	PO1, PO3, PSO2
CO5	Design and validate NLP applications for text summarization, classification and generation through	5	PO1, PO3
CO6	Evaluate NLP pipelines to build small scale applications for real time deployment.	5	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, 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.

25GAM3101A - NATURAL LANGUAGE PROCESSING AND APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GAM3101A	NATURAL LANGUAGE PROCESSING AND APPLICATIONS	NLPA	A	4	1	2	0	6

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	PO2, PSO1
CO3	Apply and Analyze the performance of algorithms for semantics in NLP and prioritize them for the existing applications.	4	PO1, PSO1
CO4	Apply machine learning models for finding solutions for problems in NLP and judge their performance.	3	PO2, PSO1
CO5	Apply the concept of attention in language modelling and analyze the performance of LLMs.	4	PO2, 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	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, PO4, 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, 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 Lope, 2009, O'Reilly Media.
- 4 Neural Network Methods in Natural Language Processing, Yoav Goldberg, 2022, Morgan & Claypool Publishers.

25GAM3101E - NATURAL LANGUAGE PROCESSING AND APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GAM3101E	NATURAL LANGUAGE PROCESSING AND APPLICATIONS	NLPA	E	4	1	2	0	6

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
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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- 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.

25GAM3202 - DEEP LEARNING FOR COMPUTER VISION APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GAM3202	DEEP LEARNING FOR COMPUTER VISION APPLICATIONS	DLCVA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental concepts in computer vision and review different feature extraction techniques.	3	PO1, PO3, PSO2
CO2	Illustrate and Apply the basic structure of DL models (CNN based) for image data classification.	3	PO2, PO3, PSO2
CO3	Apply the autoencoder algorithms for object segmentation and generation.	3	PO2, PO3, PSO2
CO4	Apply deep learning models for finding solutions for problems in computer vision and judge their performance.	3	PO1, PO2, PSO2

Syllabus

Image Fundamentals: Introduction to Image Formation, Capture, and Representation; Image Enhancement: Linear Filtering, Features: Edge, Blobs, Corner Detection; Scale 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, and Attention-based CNN models: Visual transformers. Realize using TensorFlow or PyTorch.

Reference Books

- 1 Deep Learning, Ian Good fellow, Yoshua Bengio, Aaron Courville, 2016, MIT Press.
- 2 Learning Deep Architectures for AI, Yoshua Bengio, 2009, now publishers Inc.
- 3 Computer Vision: Models, Learning, and Inference, Simon Prince, 2012, Cambridge University Press.
- 4 Deep Learning: A Visual Approach, Andrew Glassner, 2021, No Starch Press.

25GAM3303 - GENERATIVE AI ARCHITECTURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GAM3303	GENERATIVE AI ARCHITECTURES	GAA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of generative modeling and distinguish between discriminative and generative approaches using real-world AI tools and platforms.	2	PO1, PO2, PSO2
CO2	Analyze and implement key generative architectures such as Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs), including their mathematical foundations and variants.	3	PO1, PO2, PO3, PSO2
CO3	Apply Transformer-based and Diffusion-based generative models for complex tasks such as text, image, and cross-modal generation.	3	PO1, PO2, PO3, PSO2
CO4	Apply evaluation metrics and responsible AI principles to assess generative models, demonstrate cross-domain applications, and formulate strategies for explainability, fairness, and risk mitigation.	3	PO1, PO2, PO3, PO5, PSO2
CO5	Design and evaluate generative AI models using VAEs, GANs, Transformers, and Diffusion architectures with PyTorch/TensorFlow, apply appropriate evaluation metrics (Inception Score, FID), and critically assess their applications, ethical implications, and fairness in real-world domains.	5	PO1, PO2, PO3, PO5, PSO2

Syllabus

Introduction to Generative AI, Overview of generative modeling, Discriminative vs. generative models, Applications: Text, Image, Music, Code, Introduction to tools: PyTorch/TensorFlow, Hugging Face.

Variational Autoencoders (VAEs) , Autoencoders: Basics and limitations, Probabilistic graphical models, ELBO, KL Divergence, Reparameterization trick, VAE applications: image generation, representation learning , Generative Adversarial Networks (GANs), GAN architecture: Generator and Discriminator, Training dynamics, mode collapse Variants: DCGAN, Conditional GANs, CycleGAN, StyleGAN, Evaluation metrics: Inception Score, FID

Transformer-based Generative Models, Self-attention and Transformer architecture, Language modeling: GPT series, Vision Transformers (ViTs), Fine-tuning and prompt engineering, Diffusion Models and Emerging Architectures, Denoising Diffusion Probabilistic Models (DDPM), Score-based models, Comparison with GANs/VAEs, Applications: Text-to-image (e.g., DALL E, Stable Diffusion)

Evaluation metrics: Inception Score, FID, Applications and Ethics, Cross-domain applications: art, design, biology, etc., Legal, ethical, and social implications, Explainability and fairness, Responsible AI and risk mitigation

Reference Books

- 1 Deep Learning , Ian Good fellow, Yoshua Bengio , 2016, Prentice Hall .
- 2 Probabilistic Machine Learning: An Introduction , Kevin P. Murphy , 2022, MIT Press .
- 3 Deep Generative Models , Jakub M. Tomczak & Max Welling , 2023, Springer.
- 4 Neural Networks and Deep Learning , Michael Nielsen , 2020, John Wiley and Sons. .

25GAM3303A - GENERATIVE AI ARCHITECTURES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GAM3303A	GENERATIVE AI ARCHITECTURES	GAA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of generative modeling and distinguish between discriminative and generative approaches using real-world AI tools and platforms.	2	PO1, PO2, PSO2
CO2	Analyze and implement key generative architectures such as Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs), including their mathematical foundations and variants.	3	PO1, PO2, PO3, PSO2
CO3	Apply Transformer-based and Diffusion-based generative models for complex tasks such as text, image, and cross-modal generation.	3	PO1, PO2, PO3, PSO2
CO4	Apply evaluation metrics and responsible AI principles to assess generative models, demonstrate cross-domain applications, and formulate strategies for explainability, fairness, and risk mitigation.	3	PO1, PO2, PO3, PSO2
CO5	Analyze and implement multimodal generative architectures that integrate text, image, audio, and video.	4	PO1, PO2, PO3, PO5, PSO2
CO6	Analyze scalability and efficiency trade-offs in large-scale generative models, applying advanced techniques such as RAG, parameter-efficient tuning, and model compression. Design and evaluate generative AI models using VAEs, GANs, Transformers, and Diffusion architectures with PyTorch/TensorFlow, apply appropriate evaluation metrics (Inception Score, FID), and critically assess their applications, ethical implications, and fairness in real-world domains.	5	PO1, PO2, PO3, PO5, PSO2

Syllabus

Introduction to Generative AI, Overview of generative modeling, Discriminative vs. generative models, Applications: Text, Image, Music, Code, Introduction to tools: PyTorch/TensorFlow, Hugging Face.

Variational Autoencoders (VAEs) , Autoencoders: Basics and limitations, Probabilistic graphical models, ELBO, KL Divergence, Reparameterization trick, VAE applications: image generation, representation learning , Generative Adversarial Networks (GANs), GAN architecture: Generator and Discriminator, Training dynamics, mode collapse Variants: DCGAN, Conditional GANs, CycleGAN, StyleGAN, Evaluation metrics: Inception Score, FID

Transformer-based Generative Models, Self-attention and Transformer architecture, Language modeling: GPT series, Vision Transformers (ViTs), Fine-tuning and prompt engineering, Diffusion Models and Emerging Architectures, Denoising Diffusion Probabilistic Models (DDPM), Score-based models, Comparison with GANs/VAEs, Applications: Text-to-image (e.g., DALL E, Stable Diffusion)

Evaluation metrics: Inception Score, FID, Applications and Ethics, Cross-domain applications: art, design, biology, etc., Legal, ethical, and social implications, Explainability and fairness, Responsible AI and risk mitigation

Multimodal and Scalable Generative Architectures: Multimodal generative models: Aligning text, image, audio, and video (e.g., CLIP, Flamingo, AudioLM). Large-scale foundation models for generation (PaLM, GPT-4, Gemini). Retrieval-augmented generation (RAG) and memory-augmented generative systems. Efficiency and scalability: parameter-efficient tuning, quantization, distillation. Future directions: hybrid models combining symbolic AI and generative models.

Reference Books

- 1 Deep Learning, Ian Good fellow, Yoshua Bengio, 2016, Prentice Hall.

- 2 Probabilistic Machine Learning: An Introduction, Kevin P. Murphy, 2022, MIT Press.
- 3 Deep Generative Models, Jakub M. Tomczak & Max Welling, 2023, Springer.
- 4 Neural Networks and Deep Learning, Michael Nielsen, 2020, John Wiley and Sons..

25GAM3303E - GENERATIVE AI ARCHITECTURES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GAM3303E	GENERATIVE AI ARCHITECTURES	GAA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of generative modeling and distinguish between discriminative and generative approaches using real-world AI tools and platforms.	2	PO1, PO2, PSO2
CO2	Analyze and implement key generative architectures such as Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs), including their mathematical foundations and variants.	3	PO1, PO2, PO3, PSO2
CO3	Apply Transformer-based and Diffusion-based generative models for complex tasks such as text, image, and cross-modal generation.	3	PO1, PO2, PO3, PSO2
CO4	Apply evaluation metrics and responsible AI principles to assess generative models, demonstrate cross-domain applications, and formulate strategies for explainability, fairness, and risk mitigation.	3	PO1, PO2, PO3, PSO2
CO5	Analyze and implement multimodal generative architectures that integrate text, image, audio, and video.	4	PO1, PO2, PO3, PO5, PSO2
CO6	Analyze scalability and efficiency trade-offs in large-scale generative models, applying advanced techniques such as RAG, parameter-efficient tuning, and model compression. Design and evaluate generative AI models using VAEs, GANs, Transformers, and Diffusion architectures with PyTorch/TensorFlow, apply appropriate evaluation metrics (Inception Score, FID), and critically assess their applications, ethical implications, and fairness in real-world domains.	5	PO1, PO2, PO3, PO5, PSO2

Syllabus

Introduction to Generative AI, Overview of generative modeling, Discriminative vs. generative models, Applications: Text, Image, Music, Code, Introduction to tools: PyTorch/TensorFlow, Hugging Face.

Variational Autoencoders (VAEs) , Autoencoders: Basics and limitations, Probabilistic graphical models, ELBO, KL Divergence, Reparameterization trick, VAE applications: image generation, representation learning , Generative Adversarial Networks (GANs), GAN architecture: Generator and Discriminator, Training dynamics, mode collapse Variants: DCGAN, Conditional GANs, CycleGAN, StyleGAN, Evaluation metrics: Inception Score, FID

Transformer-based Generative Models, Self-attention and Transformer architecture, Language modeling: GPT series, Vision Transformers (ViTs), Fine-tuning and prompt engineering, Diffusion Models and Emerging Architectures, Denoising Diffusion Probabilistic Models (DDPM), Score-based models, Comparison with GANs/VAEs, Applications: Text-to-image (e.g., DALL E, Stable Diffusion)

Evaluation metrics: Inception Score, FID, Applications and Ethics, Cross-domain applications: art, design, biology, etc., Legal, ethical, and social implications, Explainability and fairness, Responsible AI and risk mitigation.

Multimodal and Scalable Generative Architectures: Multimodal generative models: Aligning text, image, audio, and video (e.g., CLIP, Flamingo, AudioLM). Large-scale foundation models for generation (PaLM, GPT-4, Gemini). Retrieval-augmented generation (RAG) and memory-augmented generative systems. Efficiency and scalability: parameter-efficient tuning, quantization, distillation. Future directions: hybrid models combining symbolic AI and generative models.

Reference Books

- 1 Deep Learning , Ian Good fellow, Yoshua Bengio , 2016, Prentice Hall .

- 2 Probabilistic Machine Learning: An Introduction , Kevin P. Murphy , 2022, MIT Press .
- 3 Deep Generative Models , Jakub M. Tomczak & Max Welling , 2023 , Springer.
- 4 Neural Networks and Deep Learning , Michael Nielsen , 2020, John Wiley and Sons. .

25GAM3404 - DESIGN OF LARGE LANGUAGE MODELS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GAM3404	DESIGN OF LARGE LANGUAGE MODELS	DLLM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply tokenization, embedding techniques, and recurrent/attention-based architectures to preprocess and model natural language sequences.	3	PO1
CO2	Apply transformer-based architectures and pretraining strategies (MLM, Causal LM) to design and analyze modern language models like BERT and GPT.	3	PO1
CO3	Apply training strategies, optimization techniques, and fine-tuning methods to effectively build and evaluate large language models.	3	PO1
CO4	Apply large language models to real-world tasks such as summarization, code generation, and conversational agents while addressing efficiency and ethical concerns.	3	PO1

Syllabus

Foundations of Language Modeling: Tokenization and Text Preprocessing, Language Modeling Basics and n-gram Models, Word Embeddings (Word2Vec, GloVe), Recurrent Neural Networks and LSTMs, Attention Mechanism and Self-Attention, Positional Encoding in Sequences.

Architecture of Transformers and Pretraining: Transformer Encoder-Decoder Architecture, Multi-Head Attention and Feedforward Layers, Pretraining Objectives: MLM and Causal LM, BERT Architecture and Variants, GPT Architecture and Variants, Scaling Laws in Language Models.

Training and Optimization of LLMs: Data Collection and Tokenization Pipelines, Training Strategies and Infrastructure Considerations, Optimization Techniques and Mixed Precision Training, Fine-Tuning and Transfer Learning, Reinforcement Learning from Human Feedback (RLHF), Evaluation Metrics for Language Models

Applications and Deployment of LLMs: Text Summarization and Question Answering, Code Generation and Conversational Agents, Multimodal LLMs and VisionLanguage Models, Prompt Engineering and In-Context Learning, Efficient Inference and Model Compression, Ethical Challenges and Bias Mitigation.

Reference Books

- 1 Transformers for Natural Language Processing, Denis Rothman, 2021, Packt Publishing.
- 2 Natural Language Processing with Transformers, s Tunstall, Leandro von Werra, and Thomas Wolf, 2022, O'Reilly Media.
- 3 Deep Learning for Natural Language Processing, y Palash Goyal, Sumit Pandey, and Karan Jain, 2018, Apress.
- 4 Neural Network Methods in Natural Language Processing, Yoav Goldberg, 2017, Morgan & Claypool Publishers.
- 5 Speech and Language Processing, Daniel Jurafsky and James H, 2023, Martin, Pearson,.

25GAM3505 - AI PRODUCT DEVELOPMENT AND MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GAM3505	AI PRODUCT DEVELOPMENT AND MANAGEMENT	APDM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying AI Product Thinking, AI lifecycle, scoping, and product management roles	3	PO1, PO2, PSO2
CO2	Apply design principles to define business and user requirements, architect AI systems, select models, and build minimum viable AI products (MVAPs).	3	PO1, PO3, PSO2
CO3	Apply development, testing, and deployment processes including CI/CD, experimentation, integration, and feedback mechanisms for AI products.	3	PO1, PO2
CO4	Apply product strategy techniques to plan go-to-market, scale AI products, and implement ethical and responsible AI governance.	3	PO1, PO2

Syllabus

Fundamentals of AI Product Thinking: AI vs Traditional Software Products, AI Lifecycle and Product Pipeline, Problem Scoping and Use Case Identification, Data-Driven Decision Making, AI Readiness Assessment, Role of Product Managers in AI Teams.

Designing AI Solutions: Defining Business and User Requirements, AI Solution Architecture and System Design, Data Acquisition and Annotation, Model Selection and Evaluation Metrics, Building Minimum Viable AI Products (MVAP), Human-in-the-Loop Design Principles.

Development, Testing, and Deployment: Model Training and Validation Workflow, Integration with Frontend and Backend Systems, Continuous Integration and Deployment (CI/CD) for AI, A/B Testing and Online Experimentation, Monitoring AI Performance PostDeployment, Model Retraining and Feedback Loops.

Product Strategy, Scaling, and Ethics: Product-Market Fit for AI Products, Roadmapping and Go-to-Market Strategy, Scaling and Monetizing AI Solutions, AI Governance and Regulatory Compliance, Responsible AI and Ethical Considerations, CrossFunctional Collaboration and Communication.

Reference Books

- 1 Building Machine Learning Powered Applications: Going from Idea to Product, Emmanuel Ameisen, 2020, O'Reilly Media.
- 2 AI and Analytics for Product Management, Doug Rose, Addison, 2021, Wesley Professional.
- 3 Designing Data-Intensive Applications, Martin Kleppmann, 2017, O'Reilly Media.

25GDU3101 - PROGRAMMING FOR GAME DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3101	PROGRAMMING FOR GAME DEVELOPMENT	PGD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of game design and development to create games.	3	PO1, PO3, PSO2
CO2	Apply the use of mathematical geometrical concepts in Game programming.	3	PO1
CO3	Apply the fundamental structures of Game Programming.	3	PO1, PO5, PSO2
CO4	Apply advance concepts in game development and explain various platforms and frameworks for game programming.	3	PO1, PO5, PSO2
CO5	Apply Project Optimization, Research and Troubleshooting approaches.	3	PO1, PO5, PSO2

Syllabus

Basics of Unity and C Scripting Introduction to Unity IDE Layout Scenes Game Objects Components creating new Unity projects and scenes Scripting in C data types methods conditionals loops Unitys scripting lifecycle Start Update Fixed Update Managing Game objects via scripts position rotation scale Input handling keyboard mouse touch

Final Game Development and Deployment Building and packaging games for PC Android or WebGL debugging techniques and using the Unity Profiler optimizing performance batching draw calls memory Version control basics Git for Unity projects Final game project create and submit a 2D or 3D game Game presentation and viva

Multimedia Integration Animation system Animator Controller Animation Clips Sound effects and background music using Audio Source Particle systems and visual effects Material and lighting settings NavMesh and basic AI navigation optional Asset store usage and 3D model import

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 B spline 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 Color consideration Transparency and Shadows

Final Game Development and Deployment using Unreal Engine Packaging and building games for Windows Android or Web Debugging and performance profiling using Unreal Insights and in editor tools Optimization techniques level streaming LODs draw calls Blueprint dativization Version control with Git and Unreal Engine integration Final game project development using Blueprints and or C Game testing polishing and playtesting Game submission deployment and presentation

Reference Books

- 1 Learning C# by Developing Games with Unity 2021, Harrison Ferrone, 6th Edition, Packt Publishing.
- 2 Game Coding Complete, Mike Mc Shaffrfy and David Graham, Fourth Edition, Cengage Learning.
- 3 Game Engine Architecture, Jason Gregory, 2009, CRC Press / A K Peters.
- 4 Virtual Reality, Brett S. Martin, 2017, Norwood House Press.

25GDU3101A - PROGRAMMING FOR GAME DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3101A	PROGRAMMING FOR GAME DEVELOPMENT	PGD	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of game design and development to create games	3	PO1, PO3, PSO2
CO2	Apply the use of mathematical geometrical concepts in Game programming	3	PO1, PO5, PSO2
CO3	Apply the fundamental structures of Game Programming	3	PO1, PO5, PSO2
CO4	Apply advance concepts in game development and explain various platforms and frameworks for game programming	3	PO1, PO5, PSO2
CO5	Apply Project Optimization, Research and Troubleshooting approaches	3	PO1, PO5, PSO2
CO6	Apply Laboratory experiments concerning Games using Unity	3	PO1, PO5, PSO2
CO7	Apply Skilling experiments concerning Games using Unity	3	PO1, PO5, PSO2

Syllabus

Basics of Unity and C Scripting Introduction to Unity IDE Layout Scenes Game Objects Components creating new Unity projects and scenes Scripting in C data types methods conditionals loops Unitys scripting lifecycle Start Update Fixed Update Managing Game objects via scripts position rotation scale Input handling keyboard mouse touch

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- 2 Game Coding Complete, Mike Mc Shaffrfy and David Graham, Fourth Edition, Cengage Learning.
- 3 Game Engine Architecture, Jason Gregory, 2009, CRC Press / A K Peters.

- 4 Virtual Reality, Brett S. Martin, 2017, Norwood House Press.
- 5 Fundamentals of Game Design, Ernest Adams and Andrew Rolling, 2nd Edition, Prentice Hall / New Riders.

25GDU3101E - PROGRAMMING FOR GAME DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3101E	PROGRAMMING FOR GAME DEVELOPMENT	PGD	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of game design and development to create games	3	PO1, PO3, PSO2
CO2	Apply the use of mathematical geometrical concepts in Game programming	3	PO1, PO5, PSO2
CO3	Apply the fundamental structures of Game Programming	3	PO1, PO5, PSO2
CO4	Apply advance concepts in game development and explain various platforms and frameworks for game programming	3	PO1, PO5, PSO2
CO5	Apply Project Optimization, Research and Troubleshooting approaches	3	PO1, PO5, PSO2
CO6	Apply Laboratory experiments concerning Games using Unity	3	PO1, PO5, PSO2
CO7	Apply Skilling experiments concerning Games using Unity	3	PO1, PO5, PSO2

Syllabus

Basics of Unity and C Scripting Introduction to Unity IDE Layout Scenes Game Objects Components creating new Unity projects and scenes Scripting in C data types methods conditionals loops Unitys scripting lifecycle Start Update Fixed Update Managing Game objects via scripts position rotation scale Input handling keyboard mouse touch

Final Game Development and Deployment Building and packaging games for PC Android or WebGL debugging techniques and using the Unity Profiler optimizing performance batching draw calls memory Version control basics Git for Unity projects Final game project create and submit a 2D or 3D game Game presentation and viva

Multimedia Integration Animation system Animator Controller Animation Clips Sound effects and background music using Audio Source Particle systems and visual effects Material and lighting settings NavMesh and basic AI navigation optional Asset store usage and 3D model import

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 B spline 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 Color consideration Transparency and Shadows

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- 1 Learning C# by Developing Games with Unity 2021, Harrison Ferrone, 6th Edition, Packt Publishing.
- 2 Game Coding Complete, Mike Mc Shaffrfy and David Graham, Fourth Edition, Cengage Learning.
- 3 Game Engine Architecture, Jason Gregory, 2009, CRC Press / A K Peters.

- 4 Virtual Reality, Brett S. Martin, 2017, Norwood House Press.
- 5 Fundamentals of Game Design, Ernest Adams and Andrew Rolling, 2nd Edition, Prentice Hall / New Riders.

25GDU3202 - UX DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3202	UX DESIGN	UXD	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
CO2	Apply User interface and differentiate from User Experience and principles of User Interface	3	PO2, PO3
CO3	Analyze and distinguish components of UI Design process with interactive Devices	3	PO1, PO8
CO4	Analyze and distinguish components of UI Design process with interactive Devices	4	PO1, PO8

Syllabus

User research techniques (in-depth interviews, ethnographic observation), Advanced persona development, Customer journey mapping, Problem framing and hypothesis generation, Ideation techniques (SCAMPER, Brainwriting, Crazy 8s), Design sprint planning using Jira, Agile UX integration during planning phase

Wireframing vs Prototyping lowfi to highfi Prototyping tools Adobe XD interactive flows Advanced usability testing methods AB testing remote usability tests SUS surveys Heuristic evaluation with Nielsens principles Integrating analytics Google Analytics Hotjar heatmaps Sprintbased feedback loops

UI UX scope and overlap Visual hierarchy clarity and consistency principles Design tokens colors typography spacing Microinteractions and UI feedback Ethical UI design avoiding dark patterns Accessibility WCAG screen readers contrast checking

Device specific design considerations Android iOS HIG tablet scaling smartwatch UI basics Adaptive responsive layouts auto layouts breakpoints Touch gestures and interaction models Secure form handling input validation prevention of data leaks Performance conscious design battery screen usage Tool comparison Adobe XD UXPressia Whimsical for prototyping flowcharts and journey maps Design handoff using Zeplin Figma version history or Git based control Agile rituals in UX daily stand ups sprint reviews retrospectives Final product storytelling and presentation skills

Reference Books

- 1 Interaction Design: Beyond Human-Computer Interaction, Jennifer Preece, Yvonne Rogers, Helen Sharp, 5th Edition (latest as of 2019), Wiley.
- 2 UX Design: Foundations for Designing Online User Experiences, Marcin Treder, latest edition, UXPin (often distributed digitally).
- 3 The User Experience Team of One: A Research and Design Survival Guide, Leah Buley, 1st Edition (2013), Rosenfeld Media.
- 4 Don't Make Me Think: A Common Sense Approach to Web Usability, Steve Krug, 3rd Edition (Revisited, 2014), New Riders.
- 5 The Design of Everyday Things, Don Norman, Revised and Expanded Edition (2013), Basic Books.

25GDU3303 - AR AND VR APPLICATION DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3303	AR AND VR APPLICATION DEVELOPMENT	AR&VR	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand Basics of Augmented Reality and Interactions fundamentals of Augmented, Mixed Reality and its features	3	PO1, PO2, PSO2
CO2	To understand Basics of Virtual Reality and Interactions fundamentals concept and components of virtual reality	3	PO1, PSO2
CO3	To understand Graphics Pipelines, creating a sample augmented reality apps in android	3	PO1, PO5, PSO2
CO4	To understand applications of virtual reality in digital entertainment	3	PO1, PO5, PSO2
CO5	Applying concepts on mixed reality and hybrid reality	3	PO1, PO5, PSO2

Syllabus

Understand the fundamental concepts, technologies, and applications of Augmented Reality (AR)

Apply tracking and mapping techniques in AR environments

Describe the evolution, components, and design of Virtual Reality (VR) systems

Analyze rendering, audio, and interface aspects of immersive VR systems

Explore applications and evaluate usability in immersive environments

Reference Books

- 1 Understanding Augmented Reality: Concepts and Applications, Alan B. Craig, 1st edition in 2013, Newnes.
- 2 Understanding Virtual Reality, William R. Sherman, Alan B. Craig, 2nd Edition 2018, Morgan Kaufmann Publishers.
- 3 Android Application Development for Java Programmers, James C. Sheusi, 1st Edition in 2012, Cengage Learning.
- 4 Game Coding Complete, Mike McShaffry, David Graham, 4th Edition (2012), Cengage Learning PTR.
- 5 Virtual Reality, Brett S. Martin, First Edition 2017, Norwood House Press (2017).
- 6 Virtual Reality Systems, John Vince, First Edition in 1995, Pearson Education.
- 7 Android Apps for Absolute Beginners, Wallace Jackson, Fourth Edition (2017), Apress.
- 8 Fundamentals of Game Design, Ernest Adams, Andrew Rollings, 2nd Edition (2009), Prentice Hall / New Riders.

25GDU3303A - AR AND VR APPLICATION DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3303A	AR AND VR APPLICATION DEVELOPMENT	AR&VR	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand Basics of Augmented Reality and Interactions fundamentals of Augmented, Mixed Reality	3	PO1, PO2, PO9, PO10
CO2	To understand Basics of Virtual Reality and Interactions fundamentals of Augmented, Virtual Reality	3	PO1, PO2, PO3, PO4, PO5, PO8, PO9
CO3	To understand Graphics Pipelines, creating a sample augmented reality apps in android	3	PO1, PO2, PO3, PO4, PO5
CO4	To understand applications of virtual reality in digital entertainment	3	PO1, PO2, PO3, PO4, PO5, PO8, PO9, PO10
CO5	Applying concepts on mixed reality and hybrid reality	3	PO1, PO2, PO3, PO4, PO5, PO8, PO9, PO10
CO6	Develop applications through Lab experiments	3	
CO7	Develop application through skill experiments	3	

Syllabus

Understand the fundamental concepts, technologies, and applications of Augmented Reality (AR)

Apply tracking and mapping techniques in AR environments

Describe the evolution, components, and design of Virtual Reality (VR) systems

Analyze rendering, audio, and interface aspects of immersive VR systems

Explore applications and evaluate usability in immersive environments

Reference Books

- 1 Understanding Augmented Reality: Concepts and Applications, Alan B. Craig, Not specified, Newnes.
- 2 Understanding Virtual Reality, William R. Sherman and Alan B. Craig, Not specified (commonly referenced: 2nd Edition), Morgan Kaufmann Publishers.
- 3 Android Application Development for Java Programmers, James C. Sheusi, Not specified (likely 1st Edition), Cengage Learning.
- 4 Game Coding Complete, Mike McShaffry and David Graham, Fourth Edition (2012), Cengage Learning PTR.
- 5 Virtual Reality, Brett S. Martin, Not specified, Norwood House Press.

25GDU3303E - AR AND VR APPLICATION DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3303E	AR AND VR APPLICATION DEVELOPMENT	AR&VR	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand Basics of Augmented Reality and Interactions fundamentals of Augmented, Mixed Reality	3	PO1, PO2, PO8, PO9, PSO1, PSO2
CO2	To understand Basics of Virtual Reality and Interactions fundamentals of Augmented, Virtual Reality	3	PO1, PO2, PO3, PO4, PO5, PO8, PO9, PSO1, PSO2
CO3	To understand Graphics Pipelines, creating a sample augmented reality apps in android	3	PO1, PO2, PO3, PO4, PO5, PSO1, PSO2
CO4	To understand applications of virtual reality in digital entertainment	3	PO1, PO2, PO3, PO4, PO5, PO8, PO9, PO10, PSO1, PSO2
CO5	Applying concepts on mixed reality and hybrid reality	3	PO1, PO2, PO3, PO4, PO5, PO8, PO9, PO10, PSO1, PSO2
CO6	Develop applications through Lab experiments	3	
CO7	Develop application through skill experiments	3	

Syllabus

Understand the fundamental concepts, technologies, and applications of Augmented Reality (AR)

Apply tracking and mapping techniques in AR environments

Describe the evolution, components, and design of Virtual Reality (VR) systems

Analyze rendering, audio, and interface aspects of immersive VR systems

Explore applications and evaluate usability in immersive environments

Reference Books

- 1 Understanding Augmented Reality: Concepts and Applications, Alan B. Craig, 1st Edition (2013), Newnes.
- 2 Understanding Virtual Reality: Interface, Application, and Design, William R. Sherman, Alan B. Craig, 2nd Edition (2018), Morgan Kaufmann Publishers.
- 3 Game Coding Complete, Mike McShaffry, David Graham, 4th Edition (2012), Cengage Learning (PTR).

- 4 Fundamentals of Game Design, Ernest Adams, Andrew Rollings, 3rd Edition 2006, Prentice Hall / New Riders.

25GDU3404 - COMPUTER GRAPHICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3404	COMPUTER GRAPHICS	CG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To Apply techniques of computer graphics for the generation of objects.	3	PO1, PO2, PO3, PO4, PO7, PO8, PO9, PO10, PO11, PSO1, PSO2
CO2	Model 2D objects using 2D Transformations	3	PO1, PO2, PO3, PO4, PO7, PO8, PO9, PO10, PO11, PSO1, PSO2
CO3	Identify clipping algorithms that are used to remove objects, lines, or line segments that are outside the viewing pane	4	PO1, PO2, PO3, PO4, PO7, PO8, PO9, PO10, PO11, PSO1, PSO2
CO4	Inspect algorithms to find out visible surface.	4	PO1, PO2, PO3, PO4, PO7, PO8, PO9, PO10, PO11, PSO1, 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 Algorithms- Ellipse Generating Algorithms- Other Curves-Parallel Curve Algorithms-Curve Functions-Pixel Addressing-Filled Area Primitives-Filled Area Functions-Cell Array- Character Generation. attributes of Output Primitives: Line and Curve Attributes -Color and Gray scale levels- Area Fill Attributes, 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 Pipeline-Viewing Coordinate Reference Frame-Window-to-Viewport Coordinate Transformation-Two-Dimensional Viewing Functions- Clipping: Clipping Operations-Point Clipping Line clipping algorithms such as Cohen Sutherland line clipping algorithm, Liang Barsky algorithm, Line clipping against nonrectangular clip windows; Polygon clipping Sutherland Hodgeman polygon clipping, Weiler and A Thorton polygon clipping, Curve clipping, Text clipping. 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.

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, B-spline 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, Color consideration, Transparency and Shadows.

Reference Books

- 1 Computer Graphics with OpenGL, D. Hearn, M. P. Baker, 4th Edition (2013), Pearson Education.
- 2 Computer Graphics: Principles and Practice, James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes, 2nd Edition (1990), Addison-Wesley.
- 3 Computer Graphics Using OpenGL, Francis S. Hill Jr., 3rd Edition 2006, Pearson Education.
- 4 Computer Graphics C Version, Donald Hearn, M. Pauline Baker, 2nd Edition (1996), Pearson Education / Prentice Hall PTR.

25GDU3405 - 3D MODELLING & ANIMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3405	3D MODELLING & ANIMATION	3DMA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and apply basic 3D modeling concepts, coordinate systems, transformations, and animation principles using industry-standard tools.	3	PO1, PO5, PO10, PSO2
CO2	Create detailed 3D models using polygonal, NURBS, and sculpting techniques with UV mapping and texturing.	3	PO1, PO2, PO3, PO5, PO10, PSO2
CO3	Implement rigging, dynamic simulations, and animation techniques including motion capture and camera movements.	4	PO1, PO2, PO3, PO4, PO5, PO9, PO10, PO11, PSO2
CO4	Apply lighting, rendering, and post-processing techniques to produce professional-quality 3D projects for industry applications	4	PO1, PO2, PO3, PO4, PO5, PO10, PSO2

Syllabus

Introduction to 3D modeling concepts and tools (Blender, Maya, 3ds Max), Basics of 3D space: coordinates, transformations, and object hierarchy. Principles of animation: timing, spacing, and keyframe animation. Creation of basic 3D models using primitives.

Polygonal modeling, NURBS, and subdivision surfaces. Organic modeling and sculpting techniques. UV mapping and unwrapping for texturing. Custom materials and procedural textures.

Rigging and skeletal structures for character animation. Particle systems and dynamic simulations (cloth, hair, and fluids). Motion paths, camera animation, and lip-syncing. Exploring motion capture technology and its applications.

Lighting techniques: global illumination, ambient occlusion, and HDRI lighting. Introduction to rendering engines (V-Ray, Arnold) and post-processing. Project-based learning: creating animated short films or virtual environments. Industry applications in gaming, film, and augmented reality

Reference Books

- 1 3D Modeling & Animation: A Primer, Magesh Chandramouli, 1st Edition 2021, CRC Press (Taylor & Francis Group).
- 2 The Complete Guide to Blender Graphics: Computer Modeling and Animation, John M. Blain, 8th Edition (2023), A K Peters / CRC Press.
- 3 The Animator's Survival Kit: A Manual of Methods, Richard Williams, 4th Edition, Revised (2012), Farrar, Straus and Giroux (trade); Faber & Faber (orig.).
- 4 Mastering Autodesk Maya 2020, Todd Palamar, Maya 2016 Edition, Sybex.

25GDU3506 - PRINCIPLES OF GAME DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3506	PRINCIPLES OF GAME DESIGN	PRGD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Video Games and Design Components	2	PO2, PO3
CO2	Game Concepts and Its World	2	PO1, PO2, PO10
CO3	Storytelling, Character & User Interface Design	3	PO1, PO2
CO4	Game Play and Mechanics	4	PO1, PO2, PO5

Syllabus

Video Games and Design Components: Definition of a game, Conventional vs. Video Games, how video games entertain. Key design components, video game structure, development stages, game design roles, design documentation, and anatomy of a game designer

Game Concepts and Its World: Getting an idea, transforming it into a design concept, defining player roles, choosing a genre, identifying target audience, understanding game progression, and exploring types of game machines. Introduction to the game world and its dimensions.

Storytelling, Character & User Interface Design: Storytelling in gameplay, goals of character design, storytelling engines, linear vs. non-linear narratives, emotional boundaries, interactive storytelling, and player-centric UI design. Input devices and design processes

Game Play and Mechanics: Making games fun, defining and balancing core mechanics, designing action, adventure, and online games. Level design process and addressing online game design issues for different audiences.

Reference Books

- 1 Fundamentals of Game Design , Ernest Adams , 3rd Edition, New Riders (an imprint of Pearson Education).
- 2 The Art of Game Design: A Book of Lenses, Jesse Schell, 3rd Edition, A K Peters/CRC Press (an imprint of Taylor & Francis).

25GDU3507 - BUSINESS OF GAMES & ENTREPRENEURSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GDU3507	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 justifiable activity.	2	PO1, PO2, PO5, PO6, PO10
CO2	Explore the mechanism behind gaming production and teamwork with a foundation in some of the project management tools and techniques	2	PO1, PO2, PO3, PO5, PO10, PO11
CO3	Understand and work out some of the presentation skills to pitch the gaming ideas as it happens in the ecosystem with enablers like investors and VC groups	2	PO1, PO2, PO3, PO4, PO5, PO9, PO10, PO11
CO4	Explore the skills required to be an entrepreneur and know the rules and regulations to start a company in a country like India, with a major focus on academic incubators.	3	PO1, PO2, PO5, PO6, PO9, PO10

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 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 a 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 the startup ecosystem, including company incorporation rules in India. Opportunities in the Startup India ecosystem towards Funding and establishment support

Reference Books

- 1 The Art of Game Design: A Book of Lenses, Jesse Schell, First Published: 2008 (latest is 3rd Edition, 2019), Taylor & Francis.
- 2 Game Design Workshop: A Playcentric Approach to Creating Innovative Games, Tracy Fullerton, First Published: 2004 (latest is 5th Edition, 2024), Morgan Kaufmann (Note: Later editions published by A K Peters/CRC Press).
- 3 Rules of Play: Game Design Fundamentals, Katie Salen & Eric Zimmerman, First Published: September 25, 2003, The MIT Press.
- 4 Play to Win: Choosing Growth Over Fear in Work and Life, Larry Wilson & Hersch Wilson, Not specified, Not specified (Common edition published by Bard Press).
- 5 Power-Up: How Japanese Video Games Gave the World an Extra Life, Chris Kohler, Not specified (Original edition: 2004; Revised edition: 2016), Originally BradyGames; Revised edition by Dover Publications.

25GET3101 - SOLAR PV AND MICRO ENERGY TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3101	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	SPMET	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the working principles, characteristics, and performance parameters of solar PV systems	2	PO1, PO3
CO2	Apply MPPT techniques and mathematical modeling to improve and analyze solar PV system performance	3	PO1, PO3
CO3	Apply fuel cell chemistry and compare different fuel cell types and applications with interfacing systems	3	PO1, PO3
CO4	Analyze and test micro energy sources (solar, fuel cells, biomass, geothermal, tidal, etc.) using heat transfer principles and performance evaluation tools	4	PO1, PO3

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, 1st Edition 2021, Green Stream Publishing.
- 2 Solar Energy Fundamentals and Application, H. P. Garg J. Prakash, 1st Edition 1997, McGraw Hill Education.
- 3 Non-Conventional Energy Sources, G. D. Rai, 1st Edition 1988, Khanna Publishers.

25GET3101A - SOLAR PV AND MICRO ENERGY TECHNOLOGIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3101A	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	SPMET	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the manufacturing, working, and performance parameters of solar PV cells	2	PO1, PO4
CO2	Apply maximum power point tracking (MPPT) techniques to improve solar PV system performance	3	PO1, PO4
CO3	Apply fuel cell chemistry to develop applications and compare different types of fuel cells	3	PO1, PO4
CO4	Make use of heat transfer principles for energy extraction from micro energy sources	3	PO1, PO4
CO5	Test and evaluate the performance of solar PV and micro energy sources using appropriate tools	4	PO1, PO4

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, 1st Edition 2021, Green Stream Publishing.
- 2 Non-Conventional Energy Sources, G. D. Rai, 1st Edition 1988, Khanna Publishers.
- 3 Solar Energy Fundamentals and Applications, H. P. Garg J. Prakash, 1st Edition 1997, McGraw Hill Education.

25GET3101E - SOLAR PV AND MICRO ENERGY TECHNOLOGIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3101E	SOLAR PV AND MICRO ENERGY TECHNOLOGIES	SPMET	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the manufacturing, working, and performance parameters of solar PV cells	2	PO1, PO4
CO2	Apply maximum power point tracking (MPPT) techniques to improve solar PV system performance	3	PO1, PO4
CO3	Apply fuel cell chemistry to develop applications and compare different types of fuel cells	3	PO1, PO4
CO4	Make use of heat transfer principles for energy extraction from micro energy sources	3	PO1, PO4
CO5	Test and evaluate the performance of solar PV and micro energy sources using appropriate tools	4	PO1, PO4

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, 1st Edition 2021, Green Stream Publishing.
- 2 Non-Conventional Energy Sources, G. D. Rai, 1st Edition 1988, Khanna Publishers.
- 3 Solar Energy Fundamentals and Applications, H. P. Garg J. Prakash, 1st Edition 1997 , McGraw Hill Education.

25GET3202 - WIND AND ENERGY STORAGE TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3202	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	
CO2	Model Solar Wind energy conversion system components	3	
CO3	Model Electro-chemical energy storage components	3	
CO4	Model Mechanical energy storage components	3	

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.

25GET3203 - ENERGY ECONOMICS AND POLICY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3203	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, PO6
CO2	Apply energy regulations and energy policies to energy markets to promote energy efficiency and Energy equity.	3	PO1, PO6
CO3	Analyze environmental externalities and impact of climate changes on energy security and energy supply.	4	PO1, PO6
CO4	Analyse policies and incentives for encourage renewable energy integration.	4	PO1

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, 1st Edition 2019, Springer London.
- 2 Energy Economics: Theory and Applications, Peter Zweifel, Aaron Praktiknjo, Georg Erdmann, 1st Edition 2017, Springer Berlin Heidelberg.
- 3 Electricity Sector in India, Alok Kumar, Sushanta Kumar Chatterjee, 1st Edition 2012, OUP India.
- 4 Indian Electricity Sector under Regulatory Regime, Pratik Biswas, Sukanya Mandal, 1st Edition 2019, White Falcon Publishing.

25GET3304 - GRID INTEGRATION OF RENEWABLE ENERGY SOURCES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3304	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	GIRES	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the control principles for PV - grid integration control.	3	PO1
CO2	Apply the control principles for wind power integration control.	3	PO2, PO3
CO3	Identify power quality challenges in grid integration of renewable energy.	3	PO3
CO4	Identify challenges in grid integration of multiple renewable sources.	3	PO3

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, 1st Edition 2009, Nova Science Publishers, New York.
- 2 Smart Grids: Infrastructure, Technology and Solutions, S. Borlase, 1st Edition 2013, CRC Press.
- 3 Grid Integration of Solar Photovoltaic Systems, Majid Jamil, M. Rizwan, D. P. Kothari, 1st Edition 2018, CRC Press (Taylor & Francis Group).

25GET3304A - GRID INTEGRATION OF RENEWABLE ENERGY SOURCES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3304A	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	GIRES	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the control principles for PV - grid integration control.	3	PO1
CO2	Apply the control principles for wind power integration control.	3	PO2, PO3
CO3	Identify power quality challenges in grid integration of renewable energy.	3	PO2, PO3
CO4	Identify challenges in grid integration of multiple renewable sources.	3	PO2, PO3
CO5	Able to acquire skills in topics of integration of micro grid.	3	PO2, PO3

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.

Power Quality Management: THD, Voltage sag, Voltage swell, Frequency change and its effects, Network voltage management PV & Wind power.

Power System Stability & Control: Frequency management, Effects on system stability, PLL, Modulation Techniques, Dimensioning of filters.

Challenges in Integration: 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, 1st Edition 2009, Nova Science Publishers, New York.
- 2 Smart Grids: Infrastructure, Technology and Solutions, S. Borlase, 1st Edition 2013, CRC Press.
- 3 Grid Integration of Solar Photovoltaic Systems, Majid Jamil, M. Rizwan, D. P. Kothari, 1st Edition 2018, CRC Press (Taylor & Francis Group).

25GET3304E - GRID INTEGRATION OF RENEWABLE ENERGY SOURCES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3304E	GRID INTEGRATION OF RENEWABLE ENERGY SOURCES	GIRES	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the control principles for PV - grid integration control.	3	PO1
CO2	Apply the control principles for wind power integration control.	3	PO2, PO3
CO3	Identify power quality challenges in grid integration of renewable energy.	3	PO2, PO3
CO4	Identify challenges in grid integration of multiple renewable sources.	3	PO2, PO3
CO5	Able to acquire skills in topics of integration of micro grid.	3	PO2, PO3

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.

Power Quality Management: THD, Voltage sag, Voltage swell, Frequency change and its effects, Network voltage management PV & Wind power.

Power System Stability & Control: Frequency management, Effects on system stability, PLL, Modulation Techniques, Dimensioning of filters.

Challenges in Integration: 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, 1st Edition 2009, Nova Science Publishers, New York.
- 2 Smart Grids: Infrastructure, Technology and Solutions, S. Borlase, 1st Edition 2013, CRC Press.
- 3 Grid Integration of Solar Photovoltaic Systems, Majid Jamil, M. Rizwan, D. P. Kothari, 1st Edition 2018, CRC Press (Taylor & Francis Group).

25GET3405 - ENERGY MANAGEMENT AND GREEN BUILDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3405	ENERGY MANAGEMENT AND GREEN BUILDING	EMGB	R	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	PO2
CO2	Interpret different types of energy conservation opportunities in electrical components used for various applications.	3	PO3
CO3	Apply different types of energy management strategies to improve energy efficiency in green buildings.	3	PO3
CO4	Apply different types of practices to get maximum life and improve energy efficiency green buildings.	3	PO3

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, 1998, Pennwell publications..
- 3 Green Building: Principles and Practices in Residential Construction, Abe Kruger, 2013, Cengage Learning.

25GET3406 - HYDROGEN FUEL CELL TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3406	HYDROGEN FUEL CELL TECHNOLOGY	HFCT	R	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
CO2	Interpret different types of Modelling and Selection of fuel cell components in fuel cell system.	3	PO3
CO3	Interpret and study different types of dynamics of hydrogen fuel cell storage and applications for storage of hydrogen storage.	3	PO3
CO4	Apply different case studies on Demonstration of Environmental and Economic Impacts of Hydrogen fuel cells.	3	PO3

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 Fuel Cell Systems Explained, Andrew Dicks, 2018, Wiley..
- 3 Hydrogen and Fuel Cell Technologies: Advances and Challenges, Rong Lan, 2021, Wiley.

25GET3507 - AI AND IOT FOR GREEN ENERGY INTEGRATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3507	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	PO1
CO2	Apply Embedded Programming to upload sensor data to cloud	3	PO2, PO3
CO3	Analyze the data in cloud through AL/ML Services.	4	PO2, PO3
CO4	Develop application for green energy technologies using cloud tools	4	PO2, PO3

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: DataPre-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, 2011, Springer.
- 2 Sensors and Actuators, D. Patranabis, 2nd Edition, 2013, PHI.
- 3 Applications of AI and IoT in Renewable Energy, R.N., Mendis, 2021, Elsevier..

25GET3508 - POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GET3508	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.	3	PO2
CO2	Apply the Power electronic converters for wind energy and storage systems.	4	PO2
CO3	Apply Power Electronics Control Techniques in Renewable Energy Systems	3	PO2
CO4	Identify the Grid Integration and Control of Renewable Energy Systems.	4	PO2

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 , 1, Springer Science.
- 2 Solar PV Power: Design, Manufacturing and Applications, Mukund R. Patel , 1, CRC Press.
- 3 Wind Energy Systems: Control Engineering Design, Mario Garcia-Sanz, 1, Taylor & Francis New York..

25GMI3101 - PRINCIPLES OF DEEP NEURAL COMPUTATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GMI3101	PRINCIPLES OF DEEP NEURAL COMPUTATION	PDNC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the foundational concepts of deep learning including neurons, activation, networks and loss.	2	
CO2	Apply optimization and training mechanisms to build and train deep neural networks.	3	
CO3	Analyze and apply advanced deep architectures (CNN, RNN, GNN, ResNet, DenseNet).	4	
CO4	Apply unsupervised learning, transformers, and flow-based generative models to complex data tasks.	3	

Syllabus

Foundations of Deep Learning: Neuron & Shallow Networks: Structure and function of artificial neurons; activation functions; bias and weight. Single-layer networks, universal approximation theorem, multivariate inputs/outputs, function fitting. Deep Neural Networks: Compositionality, network depth, hierarchical feature learning, comparing shallow and deep networks. Loss Functions: Maximum likelihood estimation, constructing loss functions, regression (MSE), binary/multiclass classification, cross-entropy loss. Initialization & Gradients: Backpropagation, chain rule, Jacobians, Xavier/He/orthogonal initialization.

Model Fitting and Optimization : Optimization: Gradient descent, SGD, momentum, Adam optimizer. Model Fitting: Training, validation, and testing strategies; regularization. Stability: Learning rate schedules, early stopping.

Advanced Deep Architectures : Convolutional Networks: Invariance/equivariance, convolution for 1D/2D signals, pooling, padding, stride, upsampling, practical applications. Residual Networks: Skip connections, residual blocks, batch normalization, representative architectures (ResNet, DenseNet). Recurrent Neural Networks: Fundamentals, training RNNs, sequence prediction, text generation, long-term dependencies, vanishing/exploding gradients. Variants (LSTM, GRU, Bidirectional RNNs). Graph Neural Networks: Graph representations, graph convolutions, node/edge classification, spectral and spatial methods. Geometric Deep Learning: Non-Euclidean data, manifolds, applications.

Advanced Deep Architectures : Convolutional Networks: Invariance/equivariance, convolution for 1D/2D signals, pooling, padding, stride, upsampling, practical applications. Residual Networks: Skip connections, residual blocks, batch normalization, representative architectures (ResNet, DenseNet). Recurrent Neural Networks: Fundamentals, training RNNs, sequence prediction, text generation, long-term dependencies, vanishing/exploding gradients. Variants (LSTM, GRU, Bidirectional RNNs). Graph Neural Networks: Graph representations, graph convolutions, node/edge classification, spectral and spatial methods. Geometric Deep Learning: Non-Euclidean data, manifolds, applications.

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, 2024, MIT Press.
- 2 Understanding Deep Learning: Theory and Algorithms, Simon J.D. Prince, 2023, MIT Press.
- 3 Neural Networks and Deep Learning, Michael Nielsen, 2006, open book.

25GMI3101A - PRINCIPLES OF DEEP NEURAL COMPUTATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GMI3101A	PRINCIPLES OF DEEP NEURAL COMPUTATION	PDNC	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and implement the fundamental mathematical, computational, and neural network principles that form the basis of deep learning models.	3	
CO2	Design, implement, and evaluate advanced deep learning architectures, including convolutional, transformer, and graph neural networks, for a variety of scientific domains	3	
CO3	Understand and apply various unsupervised and generative deep learning models, such as Normalizing Flows, VAEs, and Diffusion Models, to generate novel data and learn complex data distributions.	3	
CO4	Explore and critically assess emerging topics in deep learning, including federated and distributed learning, while evaluating the ethical implications and responsibilities of AI systems	3	

Syllabus

Foundations of Deep Learning Neuron: Structure and function of artificial neurons; activation functions; bias and weight. Shallow Neural Networks: Single-layer networks, universal approximation theorem, multivariate inputs/outputs, function fitting. Deep Neural Networks: Compositionality, network depth, hierarchical feature learning, comparing shallow and deep networks. Loss Functions: Maximum likelihood estimation, constructing loss functions, regression (MSE), binary/multiclass classification, cross-entropy loss. Model Fitting: Optimization techniques gradient descent, stochastic gradient descent (SGD), momentum, Adam optimizer. Gradients and Initialization: Backpropagation, chain rule, Jacobians, parameter initialization strategies (Xavier, He, orthogonal).

Advanced Deep Learning Architectures Convolutional Networks: Invariance/equivariance, convolution for 1D/2D signals, pooling, padding, stride, upsampling, practical applications. Residual Networks: Deep sequential processing, skip connections, residual blocks, batch normalization, representative architectures (ResNet, DenseNet). Recurrent Neural Networks (RNNs): Fundamentals, training RNNs, applications (sequence prediction, text generation), challenges (long-term dependencies, vanishing/exploding gradients), variants (LSTM, GRU, Bidirectional RNNs). Graph Neural Networks: Graph representations, graph convolutions, node/edge classification, spectral and spatial methods. Geometric Deep Learning: Deep learning on non Euclidean data, manifolds, applications in chemistry, drug discovery, and computer graphics.

Unsupervised and Transformers Unsupervised Learning: Types and taxonomy clustering, manifold learning, autoencoders, generative modelling. Transformers: Dot-product self-attention, multi-head attention, transformer layers, applications in NLP and vision (Vision Transformers). Normalizing Flows: Invertible neural network layers, constructing flow-based generative models, multi-scale architectures.

Emerging Topics and Ethical Considerations Federated Learning: Principles, privacy, security, federated averaging, real-world applications and technical challenges. Distributed Deep Learning: Data/model parallelism, distributed optimization algorithms, frameworks (Horovod, PyTorch DDP), scaling laws. Why Does Deep Learning Work?: Overparameterization, double descent, implicit regularization, loss surface geometry, the role of depth and width. Ethical AI: Value alignment, fairness, bias, adversarial risks, professional responsibility, frameworks for ethical AI research and deployment.

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, 2024, MIT Press.
- 2 Understanding Deep Learning: Theory and Algorithms, Simon J.D. Prince, 2023, MIT Press.

- 3 Neural Networks and Deep Learning, Michael Nielsen, 2006, Open Book.

25GMI3101E - PRINCIPLES OF DEEP NEURAL COMPUTATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GMI3101E	PRINCIPLES OF DEEP NEURAL COMPUTATION	PDNC	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the foundational concepts of deep learning including neurons, activation, networks and loss.	2	
CO2	Apply optimization and training mechanisms to build and train deep neural networks.	3	
CO3	Analyze and apply advanced deep architectures (CNN, RNN, GNN, ResNet, DenseNet).	4	
CO4	Apply unsupervised learning, transformers, and flow-based generative models to complex data tasks.	3	
CO5	Analyze emerging topics in federated, distributed, and ethical AI including theoretical perspectives.	4	

Syllabus

Foundations of Deep Learning: Neuron & Shallow Networks: Structure and function of artificial neurons; activation functions; bias and weight. Single-layer networks, universal approximation theorem, multivariate inputs/outputs, function fitting. Deep Neural Networks: Compositionality, network depth, hierarchical feature learning, comparing shallow and deep networks. Loss Functions: Maximum likelihood estimation, constructing loss functions, regression (MSE), binary/multiclass classification, cross-entropy loss. Initialization & Gradients: Backpropagation, chain rule, Jacobians, Xavier/He/orthogonal initialization.

Model Fitting and Optimization : Optimization: Gradient descent, SGD, momentum, Adam optimizer. Model Fitting: Training, validation, and testing strategies; regularization. Stability: Learning rate schedules, early stopping.

Advanced Deep Architectures : Convolutional Networks: Invariance/equivariance, convolution for 1D/2D signals, pooling, padding, stride, upsampling, practical applications. Residual Networks: Skip connections, residual blocks, batch normalization, representative architectures (ResNet, DenseNet). Recurrent Neural Networks: Fundamentals, training RNNs, sequence prediction, text generation, long-term dependencies, vanishing/exploding gradients. Variants (LSTM, GRU, Bidirectional RNNs). Graph Neural Networks: Graph representations, graph convolutions, node/edge classification, spectral and spatial methods. Geometric Deep Learning: Non-Euclidean data, manifolds, applications.

Unsupervised and Transformer Models: Unsupervised Learning: Clustering, manifold learning, autoencoders, generative modeling. Transformers: Dot-product self-attention, multi-head attention, transformer layers, Vision Transformers. Normalizing Flows: Invertible neural network layers, flow-based generative models, multi-scale architectures.

Emerging Topics and Ethical Considerations: Federated Learning: Principles, privacy, security, federated averaging, applications and challenges. Distributed Deep Learning: Data/model parallelism, distributed optimization, frameworks (Horovod, PyTorch DDP), scaling laws. Theoretical Foundations: Overparameterization, double descent, implicit regularization, loss surface geometry, depth vs. width. Ethical AI: Value alignment, fairness, bias, adversarial risks, professional responsibility, frameworks for ethical deployment.

Reference Books

- 1 Deep Learning, Ian Goodfellow, Yoshua Bengio, 2024, MIT Press.
- 2 Understanding Deep Learning: Theory and Algorithms, Simon J.D. Prince, 2023, MIT Press.
- 3 Neural Networks and Deep Learning, Michael Nielsen, 2006, open book.

25GMI3202 - ENGINEERING LARGE LANGUAGE MODEL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GMI3202	ENGINEERING LARGE LANGUAGE MODEL SYSTEMS	ELLMS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply foundational concepts of NLP, statistical language models, and deep learning techniques using PyTorch to develop and evaluate language processing applications.	3	
CO2	Apply advanced word representation techniques, neural language models, and decoding strategies to build and optimize sequence-to-sequence and transformer models using PyTorch.	3	
CO3	Analyze various pre-training strategies, prompt-based learning methods, and retrieval-augmented models to evaluate their effectiveness in language understanding and question-answering tasks.	4	
CO4	Analyze the representation, completion, and alignment tasks of knowledge graphs, distinguishing between graph neural networks and neural KG inference methods. Additionally, evaluate parameter-efficient adaptation techniques, interpretability methods, and ethical challenges such as bias and toxicity in contemporary NLP models like GPT-4 and Llama-3.	4	

Syllabus

Introduction to NLP (NLP Pipeline, Applications of NLP), Statistical Language Models- Advanced Smoothing and Evaluation, Deep Learning (Perceptron, ANN, Backpropagation, CNN), PyTorch introduction

?Word Representation?- Word2Vec, fastText, GloVe ,Tokenization Strategies, Neural Language Models - CNN, RNN, LSTM, GRU, Sequence-to-Sequence Models, Greedy Decoding, Beam search, Other Decoding Strategies: Nucleus Sampling, Temperature Sampling, Top-k Sampling, Attention in Sequence-to-Sequence Models, Introduction to Transformers - Self and Multi-Head Attention, Positional Encoding and Layer Normalization, Implementation of Transformers using PyTorch

Pre-Training Strategies: ELMo, BERT (Encoder-only Model), Pre-Training Strategies: Encoder-decoder and Decoder-only Models, Introduction to HuggingFace, Instruction Tuning, Prompt-based Learning, Advanced Prompting Techniques and Prompt Sensitivity, Alignment of Language Models with Human Feedback (RLHF), Open-book question answering: The case for retrieving from structured and unstructured sources; retrieval-augmented inference and generation, Retrieval augmentation techniques - Key-value memory networks in QA for simple paths in KGs, Early HotPotQA solvers, pointer networks, reading comprehension, REALM, RAG, FiD, Unlimiformer, KGQA (e.g., EmbedKGQA, GrailQA)

Reference Books

- 1 Introduction to Large Language Models, Tanmoy Chakraborty, 2025, Wiley.
- 2 Speech and Language Processing, Dan Jurafsky and James H. Martin, 2008, Pearson Press.
- 3 Natural Language Processing, Jacob Eisenstein, 2019, The MIT Press.

25GMI3303 - REINFORCEMENT LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GMI3303	REINFORCEMENT LEARNING	RL	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25GMI3303A - REINFORCEMENT LEARNING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GMI3303A	REINFORCEMENT LEARNING	RL	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the core principles of agent-environment interaction, states, actions, rewards, and policies in RL systems.	2	PO1, PO2, PO3, PSO1
CO2	Implement and experiment with model-free algorithms such as Monte Carlo, Temporal Difference, Q-Learning, and SARSA for simple environments.	3	PO2, PO3, PO4, PSO2
CO3	Evaluate the behavior and stability of RL algorithms under different exploration-exploitation strategies and reward structures.	4	PO2, PO3, PO4, PSO1
CO4	Integrate neural networks with RL techniques (e.g., Deep Q-Networks, Policy Gradient Methods) to handle high-dimensional state and action spaces.	6	PO2, PO3, PO4, PSO2
CO5	Formulate, implement, and fine-tune reinforcement learning models for applications in robotics, autonomous systems, and industrial automation.	5	PO3, PO4, PO5, PSO1

Syllabus

Foundations and Markov Decision Processes

Model-Free RL and Temporal Difference Learning

Deep Reinforcement Learning

Advanced Topics, Multi-Agent RL, and Applications

Reference Books

- 1 Reinforcement Learning: An Introduction, Richard S. Sutton, Andrew G. Barto, 2nd, MIT Press, 2018.
- 2 Deep Reinforcement Learning Hands-On, Maxim Lapan, 2nd, Packt Publishing, 2020.
- 3 Algorithms for Reinforcement Learning, Csaba Szepesvári, 1st, Morgan & Claypool, 2010.

25GMI3303E - REINFORCEMENT LEARNING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GMI3303E	REINFORCEMENT LEARNING	RL	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25GMI3404 - GENERATIVE AI, AGENTIC AI & RETRIEVAL AUGMENTED GENERATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GMI3404	GENERATIVE AI, AGENTIC AI & RETRIEVAL AUGMENTED GENERATION	GAAR	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain and implement foundational generative models and agentic system paradigms across multiple domains including autoregressive flow based energy based score based and diffusion models	4	
CO2	Design develop and evaluate agentic architectures and reasoning mechanisms for intelligent systems including single and multi agent systems knowledge representation planning and learning strategies integrated with generative AI capabilities	5	
CO3	Build and deploy advanced agentic systems by integrating meta reasoning tool augmentation collaborative frameworks agent memory trustworthiness and responsible design principles addressing real world application domains	5	
CO4	Engineer optimize and critically assess retrieval augmented generation RAG pipelines and modular agentic architectures including infrastructure design deployment observability and evaluation in multi agent and domain specific contexts	5	

Syllabus

Introduction to Generative AI core concepts evolution of generative paradigms applications across domains text image audio video 3D tabular Autoregressive models sequence modeling using masked architectures PixelCNN PixelRNN sampling and likelihood computation Normalizing flow based models invertible neural networks RealNVP Glow MAF exact likelihood computation Energy based models contrastive divergence Langevin dynamics MCMC Score based and diffusion models denoising score matching SDEs DDPMs Generative models for time series and voice WaveNet SampleRNN GradTTS FastDiff Bark AudioLDM AudioCraft Synthetic data generation hybrid training domain adaptation privacy preserving data ShapeNet SYNTHIA SceneNet Virtual KITTI CARLA AirSim Gazebo

Foundations of agentic systems concepts of agency autonomy reactivity proactivity Agent architectures reactive deliberative hybrid Multi agent systems coordination cooperation communication negotiation Knowledge representation semantic networks ontologies logic based systems Reasoning mechanisms deductive inductive abductive Learning in adaptive agents reinforcement learning imitation learning continual adaptation Planning algorithms STRIPS Graphplan FF heuristic planning Integration with generative AI prompt engineering hybrid LLM agent setups

Meta reasoning and introspection self monitoring belief modeling confidence tracking Tool augmented agents function calling custom tools API integration Planning with tools AutoGen CrewAI LangGraph Collaborative agent architectures CWD task decomposition Agent memory systems episodic working long term memory Building trustworthy agents transparency explainability interpretability bias detection Ethics and safety responsible design hallucination mitigation alignment with values Application domains healthcare education robotics creative arts autonomous systems Future directions AGI multimodal cognition experiential learning

Fundamentals of retrieval augmented generation RAG dense and sparse retrieval semantic chunking embeddings vector stores FAISS Weaviate Qdrant Advanced RAG pipelines hybrid retrieval source grounding query rewriting structured RAG with SQL evaluation with precision metrics MCP architecture modular agent tool planner design schema based tool calling orchestration LangServe AutoGen CrewAI LangChain LangGraph Infrastructure and deployment FastAPI gRPC Redis memory Celery async execution observability fault tolerance Applications and evaluation domain specific RAG agents collaborative multi agent systems latency analysis hallucination control ethical safeguards

Reference Books

- 1 Generative Deep Learning, David Foster, 2025, O'Reilly.
- 2 Multimodal Machine Learning, Morency et al, 2024, CMU.

3 Introduction to Large Language Models, Tanmoy Chakraborty , 2024, -.

25GMI3505 - MULTI-MODAL INTELLIGENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GMI3505	MULTI-MODAL INTELLIGENCE	MMI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and construct multimodal representations by integrating information from vision audio and text modalities using encoding fusion and embedding techniques	4	
CO2	Design and implement structured and probabilistic models for multimodal data including graphical models sequence models and advanced cross modal alignment strategies	5	
CO3	Develop and deploy generative and interactive multimodal AI systems leveraging VAEs GANs RL based fusion and meta learning or co learning approaches to synthesize augment and interact with complex multimodal data	5	
CO4	Critically evaluate and address ethical fairness privacy and human centered issues in multimodal AI including emerging topics such as retrieval augmented multimodal generation memory augmented agents and parameter efficient adaptation	5	

Syllabus

Modality encoders CNNs for vision spectrogram RNNs for audio text RNNs LSTMs GRUs Cross modal fusion and attention early vs late fusion pooling cross attention layers Joint embedding spaces multimodal autoencoders deep CCA matrix factorization Training objectives contrastive InfoNCE CLIP cross modal reconstruction alignment losses gradient optimization

Graphical and sequence models multimodal HMMs coupled HMMs dynamic Bayesian nets Conditional structured predictors multimodal CRFs for sequence labeling fully connected CRFs for segmentation Compositional architectures tree structured fusion networks module networks for VQA graph neural networks Cross modal alignment temporal alignment DTW embedding regression cycle consistency

Multimodal generative models joint VAEs GANs latent diffusion flow based fusion Agentic and RL driven fusion multimodal RL grounded dialog embodied agents Few shot and co learning meta learning across modalities co contrastive learning multi kernel fusion Synthetic multimodal data diffusion GAN augmentation speech and video synthesis privacy preserving generation

Embodied grounding language to vision or action pipelines multimodal navigation agents Discourse and semantics multimodal dialog state tracking grounded discourse modeling cross modal retrieval Fairness and privacy debiasing embeddings federated multimodal learning differentially private data Frontier topics retrieval augmented multimodal generation memory augmented agents parameter efficient tuning LoRA

Reference Books

- 1 Multimodal Machine Learning: A Survey and Taxonomy, Tadas Baltrusaitis, Chaitanya Ahuja, Louis Philippe Morency, 2018, Foundations Trends.
- 2 Deep Learning for Multi-Modality , John D Kelleher, Brian Mac Namee , 2024, MIT Press.
- 3 Representation Learning on Graphs and Manifolds, Michael Bronstein, Joan Bruna , 2023, O'Reilly.

25GSD3101 - GREEN SOFTWARE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GSD3101	GREEN SOFTWARE ENGINEERING	GSE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of sustainable software engineering, green lifecycles, and environmental impact of computing.	2	
CO2	Apply architecture-level optimization and design strategies for energy-efficient and sustainable software development.	3	
CO3	Analyze and refactor code for sustainability by applying green coding practices and evaluating energy impact.	4	
CO4	Evaluate green software using energy/carbon metrics, profiling tools, and implement sustainable CI/CD and cloud practices.	4	

Syllabus

Introduction to Green Software: Sustainability in software engineering; Green software lifecycle; Environmental impact of computing; Principles of sustainable software design

Design Strategies for Energy Efficiency: Architecture-level energy optimization; Design patterns for sustainable software; Component-based green design

Green Coding Practices and Refactoring: Efficient coding techniques; Code smells and their impact on energy; Refactoring for sustainability; Case studies

Evaluation and Metrics, Green DevOps and Cloud Sustainability: Energy and carbon metrics (Joules, CO₂eq); Green performance analysis; Tools for energy profiling and carbon measurement; Sustainable CI/CD; Container optimization; Carbon-aware deployment; Monitoring and reporting

Reference Books

- 1 Green Software Engineering, Wilke, S. et al., 2022, Springer.
- 2 Greener IT, Hennessy, M., 2021, Wiley.
- 3 Energy-Efficient Computing and Green IT, Bhuvan Unhelkar, 2016, CRC Press.

25GSD3101A - GREEN SOFTWARE ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GSD3101A	GREEN SOFTWARE ENGINEERING	GSE	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of sustainable software engineering, green lifecycles, and environmental impact of computing.	2	
CO2	Apply architecture-level optimization and design strategies for energy-efficient and sustainable software development.	3	
CO3	Evaluate green software using energy/carbon metrics, profiling tools, and implement sustainable CI/CD and cloud practices.	4	
CO4	Evaluate green software using energy/carbon metrics, profiling tools, and implement sustainable CI/CD and cloud practices.	4	

Syllabus

Introduction to Green Software: Sustainability in software engineering; Green software lifecycle; Environmental impact of computing; Principles of sustainable software design

Design Strategies for Energy Efficiency: Architecture-level energy optimization; Design patterns for sustainable software; Component-based green design

Green Coding Practices and Refactoring: Efficient coding techniques; Code smells and their impact on energy; Refactoring for sustainability; Case studies

Evaluation and Metrics, Green DevOps and Cloud Sustainability: Energy and carbon metrics (Joules, CO₂eq); Green performance analysis; Tools for energy profiling and carbon measurement; Sustainable CI/CD; Container optimization; Carbon-aware deployment; Monitoring and reporting

Reference Books

- 1 Green Software Engineering, Wilke, S. et al., 2022, Springer.
- 2 Greener IT, Hennessy, M., 2021, Wiley.
- 3 Energy-Efficient Computing and Green IT, Bhuvan Unhelkar, 2016, CRC Press.

25GSD3101E - GREEN SOFTWARE ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GSD3101E	GREEN SOFTWARE ENGINEERING	GSE	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of sustainable software engineering, green lifecycles, and environmental impact of computing.	2	
CO2	Apply architecture-level optimization and design strategies for energy-efficient and sustainable software development.	3	
CO3	Analyze and refactor code for sustainability by applying green coding practices and evaluating energy impact.	4	
CO4	Evaluate green software using energy/carbon metrics, profiling tools, and implement sustainable CI/CD and cloud practices.	4	

Syllabus

Introduction to Green Software: Sustainability in software engineering; Green software lifecycle; Environmental impact of computing; Principles of sustainable software design

Design Strategies for Energy Efficiency: Architecture-level energy optimization; Design patterns for sustainable software; Component-based green design

Green Coding Practices and Refactoring: Efficient coding techniques; Code smells and their impact on energy; Refactoring for sustainability; Case studies

Evaluation and Metrics, Green DevOps and Cloud Sustainability: Energy and carbon metrics (Joules, CO₂eq); Green performance analysis; Tools for energy profiling and carbon measurement; Sustainable CI/CD; Container optimization; Carbon-aware deployment; Monitoring and reporting

Reference Books

- 1 Green Software Engineering, Wilke, S. et al., 2022, Springer.
- 2 Greener IT, Hennessy, M., 2021, Wiley.
- 3 Energy-Efficient Computing and Green IT, Bhuvan Unhelkar, 2016, CRC Press.

25GSD3202 - GREEN ALGORITHMS AND SUSTAINABLE APP DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GSD3202	GREEN ALGORITHMS AND SUSTAINABLE APP DESIGN	GAD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamentals of green computing, sustainability concepts, and metrics for measuring energy efficiency.	2	
CO2	Apply knowledge of energy-efficient algorithms and data structures to minimize resource consumption.	3	
CO3	Develop sustainable application designs using green software engineering lifecycle principles, design patterns, and green APIs.	3	
CO4	Analyze and optimize software energy consumption through profiling, refactoring, and evaluation of industry practices.	4	

Syllabus

Introduction to Green Computing and Sustainability: Definition and importance of green computing; Carbon footprint of software systems; Metrics for measuring energy efficiency

Energy-Efficient Algorithms and Data Structures: Algorithm complexity vs. energy consumption; Cache-friendly algorithms; Energy-aware data structures

Sustainable Application Design: Green software engineering lifecycle; Design patterns for sustainability; Green APIs

Energy Profiling and Optimization Techniques, Case Studies and Emerging Trends: Runtime profiling; Energy-aware refactoring; Tools and benchmarks for software energy profiling; Case studies on sustainable software systems; Green AI; Industry practices and policies

Reference Books

- 1 Green Software Engineering, B. Penzenstadler et al., 2021, Springer.
- 2 Sustainable Computing, R. Buyya & A. Beloglazov, 2017, Wiley.
- 3 Software Engineering for Green Computing, Y. Hilty, 2020, CRC Press.

25GSD3303 - SUSTAINABLE CLOUD AND EDGE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GSD3303	SUSTAINABLE CLOUD AND EDGE COMPUTING	SCE	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the foundations of sustainable computing, including energy-efficient architectures and carbon footprint metrics.	2	
CO2	Apply techniques for cloud sustainability through virtualization efficiency, workload scheduling, and carbon-aware computing.	3	
CO3	Analyze edge architectures, offloading strategies, and latency-energy trade-offs for sustainable computing at the edge.	4	
CO4	Evaluate workload distribution, monitoring, and benchmarking using green metrics, tools, and container orchestration.	4	

Syllabus

Foundations of Sustainable Computing: Green computing principles, energy-efficient architecture, carbon footprint metrics

Cloud Sustainability and Energy Optimization: Virtualization efficiency, workload scheduling, carbon-aware computing in cloud platforms

Edge Computing for Sustainability: Edge architectures, offloading strategies, latency-energy trade-offs

Sustainable Workload Distribution, Monitoring and Benchmarking Green Metrics: Energy-aware container orchestration (Kubernetes), scheduling policies, demand prediction, power profiling tools, emission calculators, sustainability KPIs

Reference Books

- 1 Green Cloud Computing, Hossain Shahriar et al., 2022, Springer.
- 2 Sustainable Cloud and Energy Services, Wilson Rivera, 2016, Springer.
- 3 Green Information and Communication Systems, Mohammad S. Obaidat, 2013, Elsevier.

25GSD3303A - SUSTAINABLE CLOUD AND EDGE COMPUTING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GSD3303A	SUSTAINABLE CLOUD AND EDGE COMPUTING	SCE	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the foundations of sustainable computing, including energy-efficient architectures and carbon footprint metrics.	2	
CO2	Apply techniques for cloud sustainability through virtualization efficiency, workload scheduling, and carbon-aware computing.	3	
CO3	Analyze edge architectures, offloading strategies, and latency-energy trade-offs for sustainable computing at the edge.	4	
CO4	Evaluate workload distribution, monitoring, and benchmarking using green metrics, tools, and container orchestration.	4	

Syllabus

Foundations of Sustainable Computing: Green computing principles, energy-efficient architecture, carbon footprint metrics

Cloud Sustainability and Energy Optimization: Virtualization efficiency, workload scheduling, carbon-aware computing in cloud platforms

Edge Computing for Sustainability: Edge architectures, offloading strategies, latency-energy trade-offs

Sustainable Workload Distribution, Monitoring and Benchmarking Green Metrics: Energy-aware container orchestration (Kubernetes), scheduling policies, demand prediction, power profiling tools, emission calculators, sustainability KPIs

Reference Books

- 1 Green Cloud Computing, Hossain Shahriar et al., 2022, Springer.
- 2 Sustainable Cloud and Energy Services, Wilson Rivera, 2016, Springer.
- 3 Green Information and Communication Systems, Mohammad S. Obaidat, 2013, Elsevier.

25GSD3303E - SUSTAINABLE CLOUD AND EDGE COMPUTING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GSD3303E	SUSTAINABLE CLOUD AND EDGE COMPUTING	SCE	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the foundations of sustainable computing, including energy-efficient architectures and carbon footprint metrics.	2	
CO2	Apply techniques for cloud sustainability through virtualization efficiency, workload scheduling, and carbon-aware computing.	3	
CO3	Analyze edge architectures, offloading strategies, and latency-energy trade-offs for sustainable computing at the edge.	4	
CO4	Evaluate workload distribution, monitoring, and benchmarking using green metrics, tools, and container orchestration.	4	

Syllabus

Foundations of Sustainable Computing: Green computing principles, energy-efficient architecture, carbon footprint metrics

Cloud Sustainability and Energy Optimization: Virtualization efficiency, workload scheduling, carbon-aware computing in cloud platforms

Edge Computing for Sustainability: Edge architectures, offloading strategies, latency-energy trade-offs

Sustainable Workload Distribution, Monitoring and Benchmarking Green Metrics: Energy-aware container orchestration (Kubernetes), scheduling policies, demand prediction, power profiling tools, emission calculators, sustainability KPIs

Reference Books

- 1 Green Cloud Computing, Hossain Shahriar et al., 2022, Springer.
- 2 Sustainable Cloud and Energy Services, Wilson Rivera, 2016, Springer.
- 3 Green Information and Communication Systems, Mohammad S. Obaidat, 2013, Elsevier.

25GSD3404 - HARDWARE FOR SUSTAINABLE DIGITAL INFRASTRUCTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GSD3404	HARDWARE FOR SUSTAINABLE DIGITAL INFRASTRUCTURE	HSDI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the role of hardware in sustainable digital infrastructures, energy consumption trends, and carbon footprint considerations in ICT systems.	2	
CO2	Apply principles of energy-efficient hardware design including CPU/GPU/FPGA optimization, DVFS, and low-power modes.	3	
CO3	Demonstrate understanding of hardware lifecycle, e-waste management, recycling, and circular economy principles for sustainability.	3	
CO4	Analyze and optimize hardware thermal management, cooling systems, and sustainable edge/embedded hardware solutions.	4	

Syllabus

Introduction to Sustainable Digital Infrastructure: Energy consumption trends in ICT, carbon footprint of data centers, sustainability goals, role of hardware in green IT

Energy-Efficient Hardware Design: Low-power CPU/GPU/FPGA design; ARM vs x86 energy profiles; sleep modes; dynamic voltage and frequency scaling (DVFS)

Hardware Lifecycle and Circular Economy: E-waste, hardware recycling and reuse, material efficiency, design for disassembly

Thermal Management and Cooling in Hardware Systems; Edge and Embedded Systems for Sustainability: Fan control, liquid cooling, waste heat recovery, thermodynamics of chips; Low-power edge devices, smart sensors, IoT gateways, hardware offloading for cloud-edge balance

Reference Books

- 1 Green IT: Technologies and Applications, Bhuvan Unhelkar, 2011, CRC Press.
- 2 Energy-Efficient Computing and Data Centers, Robert Geer, 2020, Springer.
- 3 Sustainable Computing, San Murugesan, 2012, Wiley.

25GSD3505 - SMART INFRASTRUCTURE FOR GREEN DATA CENTERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25GSD3505	SMART INFRASTRUCTURE FOR GREEN DATA CENTERS	SIGD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamentals of green data centers, energy consumption trends, and sustainability principles in ICT systems.	2	
CO2	Apply techniques for designing energy-efficient infrastructure including HVAC optimization, virtualization, and renewable energy integration.	3	
CO3	Analyze and implement smart monitoring and automation using IoT sensors, DCIM tools, and predictive maintenance for sustainable operations.	4	
CO4	Evaluate intelligent resource management strategies using AI/ML for forecasting, workload balancing, and container-based efficiency.	4	

Syllabus

Introduction to Green Data Centers: Energy consumption trends, sustainability in computing, components of green data centers, power usage effectiveness (PUE), case studies

Energy-Efficient Infrastructure Design: HVAC optimization, server virtualization, hot/cold aisle containment, renewable energy integration

Smart Monitoring and Automation: IoT sensors for temperature/humidity, DCIM tools, energy-aware scheduling, predictive maintenance

Intelligent Resource Management: Dynamic workload balancing, AI/ML for energy forecasting, virtualization & containerization for efficiency

Reference Books

- 1 Green Data Centers Monthly, BICSI, 2020, BICSI Press.
- 2 Green IT: Reducing the Carbon Footprint of IT, Toby Velte, 2008, McGraw-Hill.
- 3 Sustainable Data Centers, Henrik Wilkening, 2020, Springer.

25HCA3101 - MULTI-MODAL INFORMATION PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3101	MULTI-MODAL INFORMATION PROCESSING	MMIP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Extract and normalize representations from text, image, and audio (tokenization, spectrograms, visual features) and align timestamps/units across streams.	3	
CO2	Analyze and implement core fusion mechanisms (early/late fusion, attention-based, cross-modal contrastive learning) and justify choice for a task.	4	
CO3	Build end-to-end multimodal pipelines for tasks such as image captioning, VQA, AV speech, or multimodal sentiment using modern transformer backbones.	4	
CO4	Evaluate multimodal systems with modality-appropriate metrics (BLEU/CIDEr/SPICE, Recall@K, WER, F1, mAP), perform error analysis, and diagnose failure modes.	5	

Syllabus

Modalities and data characteristics include text, image, and audio. Preprocessing steps vary: text requires tokenization using methods like Byte-Pair Encoding (BPE) or WordPiece; images are preprocessed through resizing and augmentations; audio involves framing and conversion to mel-spectrograms. Feature extraction methods include CNN-based models like ResNet and EfficientNet for images, TorchAudio or Librosa for audio, and basic phonetic or prosodic cues. Time and unit alignment techniques include frame-to-token synchronization and forced alignment. Common dataset formats include COCO and Flickr8k for image-text pairs, VQA v2 for image-question-answer tasks, and CMU-MOSI and MOSEI for multimodal video-text-audio analysis. Reproducible data loaders can be implemented using the Hugging Face Datasets library. Ethical considerations involve ensuring informed consent when collecting or using audio and video.

Early vs late vs hybrid fusion attention pooling and cross attention contrastive learning InfoNCE and CLIP style image text alignment projection heads temperature scaling audio visual correspondence AVC and synchronization shared embedding spaces similarity losses modality dropout and missing modality handling practical recipes freezing backbones adapters LoRA for efficient fine tuning small scale image text retrieval and audio visual event tagging

image captioning encoder decoder with scheduling and teacher forcing, metrics bleu cider spice. visual question answering vqa fusion of visual tokens and question tokens, answer classification vs generative decoding. multimodal sentiment emotion cmu mosi mosei, prosody transcript facial frames. audio visual speech basics lip features audio. speech image text retrieval. prompt conditioning for vision language models. lightweight serving with fastapi.

metrics per task bleu cider spice meteor, recall k, map, wer cer for speech, f1 roc auc for classification. calibration error analysis confusion, attentional heatmaps, grad cam on visual tokens. robustness noise, occlusion, accent, domain shift. fairness bias probes across language, accent, gender. compression distillation quantization for edge. packaging models onnx torchscript, latency budgeting. privacy pii in audio video, face voice anonymization, governance model cards.

Reference Books

- 1 Multimodal Machine Learning: A Survey and Taxonomy, T. Baltrusaitis, C. Ahuja, L-P. Morency, 2019, Foundations & Trends in ML.
- 2 Natural Language Processing with Transformers, L. Tunstall, L. von Werra, T. Wolf, 2022, O'Reilly.
- 3 Computer Vision: Algorithms and Applications (2e), R. Szeliski, 2022, Springer.

25HCA3101A - MULTI-MODAL INFORMATION PROCESSING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3101A	MULTI-MODAL INFORMATION PROCESSING	MMIP	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Extract and normalize representations from text, image, and audio (tokenization, spectrograms, visual features) and align timestamps/units across streams.	3	
CO2	Analyze and implement core fusion mechanisms (early/late fusion, attention-based, cross-modal contrastive learning) and justify choice for a task.	4	
CO3	Build end-to-end multimodal pipelines for tasks such as image captioning, VQA, AV speech, or multimodal sentiment using modern transformer backbones.	4	
CO4	Evaluate multimodal systems with modality-appropriate metrics (BLEU/CIDEr/SPICE, Recall@K, WER, F1, mAP), perform error analysis, and diagnose failure modes.	5	
CO5	Assess robustness, bias/fairness, privacy, and deployment constraints (latency, compression, on-device) and defend design trade-offs for a production context.	5	

Syllabus

Modalities & data characteristics text vs image vs audio preprocessing tokenization BPE WordPiece, image resizing augmentations, audio framing & mel spectrograms; feature extraction CNN features ResNet EfficientNet, TorchAudio Librosa features, basic phonetic prosodic cues; time & unit alignment frame token sync, forced alignment basics; dataset formats COCO Flickr8k image text, VQA v2 image question answer, CMU MOSI MOSEI video text audio; reproducible data loaders with Hugging Face Datasets; ethics primer on consent for audio video.

Early vs late vs hybrid fusion; attention pooling & cross attention; contrastive learning InfoNCE and CLIP style image text alignment projection heads, temperature scaling; audio visual correspondence AVC and synchronization; shared embedding spaces, similarity losses; modality dropout & missing modality handling.

Practical recipes freezing backbones, adapters LoRA for efficient fine tuning; small scale image text retrieval and audio visual event tagging; prompt conditioning for vision language models; lightweight serving with FastAPI.

Image captioning encoder decoder with scheduling & teacher forcing; metrics BLEU CIDEr SPICE; Visual Question Answering VQA fusion of visual tokens + question tokens; answer classification vs generative decoding; Multimodal sentiment emotion CMU MOSI MOSEI; prosody + transcript + facial frames; Audio Visual Speech basics lip features + audio; Speech image text retrieval.

Metrics per task BLEU CIDEr SPICE, METEOR; Recall@K, mAP; WER CER for speech; F1 ROC AUC for classification; calibration & error analysis confusion, attentional heatmaps, Grad CAM on visual tokens; robustness noise, occlusion, accent, domain shift; fairness bias probes across language accent gender; compression distillation quantization for edge; packaging models ONNX torchscript, latency budgeting; privacy PII in audio video, face voice anonymization, governance & model cards.

Reference Books

- 1 Multimodal Machine Learning: A Survey and Taxonomy, T. Baltrusaitis, C. Ahuja, L-P. Morency, 2019, Foundations & Trends in ML.
- 2 Natural Language Processing with Transformers, L. Tunstall, L. von Werra, T. Wolf, 2022, O'Reilly.
- 3 Deep Learning, I. Goodfellow, Y. Bengio, A. Courville, 2016, MIT Press.

25HCA3101E - MULTI-MODAL INFORMATION PROCESSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3101E	MULTI-MODAL INFORMATION PROCESSING	MMIP	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Extract and normalize representations from text, image, and audio (tokenization, spectrograms, visual features) and align timestamps/units across streams.	3	
CO2	Analyze and implement core fusion mechanisms (early/late fusion, attention-based, cross-modal contrastive learning) and justify choice for a task.	4	
CO3	Build end-to-end multimodal pipelines for tasks such as image captioning, VQA, AV speech, or multimodal sentiment using modern transformer backbones.	4	
CO4	Evaluate multimodal systems with modality-appropriate metrics (BLEU/CIDEr/SPICE, Recall@K, WER, F1, mAP), perform error analysis, and diagnose failure modes.	5	
CO5	Assess robustness, bias/fairness, privacy, and deployment constraints (latency, compression, on-device) and defend design trade-offs for a production context.	5	

Syllabus

Modalities & data characteristics text vs image vs audio preprocessing tokenization BPE WordPiece, image resizing augmentations, audio framing & mel spectrograms; feature extraction CNN features ResNet EfficientNet, TorchAudio Librosa features, basic phonetic prosodic cues; time & unit alignment frame token sync, forced alignment basics; dataset formats COCO Flickr8k image text, VQA v2 image question answer, CMU MOSI MOSEI video text audio; reproducible data loaders with Hugging Face Datasets; ethics primer on consent for audio video.

Early vs late vs hybrid fusion; attention pooling & cross attention; contrastive learning InfoNCE and CLIP style image text alignment projection heads, temperature scaling; audio visual correspondence AVC and synchronization; shared embedding spaces, similarity losses; modality dropout & missing modality handling.

Practical recipes freezing backbones, adapters LoRA for efficient fine tuning; small scale image text retrieval and audio visual event tagging; prompt conditioning for vision language models; lightweight serving with FastAPI.

Image captioning encoder decoder with scheduling & teacher forcing; metrics BLEU CIDEr SPICE; Visual Question Answering VQA fusion of visual tokens + question tokens; answer classification vs generative decoding; Multimodal sentiment emotion CMU MOSI MOSEI; prosody + transcript + facial frames; Audio Visual Speech basics lip features + audio; Speech image text retrieval.

Metrics per task BLEU CIDEr SPICE, METEOR; Recall@K, mAP; WER CER for speech; F1 ROC AUC for classification; calibration & error analysis confusion, attentional heatmaps, Grad CAM on visual tokens; robustness noise, occlusion, accent, domain shift; fairness bias probes across language accent gender; compression distillation quantization for edge; packaging models ONNX torchscript, latency budgeting; privacy PII in audio video, face voice anonymization, governance & model cards.

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- 1 Multimodal Machine Learning: A Survey and Taxonomy, T. Baltrusaitis, C. Ahuja, L-P. Morency, 2019, Foundations & Trends in ML.
- 2 Natural Language Processing with Transformers, L. Tunstall, L. von Werra, T. Wolf, O Reilly, 2022.
- 3 Deep Learning, I. Goodfellow, Y. Bengio, A. Courville, 2016, MIT Press.

25HCA3202 - NATURAL LANGUAGE PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3202	NATURAL LANGUAGE PROCESSING	NLP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Preprocess and normalize text corpora, including tokenization, stemming/lemmatization, POS tagging, and syntactic parsing.	3	
CO2	Analyze and implement statistical, neural, and transformer-based language models for tasks like classification, tagging, and translation.	4	
CO3	Design and fine-tune transformer architectures (BERT, RoBERTa, GPT-style) for downstream NLP tasks.	4	
CO4	Evaluate NLP systems using appropriate metrics (accuracy, BLEU, ROUGE, F1) and perform interpretability/error analysis.	5	

Syllabus

Text encoding ASCII Unicode UTF-8 tokenization word subword BPE WordPiece stemming lemmatization POS tagging chunking syntactic parsing NER stopword removal sentence segmentation feature extraction Bag-of-Words TF-IDF embeddings Word2Vec GloVe fastText dataset curation from Hugging Face ethical handling of text data.

N-gram language models, smoothing techniques; Naïve Bayes and logistic regression for text classification; HMMs & CRFs for POS tagging and NER; sequence labeling and alignment, machine translation with phrase-based SMT, intro to attention in seq2seq, sentiment analysis with classical ML, pipeline building with scikit-learn.

RNNs GRUs LSTMs encoder decoder architectures seq2seq for translation attention mechanisms Bahdanau Luong transformer architecture deep dive multihead attention positional encoding feedforward layers pretrained language models BERT RoBERTa

Metrics accuracy precision recall F1 BLEU ROUGE METEOR perplexity interpretability tools LIME SHAP attention visualization bias detection and mitigation adversarial testing TextAttack model compression distillation serving NLP models via FastAPI latency and scalability in inference responsible deployment and compliance GDPR CCPA

Reference Books

- 1 Speech and Language Processing (3rd ed. draft), Jurafsky & Martin, 2023, Prentice Hall (online draft).
- 2 Natural Language Processing with PyTorch, Delip Rao & Brian McMahan, 2019, O Reilly.
- 3 Deep Learning for Natural Language Processing, Palash Goyal, Sumit Pandey, Karan Jain, 2018, Apress.

25HCA3203 - COMPUTER VISION & OBJECT DETECTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3203	COMPUTER VISION & OBJECT DETECTION	CVOD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply image-processing foundations and build robust data/annotation pipelines; compute IoU/NMS and handle dataset schemas (VOC/COCO/YOLO).	3	
CO2	Analyze modern detection architectures (Faster R-CNN, RetinaNet, YOLO family, anchor-free) and implement effective training strategies (losses, anchors, aug).	4	
CO3	Build end-to-end systems for detection and extensions (instance/semantic segmentation, keypoints, tracking-by-detection) tailored to a domain.	4	
CO4	Evaluate detectors with COCO metrics (mAP@[.5:.95]), PR curves, and perform structured error analysis (localization/class confusion/small object).	5	

Syllabus

Image formation basics color spaces RGB HSV YCbCr resizing cropping normalization classic CV edges HOG SIFT ORB to motivate learned features CNN refresher conv BN pooling residuals annotation schemas VOC COCO YOLO bbox formats xyxy vs cxcywh IoU NMS dataset curation splits augmentation flip color jitter Cutout MixUp Mosaic pros cons class imbalance sampling reproducible loaders with Torchvision HF Datasets ethics privacy in image data

Twostage vs onestage RCNN Fast Faster RCNN FPN multiscale features anchors priors vs anchorfree FCOS YOLOv8 losses crossentropy focal GloU DloU CloU assignment ATSS SimOTA training recipes LR schedulers warmup EMA gradient accumulation detectionspecific augs Mosaic MixUp smallobject strategies tiling higher input res focal loss tuning domainspecific heads rotated bboxes

Semantic vs instance segmentation UNet Mask RCNN DeepLabv3 keypoint pose Keypoint RCNN HRNet essentials panoptic overview trackingbydetection IoU Kalman SORT ByteTrack notions handling video streams active learning to cut labeling cost synthetic data basics verticals retail shelf analytics traffic crowd manufacturing defects medical masks lesions privacy considerations

Metrics AP mAP on COCO AP50 AP75 APs Ap MPL PR curves per class AP error taxonomy localization background false positives duplicates class confusion explainability GradCAM for classifiers heatmaps attention visualizations for detectors export TorchScript ONNX runtime ONNX Runtime note TensorRT OpenVINO options quantization PTQ QAT pruning distillation batching throughput vs latency edge deployment notes drift

Reference Books

- 1 Computer Vision: Algorithms and Applications (2e), Richard Szeliski, 2022, Springer.
- 2 Deep Learning, Goodfellow, Bengio, Courville, 2016, MIT Press.
- 3 Deep Learning for Vision Systems, Mohamed Elgendy, 2020, Manning.

25HCA3204 - COMPUTATIONAL PARALINGUISTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3204	COMPUTATIONAL PARALINGUISTICS	CPL	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply paralinguistic theory to identify and extract prosodic, spectral, and voice-quality cues from speech.	3	
CO2	Analyze annotated corpora and build classical baselines for emotion, speaker states, and social signals using robust evaluation protocols.	4	
CO3	Implement deep paralinguistic models (SSL embeddings, CNN/RNN/attention) with noise/channel robustness and domain adaptation.	4	
CO4	Evaluate fairness, privacy, and deployment constraints; design on-device/streaming inference with explainability and governance.	5	

Syllabus

Speech production, perception, and suprasegmentals. Taxonomy of paralinguistic cues: emotion, affect, arousal, valence, personality indicators, speaking style, confidence, deception cues, sleepiness, laughters, filled pauses, turn-taking. Acoustic correlates: F0, energy, tempo, formants, spectral tilt, jitter, shimmer, HNR. Annotation quality and inter-rater reliability. Corpora overview: IEMOCAP, MSP-IMPROV, Emo-DB, ComParE tasks. Evaluation metrics: UAR, F1, CCC, EER, and cross-corpus validation.

Pre-processing: VAD, segmentation, channel normalization. Feature sets: openSMILE, ComParE LLDs, prosodic functionals, MFCCs, formants. Feature selection and scaling. Baseline learners: SVM, LR, RF, XGBoost. Calibration, confidence scoring. Experiment design: k-fold, subject-independent, cross-corpus. Error analysis and ablations. Reproducible pipelines.

SSL acoustic embeddings: wav2vec 2.0, HuBERT, WavLM, Whisper encoders. Fine-tuning vs frozen-backbone with light heads. CNN, CRNN, Transformer encoders, attention pooling. Multi-task learning: emotion and speaker states. Robustness: augmentation with MUSAN noise, RIRs, SpecAugment, mixup. Domain adaptation: CORAL, adversarial feature alignment. Diarization and context with pyannote. Low-resource and cross-lingual transfer.

Streaming and on-device inference: frame-level windows, overlap-add. Latency and cost trade-offs. Quantization and distillation: 8-bit, int16, ONNX, TFLite runtimes. Privacy-preserving training: federated learning simulation, differential privacy concepts. Fairness and bias auditing: accent, age, gender groups. Mitigation: reweighting, adversarial debiasing. Explainability: per-feature SHAP, saliency on spectrograms. Consent, data retention, governance. Red-team testing and safety model cards.

Reference Books

- 1 Computational Paralinguistics: Emotion, Affect and Personality in Speech and Language Processing, Bjorn Schuller, Anton Batliner, 2013, Wiley.
- 2 Speech and Language Processing (3e draft), Daniel Jurafsky, James H. Martin, 2023, Pearson (draft online).
- 3 Fundamentals of Speaker Recognition, Homayoon Beigi, 2011, Springer.

25HCA3305 - LARGE LANGUAGE MODELS & CONVERSATIONAL AI (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3305	LARGE LANGUAGE MODELS & CONVERSATIONAL AI	LLMC	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply transformer-based architectures and tokenization strategies for building large language model (LLM) pipelines.	3	
CO2	Analyze and fine-tune pre-trained LLMs for domain-specific tasks such as Q&A, summarization, and dialogue.	4	
CO3	Design conversational AI systems with dialog state tracking, context handling, and retrieval-augmented generation (RAG).	4	
CO4	Evaluate LLM outputs for correctness, bias, and hallucinations using qualitative and quantitative metrics.	5	

Syllabus

Sequence modeling recap: RNN, LSTM, Transformer evolution. Attention mechanisms. Positional encoding. Subword tokenization: BPE, SentencePiece, WordPiece. Embeddings and context windows. Hugging Face Transformers ecosystem. Prompt basics. Role of pre-training vs fine-tuning. Introduction to open-source LLMs: LLaMA, Mistral, Falcon.

Full fine-tuning vs parameter-efficient tuning: LoRA, QLoRA, adapters. Supervised fine-tuning vs RLHF, Reinforcement Learning with Human Feedback. Domain adaptation workflows. Instruction tuning. Dataset preparation and cleaning for LLMs. Case study: fine-tuning for legal and medical domain question answering. Latency and throughput implications of fine-tuning.

Retrieval-Augmented Generation RAG pipeline: embedding models such as SBERT and OpenAI, vector stores like FAISS and Pinecone, retrievers. Dialog state tracking. Context window management. Multi-turn conversation handling. Grounding with external APIs and tools. Hallucination mitigation techniques. Designing safe and helpful AI personas.

Metrics: BLEU, ROUGE, METEOR, BERTScore, human evaluation rubrics. Bias detection tools: AIF360, Fairlearn. Hallucination detection. Model compression: quantization, distillation. Serving LLMs via FastAPI and Gradio. Scaling with Hugging Face Inference API, vLLM, or LangServe. Compliance frameworks: GDPR, HIPAA where applicable. Ethical considerations in deployment.

Reference Books

- 1 Natural Language Processing with Transformers, Tunstall, von Werra, Wolf, 2022, O Reilly.
- 2 Transformers for Natural Language Processing (2e), Denis Rothman, 2022, Packt.
- 3 Speech and Language Processing (3e draft), Jurafsky, Martin, 2023, Prentice Hall.

25HCA3305A - LARGE LANGUAGE MODELS & CONVERSATIONAL AI (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3305A	LARGE LANGUAGE MODELS & CONVERSATIONAL AI	LLMC	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply transformer-based architectures and tokenization strategies for building large language model (LLM) pipelines.	3	
CO2	Analyze and fine-tune pre-trained LLMs for domain-specific tasks such as Q&A, summarization, and dialogue.	4	
CO3	Design conversational AI systems with dialog state tracking, context handling, and retrieval-augmented generation (RAG).	4	
CO4	Evaluate LLM outputs for correctness, bias, and hallucinations using qualitative and quantitative metrics.	5	
CO5	Optimize and deploy LLM-based applications in production environments with latency, cost, and compliance considerations.	5	

Syllabus

Sequence modeling recap: RNN, LSTM, Transformer evolution. Attention mechanisms. Positional encoding. Subword tokenization: BPE, SentencePiece, WordPiece.

Embeddings and context windows. Hugging Face Transformers ecosystem. Prompt basics. Role of pre-training vs fine-tuning. Introduction to open-source LLMs: LLaMA, Mistral, Falcon.

Full fine-tuning vs parameter-efficient tuning: LoRA, QLoRA, adapters. Supervised fine-tuning vs RLHF, Reinforcement Learning with Human Feedback. Domain adaptation workflows. Instruction tuning.

Dataset preparation and cleaning for LLMs. Case study: fine-tuning for legal and medical domain question answering. Latency and throughput implications of fine-tuning. Retrieval-Augmented Generation (RAG) pipeline: embedding models such as SBERT and OpenAI, vector stores like FAISS and Pinecone, retrievers.

Dialog state tracking. Context window management. Multi-turn conversation handling. Grounding with external APIs and tools. Hallucination mitigation. Metrics: BLEU, ROUGE, METEOR, BERTScore, human evaluation rubrics. Bias detection tools: AIF360, Fairlearn. Hallucination detection. Model compression: quantization, distillation. Serving LLMs via FastAPI and Gradio. Scaling with Hugging Face Inference API, vLLM, or LangServe. Compliance frameworks: GDPR, HIPAA. Ethical considerations in deployment.

Reference Books

- 1 Natural Language Processing with Transformers, Tunstall, von Werra, Wolf, 2022, O Reilly.
- 2 Transformers for Natural Language Processing (2e), Denis Rothman, 2022, Packt.
- 3 Speech and Language Processing (3e draft), Jurafsky, Martin, 2023, Prentice Hall.

25HCA3305E - LARGE LANGUAGE MODELS & CONVERSATIONAL AI (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3305E	LARGE LANGUAGE MODELS & CONVERSATIONAL AI	LLMC	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply transformer-based architectures and tokenization strategies for building large language model (LLM) pipelines.	3	
CO2	Analyze and fine-tune pre-trained LLMs for domain-specific tasks such as Q&A, summarization, and dialogue.	4	
CO3	Design conversational AI systems with dialog state tracking, context handling, and retrieval-augmented generation (RAG).	4	
CO4	Evaluate LLM outputs for correctness, bias, and hallucinations using qualitative and quantitative metrics.	5	
CO5	Optimize and deploy LLM-based applications in production environments with latency, cost, and compliance considerations.	5	

Syllabus

Sequence modeling recap: RNN, LSTM, Transformer evolution. Attention mechanisms. Positional encoding. Subword tokenization: BPE, SentencePiece, WordPiece.

Embeddings and context windows. Hugging Face Transformers ecosystem. Prompt basics. Role of pre-training vs fine-tuning. Introduction to open-source LLMs: LLaMA, Mistral, Falcon.

Full fine-tuning vs parameter-efficient tuning: LoRA, QLoRA, adapters. Supervised fine-tuning vs RLHF, Reinforcement Learning with Human Feedback. Domain adaptation workflows. Instruction tuning.

Dataset preparation and cleaning for LLMs. Case study: fine-tuning for legal and medical domain question answering. Latency and throughput implications of fine-tuning. Retrieval-Augmented Generation (RAG) pipeline: embedding models such as SBERT and OpenAI, vector stores like FAISS and Pinecone, retrievers.

Dialog state tracking. Context window management. Multi-turn conversation handling. Grounding with external APIs and tools. Hallucination mitigation. Metrics: BLEU, ROUGE, METEOR, BERTScore, human evaluation rubrics. Bias detection tools: AIF360, Fairlearn. Hallucination detection. Model compression: quantization, distillation. Serving LLMs via FastAPI and Gradio. Scaling with Hugging Face Inference API, vLLM, or LangServe. Compliance frameworks: GDPR, HIPAA. Ethical considerations in deployment.

Reference Books

- 1 Natural Language Processing with Transformers, Tunstall, von Werra, Wolf, 2022, O Reilly.
- 2 Transformers for Natural Language Processing (2e), Denis Rothman, 2022, Packt.
- 3 Speech and Language Processing (3e draft), Jurafsky, Martin, 2023, Prentice Hall.

25HCA3306 - IMAGE PROCESSING & SCENE UNDERSTANDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3306	IMAGE PROCESSING & SCENE UNDERSTANDING	IPSU	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamental image processing techniques for feature extraction, enhancement, and segmentation.	3	
CO2	Analyze spatial, frequency, and color representations to interpret and preprocess visual data.	4	
CO3	Implement classical and deep learning-based scene understanding methods for object detection, segmentation, and tracking.	4	
CO4	Evaluate scene understanding models for accuracy, robustness, and real-world applicability.	5	

Syllabus

Digital image representation, sampling, quantization. Intensity transformations. Histogram processing. Spatial filtering. Smoothing and sharpening. Noise removal. Edge detection: Sobel, Canny, Laplacian. Morphological operations. Introduction to OpenCV for basic image processing.

Color models: RGB, HSV, Lab, YCbCr. Color transformations. Geometric transformations. Frequency domain processing: FFT, DCT, Wavelets. Feature descriptors: SIFT, SURF, ORB. Harris corner detection. Texture analysis. Use of image pyramids for multi-scale representation.

Semantic segmentation: FCN, U-Net, DeepLab. Instance segmentation: Mask R-CNN, SOLO. Object detection: Faster R-CNN, SSD, YOLO. Scene classification. Optical flow estimation. Object tracking: KCF, Deep SORT. 3D scene understanding basics.

Metrics: IoU, mAP, pixel accuracy, F1-score. Model compression for real-time processing. Deployment on edge devices: Jetson Nano, Coral TPU. Integration with robotics and AR/VR pipelines. Real-time video analytics. Case studies in autonomous driving and surveillance.

Reference Books

- 1 Digital Image Processing (4e), Rafael C. Gonzalez, Richard E. Woods, 2018, Pearson.
- 2 Computer Vision: Algorithms and Applications, Richard Szeliski, 2022, Springer.
- 3 Programming Computer Vision with Python, Jan Erik Solem, O Reilly, 2012.

25HCA3306A - IMAGE PROCESSING & SCENE UNDERSTANDING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3306A	IMAGE PROCESSING & SCENE UNDERSTANDING	IPSU	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamental image processing techniques for feature extraction, enhancement, and segmentation.	3	
CO2	Analyze spatial, frequency, and color representations to interpret and preprocess visual data.	4	
CO3	Implement classical and deep learning-based scene understanding methods for object detection, segmentation, and tracking.	4	
CO4	Evaluate scene understanding models for accuracy, robustness, and real-world applicability.	5	
CO5	Integrate scene understanding pipelines into AI-driven applications for vision, robotics, and autonomous systems.	5	

Syllabus

Digital image representation, sampling, quantization. Intensity transformations. Histogram processing. Spatial filtering. Smoothing and sharpening. Noise removal. Edge detection: Sobel, Canny, Laplacian.

Morphological operations. Introduction to OpenCV for basic image processing.

Color models: RGB, HSV, Lab, YCbCr. Color transformations. Geometric transformations. Frequency domain processing: FFT, DCT, Wavelets. Feature descriptors: SIFT, SURF, ORB. Harris corner detection. Texture analysis. Use of image pyramids for multi-scale representation.

Semantic segmentation: FCN, U-Net, DeepLab. Instance segmentation: Mask R-CNN, SOLO. Object detection: Faster R-CNN, SSD, YOLO. Scene classification. Optical flow estimation. Object tracking: KCF, Deep SORT. 3D scene understanding basics.

Metrics: IoU, mAP, pixel accuracy, F1-score. Model compression for real-time processing. Deployment on edge devices: Jetson Nano, Coral TPU. Integration with robotics and AR/VR pipelines. Real-time video analytics. Case studies in autonomous driving and surveillance.

Reference Books

- 1 Digital Image Processing (4e), Rafael C. Gonzalez, Richard E. Woods, 2018, Pearson.
- 2 Computer Vision: Algorithms and Applications, Richard Szeliski, 2022, Springer.
- 3 Programming Computer Vision with Python, Jan Erik Solem, O Reilly, 2012.

25HCA3306E - IMAGE PROCESSING & SCENE UNDERSTANDING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3306E	IMAGE PROCESSING & SCENE UNDERSTANDING	IPSU	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamental image processing techniques for feature extraction, enhancement, and segmentation.	3	
CO2	Analyze spatial, frequency, and color representations to interpret and preprocess visual data.	4	
CO3	Implement classical and deep learning-based scene understanding methods for object detection, segmentation, and tracking.	4	
CO4	Evaluate scene understanding models for accuracy, robustness, and real-world applicability.	5	
CO5	Integrate scene understanding pipelines into AI-driven applications for vision, robotics, and autonomous systems.	5	

Syllabus

Digital image representation, sampling, quantization. Intensity transformations. Histogram processing. Spatial filtering. Smoothing and sharpening. Noise removal. Edge detection: Sobel, Canny, Laplacian.

Morphological operations. Introduction to OpenCV for basic image processing.

Color models: RGB, HSV, Lab, YCbCr. Color transformations. Geometric transformations. Frequency domain processing: FFT, DCT, Wavelets. Feature descriptors: SIFT, SURF, ORB. Harris corner detection. Texture analysis. Use of image pyramids for multi-scale representation.

Semantic segmentation: FCN, U-Net, DeepLab. Instance segmentation: Mask R-CNN, SOLO. Object detection: Faster R-CNN, SSD, YOLO. Scene classification. Optical flow estimation. Object tracking: KCF, Deep SORT. 3D scene understanding basics.

Metrics: IoU, mAP, pixel accuracy, F1-score. Model compression for real-time processing. Deployment on edge devices: Jetson Nano, Coral TPU. Integration with robotics and AR/VR pipelines. Real-time video analytics. Case studies in autonomous driving and surveillance.

Reference Books

- 1 Digital Image Processing (4e), Rafael C. Gonzalez, Richard E. Woods, 2018, Pearson.
- 2 Computer Vision: Algorithms and Applications, Richard Szeliski, 2022, Springer.
- 3 Deep Learning for Computer Vision, Rajalingappaa Shanmugamani, 2018, Packt.

25HCA3307 - SPEECH PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3307	SPEECH PROCESSING	SP	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply speech-signal fundamentals (time/frequency analysis, prosody) to segment and characterize speech under real-world conditions.	3	
CO2	Analyze feature pipelines (VAD, MFCC/FBank/PLP, CMVN) and classical baselines for ASR/KWS/diarization with sound evaluation protocols.	4	
CO3	Implement modern neural speech models (CTC/Transducer/Transformer) and decoding with language models; quantify robustness to noise/channel shift.	4	
CO4	Evaluate and deploy streaming/edge speech systems with adaptation, efficiency (quantization), and responsible-AI checks (fairness/privacy/model cards).	5	

Syllabus

Speech production and articulation. Sampling, framing, windowing. Pre-emphasis. STFT, spectrograms, mel scale. Pitch (F0), energy, formants. Voicing and prosody. SNR, reverberation, and room acoustics (RIRs). Endpoints and segmentation basics. Metrics for segmentation: precision, recall, real-time factor (RTF)

VAD and endpointing: energy-based, WebRTC VAD. MFCC, FBank, PLP, and deltas. CMVN, per-speaker and per-utterance normalization. Robust feature design for telephony vs far-field. Shallow models: logistic regression, SVM, random forest, XGBoost for keyword spotting and emotion tags. Diarization concepts: segmentation and clustering, diarization error rate (DER). Experimental design: speaker-independent splits, cross-corpus tests. Error analysis and ablations.

CTC, seq2seq attention, RNN-Transducer. Encoder choices: CNN, CRNN, Conformer. SSL embeddings: wav2vec 2.0, HuBERT, WavLM, Whisper encoder vs end-to-end fine-tuning. Decoding: greedy, beam search, CTC with pyctcdecode and KenLM. Language models: n-gram vs neural shallow fusion. Robustness via augmentation: MUSAN noise, RIRs, SpecAugment. Metrics: word error rate (WER), character error rate (CER), latency, real-time factor (RTF).

Chunked and streaming inference with VAD gating. On-device and edge constraints. Quantization (int8) with ONNX Runtime. Domain adaptation: noise, accent, lexicon biasing. Multilingual and code-mixed considerations. Monitoring and drift signals. Privacy: personally identifiable information (PII), opt-in audio. Fairness audits: accent, gender, age labels where available. Documentation with model cards. Security and misuse considerations.

Reference Books

- 1 Speech and Language Processing (3e draft), Daniel Jurafsky, James H. Martin, 2023, Pearson (draft online).
- 2 Fundamentals of Speech Recognition, Lawrence Rabiner, Biing-Hwang Juang, 1993, Prentice Hall.
- 3 Speech and Audio Signal Processing (2e), Ben Gold, Nelson Morgan, Dan Ellis, 2011, Wiley.

25HCA3307A - SPEECH PROCESSING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3307A	SPEECH PROCESSING	SP	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply speech-signal fundamentals (time/frequency analysis, prosody) to segment speech under real-world conditions.	3	
CO2	Characterize speech segments using speech-signal fundamentals in noisy and reverberant environments.	4	
CO3	Analyze feature pipelines (VAD, MFCC/FBank/PLP, CMVN) and classical baselines for ASR/KWS/diarization with sound evaluation protocols.	4	
CO4	Implement modern neural speech models (CTC/Transducer/Transformer) and decoding with language models; quantify robustness to noise/channel shift.	5	
CO5	Evaluate and deploy streaming/edge speech systems with adaptation, efficiency (quantization), and responsible-AI checks (fairness/privacy/model cards).	5	

Syllabus

Speech production and articulation. Sampling, framing, windowing. Pre-emphasis. STFT, spectrograms, mel scale. Pitch (F0), energy, formants. Voicing and prosody. SNR, reverberation, and room acoustics (RIRs).

Endpoints and segmentation basics. Metrics for segmentation: precision, recall, real-time factor (RTF).

VAD and endpointing: energy-based, WebRTC VAD. MFCC, FBank, PLP, and deltas. CMVN, per-speaker and per-utterance normalization. Robust feature design for telephony vs far-field. Shallow models: logistic regression, SVM, random forest, XGBoost for keyword spotting and emotion tags. Diarization concepts: segmentation and clustering, diarization error rate (DER).

Experimental design: speaker-independent splits, cross-corpus tests. Error analysis and ablations. CTC, seq2seq attention, RNN-Transducer. Encoder choices: CNN, CRNN, Conformer. SSL embeddings: wav2vec 2.0, HuBERT, WavLM, Whisper encoder vs end-to-end fine-tuning. Decoding: greedy, beam search, CTC with pyctcdecode and KenLM. Language models: n-gram vs neural shallow fusion.

Robustness via augmentation: MUSAN noise, RIRs, SpecAugment. Metrics: word error rate (WER), character error rate (CER), latency, real-time factor (RTF). Chunked and streaming inference with VAD gating. On-device and edge constraints. Quantization (int8) with ONNX Runtime. Domain adaptation: noise, accent, lexicon biasing. Multilingual and code-mixed considerations. Monitoring and drift signals. Privacy: personally identifiable information (PII), opt-in audio. Fairness audits: accent, gender, age labels where available. Documentation with model cards. Security and misuse considerations.

Reference Books

- 1 Speech and Language Processing (3e draft), Daniel Jurafsky, James H. Martin, 2023, Pearson (draft online).
- 2 Fundamentals of Speaker Recognition, Homayoon Beigi, 2011, Springer.
- 3 Automatic Speech Recognition: A Deep Learning Approach, Dong Yu, Li Deng, 2015, Springer.

25HCA3307E - SPEECH PROCESSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3307E	SPEECH PROCESSING	SP	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply speech-signal fundamentals (time/frequency analysis, prosody) to segment speech under real-world conditions.	3	
CO2	Characterize speech segments using speech-signal fundamentals in noisy and reverberant environments.	4	
CO3	Analyze feature pipelines (VAD, MFCC/FBank/PLP, CMVN) and classical baselines for ASR/KWS/diarization with sound evaluation protocols.	4	
CO4	Implement modern neural speech models (CTC/Transducer/Transformer) and decoding with language models; quantify robustness to noise/channel shift.	5	
CO5	Evaluate and deploy streaming/edge speech systems with adaptation, efficiency (quantization), and responsible-AI checks (fairness/privacy/model cards).	5	

Syllabus

Speech production and articulation. Sampling, framing, windowing. Pre-emphasis. STFT, spectrograms, mel scale. Pitch (F0), energy, formants. Voicing and prosody. SNR, reverberation, and room acoustics (RIRs).

Endpoints and segmentation basics. Metrics for segmentation: precision, recall, real-time factor (RTF).

VAD and endpointing: energy-based, WebRTC VAD. MFCC, FBank, PLP, and deltas. CMVN, per-speaker and per-utterance normalization. Robust feature design for telephony vs far-field. Shallow models: logistic regression, SVM, random forest, XGBoost for keyword spotting and emotion tags. Diarization concepts: segmentation and clustering, diarization error rate (DER).

Experimental design: speaker-independent splits, cross-corpus tests. Error analysis and ablations. CTC, seq2seq attention, RNN-Transducer. Encoder choices: CNN, CRNN, Conformer. SSL embeddings: wav2vec 2.0, HuBERT, WavLM, Whisper encoder vs end-to-end fine-tuning. Decoding: greedy, beam search, CTC with pyctcdecode and KenLM. Language models: n-gram vs neural shallow fusion.

Robustness via augmentation: MUSAN noise, RIRs, SpecAugment. Metrics: word error rate (WER), character error rate (CER), latency, real-time factor (RTF). Chunked and streaming inference with VAD gating. On-device and edge constraints. Quantization (int8) with ONNX Runtime. Domain adaptation: noise, accent, lexicon biasing. Multilingual and code-mixed considerations. Monitoring and drift signals. Privacy: personally identifiable information (PII), opt-in audio. Fairness audits: accent, gender, age labels where available. Documentation with model cards. Security and misuse considerations.

Reference Books

- 1 Speech and Language Processing (3e draft), Daniel Jurafsky, James H. Martin, 2023, Pearson (draft online).
- 2 Fundamentals of Speaker Recognition, Homayoon Beigi, 2011, Springer.
- 3 Automatic Speech Recognition: A Deep Learning Approach, Dong Yu, Li Deng, 2015, Springer.

25HCA3408 - VISION TRANSFORMERS & GENERATIVE MODELS FOR VISION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3408	VISION TRANSFORMERS & GENERATIVE MODELS FOR VISION	VTGM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Vision Transformer (ViT) architectures for various vision tasks, understanding their patch embedding, self-attention, and positional encoding mechanisms.	3	
CO2	Analyze performance trade-offs between CNNs and Transformer-based vision models across datasets and tasks.	4	
CO3	Implement generative models (GANs, diffusion models, autoregressive) for image synthesis, inpainting, and style transfer with evaluation metrics.	4	
CO4	Design and evaluate large-scale, multimodal, or hybrid vision architectures with considerations for deployment efficiency, fairness, and ethics.	5	

Syllabus

Evolution from CNNs to ViTs. Patch embeddings and tokenization. Positional encodings. Multi-head self-attention in vision. MLP heads. Training from scratch versus fine-tuning. Data requirements and augmentation strategies. DeiT (Data-efficient ViTs). Application domains: classification, detection, segmentation.

Swin Transformer (shifted windows). ConvNeXt hybrid designs. Pyramid Vision Transformer. Multi-scale attention. Masked autoencoders (MAE) for pretraining. Benchmarking ViT versus ResNet. Computational complexity and scaling laws. Interpretability of attention maps.

GAN architectures: DCGAN, StyleGAN, CycleGAN. Diffusion models: DDPM, DDIM, Latent Diffusion, Stable Diffusion. Autoregressive vision transformers: ImageGPT, Parti. Training stability and tricks. Conditioning and control: ControlNet, text-to-image. Evaluation metrics: FID, IS, CLIPScore.

Vision-language transformers: CLIP, BLIP, Flamingo. Integrating generative models into vision pipelines. Deployment challenges: latency, cost, model compression pruning, quantization, distillation. Fairness and bias detection in generative outputs. Copyright and misuse mitigation. Red-teaming for generative vision.

Reference Books

- 1 Deep Learning for Vision Systems, Mohamed Elgendy, 2020, Manning.
- 2 Transformers for Machine Learning, Uday Kamath, John Liu, James Whitaker, Apress, 2022.
- 3 Generative Deep Learning (2e), David Foster, O Reilly, 2022.

25HCA3509 - AI ETHICS, FAIRNESS & RESPONSIBLE DEPLOYMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3509	AI ETHICS, FAIRNESS & RESPONSIBLE DEPLOYMENT	AIFD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply ethical frameworks and global guidelines to evaluate AI systems for fairness, transparency, and accountability.	3	
CO2	Analyze bias, fairness, privacy, and security challenges in AI pipelines, and assess societal and environmental impacts.	4	
CO3	Design mitigation strategies for bias, explainability, data governance, and safety aligned with regulations.	4	
CO4	Evaluate AI models for responsible deployment, integrating governance, compliance, monitoring, and lifecycle management.	5	

Syllabus

Introduction to AI ethics principles, fairness, accountability, transparency, privacy, FATP. IEEE, OECD, UNESCO guidelines. Global regulations, EU AI Act, GDPR, India DPDP Act, US NIST AI RMF. Ethical frameworks for AI decision making. Responsible innovation models. Corporate AI governance structures.

Types of bias, dataset, label, algorithmic, representation. Fairness metrics, Demographic Parity, Equalized Odds, Disparate Impact. Bias in NLP, computer vision, speech, recommendation. Societal impacts, disinformation, surveillance, automation displacement. Environmental footprint of AI models. Bias case studies, COMPAS, facial recognition.

Debiasing data, resampling, reweighting, augmentation. Algorithmic interventions, fairness constraints, adversarial debiasing. Model interpretability, SHAP, LIME, Grad CAM, attention visualization. Uncertainty quantification. Privacy preserving machine learning, differential privacy, federated learning, secure MPC. Safety checks for generative AI, hallucination control, harmful output filtering.

Governance frameworks for deployment. Model cards, datasheets for datasets, AI FactSheets. Compliance pipelines. Continuous monitoring for bias and drift. Human in the loop review systems. Rollback strategies. Security in deployment, adversarial robustness, prompt injection mitigation, supply chain security. Sustainability, energy efficient inference, green AI practices.

Reference Books

- 1 Ethics of Artificial Intelligence and Robotics, Vincent C. Müller (Ed.), 2020, Springer Handbook.
- 2 Responsible AI: Implementing Ethical Principles, Virginia Dignum, 2019, Springer.
- 3 Fairness and Machine Learning, Solon Barocas, Moritz Hardt, Arvind Narayanan, 2023, MIT Press.

25HCA3510 - HUMAN-AI INTERACTION & USER-CENTERED DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HCA3510	HUMAN-AI INTERACTION & USER-CENTERED DESIGN	HAI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze the principles of human-centered AI design, including perception, cognition, and trust in AI.	3	
CO2	Apply user-centered design methodologies to AI-powered vision, language, and speech systems.	4	
CO3	Evaluate AI systems for usability, accessibility, fairness, and inclusivity.	5	
CO4	Design and prototype human-AI interaction workflows with iterative feedback and testing.	5	

Syllabus

This module covers human cognition and perception in AI system design. It explores human-in-the-loop AI models. The course discusses trust, explainability, and transparency in AI decisions. Case studies include GPT-powered assistants and vision-based safety systems.

Students learn about conversational interfaces such as chatbots and voice assistants. Visual interaction topics include AR and VR and computer vision in real-time user experiences. The module covers multisensory AI, combining vision, speech, and gestures. It also addresses cross-platform AI application experiences.

This module teaches usability heuristics for AI-powered systems. It explains accessibility standards like WCAG and ARIA for AI tools. The course emphasizes inclusive AI design for diverse populations. It also addresses bias and fairness in AI interfaces.

Students learn rapid prototyping techniques for AI-driven applications. The module covers usability testing methods, including A/B testing and heuristic evaluation. It discusses metrics for human-AI collaboration performance. Finally, it focuses on iterative refinement and deployment strategies.

Reference Books

- 1 Human-Centered AI, Ben Shneiderman, 2022, Oxford University Press.
- 2 Designing Agentive Technology: AI That Works for People, Christopher Noessel, 2020, Rosenfeld Media.
- 3 Human-Computer Interaction, Alan Dix, Janet Finlay et al., 2014, Pearson.

25HDA3101 - INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3101	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	ISDPDD	R	3	0	2	0	4

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, PO11, 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, PO11, 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, PO11, 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, PO11, PSO1
CO5	Analyze case studies where AI and data science have successfully accelerated drug discovery and development.	5	PO1, PO5, PO11, PSO1
CO6	Develop frameworks for analyzing the outcomes and impacts of AI-driven drug discovery projects.	6	PO1, PO5, PO11, 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) .

25HDA3101A - INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3101A	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	ISDPDD	A	4	1	2	0	6

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, PO11, 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, PO11, 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, PO11, 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, PO11, 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, PO11, PSO1
CO6	Analyze case studies where AI and data science have successfully accelerated drug discovery and development.	5	PO1, PO5, PO11, PSO1
CO7	Develop frameworks for analyzing the outcomes and impacts of AI-driven drug discovery projects.	6	PO1, PO5, PO11, 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 Trial

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.

25HDA3101E - INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3101E	INTELLIGENT SYSTEMS FOR DISEASE PREDICTION & DRUG DISCOVERY	ISDPDD	E	4	1	2	0	6

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, PO11, 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, PO11, 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, PO11, 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, PO11, 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, PO11, PSO1
CO6	Analyze case studies where AI and data science have successfully accelerated drug discovery and development.	5	PO1, PO5, PO11, PSO1
CO7	Develop frameworks for analyzing the outcomes and impacts of AI-driven drug discovery projects	6	PO1, PO5, PO11, 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) .

25HDA3202 - BIO MEDICAL INFORMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3202	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
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..

25HDA3203 - GENETIC PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3203	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, PO2, PSO1
CO2	Implement Genetic Programming in order to achieve programme evolution.	3	PO1, PO2, 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 Introduction to Evolutionary Computing,, Agoston E Eiben, John E Smith,, 2005, ., Springer.
- 2 Genetic Algorithms-In Search, optimization and Machine learning, , David E. Goldberg, , 1989, , Pearson Education..
- 3 An Introduction to Genetic Algorithms, Melanie Mitchell, 1998, Bradford Books.

25HDA3204 - PYTHON FOR GENOMIC DATA SCIENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3204	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.

Reference Books

- 1 Data Science for Genomics, Amit Kumar Tyagi, Ajith Abraham, 2022, eBook.
- 2 Deep Learning for genomics, Upendra Kumar Devisetty, 1st Edition, 2022, Packt.
- 3 Bioinformatics with Python Cookbook, Tiago Antao, 2st Edition, 2018, eBook.

25HDA3305 - COMPUTATIONAL NEUROSCIENCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3305	COMPUTATIONAL NEUROSCIENCE	CNSE	R	3	0	0	2	3.5

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	
CO2	2 Apply mathematical and computational models to analyze neural systems and brain function to investigate how neural systems process information and perform various functions.	3	
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	
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	
CO5	Evaluate the implications of computational neuroscience research for understanding brain disorders and developing treatments	5	
CO6	Evaluate the computational Neuroscience models in laboratory exercises and projects that involve implementing computational models, running simulations, and analyzing results	5	

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

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 From Neuron to Cognition via Computational Neuroscience, , Michael A. Arbib and James J. Bonaiuto, , 2016, , MIT press..

25HDA3305A - COMPUTATIONAL NEUROSCIENCE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3305A	COMPUTATIONAL NEUROSCIENCE	CNSE	A	4	1	0	2	5.5

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, PSO2
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, PSO2
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, PSO2
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, PSO2
CO5	Evaluate the implications of computational neuroscience research for understanding brain disorders and developing treatments.	5	PO1, PO2, PO3, PSO1, PSO2
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, PSO2
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, PSO2

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

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..

25HDA3305E - COMPUTATIONAL NEUROSCIENCE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3305E	COMPUTATIONAL NEUROSCIENCE	CNSE	E	4	1	0	2	5.5

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	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)

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 From Neuron to Cognition via Computational Neuroscience,, Michael A. Arbib and James J. Bonaiuto, , 2016, , MIT Press..

25HDA3406 - NGS SEQUENCING AND DATA ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3406	NGS SEQUENCING AND DATA ANALYSIS	NGSDA	R	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	
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	
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	
CO4	Interpret Transcriptomics and Differential Gene Expression: Engage in transcriptomic studies to explore gene expression levels under different conditions	3	

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,

Reference Books

- 1 ext-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.

25HDA3407 - INTRODUCTION TO GENOMIC TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3407	INTRODUCTION TO GENOMIC TECHNOLOGIES	IGT	R	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	PO1, PO2, 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, PO4, PSO2
CO3	Discover computing techniques related to Genomic technologies with respect to DNA, and relate computing and biology.	3	PO3, PSO1
CO4	Correlate Artificial Intelligence algorithms with genomic technologies and practice experimental design and implementation	4	PO2, 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

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 Proteomics: Tools for the New Biology, Liebler, First Edition, 2001, Humana Press.

25HDA3509 - MOLECULAR MODELLING AND DRUG DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3509	MOLECULAR MODELLING AND DRUG DESIGN	MMOD	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 ⁹	3	PO2, PSO1
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, PSO1
CO3	Demonstrate biomolecular interactions, such as protein-protein, protein-ligand, and protein-DNA/RNA interactions in biological systems	3	PO3, PSO1
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, PSO1

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

Reference Books

- 1 Molecular Modeling of Proteins, Andreas Kukol, 2016, Springer New York.
- 2 Molecular Modelling: Computational Chemistry Demystified, Bladon P, 2021, Rsc Publishing.

25HDA3510 - GENOMIC DATASCIENCE AND CLUSTERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3510	GENOMIC DATASCIENCE AND 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

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.

25HDA3511 - EPI GENETIC CONTROL FOR GENE EXPRESSION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HDA3511	EPI GENETIC CONTROL FOR 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, PO2, 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	PO3, PO4, PSO2
CO4	Devise real world problems pertained to Epigenetics and discuss the various Epigenetic solutions by design and implementation using a case study	4	PO2, PO3, PSO1

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: Development and Disease, Tapas Kumar Kundu, First Edition, 2013, Springer Nature Publisher.
- 2 Introduction to Genomics, Arthur M. Lesk, Third Edition, 2017, Oxford University Press.
- 3 Epigenetics, C. David Allis, Second Edition, 2015, Cold Spring Harbor Laboratory Press.

25HSS3101 - INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3101	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	ITHSCD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3101A - INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3101A	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	ITHSCD	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3101E - INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3101E	INTRODUCTION TO HARDWARE-SOFTWARE CO-DESIGN	ITHSCD	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3202 - FUNDAMENTALS OF COMPUTER SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3202	FUNDAMENTALS OF COMPUTER SECURITY	FOCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3303 - HARDWARE SECURITY MECHANISMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3303	HARDWARE SECURITY MECHANISMS	HSM	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3303A - HARDWARE SECURITY MECHANISMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3303A	HARDWARE SECURITY MECHANISMS	HSM	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3303E - HARDWARE SECURITY MECHANISMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3303E	HARDWARE SECURITY MECHANISMS	HSM	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3404 - SOFTWARE SECURITY PRINCIPLES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3404	SOFTWARE SECURITY PRINCIPLES	SSP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3405 - SECURE CO-DESIGN METHODOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3405	SECURE CO-DESIGN METHODOLOGIES	SCDM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3406 - HARDWARE TROJAN DETECTION AND PREVENTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3406	HARDWARE TROJAN DETECTION AND PREVENTION	HTDAP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3507 - SIDE-CHANNEL ATTACKS AND COUNTER MEASURES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3507	SIDE-CHANNEL ATTACKS AND COUNTER MEASURES	SCACM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3508 - FORMAL METHODS FOR HARDWARE-SOFTWARE SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3508	FORMAL METHODS FOR HARDWARE-SOFTWARE SECURITY	FMHSS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3509 - TRUSTED PLATFORM MODULES AND SECURE ELEMENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3509	TRUSTED PLATFORM MODULES AND SECURE ELEMENTS	TPMASE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3511 - HARDWARE-SOFTWARE CO-DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3511	HARDWARE-SOFTWARE CO-DESIGN	HSCCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25HSS3512 - FUTURE TRENDS IN HARDWARE-SOFTWARE CO-DESIGN FOR SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25HSS3512	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	
CO2	Evaluate various hardware-software co-design techniques and their impact on system security.	2	
CO3	Apply co-design methodologies to develop robust and secure hardware-software systems.	3	
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	

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.

25IBT3101 - PHARMACEUTICAL BIOTECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3101	PHARMACEUTICAL BIOTECHNOLOGY	PBT	R	3	0	2	0	4

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, 2007, Oxford University Press.

25IBT3101A - PHARMACEUTICAL BIOTECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3101A	PHARMACEUTICAL BIOTECHNOLOGY	PBT	A	4	1	2	0	6

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.

25IBT3101E - PHARMACEUTICAL BIOTECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3101E	PHARMACEUTICAL BIOTECHNOLOGY	PBT	E	4	1	2	0	6

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.

25IBT3202 - PHARMACOVIGILANCE AND SAFETY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3202	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.

25IBT3203 - BIOPROCESS ECONOMICS AND PLANT DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3203	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.

25IBT3304 - ENZYME ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3304	ENZYME ENGINEERING	EE	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of protein structure, function, and kinetics to enzyme engineering.	3	
CO2	Analyze the relationship between enzyme structure and function in the context of engineering enzymes for desired activities.	3	
CO3	Design and utilize various protein engineering techniques for enzyme modification.	3	
CO4	Evaluate the effectiveness of enzyme engineering strategies through computational and experimental methods	3	
CO5	Apply engineered enzymes for specific industrial, environmental, or bioremediation applications.	3	

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

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 Introduction to Enzymes, Y V Satyanarayana, 8, Springer.

25IBT3304A - ENZYME ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3304A	ENZYME ENGINEERING	EE	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of protein structure, function, and kinetics to enzyme engineering.	3	PO1, PSO1
CO2	Analyze the relationship between enzyme structure and function in the context of engineering enzymes for desired activities.	4	PO1, PO2, PSO2
CO3	Design and utilize various protein engineering techniques for enzyme modification.	6	PO1, PO2, PSO2
CO4	Evaluate the effectiveness of enzyme engineering strategies through computational and experimental methods	5	PO1, PO2, PSO1
CO5	Apply engineered enzymes for specific industrial, environmental, or bioremediation applications.	3	PO1, PSO1
CO6	Effectively communicate the principles and applications of enzyme engineering in written and oral formats	5	PO2, PSO2
CO7	Demonstrate an understanding of the ethical considerations and potential risks associated with enzyme engineering.	4	PO5, PSO2

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...

25IBT3304E - ENZYME ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3304E	ENZYME ENGINEERING	EE	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamental principles of protein structure, function, and kinetics to enzyme engineering	3	PO1, PSO1
CO2	Analyze the relationship between enzyme structure and function in the context of engineering enzymes for desired activities.	4	PO1, PO2, PSO2
CO3	Design and utilize various protein engineering techniques for enzyme modification	6	PO1, PO2, PSO2
CO4	Evaluate the effectiveness of enzyme engineering strategies through computational and experimental methods.	5	PO1, PO2, PSO2
CO5	Apply engineered enzymes for specific industrial, environmental, or bioremediation applications.	3	PO1, PSO1
CO6	Effectively communicate the principles and applications of enzyme engineering in written and oral formats	5	PO2, PSO2
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.

25IBT3405 - BIOPROCESS VALIDATION AND CGMP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3405	BIOPROCESS VALIDATION AND CGMP	BVCGMP	R	3	0	2	0	4

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..

25IBT3406 - FOOD TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3406	FOOD TECHNOLOGY	FT	R	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	PO1
CO2	Outline the methods of food processing	3	PO4
CO3	Illustrate various strategies involved in preservation and storage	3	PO9
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.

25IBT3507 - MICROBIAL TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3507	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, PSO1
CO2	Apply the concept of medium screen out and strain development	3	PO1, PO7, PSO1
CO3	Develop various strategies to produce Primary and secondary Metabolites	3	PO3, PO7, PSO1
CO4	Design various strategies for the production of enzymes, recombinant proteins, and other special bioproducts	3	PO3, PO7, PSO1

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 Bailly & DF Ollis , , 2017,, McGraw Hill Book Co.NewYork..
- 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..

25IBT3508 - METABOLIC ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IBT3508	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	PO4
CO3	Utilize synthetic biology tools and genetic engineering techniques to design and construct engineered metabolic pathways.	3	, PSO2
CO4	Evaluate and integrate omics data with computational modeling approaches to predict and improve metabolic pathway performance.	3	PO11

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..

25IGD3101 - GAME DEVELOPMENT WITH UNREAL ENGINE (C++) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3101	GAME DEVELOPMENT WITH UNREAL ENGINE (C++)	GDUE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Implement C++ classes using Unreal's Actor and Component model	3	
CO2	Analyze Unreal's gameplay framework and event-driven architecture	4	
CO3	Integrate C++ and Blueprints for advanced gameplay logic	5	
CO4	Develop a functional, modular 3D game using Unreal Engine with optimized asset pipelines	5	

Syllabus

Unreal Engine Foundations UE5 architecture, C++ project setup, Game Module, GameMode, Pawn, PlayerController, compiling and hot reloading, input mapping

Actors, Components & Gameplay Framework Actor lifecycle, Scene Components, collision handling, Actor spawning, Tick functions, GameInstance and GameState

Blueprints and C++ Integration Communication between Blueprints and C++, exposing functions/variables to Blueprints, events and delegates, gameplay triggers

UI, Animation & Level Scripting UMG (Unreal Motion Graphics), HUD design, animation blueprints, Level Blueprint scripting, materials, lighting, and post-processing

Reference Books

- 1 Learning C++ by Creating Games with UE, William Sherif, 1st Edition, Packt Publishing.
- 2 Unreal Engine 5 Game Development, Ashish Amresh et al., 1st Edition, Packt Publishing.
- 3 Mastering Unreal Engine 4.X, Muhammad A. Moniem, 1st Edition, Packt Publishing.
- 4 Unreal Engine C++ Developer, Ben Tristem (online resource, book alike), Online Edition, Udemey Labs.
- 5 Unreal Engine Game Development Cookbook, John P. Doran, 1st Edition, Packt Publishing.

25IGD3101A - GAME DEVELOPMENT WITH UNREAL ENGINE (C++) (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3101A	GAME DEVELOPMENT WITH UNREAL ENGINE (C++)	GDUE	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Implement C++ classes using Unreal's Actor and Component model	3	
CO2	Analyze Unreal's gameplay framework and event-driven architecture	4	
CO3	Integrate C++ and Blueprints for advanced gameplay logic	5	
CO4	Develop a functional, modular 3D game using Unreal Engine with optimized asset pipelines	5	

Syllabus

Unreal Engine Foundations UE5 architecture, C++ project setup, Game Module, GameMode, Pawn, PlayerController, compiling and hot reloading, input mapping

Actors, Components & Gameplay Framework Actor lifecycle, Scene Components, collision handling, Actor spawning, Tick functions, GameInstance and GameState

Blueprints and C++ Integration Communication between Blueprints and C++, exposing functions/variables to Blueprints, events and delegates, gameplay triggers

UI, Animation & Level Scripting UMG (Unreal Motion Graphics), HUD design, animation blueprints, Level Blueprint scripting, materials, lighting, and post-processing

Reference Books

- 1 Learning C++ by Creating Games with UE, William Sherif, 1st Edition, Packt Publishing.
- 2 Unreal Engine 5 Game Development, Ashish Amresh et al., 1st Edition, Packt Publishing.
- 3 Mastering Unreal Engine 4.X, Muhammad A. Moniem, 1st Edition, Packt Publishing.
- 4 Unreal Engine C++ Developer, Ben Tristem (online resource, book-alike), Online Edition, Udemy Labs.
- 5 Unreal Engine Game Development Cookbook, John P. Doran, 1st Edition, Packt Publishing.

25IGD3101E - GAME DEVELOPMENT WITH UNREAL ENGINE (C++) (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3101E	GAME DEVELOPMENT WITH UNREAL ENGINE (C++)	GDUE	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Implement C++ classes using Unreal's Actor and Component model	3	
CO2	Analyze Unreal's gameplay framework and event-driven architecture	4	
CO3	Integrate C++ and Blueprints for advanced gameplay logic	5	
CO4	Develop a functional, modular 3D game using Unreal Engine with optimized asset pipelines	5	

Syllabus

Unreal Engine Foundations UE5 architecture, C++ project setup, Game Module, GameMode, Pawn, PlayerController, compiling and hot reloading, input mapping

Actors, Components & Gameplay Framework Actor lifecycle, Scene Components, collision handling, Actor spawning, Tick functions, GameInstance and GameState

Blueprints and C++ Integration Communication between Blueprints and C++, exposing functions/variables to Blueprints, events and delegates, gameplay triggers

UI, Animation & Level Scripting UMG (Unreal Motion Graphics), HUD design, animation blueprints, Level Blueprint scripting, materials, lighting, and post processing

Reference Books

- 1 Learning C++ by Creating Games with UE, William Sherif, 1st Edition, Packt Publishing.
- 2 Unreal Engine 5 Game Development, Ashish Amresh et al., 1st Edition, Packt Publishing.
- 3 Mastering Unreal Engine 4.X, Muhammad A. Moniem, 1st Edition, Packt Publishing.
- 4 Unreal Engine C++ Developer, Ben Tristem (online resource, book alike), Online Edition, Udemey Labs.
- 5 Unreal Engine Game Development Cookbook, John P. Doran, 1st Edition, Packt Publishing.

25IGD3102 - GAME DEVELOPMENT WITH UNITY ENGINE (C#) (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3102	GAME DEVELOPMENT WITH UNITY ENGINE (C#)	GDUN	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Unitys component based system to develop interactive 2D 3D games	3	
CO2	Analyze scene structure, input systems, and animation mechanisms in Unity	4	
CO3	Develop reusable scripts for game logic, UI, and audio-visual effects	5	
CO4	Construct a complete Unity-based game with modular architecture and platform compatibility	5	

Syllabus

Unity installation and IDE configuration (Visual Studio), project structure, scenes and game objects, prefabs, asset store usage, basic 2D & 3D navigation, editor scripting

Unity component model, Rigidbody, Collider, Physics Materials, triggers, physics layers, C# scripting fundamentals, MonoBehaviour lifecycle, input handling

Animator Controller, blend trees, timeline, audio mixers, UI design with Canvas, buttons, sliders, dynamic UI creation, event systems

Scene transitions, game manager patterns, persistent objects, player prefs, save/load, optimization, build settings, deployment to PC, mobile, WebGL, and consoles

Reference Books

- 1 Unity in Action, Joseph Hocking, 4th Edition, 2022, Manning.
- 2 Learning C# by Developing Games in Unity, Harrison Ferrone, 5th Edition, 2021, Packt Publishing.
- 3 Mastering Unity Scripting, Alan Thorn, 2nd Edition, 2015, Packt Publishing.
- 4 Unity 2023 Game Development Cookbook, Paris Buttfield Addison et al., 1st Edition, 2023, O Reilly.
- 5 Game Development Projects with Unity, Chris Greening, 1st Edition, 2022, Packt Publishing.

25IGD3102A - GAME DEVELOPMENT WITH UNITY ENGINE (C#) (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3102A	GAME DEVELOPMENT WITH UNITY ENGINE (C#)	GDUN	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Unitys component based system to develop interactive 2D 3D games	3	
CO2	Analyze scene structure, input systems, and animation mechanisms in Unity	4	
CO3	Develop reusable scripts for game logic, UI, and audio visual effects	5	
CO4	Construct a complete Unity-based game with modular architecture and platform compatibility	5	

Syllabus

Unity installation and IDE configuration (Visual Studio), project structure, scenes and game objects, prefabs, asset store usage, basic 2D & 3D navigation, editor scripting

Unity component model, Rigidbody, Collider, Physics Materials, triggers, physics layers, C# scripting fundamentals, MonoBehaviour lifecycle, input handling

Animator Controller, blend trees, timeline, audio mixers, UI design with Canvas, buttons, sliders, dynamic UI creation, event systems

Scene transitions, game manager patterns, persistent objects, player prefs, save/load, optimization, build settings, deployment to PC, mobile, WebGL, and consoles

Reference Books

- 1 Unity in Action, Joseph Hocking, 4th Edition, 2022, Manning.
- 2 Learning C# by Developing Games in Unity, Harrison Ferrone, 5th Edition, 2021, Packt Publishing.
- 3 Mastering Unity Scripting, Alan Thorn, 2nd Edition, 2015, Packt Publishing.
- 4 Unity 2023 Game Development Cookbook, Paris Buttfield-Addison et al., 1st Edition, 2023, O Reilly.
- 5 Game Development Projects with Unity, Chris Greening, 1st Edition, 2022, Packt Publishing.

25IGD3102E - GAME DEVELOPMENT WITH UNITY ENGINE (C#) (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3102E	GAME DEVELOPMENT WITH UNITY ENGINE (C#)	GDUN	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Units component based system to develop interactive 2D 3D games	3	
CO2	Analyze scene structure, input systems, and animation mechanisms in Unity	4	
CO3	Develop reusable scripts for game logic, UI, and audio-visual effects	5	
CO4	Construct a complete Unity-based game with modular architecture and platform compatibility	5	

Syllabus

Unity installation and IDE configuration (Visual Studio), project structure, scenes and game objects, prefabs, asset store usage, basic 2D & 3D navigation, editor scripting

Unity component model, Rigidbody, Collider, Physics Materials, triggers, physics layers, C# scripting fundamentals, MonoBehaviour lifecycle, input handling

Animator Controller, blend trees, timeline, audio mixers, UI design with Canvas, buttons, sliders, dynamic UI creation, event systems

Scene transitions, game manager patterns, persistent objects, player prefs, save/load, optimization, build settings, deployment to PC, mobile, WebGL, and consoles

Reference Books

- 1 Unity in Action, Joseph Hocking, 4th Edition, 2022, Manning.
- 2 Learning C# by Developing Games in Unity, Harrison Ferrone, 5th Edition, 2021, Packt Publishing.
- 3 Mastering Unity Scripting, Alan Thorn, 2nd Edition, 2015, Packt Publishing.
- 4 Unity 2023 Game Development Cookbook, Paris Buttfield Addison et al, 1st Edition, 2023, O Reilly.
- 5 Game Development Projects with Unity, Chris Greening, 1st Edition, 2022, Packt Publishing.

25IGD3203 - MULTIPLAYER GAME DEVELOPMENT AND NETWORKING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3203	MULTIPLAYER GAME DEVELOPMENT AND NETWORKING	MGDN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply networking principles to implement peer-to-peer and client-server communication in games	3	
CO2	Analyze game synchronization, message passing, and authority control in multiplayer architecture	4	
CO3	Design and develop matchmaking, lobby systems, and state replication	5	
CO4	Construct a complete multiplayer game prototype with reliable and secure real-time gameplay	5	

Syllabus

Types of multiplayer games (LAN, Online, MMOG), network topologies (P2P, client-server), UDP vs TCP in gaming, NAT traversal, port forwarding, introductory serialization

Game loop in networked games, state authority, RPC (Remote Procedure Calls), message queues, network latency, tickrate, rollback, and lag compensation

Entity interpolation/extrapolation, delta compression, bandwidth optimization, snapshot vs event-based sync, dead reckoning, ghosting, and state conflicts

Lobby creation, join/leave logic, session management, user ID management, matchmaking algorithms, voice chat integration, security concerns (spoofing, cheating, replay attacks)

Reference Books

- 1 Multiplayer Game Programming, Josh Glazer & Sanjay Madhav, 2015, Addison-Wesley.
- 2 Game Programming Patterns, Robert Nystrom, 2014, Genever Benning.
- 3 Game Engine Architecture, Jason Gregory, 2021, CRC Press.
- 4 Foundations of Game Engine Development, Vol. 2: Rendering, Eric Lengyel, 2019, Terathon Software.
- 5 Real Time Multiplayer Game Programming, Srecko Joksimovic, 2022, Packt Publishing.

25IGD3204 - GAME DEVOPS AND CLOUD DEPLOYMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3204	GAME DEVOPS AND CLOUD DEPLOYMENT	GDCD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Implement CI/CD pipelines and versioning strategies for iterative game builds	3	
CO2	Analyze and deploy backend services on cloud platforms using serverless and container orchestration techniques	4	
CO3	Develop secure and scalable infrastructure for game servers using IAC and monitoring tools	5	
CO4	Deploy a production-grade cloud-native multiplayer or API-driven game service	5	

Syllabus

Agile CI/CD principles for game projects, GitHub Actions, version control workflows, build versioning, automated asset packaging, Unity/Unreal CI setup

Bare-metal vs cloud game server deployment, containerization with Docker, orchestration with Kubernetes, autoscaling, cost optimization strategies, traffic routing (Load Balancers, Ingress)

Firebase, PlayFab, Nakama, Unity Gaming Services (UGS), login, leaderboards, matchmaking, cloud scripting, microservice interaction

Terraform basics, Helm for Kubernetes, logging (Grafana, Loki), monitoring and alerting with Prometheus, securing infrastructure, DDOS mitigation basics

Reference Books

- 1 Cloud Native DevOps with Kubernetes, John Arundel, Justin Domingus, 2021, O Reilly.
- 2 The DevOps Handbook, Gene Kim et al, 2021, IT Revolution Press.
- 3 Mastering Game Server Scaling, Francisco Tufr?, 2023, Packt Publishing.
- 4 Hands-On Kubernetes on Azure, Shivakumar Gopalakrishnan, 2020, Packt Publishing.
- 5 Unity 2023 Game Optimization and Deployment, Joel Penn, 2023, Packt Publishing.

25IGD3305 - 3D GAME PROGRAMMING AND PHYSICS SIMULATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3305	3D GAME PROGRAMMING AND PHYSICS SIMULATION	3DPS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply 3D mathematical transformations to build and manipulate virtual environments	3	
CO2	Analyze real time rendering pipelines and visual effects in 3D engines	4	
CO3	Evaluate physical interactions including rigid and soft body simulations	5	
CO4	Develop an interactive 3D scene incorporating animation collision and physics	5	

Syllabus

Foundations of 3D Math and Transformations 3D coordinate spaces transformations using matrices and quaternions scene graphs camera systems view frustum projection matrices orthographic vs perspective MVP pipeline

Rendering Pipeline and Shaders Forward vs deferred rendering lighting models Phong Blinn Phong PBR Physically Based Rendering real time shadows normal and bump mapping Z buffering occlusion culling shader programming GLSL HLSL

Physics Simulation Techniques Rigid body dynamics mass velocity friction restitution collision detection AABB OBB ray casting impulse and force application constraints joints trigger colliders cloth and soft body simulation

Character Animation and Physical Interaction Skeletal rigging keyframe vs procedural animation animation blending and state machines inverse and forward kinematics ragdoll systems physics driven character movement animation retargeting

Reference Books

- 1 3D Math Primer for Graphics and Game Development, Fletcher Dunn Ian Parberry, 2nd Edition, CRC Press.
- 2 Real Time Rendering, Tomas Akenine M?ller et al, 4th Edition, A K Peters CRC Press.
- 3 Game Physics Engine Development, Ian Millington, 2nd Edition, Morgan Kaufmann.
- 4 Mathematics for 3D Game Programming and Computer Graphics, Eric Lengyel, 4th Edition, Cengage Learning.
- 5 Foundations of Game Engine Development Volume 2 Rendering, Eric Lengyel, 1st Edition, Terathon Software.

25IGD3305A - 3D GAME PROGRAMMING AND PHYSICS SIMULATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3305A	3D GAME PROGRAMMING AND PHYSICS SIMULATION	3DPS	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply 3D mathematical transformations to build and manipulate virtual environments	3	
CO2	Analyze real-time rendering pipelines and visual effects in 3D engines	4	
CO3	Evaluate physical interactions including rigid and soft body simulations	5	
CO4	Develop an interactive 3D scene incorporating animation, collision, and physics	5	

Syllabus

Foundations of 3D Math and Transformations 3D coordinate spaces, transformations using matrices and quaternions, scene graphs, camera systems, view frustum, projection matrices (orthographic vs. perspective), MVP pipeline

Rendering Pipeline and Shaders Forward vs deferred rendering, lighting models (Phong, Blinn-Phong), PBR (Physically Based Rendering), real-time shadows, normal/bump mapping, Z-buffering, occlusion culling, shader programming (GLSL/HLSL)

Physics Simulation Techniques Rigid body dynamics (mass, velocity, friction, restitution), collision detection (AABB, OBB, ray casting), impulse and force application, constraints, joints, trigger colliders, cloth and soft body simulation

Character Animation and Physical Interaction Skeletal rigging, keyframe vs procedural animation, animation blending and state machines, inverse and forward kinematics, ragdoll systems, physics-driven character movement, animation retargeting

Reference Books

- 1 3D Math Primer for Graphics and Game Development, Fletcher Dunn, Ian Parberry, 2nd Edition, CRC Press.
- 2 Real Time Rendering, Tomas Akenine Moller, Eric Haines, Naty Hoffman, 4th Edition, A K Peters , CRC Press.
- 3 Game Physics Engine Development, Ian Millington, 3rd Edition, Morgan Kaufmann.
- 4 Mathematics for 3D Game Programming and Computer Graphics, Eric Lengyel, 4th Edition, Cengage Learning.

25IGD3305E - 3D GAME PROGRAMMING AND PHYSICS SIMULATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3305E	3D GAME PROGRAMMING AND PHYSICS SIMULATION	3DPS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply 3D mathematical transformations to build and manipulate virtual environments	3	
CO2	Analyze real time rendering pipelines and visual effects in 3D engines	4	
CO3	Evaluate physical interactions including rigid and soft body simulations	5	
CO4	Develop an interactive 3D scene incorporating animation collision and physics	5	

Syllabus

Foundations of 3D Math and Transformations 3D coordinate spaces transformations using matrices and quaternions scene graphs camera systems view frustum projection matrices orthographic vs perspective MVP pipeline

Rendering Pipeline and Shaders Forward vs deferred rendering lighting models Phong Blinn Phong PBR Physically Based Rendering real time shadows normal and bump mapping Z buffering occlusion culling shader programming GLSL HLSL

Physics Simulation Techniques Rigid body dynamics mass velocity friction restitution collision detection AABB OBB ray casting impulse and force application constraints joints trigger colliders cloth and soft body simulation

Character Animation and Physical Interaction Skeletal rigging keyframe vs procedural animation animation blending and state machines inverse and forward kinematics ragdoll systems physics driven character movement animation retargeting

Reference Books

- 1 3D Math Primer for Graphics and Game Development, Fletcher Dunn Ian Parberry, 2nd Edition, CRC Press.
- 2 Real Time Rendering, Tomas Akenine M?ller et al, 4th Edition, A K Peters CRC Press.
- 3 Game Physics Engine Development, Ian Millington, 2nd Edition, Morgan Kaufmann.
- 4 Mathematics for 3D Game Programming and Computer Graphics, Eric Lengyel, 4th Edition, Cengage Learning.
- 5 Foundations of Game Engine Development Volume 2 Rendering, Eric Lengyel, 1st Edition, Terathon Software.

25IGD3306 - PROCEDURAL WORLD BUILDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3306	PROCEDURAL WORLD BUILDING	PWB	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply procedural generation techniques to create dynamic terrain and levels	3	
CO2	Analyze spatial partitioning and content generation algorithms for scalability	4	
CO3	Evaluate different noise-based approaches for biome and environment modeling	5	
CO4	Design and implement a modular world builder system integrated with game engines	5	

Syllabus

Rule-based vs. stochastic generation, proceduralism in game design, advantages and limitations, random seeds and entropy, repeatability, world design pipelines

Perlin noise, Simplex noise, Worley noise, fractals, octaves, terrain elevation maps, heightmaps, erosion simulation, thermal and hydraulic erosion, procedural rivers

Grid-based vs. graph-based approaches, cellular automata, Binary Space Partitioning (BSP), maze generation algorithms, room and corridor linking, pathfinding integration

Biome blending, temperature-humidity maps, procedural vegetation, climate zones, weather systems, seasonal variation, flora/fauna population generation, L-systems for plants

Reference Books

- 1 Procedural Generation in Game Design, Tanya Short, Tarn Adams, 2017, CRC Press.
- 2 Game Programming Gems Series, Various, 2008, Charles River Media.
- 3 The Nature of Code, Daniel Shiffman, 2012, Nature of Code.
- 4 Real-Time 3D Terrain Engines Using C++ and DirectX 9, Greg Snook, 2006, Charles River Media.
- 5 Advanced Game Design with Procedural Content Generation, Gabriel Gambetta, 2020, Independently Published.

25IGD3306A - PROCEDURAL WORLD BUILDING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3306A	PROCEDURAL WORLD BUILDING	PWB	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply procedural generation techniques to create dynamic terrain and levels	3	
CO2	Analyze spatial partitioning and content generation algorithms for scalability	4	
CO3	Evaluate different noise-based approaches for biome and environment modeling	5	
CO4	Design and implement a modular world builder system integrated with game engines	5	

Syllabus

Rule-based vs. stochastic generation, proceduralism in game design, advantages and limitations, random seeds and entropy, repeatability, world design pipelines

Perlin noise, Simplex noise, Worley noise, fractals, octaves, terrain elevation maps, heightmaps, erosion simulation, thermal and hydraulic erosion, procedural rivers

Grid-based vs. graph-based approaches, cellular automata, Binary Space Partitioning (BSP), maze generation algorithms, room and corridor linking, pathfinding integration

Biome blending, temperature-humidity maps, procedural vegetation, climate zones, weather systems, seasonal variation, flora/fauna population generation, L-systems for plants

Reference Books

- 1 Procedural Generation in Game Design, Tanya Short, Tarn Adams, 2017, CRC Press.
- 2 Game Programming Gems Series, Various, 2008, Charles River Media.
- 3 The Nature of Code, Daniel Shiffman, 2012, Nature of Code.
- 4 Real-Time 3D Terrain Engines Using C++ and DirectX 9, Greg Snook, 2006, Charles River Media.
- 5 Advanced Game Design with Procedural Content Generation, Gabriel Gambetta, 2020, Independently Published.

25IGD3306E - PROCEDURAL WORLD BUILDING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3306E	PROCEDURAL WORLD BUILDING	PWB	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply procedural generation techniques to create dynamic terrain and levels	3	
CO2	Analyze spatial partitioning and content generation algorithms for scalability	4	
CO3	Evaluate different noise-based approaches for biome and environment modeling	5	
CO4	Design and implement a modular world builder system integrated with game engines	5	

Syllabus

Rule-based vs. stochastic generation, proceduralism in game design, advantages and limitations, random seeds and entropy, repeatability, world design pipelines

Perlin noise, Simplex noise, Worley noise, fractals, octaves, terrain elevation maps, heightmaps, erosion simulation, thermal and hydraulic erosion, procedural rivers

Grid-based vs. graph-based approaches, cellular automata, Binary Space Partitioning (BSP), maze generation algorithms, room and corridor linking, pathfinding integration

Biome blending, temperature-humidity maps, procedural vegetation, climate zones, weather systems, seasonal variation, flora/fauna population generation, L-systems for plants

Reference Books

- 1 Procedural Generation in Game Design, Tanya Short, Tarn Adams, 2017, CRC Press.
- 2 Game Programming Gems Series, Various, 2008, Charles River Media.
- 3 The Nature of Code, Daniel Shiffman, 2012, Nature of Code.
- 4 Real-Time 3D Terrain Engines Using C++ and DirectX 9, Greg Snook, 2006, Charles River Media.
- 5 Advanced Game Design with Procedural Content Generation, Gabriel Gambetta, 2020, Independently Published.

25IGD3407 - IMMERSIVE GAME DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3407	IMMERSIVE GAME DEVELOPMENT	IGD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply principles of spatial computing to design immersive game environments	3	
CO2	Analyze AR/VR/XR device ecosystems and development pipelines	4	
CO3	Evaluate user experience and interaction models for immersive environments	5	
CO4	Evaluate user experience and interaction models for immersive environments	5	

Syllabus

Foundations of Immersive Game Design: Human perception in immersive systems, spatial awareness, degrees of freedom (3DoF vs 6DoF), AR/VR/XR continuum, use cases in entertainment, education, therapy, and simulation

AR/VR/XR Technologies and Platforms: Comparison of XR headsets (Meta Quest, HoloLens, HTC Vive), inside-out vs outside-in tracking, camera-based SLAM, sensor fusion, runtime engines (Unity XR Toolkit, OpenXR)

Interaction Design in XR: 3D UI/UX, gesture-based controls, gaze tracking, hand tracking APIs, controller input systems, haptic feedback, spatial audio, accessibility in immersive design

Development & Deployment Pipelines: Scene anchoring and plane detection, environmental occlusion, XR SDKs and plugins, mobile XR vs headset XR, building and deploying to Meta Quest, HoloLens, or mobile AR platforms, debugging immersive apps

Reference Books

- 1 Understanding Virtual Reality, William R. Sherman, Alan Craig, 2018, Morgan Kaufmann.
- 2 Learning Virtual Reality, Tony Parisi, 2015, O Reilly Media.
- 3 Augmented Human: How Technology is Shaping the New Reality, Helen Papagiannis, 2017, O Reilly Media.

25IGD3408 - SPATIAL COMPUTING FOR INTERACTIVE SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3408	SPATIAL COMPUTING FOR INTERACTIVE SYSTEMS	SCIS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand spatial computing frameworks and real-world applications	3	
CO2	Analyze spatial perception, object tracking, and environmental mapping	4	
CO3	Design spatial interfaces using gesture, gaze, voice, and haptics	5	
CO4	Build spatially aware applications for interactive systems in XR or IoT	5	

Syllabus

Foundations of Spatial Computing: Evolution of spatial computing; 2D vs 3D interfaces; Mixed Reality vs Spatial Computing; Ambient intelligence; Use cases in gaming, retail, healthcare, industry; Overview of tools (Unity XR, OpenXR, HoloLens SDK, etc.)

Spatial Perception and Mapping: SLAM (Simultaneous Localization and Mapping); Environment meshing; Surface reconstruction; Spatial anchors; Occlusion detection; Persistent mapping; Real-time mesh optimization

Spatial Interaction Modalities: Interaction models (gaze, gesture, voice, proximity); Spatial UI/UX principles; Multimodal input fusion; Tactile and auditory feedback systems; Adaptive interfaces; Affordances in space

Design of Spatially Aware Interactive Systems: Design patterns for immersive interaction; Spatial storytelling; Smart space design (IoT + spatial); Context-awareness and edge AI integration; Real-world deployment using Unity XR SDK, ARKit/ARCore; Project scoping and performance testing

Reference Books

- 1 Spatial Computing, Samir AbdelRahman & Gerard Medioni, 2020, Springer.
- 2 Understanding Augmented Reality, Alan Craig, 2013, Morgan Kaufmann.
- 3 Designing Immersive 3D Experiences, Doris Rusch, 2022, CRC Press.

25IGD3509 - GAME AI AND AUTONOMOUS AGENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3509	GAME AI AND AUTONOMOUS AGENTS	GAIA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply classic AI techniques to design intelligent game behaviors	3	
CO2	Develop autonomous agents with decision trees and behavior trees	4	
CO3	Analyze and optimize real-time pathfinding and movement strategies	4	
CO4	Build adaptive AI systems using rule-based, goal-based, or learning agents	5	

Syllabus

Foundations of Game AI: Game AI vs academic AI; Agents and environments; Finite-state machines (FSMs); Decision trees; Rule-based AI; Strategy layers vs tactic layers; Scripting vs hard-coded behavior

Movement and Pathfinding: Grid-based vs navmesh pathfinding; A*, Dijkstra, Jump Point Search (JPS); Steering behaviors (seek, flee, wander, arrive, avoid); Boid systems for flocking; Influence maps

Goal-Oriented and Behavior-Based AI: Behavior trees; Utility-based decision-making; GOAP (Goal-Oriented Action Planning); Task scheduling; Influence of emotions and moods; Priority queues; Squad-level coordination

Adaptive and Learning Agents: Blackboard architecture; Reinforcement learning basics (Q-learning in games); Neural networks in games; Opponent modeling; Dynamic difficulty adjustment (DDA); Ethical AI in games

Reference Books

- 1 AI for Games, Ian Millington, 2021, CRC Press.
- 2 Programming Game AI by Example, Mat Buckland, 2005, Jones & Bartlett.
- 3 Behavioral Mathematics for Game AI, Dave Mark, 2009, Cengage Learning.

25IGD3510 - GENERATIVE AI IN GAME DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IGD3510	GENERATIVE AI IN GAME DESIGN	GAID	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the role and evolution of generative AI in modern game design	3	
CO2	Apply generative models for asset and content generation	4	
CO3	Develop intelligent NPCs and dynamic storytelling systems using LLMs	5	
CO4	Build and integrate multimodal AI pipelines for end-to-end game content	5	

Syllabus

Foundations of Generative AI in Gaming: History of procedural generation; Intro to LLMs, GANs, VAEs, diffusion models; Game design implications; Ethics, control vs creativity, copyright issues; Prompt engineering

Text-Based Generation and Dynamic Narratives: LLMs for interactive storytelling (GPT, Claude, Mistral); Real-time narrative branching; AI-generated quests and dialogues; Maintaining context and player memory; Text-to-JSON game logic generation

Visual Content and Asset Generation: Text-to-image tools (Stable Diffusion, DALL·E 3, MidJourney); Image-to-asset pipelines; Generating 2D sprites and 3D models from prompts; Inpainting and outpainting for scene continuity

Integrated Multimodal Game Content Pipelines: Using Unity/Unreal with GenAI APIs; AI-generated animations (DeepMotion, RADiCAL); Speech synthesis and voice cloning for NPCs; Live LLM agents in Unity/UE; Safety, testing and performance considerations

Reference Books

- 1 Procedural Storytelling in Game Design, Tanya Short & Tarn Adams, 2019, CRC Press.
- 2 Game Development with ChatGPT and OpenAI API, Lee Stringer, 2023, Apress.
- 3 Designing Bots: Creating Conversational Experiences, Amir Shevat, 2017, O Reilly Media.

25ILA3101 - INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3101	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	IIIoT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of Industry 4.0 globalization, sensing, actuation, and communication	3	
CO2	Apply IIoT models, architectures, and computing techniques including big data, fog, and security	3	
CO3	Analyze various IIoT applications across domains such as healthcare, power, oil, and UAV systems	4	
CO4	Design and exercise IIoT components, sensors, actuators, and embedded platforms (Arduino, ESP32, Raspberry Pi)	3	

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, IIoT Layers.

Industrial IIoT Computing: Big Data Analytics and Software Defined Networks, Data Center Networks, Security and Fog Computing in IIoT.

Industrial IIoT Application Domains: Healthcare, Power Systems, Oil, Chemical and Pharmaceutical Industry, Applications of UAVs in Industries, Real Case Studies. Practical: Exercise the behavior of sensors and actuators with communication capabilities; design IIoT applications using Arduino, Wokwi, ESP32, Raspberry Pi Pico W boards.

Reference Books

- 1 Industrial Internet of Things: Cybermanufacturing Systems, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, 1st Edition 2016, Springer.
- 2 The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj, Anupama C. Raman, 1st Edition 2017, CRC Press.
- 3 From 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, 1st Edition 2014, Academic Press.

25ILA3101A - INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3101A	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	IIIoT	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of Industry 4.0 and globalization	3	
CO2	Apply IIoT models and reference architectures	3	
CO3	Apply IIoT computing techniques such as big data, fog, and security	3	
CO4	Analyze various IIoT application domains including healthcare, power, oil, and UAV industries	4	
CO5	Apply IIoT components, sensors, actuators, and development platforms (Arduino, ESP32, Raspberry Pi)	3	

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, IIoT Layers.

Industrial IIoT Computing: Big Data Analytics and Software Defined Networks, Data Center Networks, Security and Fog Computing in IIoT.

Industrial IIoT Application Domains: Healthcare, Power Systems, Oil, Chemical and Pharmaceutical Industry, Applications of UAVs in Industries, Real Case Studies. Practical: Exercise the behavior of sensors and actuators with communication capabilities; design IIoT applications using Arduino, Wokwi, ESP32, Raspberry Pi Pico W boards.

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- 1 From 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, 1st Edition 2014, Academic Press.
- 2 The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj, Anupama C. Raman, 1st Edition 2017, CRC Press.
- 3 Industrial Internet of Things: Cybermanufacturing Systems, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, 1st Edition 2016, Springer.

25ILA3101E - INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3101E	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS	IIIoT	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles of Industry 4.0 and globalization	3	
CO2	Apply IIoT models and reference architectures	3	
CO3	Apply IIoT computing techniques such as big data, fog, and security	3	
CO4	Analyze various IIoT application domains including healthcare, power, oil, and UAV industries	4	
CO5	Apply IIoT components, sensors, actuators, and development platforms (Arduino, ESP32, Raspberry Pi)	3	

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, IIoT Layers.

Industrial IIoT Computing: Big Data Analytics and Software Defined Networks, Data Center Networks, Security and Fog Computing in IIoT.

Industrial IIoT Application Domains: Healthcare, Power Systems, Oil, Chemical and Pharmaceutical Industry, Applications of UAVs in Industries, Real Case Studies. Practical: Exercise the behavior of sensors and actuators with communication capabilities; design IIoT applications using Arduino, Wokwi, ESP32, Raspberry Pi Pico W boards.

Reference Books

- 1 From 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, 1st Edition 2014, Academic Press.
- 2 The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Pethuru Raj, Anupama C. Raman, 1st Edition 2017, CRC Press.
- 3 Industrial Internet of Things: Cybermanufacturing Systems, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, 1st Edition 2016, Springer.

25ILA3202 - INDUSTRIAL AUTOMATION AND ROBOTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3202	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	
CO2	Apply control system principles for automation.	3	
CO3	Analyze characteristics of Industrial Robots.	4	
CO4	Analyze the robotic end effectors and Sensors.	4	

Syllabus

Introduction: 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.

Reference Books

- 1 An Introduction to Robot Technology, Phillipe Collet, 1, Prentice Hall.
- 2 Industrial Automation and Robotics, A.K Gupta, S.K. Arora, 1, Laxmi Publication.
- 3 Industrial Automation and Robotics: An Introduction, Jean Riescher Westcott, 1, Mercury Learning & Information..

25ILA3203 - EDGE COMPUTING FOR INDUSTRY 4.0 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3203	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	
CO2	Examine the Architecture of Edge Computing and explore the issues that are being addressed by the industry.	3	
CO3	Interpret the Middleware needed for Edge Computing and its Security Requirements.	3	
CO4	Assess the need for Edge/Fog Computing in various real-time projects.	3	

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.

Reference Books

- 1 Fog and Edge Computing-Simply Indepth, Singh Ajit, 1, Paperback.
- 2 Edge Computing: A Primer, Jie CaoQuan ZhangWeisong Sh, 1, Springer.
- 3 IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, Perry Lea, 1, Paperback.

25ILA3304 - INDUSTRIAL DRIVES AND CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3304	INDUSTRIAL DRIVES AND CONTROL	ID&C	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select and size electric drive for industrial automation application.	3	
CO2	Analyze dc drives for industrial automation.	4	
CO3	Analyze ac drives for industrial automation.	4	
CO4	Analyze PLC control of industrial drives.	4	

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 Edition, PHI.
- 2 Modern Power Electronics & AC Drives, B. K. Bose, 1st Edition, Pearson.
- 3 Industrial Automation and Robotics, A. K. Gupta, S. K. Arora, 3rd Edition, Laxmi Publications (P) Ltd..

25ILA3304A - INDUSTRIAL DRIVES AND CONTROL (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3304A	INDUSTRIAL DRIVES AND CONTROL	ID&C	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select and size electric drive for industrial automation application.	3	
CO2	Analyze dc drives for industrial automation.	4	
CO3	Analyze ac drives for industrial automation.	4	
CO4	Analyze PLC control of industrial drives.	4	
CO5	Test the dynamics of industrial drives using Software Tools	3	

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 Control (Basics): Induction motor torque expression, Effect of harmonics in input voltage, V/f control, Analog SPWM implementation, Static rotor resistance control.

Advanced Induction Motor Control: Parks Transformation, Clarkes 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 Edition, PHI.
- 2 Modern Power Electronics & AC Drives, B. K. Bose, 1st Edition, Pearson.
- 3 Industrial Automation and Robotics, A. K. Gupta, S. K. Arora, 3rd Edition, Laxmi Publications (P) Ltd..

25ILA3304E - INDUSTRIAL DRIVES AND CONTROL (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3304E	INDUSTRIAL DRIVES AND CONTROL	ID&C	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Select and size electric drive for industrial automation application.	3	
CO2	Analyze dc drives for industrial automation.	4	
CO3	Analyze ac drives for industrial automation.	4	
CO4	Analyze PLC control of industrial drives.	4	
CO5	Test the dynamics of industrial drives using Software Tools	3	

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 Control (Basics): Induction motor torque expression, Effect of harmonics in input voltage, V/f control, Analog SPWM implementation, Static rotor resistance control.

Advanced Induction Motor Control: Parks Transformation, Clarkes 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 Edition, PHI.
- 2 Modern Power Electronics & AC Drives, B. K. Bose, 1st Edition, Pearson.
- 3 Industrial Automation and Robotics, A. K. Gupta, S. K. Arora, 3rd Edition, Laxmi Publications (P) Ltd..

25ILA3405 - INDUSTRIAL COMMUNICATION PROTOCOLS AND CYBER SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3405	INDUSTRIAL COMMUNICATION PROTOCOLS AND CYBER SECURITY	ICPCS	R	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	
CO2	Understanding various industrial protocols and standards is essential for professionals in fields such as industrial automation, control systems engineering, and industrial networking.	2	
CO3	Understanding the concepts of information security and hacking tools is crucial for professionals working in cybersecurity, IT security, and related fields.	2	
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	

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 Cyber Security and Industrial Communication Protocols, Rajveer Singh and Krishna Chand Gupta, 1, Notion Press.
- 2 Industrial Communication Technology Handbook, Richard Zurawski, 1, CRC Press.
- 3 Industrial Communication Systems, Hubert Kirmann, Knut Schwalenberg, and Christine Rossbach, 1, Wiley.

25ILA3406 - DIGITAL MANUFACTURING AND DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3406	DIGITAL MANUFACTURING AND DESIGN	DMD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply Digital thread principles to manufacturing processes	3	
CO2	Apply data analytics for digitalization of manufacturing process	3	
CO3	Analyze cybersecurity for Digitalization of manufacturing processes	4	
CO4	Analyze model based manufacturing systems for digital manufacturing	4	

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

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

Model Based Systems Engineering-Introduction to Systems Engineering, Business Impacts of Systems Engineering, ModelBased 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, Kaushik Kumar, 2019, CRC press.
- 2 Automation, Mikell P. Groover, 2012, PHI Learning.
- 3 Digital Manufacturing: Design, Technology, and Innovation, Luciano Batista, 2015, CRC Press..

25ILA3507 - SMART SENSORS AND SENSOR NETWORKING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3507	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	
CO2	Apply the sensor communication protocols.	3	
CO3	Apply the packaging, testing and reliability of smart sensors	3	
CO4	Apply Power sources for WSN-Power generation-conversion	3	

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 sensorssources 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 Microgrids: Architectures and Control, Nikos Hatziaargyriou, 2014, Wiley-IEEE Press.

25ILA3508 - PLC PROGRAMMING AND CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25ILA3508	PLC PROGRAMMING AND CONTROL	PLCPC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the Programming Logic architecture.	3	
CO2	Apply PLC Programming features	3	
CO3	Apply knowledge PLC Programming for various automation cases	3	
CO4	Apply PLC programming for industrial control applications	3	

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.

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.

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, K. McMillan, 2018, Tata Mc-Graw Hill.
- 3 Introduction to Industrial automation, Stamatios Manesis, 2018, CRC Press.

25IOT3101 - INDUSTRIAL INTERNET OF THINGS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3101	INDUSTRIAL INTERNET OF THINGS	IIOT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3101A - INDUSTRIAL INTERNET OF THINGS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3101A	INDUSTRIAL INTERNET OF THINGS	IIOT	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3101E - INDUSTRIAL INTERNET OF THINGS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3101E	INDUSTRIAL INTERNET OF THINGS	IIOT	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3202 - EDGE COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3202	EDGE COMPUTING	EC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the motivations, architectures, and use-cases of edge computing in IoT systems.	2	
CO2	Analyze and compare edge, fog, and cloud paradigms, and design appropriate architectures.	4	
CO3	Implement the core modules of an IoT + edge setup (e.g. sensor interfacing, protocols, edge analytics).	3	
CO4	Evaluate performance, security, and privacy trade-offs in edge computing systems.	5	

25IOT3203 - PRECISION AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3203	PRECISION AGRICULTURE	PA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3204 - SMART FARMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3204	SMART FARMING	SF	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3305 - DEEP LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3305	DEEP LEARNING	DL	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3305A - DEEP LEARNING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3305A	DEEP LEARNING	DL	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3305E - DEEP LEARNING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3305E	DEEP LEARNING	DL	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3406 - DATA VISUALIZATION TECHNIQUES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3406	DATA VISUALIZATION TECHNIQUES	DVT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3407 - APPLIED MACHINE LEARNING FOR AGRICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3407	APPLIED MACHINE LEARNING FOR AGRICULTURE	AMLA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25IOT3508 - BIG DATA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IOT3508	BIG DATA ANALYTICS	BDA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe foundational concepts and architecture of big data and its ecosystem	2	
CO2	Explain Hadoop architecture and its core components including HDFS and MapReduce	2	
CO3	Apply and differentiate NoSQL database models and query languages (MongoDB, Cassandra, Hive)	3	
CO4	Analyze Spark operations and interpret basic analytics techniques for big data	4	

Syllabus

Introduction to Big Data and Ecosystem, Big Data introduction: Definitions, characteristics (Volume, Variety, Velocity, Veracity), Big Data lifecycle and architecture, Business drivers and applications of Big Data, Difference between traditional data processing and Big Data approaches, Overview of Big Data ecosystems and platforms

Hadoop Fundamentals: Hadoop architecture: HDFS, NameNode, DataNode, and secondary NameNode, Data storage in HDFS Blocks, replication, fault tolerance, Hadoop YARN for resource management, MapReduce programming model: Mapper, Reducer, Combiner, Partitioner (conceptual understanding), Ecosystem components overview: Pig, Hive, HBase

NoSQL Databases and Big Data Warehousing: Need for NoSQL: Limitations of RDBMS for Big Data, Types of NoSQL databases, MongoDB and Cassandra: Data models, CRUD operations, primary features, Hive architecture and Hive Query Language (HQL), Practical examples of query execution in NoSQL and Hive

Apache Spark and Big Data Analytics Techniques: Apache Spark overview and architecture, Resilient Distributed Datasets (RDDs), transformations, and actions, Introduction to Spark SQL and Data Frames, Basic analytics techniques: filtering, grouping, aggregation, Spark MLlib overview: classification, clustering, regression (conceptual), Real-world applications and case studies in Big Data analytics

Reference Books

- 1 Big Data and Analytics, Seema Acharya & Subhashini Chellappan, 1, Willey.
- 2 Hadoop: The Definitive Guide, Tom White, 3, O'Reilly.
- 3 Learning Spark, Holden Karau et al, 1, O'Reilly.
- 4 Big Data Analytics: A Hands-On Approach, Arshdeep Bahga & Vijay Madisetti, 1, VPT Publications.

25MBT3101 - STEM CELL TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3101	STEM CELL TECHNOLOGY	SCT	R	3	0	2	0	4

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	PO4, PO5
CO5	Apply the principles of stem cell culture for upskilling on the practical front	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

Reference Books

- 1 Essentials of Stem Cell Biology, Robert Lanza, 2015, Elsevier Academic Press.
- 2 Tissue Engineering and Artificial Organs Biomedical Engineering Handbook, Joseph D. Bronzino, 2010, CRC Press.
- 3 Tissue Engineering Engineering Principles for the Design of Replacement Organs and Tissues, W. Mark Saltzman, 2004, Oxford University Press.

25MBT3101A - STEM CELL TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3101A	STEM CELL TECHNOLOGY	SCT	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the strategies for isolation and maintenance of embryonic stem cells	3	PO3
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	PO3
CO4	Apply the aspects of stem cell biology in therapy and organ development	3	PO7
CO5	Apply the principles of stem cell technology for upskilling on the practical front	3	, PSO1
CO6	Apply the cell culture techniques to maintain the cells in aseptic conditions and analyze their metabolic activity	3	PO6
CO7	Apply the principles of cell culture in analyzing the mechanism of Tissue healing	3	PO7

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, Robert Lanza, 2015, Elsevier Academic Press.
- 2 Tissue Engineering and Artificial Organs Biomedical Engineering Handbook, 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.

25MBT3101E - STEM CELL TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3101E	STEM CELL TECHNOLOGY	SCT	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the strategies for isolation and maintenance of embryonic stem cells	3	PO3
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	PO3
CO4	Apply the aspects of stem cell biology in therapy and organ development	3	PO4
CO5	Apply the principles of stem cell technology for upskilling on the practical front	3	, PSO1
CO6	Apply the cell culture techniques to maintain the cells in aseptic conditions and analyze their metabolic activity	3	PO7
CO7	Apply the principles of cell culture in analyzing the mechanism of Tissue healing	4	PO7

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, Robert Lanza, 2015, Elsevier Academic Press.
- 2 Tissue Engineering and Artificial Organs Biomedical Engineering Handbook, 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.

25MBT3202 - VIROLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3202	VIROLOGY	VR	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Viral Structure and Function	2	
CO2	Analyzing Viral Pathogenesis and Host Interactions: investigate and analyze the mechanisms of viral pathogenesis, including viral entry, immune evasion	3	
CO3	Exploring Antiviral Strategies and Therapeutics: explore and apply various antiviral strategies, including the development and testing of antiviral drugs	3	
CO4	Investigating Emerging Viral Diseases and Public Health Impact: investigate emerging viral diseases by analyzing epidemiological data, transmission dynamics	3	
CO5	Applying Virological Principles in Research and Healthcare: apply fundamental virological principles in the design and execution of research studies and healthcare applications	3	

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.

25MBT3203 - NANOBIO TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3203	NANOBIO TECHNOLOGY	TE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Nanobiotechnology Fundamentals	2	
CO2	Exploring Nanomaterials in Biomedical Applications	3	
CO3	Investigating Nanosensors and Nanodevices	3	
CO4	Applying Nanobiotechnology in Biotechnology and Environmental Science	3	

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, Amretashis Sengupta (Editor), Chandan Kumar Sarkar (Editor), 2015, Springer.

25MBT3304 - HEALTHCARE BIOTECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3304	HEALTHCARE BIOTECHNOLOGY	HBT	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of simple proteins and therapeutic agents	3	
CO2	Apply the knowledge of Healthcare Biotechnology to understand Human diseases	3	
CO3	Apply the concepts of various vaccines used for diseases	3	
CO4	Apply the applications of genetic engineering in healthcare	3	
CO5	Apply the role of Recombinant Proteins in therapeutic and diagnostic applications	3	
CO6	Apply the Role Biotechnology in Healthcare Experiments	3	

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, Iontophoresis 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, Iontophoresis 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, B. R. Glick, J. J. Pasternak, 1998, ASM Press.
- 2 Technology and Future of Health Care Preparing for the Next 30 Years, Joseph D. Bronzino, 2006, John Wiley.

- 3 Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 2021, W. H. Freeman.

25MBT3304A - HEALTHCARE BIOTECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3304A	HEALTHCARE BIOTECHNOLOGY	HBT	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of simple proteins and therapeutic agents	3	
CO2	Apply the knowledge of Healthcare Biotechnology to understand Human diseases	3	
CO3	Apply the concepts of various vaccines used for diseases	3	
CO4	Apply the applications of genetic engineering in healthcare	3	
CO5	Apply the role of Recombinant Proteins in therapeutic and diagnostic applications	3	
CO6	Apply the Role Biotechnology in Healthcare Experiments	3	
CO7	Apply the Role of various skilling in Healthcare Biotechnology Experiments	3	

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
SME: SARADA PRASANNA MALLICK

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, B. R. Glick, J. J. Pasternak, 1998, ASM Press.
- 2 Technology and Future of Health Care Preparing for the Next 30 Years, Joseph D. Bronzino, 2006, John Wiley.
- 3 Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 2021, W. H. Freeman.

25MBT3304E - HEALTHCARE BIOTECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3304E	HEALTHCARE BIOTECHNOLOGY	HBT	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of simple proteins and therapeutic agents	3	
CO2	Apply the knowledge of Healthcare Biotechnology to understand Human diseases	3	
CO3	Apply the concepts of various vaccines used for diseases	3	
CO4	Apply the applications of genetic engineering in healthcare	3	
CO5	Apply the role of Recombinant Proteins in therapeutic and diagnostic applications	3	
CO6	Apply the Role Biotechnology in Healthcare Experiments	3	
CO7	Apply the Role of various skilling in Healthcare Biotechnology Experiments	3	

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
SME: SARADA PRASANNA MALLICK, yourssarada@kluniversity.in PEC -

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, B. R. Glick, J. J. Pasternak, 1998, ASM Press.
- 2 Technology and Future of Health Care Preparing for the Next 30 Years, Joseph D. Bronzino, 2006, John Wiley.
- 3 Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox, 2021, W. H. Freeman.

25MBT3405 - CANCER BIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3405	CANCER BIOLOGY	CB	R	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	
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	
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	
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	

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, N. J. Dimmock, 1974, Blackwell Scientific Publications.
- 2 Blackwell Scientific Publications, Roger G. B., 2000, Prentice Hall.
- 3 Introduction to Molecular and Cellular Biology of Cancer, Margaret A. Knowles, Peter J. Shelly, 1997, Elsevier Publications.

25MBT3406 - NEUROBIOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3406	NEUROBIOLOGY	NB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the cells and organization of nervous system	2	
CO2	Understand the physiology of the nerve impulse transmission	2	
CO3	Articulate the Sensory and motor system and the underlying neurodegenerative disorders	3	
CO4	Articulate the inter-connectivity between neuroscience and computational engineering	3	

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 .

25MBT3507 - BIOELECTRONICS AND BIOSENSORS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3507	BIOELECTRONICS AND BIOSENSORS	BB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding Bioelectronics Principles	2	
CO2	Designing and Fabricating Biosensors: design and fabricate various types of biosensors, applying various techniques	3	
CO3	3 Analyzing Signal Transduction Mechanisms: investigate and analyze the mechanisms of signal transduction in biosensors	3	
CO4	Applying Bioelectronics & Biosensors in Healthcare and Biotechnology: apply bioelectronics and biosensor technologies in practical scenarios within healthcare and biotechnology	3	

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, Prof. Dr. Itamar Willner, 2005, Wiley..
- 2 Biosensors: Fundamentals and Application, Bansil D. Malhotra and Chandra Mouli Pandey, 2019, De Gruyter.
- 3 Smart Biosensor Technology, By George K. Knopf, 2019, Taylor & Francis.

25MBT3508 - TISSUE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MBT3508	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	
CO2	Apply the knowledge of Tissue culture basics in maintaining cells	3	
CO3	Apply the principles of 3D Tissue organization and angiogenesis	3	
CO4	Apply the role TE components in Cell based Therapies with case studies	3	

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 Principles of Tissue Engineering, Antonios G Mikos, 2000, CRC.

25NT03101 - THIN FILM TECHNOLOGIES FOR NANOELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03101	THIN FILM TECHNOLOGIES FOR NANOELECTRONICS	TTN	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand the principle, differences and similarities, advantages, and disadvantages of different thin film deposition Techniques.	2	
CO2	To understand and evaluate and use models for understanding nucleation and growth of thin films.	3	
CO3	To understand about different instrumentation techniques and to analyze thin film properties to apply for various applications.	3	
CO4	To improve problems solving skills related to evaluation of different properties of thin films.	3	
CO5	Spatial absorption profile inside a layer you must compute field amplitudes in each layer (requires an extension of the TMM routine to return fields). See advanced TMM toolboxes on MATLAB Central and GitHub.	4	

Syllabus

Physical methods: Thermal evaporation, Cathodic sputtering, Molecular beam epitaxy and Laser ablation methods. Chemical methods: Electrolytic deposition, Chemical vapor deposition. Vacuum Technology: Gas Laws, Kinetic Theory of Gases, Conductance and Throughput, Gas Sources in a Vacuum Chamber, Vacuum Pumps.

Growth and Structure of Films: General Features, Nucleation theories, Effect of electron bombardment on film structure, Post-nucleation growth, Epitaxial film growth, Structural defects. Thermodynamics and Thin Film growth, Film Formation and Structure: Capillarity Theory, Atomistic Nucleation processes, Cluster Coalescence, Grain Structure of Films.

Properties of Thin Films Mechanical properties: Elastic and Plastic behavior. Optical properties: Reflectance and transmittance spectra, Absorbing films, Optical constants of film material, Multilayer films, Anisotropic and isotropic films. Electrical properties: Conductivity in metal, Semiconductor and Insulating films, Discontinuous films, Superconducting films.

Thickness Measurement, Characterization and Fabrication: Electrical, Mechanical, Optical, Microbalance, Quartz crystal methods. Analytical techniques of characterization: X-ray diffraction, Electron microscopy, Auger emission spectroscopy. Physical Vapor Deposition: Sputtering (Plasma Physics (DC Diode), RF Plasmas, Magnetic Fields in Plasmas, Sputtering Mechanisms), Evaporation. Chemical Vapor Deposition, Etching: Wet Chemical Etching, Dry Plasma Etching/Reactive Ion Etching. Fabrication Of Thin Films Sol-gel synthesis, Spin coating, Chemical vapor deposition, Physical vapor deposition, Sputtering deposition, ion implantation, Cathodic arc deposition, Pulsed laser deposition, Molecular beam epitaxy, Applications of Thin film devices in nanoelectronics.

Reference Books

- 1 Thin Film Solar Cells, K. L. Chopra and S. R. Das, 1983, Springer.
- 2 Handbook of Thin Film Technology, L. I. Maissel and Glang, 1970, McGraw Hill Higher Education.
- 3 The Use of Thin Films in Physical Investigation, J. C. Anderson, 1966, Academic Press Inc.
- 4 Active and Passive Thin Film Devices, J. J. Coutts, 1978, Academic Press Inc.
- 5 Thin Film Technology, R.W. Berry, P.M. Hall and M.T. Harris, 1968, Van Nostrand.
- 6 Nanostructures & Nanomaterials: Synthesis, Properties & Applications, G. Cao, 2004, Imperial College Press.

25NT03101A - THIN FILM TECHNOLOGIES FOR NANOELECTRONICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03101A	THIN FILM TECHNOLOGIES FOR NANOELECTRONICS	TTN	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand the principle, differences and similarities, advantages, and disadvantages of different thin film deposition Techniques.	2	
CO2	To understand and evaluate and use models for understanding nucleation and growth of thin films.	3	
CO3	To understand about different instrumentation techniques and to analyze thin film properties to apply for various applications.	3	
CO4	To improve problems solving skills related to evaluation of different properties of thin films.	3	
CO5	Apply thin film techniques in nanoelectronics	3	

Syllabus

Physical methods: Thermal evaporation, Cathodic sputtering, Molecular beam epitaxy and Laser ablation methods. Chemical methods: Electrolytic deposition, Chemical vapor deposition. Vacuum Technology: Gas Laws, Kinetic Theory of Gases, Conductance and Throughput, Gas Sources in a Vacuum Chamber, Vacuum Pumps.

Growth and Structure of Films General Features, Nucleation theories, Effect of electron bombardment on film structure, Post-nucleation growth, Epitaxial film growth, Structural defects. Thermodynamics and Thin Film growth, Film Formation and Structure: Capillarity Theory, Atomistic Nucleation processes, Cluster Coalescence, Grain Structure of Films.

Properties of Thin Films Mechanical properties: Elastic and Plastic behavior. Optical properties: Reflectance and transmittance spectra, Absorbing films, Optical constants of film material, Multilayer films, Anisotropic and isotropic films. Electrical properties: Conductivity in metal, Semiconductor and Insulating films, Discontinuous films, Superconducting films.

Thickness Measurement, Characterization and Fabrication Electrical, Mechanical, Optical, Microbalance, Quartz crystal methods. Analytical techniques of characterization: X-ray diffraction, Electron microscopy, Auger emission spectroscopy. Physical Vapor Deposition: Sputtering (Plasma Physics (DC Diode), RF Plasmas, Magnetic Fields in Plasmas, Sputtering Mechanisms), Evaporation. Chemical Vapor Deposition, Etching: Wet Chemical Etching, Dry Plasma Etching/Reactive Ion Etching. Fabrication Of Thin Films Sol-gel synthesis, Spin coating, Chemical vapor deposition, Physical vapor deposition, Sputtering deposition, ion implantation, Cathodic arc deposition, Pulsed laser deposition, Molecular beam epitaxy, Applications of Thin film devices in nanoelectronics.

Reference Books

- 1 Thin Film Phenomena, K.L. Chopra, 1969, McGraw-Hill.
- 2 Physics of Thin Films, George Hass, 1963, Academic Press Inc.

25NT03101E - THIN FILM TECHNOLOGIES FOR NANO ELECTRONICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03101E	THIN FILM TECHNOLOGIES FOR NANO ELECTRONICS	TTN	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand the principle, differences and similarities, advantages, and disadvantages of different thin film deposition Techniques.	2	
CO2	To understand and evaluate and use models for understanding nucleation and growth of thin films	3	
CO3	To understand about different instrumentation techniques and to analyze thin film properties to apply for various applications	3	
CO4	To improve problems solving skills related to evaluation of different properties of thin films	3	
CO5	Spatial absorption profile inside a layer you must compute field amplitudes in each layer (requires an extension of the TMM routine to return fields). See advanced TMM toolboxes on MATLAB Central and GitHub.	4	

Syllabus

Physical methods: Thermal evaporation, Cathodic sputtering, Molecular beam epitaxy and Laser ablation methods. Chemical methods: Electrolytic deposition, Chemical vapor deposition. Vacuum Technology: Gas Laws, Kinetic Theory of Gases, Conductance and Throughput, Gas Sources in a Vacuum Chamber, Vacuum Pumps.

Growth and Structure of Films: General Features, Nucleation theories, Effect of electron bombardment on film structure, Post-nucleation growth, Epitaxial film growth, Structural defects. Thermodynamics and Thin Film growth, Film Formation and Structure: Capillarity Theory, Atomistic Nucleation processes, Cluster Coalescence, Grain Structure of Films.

Properties of Thin Films Mechanical properties: Elastic and Plastic behavior. Optical properties: Reflectance and transmittance spectra, Absorbing films, Optical constants of film material, Multilayer films, Anisotropic and isotropic films. Electrical properties: Conductivity in metal, Semiconductor and Insulating films, Discontinuous films, Superconducting films

Thickness Measurement, Characterization and Fabrication: Electrical, Mechanical, Optical, Microbalance, Quartz crystal methods. Analytical techniques of characterization: X-ray diffraction, Electron microscopy, Auger emission spectroscopy. Physical Vapor Deposition: Sputtering (Plasma Physics (DC Diode), RF Plasmas, Magnetic Fields in Plasmas, Sputtering Mechanisms), Evaporation. Chemical Vapor Deposition, Etching: Wet Chemical Etching, Dry Plasma Etching/Reactive Ion Etching. Fabrication Of Thin Films Sol-gel synthesis, Spin coating, Chemical vapor deposition, Physical vapor deposition, Sputtering deposition, ion implantation, Cathodic arc deposition, Pulsed laser deposition, Molecular beam epitaxy, Applications of Thin film devices in nanoelectronics.

Reference Books

- 1 Thin Film Phenomena, K.L. Chopra, 1969, McGraw-Hill.
- 2 Physics of Thin Films, George Hass, 1963, Academic Press Inc.
- 3 Thin Film Solar Cells, K. L. Chopra and S. R. Das, 1983, Springer.
- 4 Handbook of Thin Film Technology, L. I. Maissel and Glang, 1970, McGraw Hill Higher Education.
- 5 The Use of Thin Films in Physical Investigation, J. C. Anderson, 1966, Academic Press Inc.
- 6 Active and Passive Thin Film Devices, J. J. Coutts, 1978, Academic Press Inc.

25NT03102 - NANOSCALE ENGINEERING FOR CLEAN ENERGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03102	NANOSCALE ENGINEERING FOR CLEAN ENERGY	NEC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to understand the fundamental electrochemical concepts including cell potentials, thermodynamics, kinetics, and the electrode behavior of energy storage systems for real world applications.	2	
CO2	Able to analyze photovoltaic energy conversion mechanisms and differentiate between types of solar cells, with a focus on comparing nanomaterial-based photovoltaic technologies for improved solar energy harvesting.	4	
CO3	Able to analyze the principles of nanostructured materials for energy storage and examine the performance of materials and battery systems in lithium-ion and hybrid energy storage applications.	4	
CO4	Able to analyze the mechanisms and material requirements of nanogenerators and hydrogen energy systems, and inspect the material suitability, functionality, and challenges in implementing practical renewable energy harvesting solutions.	4	
CO5	Able to design, simulate, and evaluate various energy systems such as batteries, supercapacitors, and energy harvesters, and assess the effectiveness of different configurations for energy storage and harvesting applications.	5	

Syllabus

Fundamental Concepts in Energy Systems: Electrochemical cell concepts, Nernst equation, Faradays laws, Electrode Potentials, Thermodynamics of electrochemical cells, Polarization losses in electrochemical cells, Electrode process and kinetics, Electrical double layer, Photoelectrochemical cell.

Nanomaterials for Photovoltaic Solar Energy Conversion Systems: Principles of photovoltaic energy conversion (PV), Types of photovoltaics Cells, Organic photovoltaic cells, thin film Dye Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Perovskite solar cells, Organic-Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells, Solar-water splitting, Current status and future trends.

Nanomaterials for Energy Storage (Batteries) Systems: Nanostructured Materials for electrochemical Energy Storage Systems, Primary and Secondary Batteries (Lithium-ion Batteries), Cathode and anode materials, redox-flow batteries for HEV/EV transportation and stationary applications, Nanostructured Carbon-based materials, Nano-Oxides, Novel hybrid electrode materials, Current status and future trends.

Renewable Energy: Nanogenerators and Hydrogen Energy Systems: Types of Nanogenerators: Piezoelectric, Thermoelectric, Pyro-electric, Electromagnetic, and Triboelectric, Key challenges for choosing nanomaterials for nanogenerators. Hydrogen energy generation, nanomaterials used for hydrogen energy generation & storage, methods to produce hydrogen energy and its key challenges, Current status and future trends.

Design and simulation of energy storage and harvesting systems including batteries, supercapacitors, and energy harvesters (piezoelectric, triboelectric, thermoelectric). Evaluation of system performance using MATLAB

Reference Books

- 1 Electrochemical methods: Fundamentals and Applications, Allen J. Bard and Larry R. Faulkner, 2nd Edition, John Wiley & Sons. Inc..
- 2 Handbook of Batteries, D. Linden, 2nd edition, McGraw-Hill, New York..
- 3 Lithium Batteries: Science and Technology, G.A. Nazri and G. Pistoia, -, Kulwer Academic Publishers.

- 4 Fuel Cell System Explained, J. Larminie and A. Dicks, -, John Wiley, New York.
- 5 Nanogenerators: Basic Concepts, Design Strategies, and Applications, Inamuddin, M. I. Ahamed, R. Boddula and T. Altalhi, 1st Edition, CRC Press.
- 6 Photoelectrochemical hydrogen generation, theory, materials advances, and challenges, Pooja Devi, -, Springer Publications.

25NT03102A - NANOSCALE ENGINEERING FOR CLEAN ENERGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03102A	NANOSCALE ENGINEERING FOR CLEAN ENERGY	NEC	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to understand the fundamental electrochemical concepts including cell potentials, thermodynamics, kinetics, and the electrode behavior of energy storage systems for real world applications.	2	
CO2	Able to analyze photovoltaic energy conversion mechanisms and differentiate between types of solar cells, with a focus on comparing nanomaterial-based photovoltaic technologies for improved solar energy harvesting.	4	
CO3	Able to analyze the principles of nanostructured materials for energy storage and examine the performance of materials and battery systems in lithium-ion and hybrid energy storage applications.	4	
CO4	Able to analyze the mechanisms and material requirements of nanogenerators and hydrogen energy systems, and inspect the material suitability, functionality, and challenges in implementing practical renewable energy harvesting solutions.	4	
CO5	Able to analyze hazardous waste and nanopollution using nanoscale techniques, and differentiate nanomaterial-based remediation methods like nano membranes, meshes, fibers, clays, zeolites, and catalysts for effective soil and water cleanup.	4	
CO6	Able to simulate, and evaluate energy systems like batteries, supercapacitors, and energy harvesters based on key parameters such as energy density, power density, efficiency, charge/discharge rate, cycle life, cost, and scalability.	5	

Syllabus

Fundamental Concepts in Energy Systems: Electrochemical cell concepts, Nernst equation, Faradays laws, Electrode Potentials, Thermodynamics of electrochemical cells, Polarization losses in electrochemical cells, Electrode process and kinetics, Electrical double layer, Photoelectrochemical cell.

Nanomaterials for Photovoltaic Solar Energy Conversion Systems: Principles of photovoltaic energy conversion (PV), Types of photovoltaics Cells, Organic photovoltaic cells, thin film Dye Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Perovskite solar cells, Organic-Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells, Solar-water splitting, Current status and future trends.

Nanomaterials for Energy Storage (Batteries) Systems: Nanostructured Materials for electrochemical Energy Storage Systems, Primary and Secondary Batteries (Lithium-ion Batteries), Cathode and anode materials, redox-flow batteries for HEV/EV transportation and stationary applications, Nanostructured Carbonbased materials, Nano-Oxides, Novel hybrid electrode materials, Current status and future trends.

Renewable Energy: Nanogenerators and Hydrogen Energy Systems: Types of Nanogenerators: Piezoelectric, Thermoelectric, Pyroelectric, Electromagnetic, and Triboelectric, Key challenges for choosing nanomaterials for nanogenerators. Hydrogen energy generation, nanomaterials used for hydrogen energy generation & storage, methods to produce hydrogen energy and its key challenges, Current status and future trends.

Nanotechnology in Remediation: Identification and characterization of hazardous waste, nano pollution, soil and water contaminants, nanomaterials-remediation: Nano membranes, nano meshes, nano fibers, nano clays, zeolites and nano catalysts.

Design and simulation of energy storage and harvesting systems including batteries, supercapacitors, and energy harvesters (piezoelectric, triboelectric, thermoelectric). Evaluation of system performance using MATLAB

Reference Books

- 1 Electrochemical methods: Fundamentals and Applications, Allen J. Bard and Larry R. Faulkner, 2nd Edition, John Wiley & Sons. Inc. .
- 2 Handbook of Batteries, D. Linden, 2nd edition, McGraw-Hill, New York. .
- 3 Lithium Batteries: Science and Technology, G.A. Nazri and G. Pistoia, -, Kulwer Academic Publishers.
- 4 Fuel Cell System Explained, J. Larminie and A. Dicks, -, John Wiley, New York.
- 5 Nanogenerators: Basic Concepts, Design Strategies, and Applications, Inamuddin, M. I. Ahamed, R. Boddula and T. Altalhi, 1st Edition, CRC Press.
- 6 Photoelectrochemical hydrogen generation, theory, materials advances, and challenges, Pooja Devi, -, Springer Publications.

25NT03102E - NANOSCALE ENGINEERING FOR CLEAN ENERGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03102E	NANOSCALE ENGINEERING FOR CLEAN ENERGY	NEC	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to understand the fundamental electrochemical concepts including cell potentials, thermodynamics, kinetics, and the electrode behavior of energy storage systems for real world applications.	2	
CO2	Able to analyze photovoltaic energy conversion mechanisms and differentiate between types of solar cells, with a focus on comparing nanomaterial-based photovoltaic technologies for improved solar energy harvesting.	4	
CO3	Able to analyze the principles of nanostructured materials for energy storage and examine the performance of materials and battery systems in lithium-ion and hybrid energy storage applications.	4	
CO4	Able to analyze the mechanisms and material requirements of nanogenerators and hydrogen energy systems, and inspect the material suitability, functionality, and challenges in implementing practical renewable energy harvesting solutions.	4	
CO5	Able to analyze hazardous waste and nanopollution using nanoscale techniques, and differentiate nanomaterial-based remediation methods like nano membranes, meshes, fibers, clays, zeolites, and catalysts for effective soil and water cleanup.	4	
CO6	Able to simulate, and evaluate energy systems like batteries, supercapacitors, and energy harvesters based on key parameters such as energy density, power density, efficiency, charge/discharge rate, cycle life, cost, and scalability.	5	

Syllabus

Fundamental Concepts in Energy Systems: Electrochemical cell concepts, Nernst equation, Faradays laws, Electrode Potentials, Thermodynamics of electrochemical cells, Polarization losses in electrochemical cells, Electrode process and kinetics, Electrical double layer, Photoelectrochemical cell.

Nanomaterials for Photovoltaic Solar Energy Conversion Systems: Principles of photovoltaic energy conversion (PV), Types of photovoltaics Cells, Organic photovoltaic cells, thin film Dye Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Perovskite solar cells, Organic-Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells, Solar-water splitting, Current status and future trends.

Nanomaterials for Energy Storage (Batteries) Systems: Nanostructured Materials for electrochemical Energy Storage Systems, Primary and Secondary Batteries (Lithium-ion Batteries), Cathode and anode materials, redox-flow batteries for HEV/EV transportation and stationary applications, Nanostructured Carbonbased materials, Nano-Oxides, Novel hybrid electrode materials, Current status and future trends.

Renewable Energy: Nanogenerators and Hydrogen Energy Systems: Types of Nanogenerators: Piezoelectric, Thermoelectric, Pyroelectric, Electromagnetic, and Triboelectric, Key challenges for choosing nanomaterials for nanogenerators. Hydrogen energy generation, nanomaterials used for hydrogen energy generation & storage, methods to produce hydrogen energy and its key challenges, Current status and future trends.

Nanotechnology in Remediation: Identification and characterization of hazardous waste, nano pollution, soil and water contaminants, nanomaterials-remediation: Nano membranes, nano meshes, nano fibers, nano clays, zeolites and nano catalysts.

Design and simulation of energy storage and harvesting systems including batteries, supercapacitors, and energy harvesters (piezoelectric, triboelectric, thermoelectric). Evaluation of system performance using MATLAB

Reference Books

- 1 Electrochemical methods: Fundamentals and Applications, Allen J. Bard and Larry R. Faulkner, 2nd Edition, John Wiley & Sons. Inc..
- 2 Handbook of Batteries, D. Linden, 2nd edition, McGraw-Hill, New York..
- 3 Lithium Batteries: Science and Technology, G.A. Nazri and G. Pistoia, -, Kulwer Academic Publishers.
- 4 Fuel Cell System Explained, J. Larminie and A. Dicks, -, John Wiley, New York.
- 5 Nanogenerators: Basic Concepts, Design Strategies, and Applications, Inamuddin, M. I. Ahamed, R. Boddula and T. Altalhi, 1st Edition, CRC Press.
- 6 Photoelectrochemical hydrogen generation, theory, materials advances, and challenges, Pooja Devi, -, Springer Publications.

25NT03203 - NANOTECHNOLOGY AND NANOSENSORS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03203	NANOTECHNOLOGY AND NANOSENSORS	NAN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of nanotechnology and nanoscale materials	2	
CO2	Apply nanomaterials in the design and development of sensors.	2	
CO3	Analyze the working principles of nanosensors for physical, chemical, and biological detection	3	
CO4	Evaluate performance metrics such as sensitivity, selectivity, and stability of nanosensors.	3	

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 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 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 Nanomaterials for Biosensors, CS Kumar, 2007, Wiley.
- 2 Smart Biosensor Technology, G.K. Knoff, A.S. Bassi, 2006, CRC Press.

25NTO3204 - NANOPHOTONICS AND BIOPHOTONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NTO3204	NANOPHOTONICS AND BIOPHOTONICS	NAB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental principles of nanophotonics and biophotonics.	2	
CO2	Identify various nanophotonic and biophotonic materials and devices.	3	
CO3	Apply nanophotonic and biophotonic concepts in sensing and imaging applications.	3	
CO4	Analyze nanophotonic structures for healthcare and environmental diagnostics.	4	

Syllabus

Fundamentals of Nanophotonics and Biophotonics Nanophotonics Introduction to nanophotonics lightmatter interaction at the nanoscale quantum confinement nanoscale optics and photonic crystals Biophotonics Basics of lighttissue interactions principles of fluorescence Raman scattering and optical coherence in biological systems

Nanophotonic and Biophotonic Materials and Devices Nanophotonic materials Plasmonic nanostructures metamaterials quantum dots and photonic crystals Biophotonic devices Waveguides biosensors optical tweezers and biochips Fabrication methods Nanofabrication techniques including ebeam lithography focused ion beam FIB milling nanosphere lithography and chemical vapor deposition CVD

Nanophotonics and Biophotonics in Sensing and Imaging Nanophotonic sensors Surface plasmon resonance SPR localized surface plasmon resonance LSPR photonic crystal fibers and metamaterial based sensors Biophotonic applications Optical coherence tomography OCT confocal microscopy fluorescence imaging and Raman spectroscopy in diagnostics Healthcare diagnostics Cancer detection tissue imaging and point of care diagnostic devices

Applications of Nanophotonics and Biophotonics Energy applications Nanophotonic devices for solar cells and LEDs light manipulation and photonic integrated circuits Biomedical applications Nanophotonic devices for bioimaging biosensing drug delivery systems and photothermal therapy Environmental sensing Nanophotonic sensors for water quality monitoring pollution detection and environmental diagnostics

Reference Books

- 1 Nanophotonics with Surface Plasmons, S. Kawata, V. M. Shalaev, 2007, Elsevier.
- 2 , Principles of Nonlinear Optics, Y. R. Shen, 2002, Wiley-Interscience.
- 3 Absorption and Scattering of Light by Small Particles, C. F. Bohren, D. R. Huffman, 1983, Wiley.

25NTO3305 - NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NTO3305	NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS	NBA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts of nanomaterials including their size-dependent properties, biomimicry principles, and synthesis methods (physical, chemical, and biological).	3	
CO2	Demonstrate an understanding of nanomaterial characterization techniques and their relevance in analyzing structural, morphological, and functional properties.	4	
CO3	Analyze bio-nanotechnology platforms such as DNA nanotechnology, protein and glyco nanotechnology, lipid nanotechnology, and carbon nanotubes for applications in sensing, targeted delivery, and nanomachinery.	4	
CO4	Evaluate the therapeutic applications of nanomaterials in cancer diagnosis, cancer therapy, regenerative medicine, tissue engineering, nano-artificial cells, and organ bioprinting.	3	
CO5	Apply nanotechnology principles in diagnostics and drug delivery, including point-of-care systems, nanopharmacology, and cellular uptake mechanisms.	4	

Syllabus

Critically examine the potential risks and toxicological aspects of nanomaterials, ensuring safe and responsible use of nanotechnology in biomedical and healthcare applications.

: Bio-Nanotechnology Platforms: DNA nanotechnology, DNA origami, self-assembly, and applications in sensing and targeted delivery. Protein & glyco nanotechnology, functional glyconanomaterials, enzyme immobilization, Lipid nanotechnology, Liposomes, Bio-nanomachines, Carbon nanotube and its bio-applications.

Applications in Therapy and Regenerative Medicine: Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering, Nano artificial cells, Nanotechnology in organ printing: 3D bioprinting.

Diagnostics, Drug Delivery, and Toxicity: Nanotechnology in point-of-care diagnostics, Nanopharmacology & drug targeting, Cellular uptake mechanisms of nanomaterials, In vitro methods to study antibacterial and anticancer properties of nanomaterials, Nanotoxicology.

Reference Books

- 1 Biomedical Nanotechnology, Malsch, N.H., , CRC Press. (2005), CRC Press. .
- 2 Nanobiotechnology II: More Concepts and Applications, Mirkin, C.A. and Niemeyer, C.M., Wiley-VCH. (2007)., Wiley-VCH. (2007)..

25NT03305A - NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03305A	NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS	NBA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts of nanomaterials, their size-dependent properties, and biomimicry principles for mimicking biological systems.	3	
CO2	Compare and apply different synthesis techniques (physical, chemical, and biological) and characterization methods for nanomaterials.	3	
CO3	Analyze various bio-nanotechnology platforms including DNA nanotechnology, protein/glyco nanotechnology, lipid nanotechnology, and carbon nanotube systems for sensing, targeted delivery, and biomedical applications.	3	
CO4	Evaluate the use of nanomaterials in therapeutic applications such as cancer diagnosis and therapy, regenerative medicine, tissue engineering, artificial cells, and 3D bioprinting.	4	
CO5	Apply nanotechnology principles in drug delivery and diagnostics, and assess cellular uptake mechanisms of nanomaterials.	4	
CO6	Investigate antibacterial and anticancer properties of nanomaterials through in vitro studies and critically assess nanotoxicological impacts on biological systems.	4	

Syllabus

Fundamentals of Nanomaterials and Biomimicry: Introduction to nano, basic concepts of nanotechnology, size dependent properties, Nano-biomimicry: Principles, mimicking biological systems, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterisation of nanomaterials.

DNA nanotechnology, DNA origami, self-assembly, and applications in sensing and targeted delivery. Protein & glyco nanotechnology, functional glyconanomaterials, enzyme immobilization, Lipid nanotechnology, Liposomes, Bio-nanomachines, Carbon nanotube and its bio-applications.

Applications in Therapy and Regenerative Medicine: Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering, Nano artificial cells, Nanotechnology in organ printing: 3D bioprinting.

Diagnostics, Drug Delivery, and Toxicity: Nanotechnology in point-of-care diagnostics,

Nanopharmacology & drug targeting, Cellular uptake mechanisms of nanomaterials, In vitro methods to study antibacterial and anticancer properties of nanomaterials, Nanotoxicology.

Reference Books

- 1 Biomedical Nanotechnology, Malsch, N.H, 2005, CRC Press.
- 2 Nanobiotechnology II: More Concepts and Applications, Mirkin, C.A. and Niemeyer, C.M, 2007, Wiley-VCH.
- 3 Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact, Kumar, C. S. S. R., Hormes, J. and Leuschner C, 2005, WILEY -VCH Verlag GmbH & Co.

25NTO3305E - NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NTO3305E	NANOMATERIALS FOR BIO-MEDICAL APPLICATIONS	NBA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamentals of nanomaterials, their size-dependent properties, and biomimetic principles used to mimic biological systems.	3	
CO2	Describe and compare various physical, chemical, and biological methods of synthesizing nanomaterials and their characterization techniques.	3	
CO3	Analyze bio-nanotechnology platforms such as DNA nanotechnology, protein/glyco nanotechnology, lipid nanotechnology, and carbon nanotubes for sensing, delivery, and other biomedical applications.	3	
CO4	Evaluate the applications of nanomaterials in cancer diagnosis/therapy, tissue engineering, nano-artificial cells, and 3D bioprinting for regenerative medicine.	4	
CO5	Assess nanotechnology-based diagnostics, targeted drug delivery, and mechanisms of cellular uptake along with in vitro studies of antibacterial and anticancer activity.	4	
CO6	Discuss the principles and implications of nanotoxicology for safe design and application of nanomaterials in healthcare.	4	

Syllabus

Fundamentals of Nanomaterials and Biomimicry: Introduction to nano, basic concepts of nanotechnology, size dependent properties, Nano-biomimicry: Principles, mimicking biological systems, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterisation of nanomaterials.

Bio-Nanotechnology Platforms: DNA nanotechnology, DNA origami, self-assembly, and applications in sensing and targeted delivery. Protein & glyco nanotechnology, functional glyconanomaterials, enzyme immobilization, Lipid nanotechnology, Liposomes, Bio-nanomachines, Carbon nanotube and its bio-applications.

Applications in Therapy and Regenerative Medicine: Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering, Nano artificial cells, Nanotechnology in organ printing: 3D bioprinting.

Diagnostics, Drug Delivery, and Toxicity: Nanotechnology in point-of-care diagnostics,

Nanopharmacology & drug targeting, Cellular uptake mechanisms of nanomaterials, In vitro methods to study antibacterial and anticancer properties of nanomaterials, Nanotoxicology.

Reference Books

- 1 Nanotherapeutics: Drug Delivery Concepts in Nanoscience, Lamprecht, A., , 2009, Pan Stanford Publishing Pte. Ltd..
- 2 The Handbook of Nanomedicine, Jain, K.K., , 2008, Humana press.

25NTO3306 - NANOROBOTICS FOR ADVANCED APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NTO3306	NANOROBOTICS FOR ADVANCED APPLICATIONS	NAA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Nanorobotics and Nanosystems: Definition, scope, and significance of nanorobotics Historical background and future trends Building blocks: nanomaterials, nanoactuators, nanosensors, and power systems Scaling laws and miniaturization challenges. Fabrication strategies: Top-down and bottom-up approaches.	4	
CO2	Design and Fabrication of Nanorobots: Structural and functional design of nanorobots Bio-inspired and hybrid nanorobot architectures Fabrication techniques: Lithography, self-assembly, chemical synthesis, molecular manufacturing Nanomanipulation tools: AFM, STM, optical tweezers, electron beam lithography Materials for nanorobots: DNA, polymers, CNTs, magnetic and piezoelectric materials.	4	
CO3	Locomotion, Sensing, and Control Mechanisms: Locomotion techniques: magnetic, chemical, acoustic, thermal, biological Sensing mechanisms: chemical sensors, tactile sensors, biosensors Onboard computation and autonomous control Communication in nanorobot swarms Navigation and localization in biological and fluidic environments.	4	
CO4	Emerging Applications and Ethical Considerations: Targeted drug delivery and controlled release Cancer cell targeting and destruction Minimally invasive surgical nanorobots In vivo biosensing and diagnostics, Nanorobots in environmental remediation Industrial and precision manufacturing applications, Risk assessment Ethical, legal, and societal implications of nanorobotics.	4	

Syllabus

Introduction to Nanorobotics and Nanosystems: Definition, scope, and significance of nanorobotics Historical background and future trends Building blocks: nanomaterials, nanoactuators, nanosensors, and power systems Scaling laws and miniaturization challenges. Fabrication strategies: Top-down and bottom-up approaches.

Design and Fabrication of Nanorobots: Structural and functional design of nanorobots Bio-inspired and hybrid nanorobot architectures Fabrication techniques: Lithography, self-assembly, chemical synthesis, molecular manufacturing Nanomanipulation tools: AFM, STM, optical tweezers, electron beam lithography Materials for nanorobots: DNA, polymers, CNTs, magnetic and piezoelectric materials.

Locomotion, Sensing, and Control Mechanisms: Locomotion techniques: magnetic, chemical, acoustic, thermal, biological Sensing mechanisms: chemical sensors, tactile sensors, biosensors Onboard computation and autonomous control Communication in nanorobot swarms Navigation and localization in biological and fluidic environments.

Emerging Applications and Ethical Considerations: Targeted drug delivery and controlled release Cancer cell targeting and destruction Minimally invasive surgical nanorobots In vivo biosensing and diagnostics, Nanorobots in environmental remediation Industrial and precision manufacturing applications, Risk assessment Ethical, legal, and societal implications of nanorobotics.

Reference Books

- 1 Nanorobotics: Current Approaches and Techniques , S. Sahoo , 1, IOP Publishing, 2021 .
- 2 Springer Handbook of Nanotechnology , Bharat Bhushan , 1, Springer, 2017 .
- 3 Introduction to Nanorobotics , Radhika Vathsan , 1, Alpha Science International, 2020 .
- 4 Robotic Microassembly , Michael Gauthier, Serge Regnier , 1, Wiley-ISTE, 2010 .

- 5 Nanorobotics and Nanomedicine , S. R. Rajan , 1, Elsevier Academic Press, 2022 .
- 6 Nanorobots for Biomedical Applications , M. Kumar et al , 1, CRC Press, 2023 .

25NTO3306A - NANOROBOTICS FOR ADVANCED APPLICATIONS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NTO3306A	NANOROBOTICS FOR ADVANCED APPLICATIONS	NAA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Nanorobotics and Nanosystems: Definition, scope, and significance of nanorobotics Historical background and future trends Building blocks: nanomaterials, nanoactuators, nanosensors, and power systems Scaling laws and miniaturization challenges Fabrication strategies: Top-down and bottom-up approaches	4	
CO2	Design and Fabrication of Nanorobots: Structural and functional design of nanorobots Bio-inspired and hybrid nanorobot architectures Fabrication techniques: Lithography, self-assembly, chemical synthesis, molecular manufacturing Nanomanipulation tools: AFM, STM, optical tweezers, electron beam lithography Materials for nanorobots: DNA, polymers, CNTs, magnetic and piezoelectric materials.	4	
CO3	Locomotion, Sensing, and Control Mechanisms: Locomotion techniques: magnetic, chemical, acoustic, thermal, biological Sensing mechanisms: chemical sensors, tactile sensors, biosensors Onboard computation and autonomous control Communication in nanorobot swarms Navigation and localization in biological and fluidic environments.	4	
CO4	Emerging Applications and Ethical Considerations: Targeted drug delivery and controlled release Cancer cell targeting and destruction Minimally invasive surgical nanorobots In vivo biosensing and diagnostics, Nanorobots in environmental remediation Industrial and precision manufacturing applications, Risk assessment Ethical, legal, and societal implications of nanorobotics.	4	

Syllabus

Introduction to Nanorobotics and Nanosystems: Definition, scope, and significance of nanorobotics Historical background and future trends Building blocks: nanomaterials, nanoactuators, nanosensors, and power systems Scaling laws and miniaturization challenges Fabrication strategies: Top-down and bottom-up approaches

Design and Fabrication of Nanorobots: Structural and functional design of nanorobots Bio-inspired and hybrid nanorobot architectures Fabrication techniques: Lithography, self-assembly, chemical synthesis, molecular manufacturing Nanomanipulation tools: AFM, STM, optical tweezers, electron beam lithography Materials for nanorobots: DNA, polymers, CNTs, magnetic and piezoelectric materials.

Locomotion, Sensing, and Control Mechanisms: Locomotion techniques: magnetic, chemical, acoustic, thermal, biological Sensing mechanisms: chemical sensors, tactile sensors, biosensors Onboard computation and autonomous control Communication in nanorobot swarms Navigation and localization in biological and fluidic environments.

Emerging Applications and Ethical Considerations: Targeted drug delivery and controlled release Cancer cell targeting and destruction Minimally invasive surgical nanorobots In vivo biosensing and diagnostics, Nanorobots in environmental remediation Industrial and precision manufacturing applications, Risk assessment Ethical, legal, and societal implications of nanorobotics.

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- 1 Nanorobotics: Current Approaches and Techniques, S. Sahoo, 1, IOP Publishing, 2021.
- 2 Springer Handbook of Nanotechnology, Bharat Bhushan, 1, Springer, 2017.
- 3 Introduction to Nanorobotics, Radhika Vathsan, 1, Alpha Science International, 2020.
- 4 Robotic Microassembly, Michael Gauthier, Serge Regnier, 1, Wiley-ISTE, 2010.

- 5 Nanorobotics and Nanomedicine, S. R. Rajan, 1, Elsevier Academic Press, 2022.
- 6 Nanorobots for Biomedical Applications, M. Kumar et al, 1, CRC Press, 2023.

25NTO3306E - NANOROBOTICS FOR ADVANCED APPLICATIONS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NTO3306E	NANOROBOTICS FOR ADVANCED APPLICATIONS	NAA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Nanorobotics and Nanosystems: Definition, scope, and significance of nanorobotics Historical background and future trends Building blocks: nanomaterials, nanoactuators, nanosensors, and power systems Scaling laws and miniaturization challenges Fabrication strategies: Top-down and bottom-up approaches	4	
CO2	Design and Fabrication of Nanorobots: Structural and functional design of nanorobots Bio-inspired and hybrid nanorobot architectures Fabrication techniques: Lithography, self-assembly, chemical synthesis, molecular manufacturing Nanomanipulation tools: AFM, STM, optical tweezers, electron beam lithography Materials for nanorobots: DNA, polymers, CNTs, magnetic and piezoelectric materials.	4	
CO3	Locomotion, Sensing, and Control Mechanisms: Locomotion techniques: magnetic, chemical, acoustic, thermal, biological Sensing mechanisms: chemical sensors, tactile sensors, biosensors Onboard computation and autonomous control Communication in nanorobot swarms Navigation and localization in biological and fluidic environments.	4	
CO4	Emerging Applications and Ethical Considerations: Targeted drug delivery and controlled release Cancer cell targeting and destruction Minimally invasive surgical nanorobots In vivo biosensing and diagnostics, Nanorobots in environmental remediation Industrial and precision manufacturing applications, Risk assessment Ethical, legal, and societal implications of nanorobotics.	4	

Syllabus

Introduction to Nanorobotics and Nanosystems: Definition, scope, and significance of nanorobotics Historical background and future trends Building blocks: nanomaterials, nanoactuators, nanosensors, and power systems Scaling laws and miniaturization challenges Fabrication strategies: Top-down and bottom-up approaches

Design and Fabrication of Nanorobots: Structural and functional design of nanorobots Bio-inspired and hybrid nanorobot architectures Fabrication techniques: Lithography, self-assembly, chemical synthesis, molecular manufacturing Nanomanipulation tools: AFM, STM, optical tweezers, electron beam lithography Materials for nanorobots: DNA, polymers, CNTs, magnetic and piezoelectric materials.

Locomotion, Sensing, and Control Mechanisms: Locomotion techniques: magnetic, chemical, acoustic, thermal, biological Sensing mechanisms: chemical sensors, tactile sensors, biosensors Onboard computation and autonomous control Communication in nanorobot swarms Navigation and localization in biological and fluidic environments.

Emerging Applications and Ethical Considerations: Targeted drug delivery and controlled release Cancer cell targeting and destruction Minimally invasive surgical nanorobots In vivo biosensing and diagnostics, Nanorobots in environmental remediation Industrial and precision manufacturing applications, Risk assessment Ethical, legal, and societal implications of nanorobotics.

Reference Books

- 1 Nanorobotics: Current Approaches and Techniques, S. Sahoo, 1, IOP Publishing, 2021.
- 2 Springer Handbook of Nanotechnology, Bharat Bhushan, 1, Springer, 2017.
- 3 Introduction to Nanorobotics, Radhika Vathsan, 1, Alpha Science International, 2020.
- 4 Robotic Microassembly, Michael Gauthier, Serge Regnier, 1, Wiley-ISTE, 2010.

- 5 Nanorobotics and Nanomedicine, S. R. Rajan , 1, Elsevier Academic Press, 2022 .
- 6 Nanorobots for Biomedical Applications , M. Kumar et al , 1, CRC Press, 2023 .

25NT03407 - COMPUTATIONAL DATA SCIENCE FOR NANOTECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03407	COMPUTATIONAL DATA SCIENCE FOR NANOTECHNOLOGY	CDN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of data science and computational techniques in nanotechnology	2	
CO2	Utilize machine learning and artificial intelligence algorithms for nanomaterial simulation	3	
CO3	Analyze large-scale nanotechnology datasets using statistical and computational tools	4	
CO4	Apply data science methods to enhance nanomaterials design and discovery	3	

Syllabus

Fundamentals of Data Science and Computational Techniques for Nanotechnology - Introduction to data science: Overview of computational data science, its role in nanotechnology, and the importance of data-driven research in nanoscale systems. Computational methods in nanotechnology - Density functional theory (DFT), molecular dynamics (MD), Monte Carlo simulations, ab-initio methods, and quantum mechanical modeling. Data preprocessing - Cleaning, normalizing, and transforming nanotechnology-related datasets, introduction to high-performance computing for nanoscale data.

Machine Learning and AI for Nanomaterial Simulation - Machine learning basics: Supervised learning, unsupervised learning, regression, and classification. AI in nanotechnology - Predictive modeling of nanomaterials properties, nanoparticle size prediction, and pattern recognition in synthesis processes. Applications - Use of AI in material discovery, optimization of synthesis processes, and prediction of nanomaterial performance.

Data Analysis for Large-Scale Nanotechnology Datasets - Statistical analysis - Descriptive and inferential statistics, hypothesis testing, ANOVA, and multivariate analysis applied to nanotechnology data. Big data in nanotechnology - Techniques for handling large datasets, data mining, and visualization techniques specific to nanomaterials and their properties. Tools - Use of Python, R, and MATLAB for nanotechnology data analysis, introduction to cloud computing for handling large-scale data (AWS, Google Cloud).

Applications of Data Science in Nanomaterials Design and Discovery- Data-driven discovery: Identification of novel nanomaterials using data science methods, material informatics for nanotechnology applications. Optimization and simulation - Optimization of nanomaterial properties through computational models, enhanced simulation methods using machine learning algorithms. Nanotechnology applications - Case studies in energy storage, environmental nanotechnology, drug delivery, and biomedical devices.

Reference Books

- 1 MATLAB Programming for Engineers, S. J. Chapman, 5th Edition, 2016., Cengage Learning.
- 2 Data-Driven Modeling & Scientific Computation: Methods for Complex Systems & Big Data, Petros Koumoutsakos, Oxford University Press, 2016..
- 3 Understanding Molecular Simulation: From Algorithms to Applications, Academic Press, G. Frenkel, 2nd Edition, Academic Press.
- 4 The Physics of Amorphous Solids, R. Zallen, 1st Edition, 2004, Wiley-VCH.

25NTO3408 - INDUSTRIAL NANOTECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NTO3408	INDUSTRIAL NANOTECHNOLOGY	INT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Fundamental principles of nanoscience and their industrial significance.	2	
CO2	Apply, Identify and analyze various nanomaterials, their synthesis routes, and properties for specific industrial applications.	3	
CO3	Apply appropriate characterization techniques to evaluate nanoscale materials and devices.	3	
CO4	Evaluate the role of nanotechnology in improving industrial processes, products, and sustainability.	3	

Syllabus

Nanotechnology in Agriculture and Food Industries Agricultureindustry. Precision farming, Smart delivery system, Insecticides using Nanotechnology, Nanofertilizers, Nanofertigation , Nano seed Science. Nanopackaging for enhanced shelf life Smart Intelligent packaging Food processing and food safety and bio security Electrochemical sensors for food analysis and contaminant detection. Nanotechnology in Agriculture and Food Industries Agricultureindustry Precision farming, Smart delivery system Insecticides using Nanotechnology Nanofertilizers Nanofertigation Nano seed Science. Nanopackaging for enhanced shelf life SmartIntelligent packaging Food processing and food safety and bio security Electrochemical sensors for food analysis and contaminant detection.

Nanotechnology in Textiles and Cosmetics Industries Textiles Industry Production of Nano woven fibers from electrospinning Controlling parameters and morphologies of nanofibers Nanocomposite fibers; Bionics Swim-suits with shark-skin effect, Soil repellence, Lotus effect Nano finishing in textiles UV resistant, anti bacterial, hydrophilic, self cleaning, flame retardant finishes; Modern textiles: Lightweight bulletproof vests and shirts, Colour changing property, Waterproof and Germ proof clothes. Cosmetics Industry: Formulation of Gels, Shampoos, Hair conditioners Micellar self-assembly and its manipulation. Sun screen dispersions for UV protection using titanium oxide Anti aging cream Colour cosmetics.

Nanotechnology in Chemical and Electrochemical Industries: Nanocatalysts Smart Materials Nanostructures for molecular recognition 0D, 1D and 2D Molecular encapsulation and its applications Nanoporous Zeolites Nano-reactors Solid lubricants Nanotechnology in Electrometallurgy, Electroplating industry and Corrosion protective organic coatings Electrolytic production of metal nanopowders, Electrochemical exfoliation for the production of Graphene and other metal chalcogenides Electrochemical preparation of Nanostructured conducting polymers.

Nanotechnology in Defence Military applications of Nanotechnology Nano-Battle suit Nano-drones Nano Satellites Nano-Propellants and Explosives Camouflage distributed sensors Armour protection Implanted Nano systems MiniMicro robots Small satellites and Space launchers Nano- Nuclear, Chemical and Biological weapons Chemical Biological protection.

Reference Books

- 1 Nanofibers and Nanotechnology in Textiles, , P. J. Brown and K. Stevens, , (2007)., Woodhead Publishing Limited, Cambridge,.
- 2 Industrial Electrochemistry, , M.R. Rifi and F.H.Covitz, , 1974, Marcel Dekker Inc, New York, .
- 3 Military Nanotechnology: Potential Applications and Preventive Arms Control, , J. Altmann, Routledge, , 2006., Taylor and Francis Group,.

25NT03509 - BIOSENSING AND BIOELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03509	BIOSENSING AND BIOELECTRONICS	BAB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Summarize the working principles of biosensors	2	
CO2	Interpret characterization of optical and electrochemical sensors	3	
CO3	Apply the response of biosensors	3	
CO4	Analyse selective biomedical devices for future applications	4	
CO5	Design and interfacing of Biological Systems with electronic systems, non-conventional bioelectronic devices using SPICE/OFDTD/COMSOL	4	

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

Design and interfacing of Biological Systems with electronic systems, non-conventional bioelectronic devices using SPICE/OFDTD/COMSOL

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 Hand book of biosensor and biosensor kinetics, Ajit sadana, Neeti sadana, 2010, elsevier.

25NT03510 - MICRO/NANO FLUIDIC SYSTEMS FOR SENSORS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25NT03510	MICRO/NANO FLUIDIC SYSTEMS FOR SENSORS	MFS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate understanding of fluid flow behavior and scaling laws in micro/nano fluidic systems.	2	
CO2	Apply design and fabrication techniques for developing micro/nanofluidic devices and components.	3	
CO3	Analyze physics and transport phenomena in micro/nano channels using theoretical and simulation tools.	3	
CO4	Integrate sensors with microfluidic systems for biomedical, diagnostic, and environmental applications.	3	

Syllabus

Introduction to Micro/Nano Fluidics: Fundamentals of fluid flow at micro and nano scales Laminar flow, slip conditions, surface tension, capillary effects Scaling laws in micro/nanofluidics Comparison between conventional and microfluidic systems Materials for microfluidic device fabrication.

Design and Fabrication of Micro/Nanofluidic Devices: Micro/nanofluidic channel design, soft lithography, photolithography, etching, and micro-milling Microvalves, micropumps, and mixers Integration of microfluidics with sensing components Packaging and interfacing techniques.

Physics and Transport Phenomena in Micro/Nano Channels: Electrokinetic phenomena: electrophoresis and electroosmosis Thermal effects and heat transfer in confined spaces Diffusion, convection, and mixing at micro/nanoscale Fluid-structure interaction and flow visualization techniques Simulation tools (e.g., COMSOL, ANSYS Fluent basics).

Sensor Integration and Detection Methods: Label-free and label-based detection techniques Electrochemical, optical, and piezoelectric sensing in microfluidics MEMS/NEMS-based sensor integration Digital microfluidics and droplet manipulation Signal processing and data acquisition for fluidic sensors. Microfluidic biosensors for glucose, pH, and pathogens Point-of-care diagnostics for blood, saliva, and sweat Environmental monitoring

Reference Books

- 1 Introduction to Microfluidics, ., Patrick Tabeling, , 2005, Oxford University Press, .
- 2 Microfluidics and Bio-MEMS Devices, , Shoji Takeuchi and Satoshi Konishi,, 2020., Springer, .
- 3 Fundamentals, Design and Fabrication,, Nam-Trung Nguyen, Micromixers:, 2008, William Andrew Publishing,.
- Microfluidics for Biological Applications, , Yujun Song, Daojian Cheng, and Liang Zhao,, 3rd Edition, 2001., Springer, 20212. A.J.Bard & L.R.Faulkner, Electrochemical methods-Fundamentals and Applications John Wiley & Sons, .
- 5 Introduction to BioMEMS, , Albert Folch,, 2012, CRC Press, .
- 6 Microfluidic Devices in Point-of-Care Diagnostics, , Harald O. Andersen,, 2023, Elsevier, .

25QCS3101 - QUANTUM HARDWARE AND CONTROL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3101	QUANTUM HARDWARE AND CONTROL SYSTEMS	QHCS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe qubit states, quantum gates, entanglement, and basic quantum circuits.	2	
CO2	Model quantum noise with Kraus operators and analyze decoherence and fidelity.	3	
CO3	Analyze physical qubit implementations, coherence, and gate performance.	3	
CO4	Apply quantum error correction and fault-tolerant computing principles including surface codes.	4	

Syllabus

Foundations of Quantum Information Quantum postulates; Qubit states; Bloch sphere; Measurement and entanglement; Quantum gates and universal sets; Bell states; Teleportation; Basic quantum circuits

Quantum Noise and Quantum Channels Density matrices Kraus operators Common noise models bit flip, phase flip, amplitude damping Fidelity, trace distance, decoherence; Quantum process tomography

Physical Qubit Implementations and Hardware Superconducting qubits transmons, Josephson junctions Trapped ions NV centers Quantum dots Photonic qubits Coherence times T1, T2 Gate fidelity Pulse level control Rabi oscillations, Ramsey fringes, Hahn echo

Quantum Error Correction and Fault Tolerance Classical vs quantum codes Knill Laflamme conditions Shor and Steane codes Stabilizer formalism Syndrome extraction Fault tolerant circuits Concatenated and surface codes Magic state distillation IBM QEC simulation

Reference Books

- 1 Quantum Computation and Quantum Information. , Nielsen, M. A., and Chuang, I. L. , 2nd edition, Cambridge University Press..
- 2 Quantum Information Theory. , Wilde, M. M. , 3rd edition, Cambridge University Press..

25QCS3101A - QUANTUM HARDWARE AND CONTROL SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3101A	QUANTUM HARDWARE AND CONTROL SYSTEMS	QHCS	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe qubit states, quantum gates, entanglement, and basic quantum circuits.	2	
CO2	Model quantum noise with Kraus operators and analyze decoherence and fidelity.	3	
CO3	Analyze physical qubit implementations, coherence, and gate performance.	3	
CO4	Apply quantum error correction and fault-tolerant computing principles including surface codes.	4	
CO5	Apply principles of quantum error correction using stabilizer formalism and standard codes (Shor, Steane, surface codes) to mitigate noise and decoherence.	4	
CO6	Analyze fault-tolerant quantum computing strategies, including syndrome extraction and magic state distillation, and assess their role in scalable quantum computation.	4	

Syllabus

Foundations of Quantum Information Quantum postulates; Qubit states; Bloch sphere; Measurement and entanglement; Quantum gates and universal sets; Bell states; Teleportation; Basic quantum circuits

Quantum Noise and Quantum Channels Density matrices; Kraus operators; Common noise models (bit-flip, phase-flip, amplitude damping); Fidelity, trace distance, decoherence; Quantum process tomography

Physical Qubit Implementations and Hardware Superconducting qubits transmons, Josephson junctions Trapped ions NV centers Quantum dots Photonic qubits Coherence times Gate fidelity Pulse level control Rabi oscillations, Ramsey fringes, Hahn echo

Quantum Error Correction and Fault Tolerance Classical vs quantum codes; Knill Laflamme conditions Shor and Steane codes Stabilizer formalism Syndrome extraction Fault tolerant circuits Concatenated and surface codes Magic state distillation IBM QEC simulation

Reference Books

- 1 Quantum Computation and Quantum Information, Nielsen, M. A., & Chuang, I. L, 2nd ed, Cambridge University Press.
- 2 Quantum Information Theory, Wilde, M. M. , 2nd ed, Cambridge University Press.
- 3 Quantum Error Correction, Lidar, D. A., & Brun, T. A. , 2nd ed, Cambridge University Press.

25QCS3101E - QUANTUM HARDWARE AND CONTROL SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3101E	QUANTUM HARDWARE AND CONTROL SYSTEMS	QHCS	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe qubit states, quantum gates, entanglement, and basic quantum circuits.	2	
CO2	Model quantum noise with Kraus operators and analyze decoherence and fidelity.	3	
CO3	Analyze physical qubit implementations, coherence, and gate performance.	3	
CO4	Apply quantum error correction and fault-tolerant computing principles including surface codes.	4	
CO5	Apply principles of quantum error correction using stabilizer formalism and standard codes (Shor, Steane, surface codes) to mitigate noise and decoherence.	4	
CO6	Analyze fault-tolerant quantum computing strategies, including syndrome extraction and magic state distillation, and assess their role in scalable quantum computation.	4	

Syllabus

Foundations of Quantum Information Quantum postulates; Qubit states; Bloch sphere; Measurement and entanglement; Quantum gates and universal sets; Bell states; Teleportation; Basic quantum circuits

Quantum Noise and Quantum Channels Density matrices; Kraus operators; Common noise models (bit-flip, phase-flip, amplitude damping); Fidelity, trace distance, decoherence; Quantum process tomography

Physical Qubit Implementations & Hardware Superconducting qubits transmons, Josephson junctions Trapped ions NV centers Quantum dots Photonic qubits Coherence times T Gate fidelity Pulse level control Rabi oscillations, Ramsey fringes, Hahn echo

Quantum Error Correction and Fault Tolerance Classical vs quantum codes Knill Laflamme conditions Shor and Steane codes Stabilizer formalism Syndrome extraction Fault tolerant circuits; Concatenated and surface codes; Magic state distillation IBM QEC simulation

Reference Books

- 1 Quantum Computation and Quantum Information, Nielsen, M. A., & Chuang, I. L, 2nd ed, Cambridge University Press.
- 2 Quantum Information Theory, Wilde, M. M. , 2nd ed, Cambridge University Press.
- 3 Quantum Error Correction, Lidar, D. A., & Brun, T. A. , 4th ed, Cambridge University Press.

25QCS3202 - QUANTUM OPTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3202	QUANTUM OPTICS	QO	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand quantization of electromagnetic fields and photon statistics.	2	
CO2	Apply optical coherence theory and interferometry concepts.	3	
CO3	Analyze phase-space representations of quantum optical states.	3	
CO4	Evaluate models of light-matter interaction in semi-classical and quantum regimes.	4	

Syllabus

Quantization of Electromagnetic Field Classical wave theory; Quantum nature of light; Quantization of EM field; Photons as discrete quanta; Fock states; Squeezed states; Hanbury-Brown and Twiss experiments; Photon bunching and anti-bunching; Hong-Ou-Mandel interference

Theory of Optical Coherence Coherent states; Light fields with minimum uncertainty; Youngs double slit experiment and first order coherence; Coherence uncertainty; Correlation functions of arbitrary order; Operator ordering - normal, symmetric, antinormal; Interferometry

Phase Space Representations of States Frequency time domain; Wigner distribution; P function; Density operator; Husimi Q function; Non classical states and applications

Light Matter Interaction Classical Hamiltonian models; Rabi oscillations; Optical Bloch equations; Semi classical light matter models; Structured waveguides; Quantum interaction models; Jaynes Cummings model

Reference Books

- 1 The Quantum Theory of Light, Loudon, R. , 3, Oxford University Press..
- 2 Optical Coherence and Quantum Optics, Mandel, L., and Wolf, E. , 1, Cambridge University Press.
- 3 Introduction to Quantum Optics, Grynberg, G., Aspect, A., Fabre, C. , 2, Cambridge University Press..
- 4 Quantum Optics, Walls, D. F., Milburn, G. J. , 2, Springer.
- 5 Quantum Optics, Scully, M. O., Zubairy, M. S. , 1, Cambridge University Press..

25QCS3303 - QUANTUM SENSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3303	QUANTUM SENSING	QS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the theory of superconducting qubits, Josephson effect, and transmon design.	2	
CO2	Apply microwave theory concepts to analyze resonators and coupling mechanisms. PO2, PO3, PSO1 3	3	
CO3	Analyze the coherence and dephasing behavior of qubits in magnetic fields.	3	
CO4	Evaluate hybrid systems and qubit magnon coupling schemes for sensing applications.	4	
CO5	Evaluate quantum sensing schemes using AC Stark shift and multimode coupling approaches.	4	
CO6	Assess hybrid systems integrating qubits and magnetic materials, and simulate qubit magnon coupling.	4	

Syllabus

Superconducting Quantum Bits Theory of qubits, qutrits, and qudits; Superconductivity and Josephson effect; Transmon qubit; Loss mechanisms Purcell, dielectric, TLS loss, quasiparticles, flux vortices

Microwave Theory & Sensing Scattering parameters in microwave networks; Resonators and quality factors; Reflection spectrum; Average photon number; Coupling resonant systems; Quantum sensing principles; AC Stark shift and multi-mode sensing schemes

Qubits in Magnetic Fields Qubit transition frequencies under magnetic fields; Resonator behavior in magnetic environments; Qubit coherence; Pure dephasing mechanisms

Coupling Qubits and Magnetic Materials Magnons and magnetic oscillations; Hybrid systems; Direct qubit magnon coupling; Choice of magnetic materials; Coupling strength calculation and simulation; Flip chip integration approaches

Reference Books

- 1 Quantum Sensing Experiments with Superconducting Qubits, Schneider, A, 2021, KIT Scientific Publishing..

25QCS3303A - QUANTUM SENSING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3303A	QUANTUM SENSING	QS	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe superconducting qubits, Josephson effect, and transmon qubit design.	2	
CO2	Explain qubit loss mechanisms such as Purcell, dielectric, TLS loss, and quasiparticles.	2	
CO3	Apply microwave theory to analyze scattering parameters, resonators, and quality factors in sensing systems.	3	
CO4	Analyze qubit behavior in magnetic fields, including coherence and pure dephasing processes.	3	
CO5	Evaluate quantum sensing schemes using AC Stark shift and multimode coupling approaches.	4	
CO6	Assess hybrid systems integrating qubits and magnetic materials and simulate qubitmagnon coupling.	4	

Syllabus

Superconducting Quantum Bits Theory of qubits, qutrits, and qudits Superconductivity and Josephson effect; Transmon qubit Loss mechanisms Purcell, dielectric, TLS loss, quasiparticles, flux vortices

Microwave Theory & Sensing Scattering parameters in microwave networks; Resonators and quality factors; Reflection spectrum; Average photon number; Coupling resonant systems; Quantum sensing principles; AC Stark shift and multi-mode sensing schemes

Qubits in Magnetic Fields Qubit transition frequencies under magnetic fields; Resonator behavior in magnetic environments; Qubit coherence; Pure dephasing mechanisms

Coupling Qubits and Magnetic Materials Magnons and magnetic oscillations Hybrid systems; Direct qubitmagnon coupling; Choice of magnetic materials; Coupling strength calculation and simulation; Flip-chip integration approaches

25QCS3303E - QUANTUM SENSING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3303E	QUANTUM SENSING	QS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe superconducting qubits, Josephson effect, and transmon qubit design.	2	
CO2	Explain qubit loss mechanisms such as Purcell, dielectric, TLS loss, and quasiparticles.	2	
CO3	Apply microwave theory to analyze scattering parameters, resonators, and quality factors in sensing systems.	3	
CO4	Analyze qubit behavior in magnetic fields, including coherence and pure dephasing processes.	4	
CO5	Evaluate quantum sensing schemes using AC Stark shift and multimode coupling approaches.	4	
CO6	Assess hybrid systems integrating qubits and magnetic materials, and simulate qubitmagnon coupling.	4	

Syllabus

Superconducting Quantum Bits Theory of qubits, qutrits, and qudits; Superconductivity and Josephson effect; Transmon qubit; Loss mechanisms Purcell, dielectric, TLS loss, quasiparticles, flux vortices

Microwave Theory & Sensing Scattering parameters in microwave networks; Resonators and quality factors; Reflection spectrum; Average photon number; Coupling resonant systems; Quantum sensing principles; AC Stark shift and multi-mode sensing schemes

Qubits in Magnetic Fields Qubit transition frequencies under magnetic fields; Resonator behavior in magnetic environments; Qubit coherence; Pure dephasing mechanisms

Coupling Qubits and Magnetic Materials Magnons and magnetic oscillations; Hybrid systems; Direct qubitmagnon coupling; Choice of magnetic materials; Coupling strength calculation and simulation; Flipchip integration approaches

Reference Books

- 1 Quantum Sensing Experiments with Superconducting Qubits, Schneider, A. , 2021, KIT Scientific Publishing..

25QCS3404 - QUANTUM RADAR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3404	QUANTUM RADAR	QR	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of radar operation, radar equations, and scattering regimes.	2	
CO2	Apply quantum information principles to radar system enhancement	3	
CO3	Analyze quantum radar principles including quantum illumination and entangled photon usage.	3	
CO4	Evaluate quantum radar cross-section concepts and implementation challenges.	4	

Syllabus

Introduction & Classical Radar Radar equation, maximum detection range; Radar cross section; Scattering regimes; Radar X-band; Scattering mechanisms; Specular and end-region returns; Energy conservation; Radar as an information channel

Quantum Radar Theory Need for improved radar systems; Quantum information to sensors; Quantum radar technology concepts

Quantum Radar Principles Standoff quantum sensors Interferometric quantum radar Quantum illumination Non entangled vs entangled photons Sensitivity comparison Gaussian states Entangled measurements Quantum radar jamming Physical realization transmitter, receiver

Quantum Radar Cross Section Desired features of Q Incident and scattered quantum fields; Operational definition of Q Quantum radar equation

Reference Books

- 1 Quantum Radar, Lanzagorta, M. , 1, Springer International Publishing.

25QCS3505 - QUANTUM SATELLITE COMMUNICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3505	QUANTUM SATELLITE COMMUNICATIONS	QSC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	understand the fundamental principles of quantum communication & satellites	2	
CO2	Apply the QKD and other protocols in space communication	3	
CO3	Apply satellite communication models to quantum systems	3	
CO4	Analyze noise, decoherence, and security issues in quantum satellite networks	4	

Syllabus

Quantum Communication Basics Introduction to Quantum Mechanics concepts for communication Qubits, entanglement, superposition Classical vs. Quantum Communication

Quantum Protocols Quantum Key Distribution (QKD): BB84, E91, decoy state protocols Quantum teleportation & entanglement swapping Quantum error correction, decoherence

Satellite Communication Principles Basics of satellite systems: LEO, MEO, GEO Free-space optical channels & photon transmission Atmospheric effects, noise, and error models

Quantum Satellite Systems Ground-to-satellite & inter-satellite quantum links Global case studies Quantum repeaters, satellite payloads

Reference Books

- 1 Quantum Communication, Nature Photonics, Gisin, N., Thew, R., 1, Nature.
- 2 Quantum Cryptography: A Primer, Scarani, V. , 1, Cambridge University Press..
- 3 Quantum Computation and Quantum Information, Nielsen, M. A., & Chuang, I. L., 2010, Cambridge University Press.

25QCS3506 - QUANTUM INFORMATION THEORY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QCS3506	QUANTUM INFORMATION THEORY	QIT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the mathematical foundations of quantum mechanics relevant to information theory.	2	
CO2	Apply quantum algorithms to solve problems more efficiently than classical algorithms in quantum states, measurements, and entanglement phenomena.	3	
CO3	Apply and Evaluation of quantum error correction methods and quantum channel performance.	3	
CO4	Analyze quantum communication protocols and cryptographic schemes.	4	

Syllabus

Mathematical Foundations Review of linear algebra: Hilbert spaces, inner products, operators. Quantum states: pure & mixed states, density matrices. Quantum measurements: projective measurement, POVMs

Postulates of Quantum Mechanics Superposition and state evolution. Unitary transformations. Tensor product spaces and composite systems, Quantum Entanglement & Information Entanglement measures (entropy, concurrence, mutual information). Bell states and EPR paradox. Quantum teleportation and superdense coding.

Quantum Channels & Error Correction Quantum noise and decoherence. Quantum error correction codes (Shor code, Steane code). Quantum channel capacity.

Reference Books

- 1 The Theory of Quantum Information, John Watrous, 1, Institute for Quantum Computing University of Waterloo.
- 2 Quantum Computation and Quantum Information, Nielsen, M. A., & Chuang, I. L., 1, Cambridge University Press..
- 3 Quantum Information Theory, Wilde, M. M., 2017, Cambridge University Press.
- 4 Principles of Quantum Computation and Information (Vol. I & II), Benenti, G., Casati, G., & Strini, G. , 2007, World Scientific.
- 5 Quantum Information Theory: Mathematical Foundation, Hayashi, M. , 2017, Springer.

25QTS3101 - QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QTS3101	QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE	QCCAFT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of qubits, quantum gates, and quantum circuits	2	
CO2	Apply quantum algorithms (Grover, Shor, VQE, QAOA) to computational problems	3	
CO3	Analyze error sources, noise models, and quantum error correction (QEC) strategies	4	
CO4	Evaluate the scalability, architectures, and fault-tolerant roadmaps for quantum computing	5	

Syllabus

Qubits, Quantum Gates & Circuits Physical realizations: superconducting qubits, trapped ions, spin qubits, photonic qubits, Qubit properties: initialization, coherence times, DiVincenzo criteria, Quantum gates: single-qubit (Pauli, Hadamard, Phase, T), multi-qubit (CNOT, Toffoli, SWAP), Universality of gate sets and compilation, Quantum circuits: diagramming, circuit depth, decomposition, Simulation frameworks: Qiskit, Cirq, PennyLane,

Quantum Algorithms Deutsch Jozsa algorithm and promise problems, Simons algorithm and hidden subgroup problems Grover's search: oracle design, amplitude amplification, quadratic speedup, Quantum Fourier Transform (QFT), Shor's algorithm period finding, integer factorization, implications for RSA, Variational algorithms VQE, QAOA, hybrid quantum-classical loops, Applications quantum chemistry, optimization, ML kernels

Error Sources, Noise Models & Quantum Error Correction Noise sources decoherence, T1/T2 relaxation, crosstalk, leakage, Noise models: bit-flip, phase-flip, depolarizing, amplitude damping Kraus operators and density matrix evolution Quantum error correction codes Shor code, Steane code, surface codes, Stabilizer formalism and syndrome extraction, Error mitigation: zero-noise extrapolation, probabilistic cancellation, dynamical decoupling

Scalability, Architectures & Fault Tolerance Scalability challenges qubit connectivity, control electronics, cryogenic requirements, Fault-tolerant threshold logical vs physical qubits, error thresholds, Overhead analysis in surface code architectures, Hardware platforms IBM, Google superconducting processors, IonQ, Honeywell ion traps, Xanadu photonic processors, neutral atom arrays Pasqal, QuEra, Future roadmaps NISQ era, FTQC transition, industry strategies IBM, Microsoft, Google, D-Wave, Application roadmaps finance, chemistry, AI

Reference Books

- 1 Quantum Computation and Quantum Information, Michael Nielsen & Isaac Chuang, 10TH, Cambridge University Press.
- 2 Quantum Computer Science: An Introduction, N. David Mermin, 2007, Cambridge University Press.
- 3 Classical and Quantum Computation, A.Y. Kitaev, A.H. Shen, M.N. Vyalyi, 2002, AMS.
- 4 Quantum Error Correction, Daniel Gottesman, edited volumes, 2013, Cambridge University Press.
- 5 Learn Quantum Computing with Python and Qiskit, Robert Lored, 2020, Packt.

25QTS3101A - QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QTS3101A	QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE	QCCAFT	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of qubits, quantum gates, and quantum circuits	2	
CO2	Apply quantum algorithms (Grover, Shor, VQE, QAOA) to computational problems	3	
CO3	Analyze error sources, noise models, and quantum error correction (QEC) strategies	4	
CO4	Evaluate the scalability, architectures, and fault-tolerant roadmaps for quantum computing	5	

Syllabus

Qubits, Quantum Gates & Circuits Physical realizations: superconducting qubits, trapped ions, spin qubits, photonic qubits, Qubit properties: initialization, coherence times, DiVincenzo criteria, Quantum gates: single-qubit (Pauli, Hadamard, Phase, T), multi-qubit (CNOT, Toffoli, SWAP), Universality of gate sets and compilation, Quantum circuits: diagramming, circuit depth, decomposition, Simulation frameworks: Qiskit, Cirq, PennyLane,

Quantum Algorithms Deutsch Jozsa algorithm and promise problems, Simons algorithm and hidden subgroup problems Grover's search: oracle design, amplitude amplification, quadratic speedup, Quantum Fourier Transform (QFT), Shor's algorithm period finding, integer factorization, implications for RSA, Variational algorithms VQE, QAOA, hybrid quantum-classical loops, Applications quantum chemistry, optimization, ML kernels

Error Sources, Noise Models & Quantum Error Correction Noise sources decoherence, T1/T2 relaxation, crosstalk, leakage, Noise models: bit-flip, phase-flip, depolarizing, amplitude damping Kraus operators and density matrix evolution Quantum error correction codes Shor code, Steane code, surface codes, Stabilizer formalism and syndrome extraction, Error mitigation: zero-noise extrapolation, probabilistic cancellation, dynamical decoupling

Scalability, Architectures & Fault Tolerance Scalability challenges qubit connectivity, control electronics, cryogenic requirements, Fault-tolerant threshold logical vs physical qubits, error thresholds, Overhead analysis in surface code architectures, Hardware platforms IBM, Google superconducting processors, IonQ, Honeywell ion traps, Xanadu photonic processors, neutral atom arrays Pasqal, QuEra, Future roadmaps NISQ era, FTQC transition, industry strategies IBM, Microsoft, Google, D-Wave, Application roadmaps finance, chemistry, AI

Reference Books

- 1 Quantum Computation and Quantum Information, Michael Nielsen & Isaac Chuang, 10 TH, Cambridge University Press.
- 2 Quantum Computer Science: An Introduction, N. David Mermin, 2007, Cambridge University Press.
- 3 Classical and Quantum Computation, A.Y. Kitaev, A.H. Shen, M.N. Vyalyi, 2002, AMS.
- 4 Quantum Error Correction, Daniel Gottesman, edited volumes, 2013, Cambridge University Press.
- 5 Learn Quantum Computing with Python and Qiskit, Robert Lored, 2020, Packt.

25QTS3101E - QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QTS3101E	QUANTUM COMPUTATION : CIRCUITS, ALGORITHMS & FAULT TOLERANCE	QCCAFT	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of qubits, quantum gates, and quantum circuits	2	
CO2	Apply quantum algorithms (Grover, Shor, VQE, QAOA) to computational problems	3	
CO3	Analyze error sources, noise models, and quantum error correction (QEC) strategies	4	
CO4	Evaluate the scalability, architectures, and fault-tolerant roadmaps for quantum computing	5	

Syllabus

Qubits, Quantum Gates & Circuits Physical realizations: superconducting qubits, trapped ions, spin qubits, photonic qubits, Qubit properties: initialization, coherence times, DiVincenzo criteria, Quantum gates: single-qubit (Pauli, Hadamard, Phase, T), multi-qubit (CNOT, Toffoli, SWAP), Universality of gate sets and compilation, Quantum circuits: diagramming, circuit depth, decomposition, Simulation frameworks: Qiskit, Cirq, PennyLane,

Quantum Algorithms Deutsch Jozsa algorithm and promise problems, Simons algorithm and hidden subgroup problems Grover's search: oracle design, amplitude amplification, quadratic speedup, Quantum Fourier Transform (QFT), Shor's algorithm period finding, integer factorization, implications for RSA, Variational algorithms VQE, QAOA, hybrid quantum-classical loops, Applications quantum chemistry, optimization, ML kernels

Error Sources, Noise Models & Quantum Error Correction Noise sources decoherence, T1/T2 relaxation, crosstalk, leakage, Noise models: bit-flip, phase-flip, depolarizing, amplitude damping Kraus operators and density matrix evolution Quantum error correction codes Shor code, Steane code, surface codes, Stabilizer formalism and syndrome extraction, Error mitigation: zero-noise extrapolation, probabilistic cancellation, dynamical decoupling

Scalability, Architectures & Fault Tolerance Scalability challenges qubit connectivity, control electronics, cryogenic requirements, Fault-tolerant threshold logical vs physical qubits, error thresholds, Overhead analysis in surface code architectures, Hardware platforms IBM, Google superconducting processors, IonQ, Honeywell ion traps, Xanadu photonic processors, neutral atom arrays Pasqal, QuEra, Future roadmaps NISQ era, FTQC transition, industry strategies IBM, Microsoft, Google, D-Wave, Application roadmaps finance, chemistry, AI

Reference Books

- 1 Quantum Computation and Quantum Information, Michael Nielsen & Isaac Chuang, 10 TH, Cambridge University Press.
- 2 Quantum Computer Science: An Introduction, N. David Mermin, 2007, Cambridge University Press.
- 3 Classical and Quantum Computation, A.Y. Kitaev, A.H. Shen, M.N. Vyalyi, 2002, AMS.
- 4 Quantum Error Correction, Daniel Gottesman, edited volumes, 2013, Cambridge University Press.
- 5 Learn Quantum Computing with Python and Qiskit, Robert Lored, 2020, Packt.

25QTS3202 - QUANTUM CRYPTOGRAPHY & QUANTUM COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QTS3202	QUANTUM CRYPTOGRAPHY & QUANTUM COMMUNICATION	QCQC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of quantum cryptography, quantum random number generation, and no-cloning theorem	2	
CO2	Apply and implement basic QKD protocols (BB84, B92, E91, BBM92) using simulations and experiments	3	
CO3	Analyze advanced QKD protocols (Decoy state, CV-QKD, MDI-QKD), security proofs, and side-channel attacks	4	
CO4	Evaluate architectures of quantum communication systems, including repeaters, memories, and satellite QKD	5	

Syllabus

Fundamentals of Quantum Cryptography & QRNG Motivation classical vs quantum cryptography , Post quantum threats to RSA,DHECC , Quantum no-cloning theorem and security foundations , Randomness in cryptography true RNG vs pseudo RNG , Quantum Random Number Generation (QRNG) physical principles, photon arrival time, phase noise, vacuum fluctuations , Certification of randomness and NIST randomness tests

Basic Quantum Key Distribution Protocols BB84 protocol polarization states, sifting, error estimation, privacy amplification ,B92 protocol minimal states efficiency and limitations , E91 protocol entanglement based QKD and Bell inequality security, BBM92 entanglement-based variant of BB84 , Practical issues error rates, key rates, reconciliation methods , Hands on simulations using Qiskit and optical setups

Advanced QKD & Security Analysis Decoy state QKD for photon number splitting PNS attacks Continuous Variable CV-QKD with coherent states and homodyne detection , Measurement Device Independent MDI-QKD , Twin field QKD and metropolitan QKD networks ,Side-channel attacks: detector blinding, Trojan horse attacks , Security proofs for QKD protocols Shannon information, Holevo bound

Quantum Communication Architectures & Applications Quantum teleportation and superdense coding Quantum repeaters entanglement swapping, purification, quantum memories , Satellite QKD demonstrations China s Micius satellite, ESA projects , Free space and fiber based quantum links , Integration of QKD with classical networks , Hybrid architectures QKD post quantum cryptography lattice-based , Roadmaps for quantum internet development

Reference Books

- 1 Quantum Cryptography and Secret-Key Distillation, Nicolas Gisin, Gr?goire Ribordy, Hugo Zbinden, 2002, Physical Review Journals.
- 2 Quantum Cryptography and Secure Communications, Marco Tomamichel, 2010, Packt.
- 3 Introduction to Quantum Information Science, Vlatko Vedral, 2006, OXFORD.
- 4 Quantum Communications and Cryptography, Alexander Sergienko, 2005, CRC Press Inc.
- 5 Quantum Internet: Building Networks for the Quantum Age, Rodney Van Meter, 2014, STE Ltd and John Wiley & Sons, Inc..

25QTS3303 - QUANTUM SENSING & METROLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QTS3303	QUANTUM SENSING & METROLOGY	QSM	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of quantum measurement theory, precision limits, and quantum Fisher information	2	
CO2	Apply squeezed states, entanglement, and interferometry techniques for quantum-enhanced measurements	3	
CO3	Analyze practical implementations of quantum sensors including clocks, magnetometers, gravimeters, and NV centers	4	
CO4	Evaluate quantum tomography, weak measurement approaches, and real-world applications of quantum metrology	5	

Syllabus

Principles of Quantum Measurement & Precision Limits, Classical vs quantum measurement theory , Quantum Cram?r Rao bound & Fisher information , Heisenberg uncertainty relation and standard quantum limit SQL , Quantum metrology surpassing SQL with entanglement , Weak vs strong measurements , Role of decoherence in measurement precision

Squeezed States, Entanglement & Interferometry , Generation and characterization of squeezed light , Applications of squeezing in precision measurements , Mach Zehnder and Ramsey interferometry Entangled probe states for enhanced sensitivity , NOON states and phase estimation , Quantum lithography and interferometric super-resolution

Quantum Sensor Implementations , Atomic clocks cesium, rubidium, optical lattice clocks , NV centers in diamond for nanoscale magnetometry , Superconducting quantum interference devices SQUIDS , Cold atom interferometers for gravimetry , Quantum gyroscopes , Practical challenges noise, calibration, scalability

Tomography, Weak Measurements & Applications Quantum state tomography qubit and multi qubit systems , Quantum process tomography , Weak value amplification , Wigner, P and Q quasiprobability distributions , Quantum imaging and sensing in biology , Industrial & defense applications navigation, underground mapping, biomedical sensing

Reference Books

- 1 Quantum Measurement and Control, H. M. Wiseman, G. J. Milburn, 2009, Cambridge University Press.
- 2 Quantum Metrology, Imaging, and Communication, David Suter et al., 2020, INC.
- 3 Quantum Optics, Marlan O. Scully, M. Suhail Zubairy, 1997, Cambridge University Press.
- 4 Quantum Measurement, Vladimir Braginsky, Farid Khalili, 1992, Cambridge University Press..
- 5 Quantum Metrology and Sensing, Zhaoying Xu, Feng Li, 1996, INC.

25QTS3303A - QUANTUM SENSING & METROLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QTS3303A	QUANTUM SENSING & METROLOGY	QSM	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of quantum measurement theory, precision limits, and quantum Fisher information	2	
CO2	Apply squeezed states, entanglement, and interferometry techniques for quantum-enhanced measurements	3	
CO3	Analyze practical implementations of quantum sensors including clocks, magnetometers, gravimeters, and NV centers	4	
CO4	Evaluate quantum tomography, weak measurement approaches, and real-world applications of quantum metrology	5	

Syllabus

Principles of Quantum Measurement & Precision Limits, Classical vs quantum measurement theory , Quantum Cram?r Rao bound & Fisher information , Heisenberg uncertainty relation and standard quantum limit SQL , Quantum metrology surpassing SQL with entanglement , Weak vs strong measurements , Role of decoherence in measurement precision

Squeezed States, Entanglement & Interferometry , Generation and characterization of squeezed light , Applications of squeezing in precision measurements , Mach Zehnder and Ramsey interferometry Entangled probe states for enhanced sensitivity , NOON states and phase estimation , Quantum lithography and interferometric super-resolution

Quantum Sensor Implementations , Atomic clocks cesium, rubidium, optical lattice clocks , NV centers in diamond for nanoscale magnetometry , Superconducting quantum interference devices SQUIDs , Cold atom interferometers for gravimetry , Quantum gyroscopes , Practical challenges noise, calibration, scalability

Tomography, Weak Measurements & Applications Quantum state tomography qubit and multi qubit systems , Quantum process tomography , Weak value amplification , Wigner, P and Q quasiprobability distributions , Quantum imaging and sensing in biology , Industrial & defense applications navigation, underground mapping, biomedical sensing

Reference Books

- 1 Quantum Measurement and Control, H. M. Wiseman, G. J. Milburn, 2009, Cambridge University Press.
- 2 Quantum Metrology, Imaging, and Communication, David Suter et al., 2020, INC.
- 3 Quantum Optics, Marlan O. Scully, M. Suhail Zubairy, 1997, Cambridge University Press.
- 4 Quantum Measurement, Vladimir Braginsky, Farid Khalili, 1992, Cambridge University Press..
- 5 Quantum Metrology and Sensing, Zhaoying Xu, Feng Li, 1996, INC.

25QTS3303E - QUANTUM SENSING & METROLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QTS3303E	QUANTUM SENSING & METROLOGY	QSM	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of quantum measurement theory, precision limits, and quantum Fisher information	2	
CO2	Apply squeezed states, entanglement, and interferometry techniques for quantum-enhanced measurements	3	
CO3	Analyze practical implementations of quantum sensors including clocks, magnetometers, gravimeters, and NV centers	4	
CO4	Evaluate quantum tomography, weak measurement approaches, and real-world applications of quantum metrology	5	

Syllabus

Principles of Quantum Measurement & Precision Limits, Classical vs quantum measurement theory , Quantum Cram?r Rao bound & Fisher information , Heisenberg uncertainty relation and standard quantum limit SQL , Quantum metrology surpassing SQL with entanglement , Weak vs strong measurements , Role of decoherence in measurement precision

Squeezed States, Entanglement & Interferometry , Generation and characterization of squeezed light , Applications of squeezing in precision measurements , Mach Zehnder and Ramsey interferometry Entangled probe states for enhanced sensitivity , NOON states and phase estimation , Quantum lithography and interferometric super-resolution

Quantum Sensor Implementations , Atomic clocks cesium, rubidium, optical lattice clocks , NV centers in diamond for nanoscale magnetometry , Superconducting quantum interference devices SQUIDS , Cold atom interferometers for gravimetry , Quantum gyroscopes , Practical challenges noise, calibration, scalability

Tomography, Weak Measurements & Applications Quantum state tomography qubit and multi qubit systems , Quantum process tomography , Weak value amplification , Wigner, P and Q quasiprobability distributions , Quantum imaging and sensing in biology , Industrial & defense applications navigation, underground mapping, biomedical sensing

Reference Books

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- 2 Quantum Metrology, Imaging, and Communication, David Suter et al., 2020, INC.
- 3 Quantum Optics, Marlan O. Scully, M. Suhail Zubairy, 1997, Cambridge University Press.
- 4 Quantum Measurement, Vladimir Braginsky, Farid Khalili, 1992, Cambridge University Press..
- 5 Quantum Metrology and Sensing, Zhaoying Xu, Feng Li, 1996, INC.

25QTS3404 - QUANTUM MATERIALS & TOPOLOGICAL MATTER (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QTS3404	QUANTUM MATERIALS & TOPOLOGICAL MATTER	QMTM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental principles of quantum materials, band theory, and correlated electron systems	2	
CO2	Apply knowledge of superconductivity, Josephson effects, and 2D materials for device applications	3	
CO3	Analyze Berry phase, topological phases, and edge states in materials relevant to quantum technologies	4	
CO4	Evaluate experimental fabrication techniques and material platforms for scalable quantum devices	5	

Syllabus

Fundamentals of Quantum Materials Band theory of solids Bloch's theorem, Brillouin zones, Fermi surfaces, density of states, effective mass, Semiconductors vs insulators vs metals, Electron correlation and Mott insulators, Magnetism: ferromagnetism, antiferromagnetism, spin liquids, Role of materials in enabling qubits silicon, diamond, superconductors

Superconductivity, Josephson Effects 2D Materials BCS theory of superconductivity, Cooper pairs and energy gap, Josephson effect: DC and AC Josephson relations, Superconducting qubits transmons, flux qubits 2D materials graphene, transition metal dichalcogenides MoS₂, WS₂, Spintronics and valleytronics in 2D systems, Material challenges in qubit coherence

Topological Phases Berry Physics Berry phase and Berry curvature, Chern number and topological invariants, Topological insulators bulk boundary correspondence, Quantum Hall effect, fractional QHE, Majorana fermions and topological superconductors, Edge states as protected channels for quantum computing, Applications in fault-tolerant quantum computing

Fabrication Characterization of Quantum Materials Thin film growth techniques MBE, CVD, PLD, Material characterization STM, TEM, ARPES, Raman spectroscopy, Nanofabrication methods for qubits and superconducting circuits, Defect engineering in diamond NV centers, Hybrid material systems for quantum devices, Challenges in large scale reproducibility, Future directions quantum metamaterials, programmable matter

Reference Books

- 1 Principles of the Theory of Solids, J.M. Ziman, 1964, Cambridge University Press.
- 2 Quantum Theory of Solids, Charles Kittel, 1963, Wiley.
- 3 Topological Insulators and Topological Superconductors, B.A. Bernevig, T.L. Hughes, 2013, Princeton.
- 4 Quantum Materials: Experiments and Theory, Efrat Shimshoni et al., 1998, IDP.
- 5 Superconductivity, Superfluids, and Condensates, James F. Annett, 2004, OXFORD.

25QTS3505 - QUANTUM AI & MACHINE LEARNING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25QTS3505	QUANTUM AI & MACHINE LEARNING	QAIML	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the principles of quantum machine learning and hybrid quantum-classical frameworks	2	
CO2	Apply quantum-enhanced ML algorithms (QNNs, kernel methods, variational classifiers) to real-world datasets	3	
CO3	Analyze AI-driven methods for quantum error mitigation, control pulses, and noise suppression	4	
CO4	Evaluate AI techniques for quantum material discovery, quantum sensing optimization, and future AI-QT systems	5	

Syllabus

Foundations of Quantum Machine Learning Review of ML basics supervised, unsupervised, reinforcement learning , Hybrid quantum classical paradigms , Quantum data encoding: amplitude, basis, and qubit efficient encodings , Variational quantum circuits VQCs , Quantum kernels for SVMs and clustering , Quantum neural networks QNNs and parameterized quantum circuits

Quantum ML Algorithms Applications , Variational classifiers VQE-based ML , Quantum Boltzmann machines , Quantum GANs for generative modeling , QAOA for ML based optimization , Applications in quantum chemistry drug discovery, finance, portfolio optimization , Benchmarking QML vs classical ML performance

AI for Quantum Technologies Control Error Mitigation Sources of noise in quantum hardware decoherence, readout errors , Aqml techniques for error mitigation neural nets for denoising, reinforcement learning for pulse shaping , Bayesian inference for error modeling , Deep learning for Hamiltonian learning and quantum system identification , AI assisted calibration of qubit gates and quantum sensors

AI in Materials & Sensing Future of Quantum AI AI for materials discovery ML for bandgap prediction, phase transitions, superconductors , AI enhanced sensing ML for NV center magnetometry denoising, quantum tomography reconstruction , Federated learning with quantum data , Future research directions: quantum advantage in ML, AI driven quantum compilers, autonomous quantum labs , Ethical societal implications of Quantum AI

Reference Books

- 1 Quantum Machine Learning: What Quantum Computing Means to Data Mining, Peter Wittek, 2014, Academic Press.
- 2 Quantum Machine Learning with Python and Qiskit, Santanu Ganguly, 1 ST, INC.
- 3 Machine Learning with Quantum Computers, Maria Schuld, Francesco Petruccione, 2020, Springer Nature .
- 4 Quantum Computing for Machine Learning, Maria Schuld, Ilya Sinayskiy, Francesco Petruccione, 2 ND, INC.
- 5 Artificial Intelligence for Quantum Computing, Vedran Dunjko , 2nd, INC.

25RAN3101 - ROBOT MOTION PLANNING, DYNAMICS AND CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3101	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	RMPDC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles of robot trajectory planning	2	
CO2	Apply motion planning principles to a robot in the presence of obstacles	3	
CO3	Analyse motion planning and control	4	
CO4	Perform basic motion, force, and hybrid motion-force control to mobile robotics	3	
CO5	Perform lab experiments using python/Robot simulator CoppeliaSim for motion planning.	4	

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, 1st Edition, Wiley..
- 2 Introduction to Autonomous Robots,, Nikolaus Correll, Bradley Hayes, and Jur van den Berg, 2022, 1st Edition, MIT Press..
- 3 Robotics, Vision and Control, Peter Corke, 2017,2nd Edition, Springer..
- 4 Planning Algorithms, Steven M. LaValle, 2021,1st Edition, Cambridge University Press.
- 5 Dynamic Simulations of Multibody Systems, Murilo G. Coutinho, 2001 ,2nd Edition, Springer.

25RAN3101A - ROBOT MOTION PLANNING, DYNAMICS AND CONTROL (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3101A	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	RMPDC	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles of robot trajectory planning	2	
CO2	Apply motion planning principles to a robot in the presence of obstacles	3	
CO3	Analyse motion planning and control	4	
CO4	Perform basic motion, force, and hybrid motion-force control to mobile robotics	3	
CO5	Apply optimization techniques for joint space trajectory	3	
CO6	Perform lab experiments using python/Robot simulator CoppeliaSim and python for motion planning.	4	

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 robo

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.

25RAN3101E - ROBOT MOTION PLANNING, DYNAMICS AND CONTROL (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3101E	ROBOT MOTION PLANNING, DYNAMICS AND CONTROL	RMPDC	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic principles of robot trajectory planning	2	
CO2	Apply motion planning principles to a robot in the presence of obstacles	3	
CO3	Analyse motion planning and control	4	
CO4	Perform basic motion, force, and hybrid motion-force control to mobile robotics	3	
CO5	Apply optimization techniques for joint space trajectory	3	
CO6	Perform lab experiments using python/Robot simulator CoppeliaSim and python for motion planning.	4	

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..

25RAN3102 - ADVANCED ROBOTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3102	ADVANCED ROBOTICS	AR	R	3	0	2	0	4

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	
CO2	Apply the basics of DH parameters for developing the models of Advanced Robotic Manipulator	3	
CO3	Apply the functional and critical operational Robotics methods for preparing advanced level of Robotics.	3	
CO4	Analyze the concepts of Advanced Robotics Systems and Real-time environment for various applications.	4	
CO5	Analyze the fetch and frieght robots with various co-ordinate frames and joint angles in an constrained environments	4	

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 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.

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.

25RAN3102A - ADVANCED ROBOTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3102A	ADVANCED ROBOTICS	AR	A	4	1	2	0	6

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	
CO2	Apply the basics of DH parameters for developing the models of Advanced Robotic Manipulator	3	
CO3	Apply the functional and critical operational Robotics methods for preparing advanced level of Robotics.	3	
CO4	Analyze the concepts of Advanced Robotics Systems and Real-time environment for various applications.	4	
CO5	Analyze the fetch and frieght robots with various co-ordinate frames and joint angles in an constrained environments	4	
CO6	Analyze the kinematics and dynamics requirements using VREP robotic simulation tool	4	

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 Springer Handbook of Robotics, Bruno Siciliano, Oussama Khatib, 2nd Edition (2016), Springer.

25RAN3102E - ADVANCED ROBOTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3102E	ADVANCED ROBOTICS	AR	E	4	1	2	0	6

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	
CO2	Apply the basics of DH parameters for developing the models of Advanced Robotic Manipulator.	3	
CO3	Apply the functional and critical operational Robotics methods for preparing advanced level of Robotics	3	
CO4	Analyze the concepts of Advanced Robotics Systems and Real-time environment for various applications	4	
CO5	Analyze the fetch and frieght robots with various co-ordinate frames and joint angles in an constrained environments	4	
CO6	Analyze the kinematics and dynamics requirements using VREP robotic simulation tool	4	

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.

25RAN3202 - AUTONOMOUS VEHICLES AND AUTOMOTIVE ELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3202	AUTONOMOUS VEHICLES AND AUTOMOTIVE ELECTRONICS	AVAE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying the basics of vehicular dynamics and control for autonomous vehicles.	3	
CO2	Apply different types of sensors and actuators used in vehicles to control different vehicular parameters.	3	
CO3	Apply the concepts of Automotive Electronics to automotive systems and subsystems	3	
CO4	Analyse the basics of wireless electronics and networking to attribute reliability, safety, and smartness to autonomous vehicles	4	

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.

Reference Books

- 1 Automotive Computers and Control System, Tom Weather Jr and Cland C. Hunter, 2nd edition, springer.
- 2 On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems, Butterworth-Heinemann Romil Rawat, 2016, Butterworth-Heinemann.
- 3 Autonomous Vehicles Volume 1: Using Machine Intelligence, Romil Rawat, A mary sowjanya, 1st edition, John Wiley & Sons Inc.

25RAN3203 - ROBOT MANIPULATION AND WHEELED MOBILE ROBOTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3203	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	
CO2	Analyze the concept of forces friction to find out the performance of the manipulator	4	
CO3	Apply the basic concepts used to check the performance of mobile robots	3	
CO4	Apply the concept of feedback control and odometry for Mobile robots	3	

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

- 1 Introduction to Autonomous Mobile Robots, R. Siegwart, I. R. Nourbakhsh,, 2, The MIT Press.
- 2 Robotics, Vision and Control, Peter Corke, 2, Springer.
- 3 Planning Algorithms, S. M. LaValle, 1, Cambridge University Press.
- 4 Probabilistic Robotics, Thrun, S., Burgard,W., and Fox, D, 1, 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, PHI.

25RAN3304 - AUTONOMOUS MOBILE ROBOT SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3304	AUTONOMOUS MOBILE ROBOT SYSTEMS	AMRS	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic mechanical and electrical systems concerning robots locomotion and manipulation.	3	
CO2	Apply the mathematical models and computational and motion control methods to mobile robotic systems.	3	
CO3	Apply the sensor systems related to state measurements, navigation and localization.	3	
CO4	Analyse the A-star, Dijkstra algorithm for planning the required path.	4	
CO5	Analyse the path planning for the multiple robots	4	

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, 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 (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).

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.
- 7 Introduction to Mobile Robot Control, SG Tzafestas, 2014, Elsevier.

25RAN3304A - AUTONOMOUS MOBILE ROBOT SYSTEMS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3304A	AUTONOMOUS MOBILE ROBOT SYSTEMS	AMRS	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic mechanical and electrical systems concerning robots locomotion and manipulation.	3	
CO2	Apply the mathematical models and computational and motion control methods to mobile robotic systems.	3	
CO3	Apply the sensor systems related to state measurements, navigation, and probabilistic map based localization	3	
CO4	Analyze the A-star, Dijkstra algorithm for planning the required path for various terrains with different combinations of robot	4	
CO5	Analyze the path planning for the multiple robots with various path planning techniques	4	
CO6	Analyze different aspects of stability for a given robot model and apply the mathematical model for the desired movements	4	

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.

25RAN3304E - AUTONOMOUS MOBILE ROBOT SYSTEMS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3304E	AUTONOMOUS MOBILE ROBOT SYSTEMS	AMRS	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic mechanical and electrical systems concerning robots locomotion and manipulation	3	
CO2	Apply the mathematical models and computational and motion control methods to mobile robotic systems.	3	
CO3	Apply the sensor systems related to state measurements, navigation, and probabilistic map based localization	3	
CO4	Analyze the A-star, Dijkstra algorithm for planning the required path for various terrains with different combinations of robot	4	
CO5	Analyze the path planning for the multiple robots with various path planning techniques	4	
CO6	Analyze different aspects of stability for a given robot model and apply the mathematical model for the desired movements	4	

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.

25RAN3405 - ARTIFICIAL INTELLIGENCE FOR ROBOTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3405	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	AIR	R	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	
CO2	Applying various AI search techniques to solve real world problems	3	
CO3	Apply principles of AI in solutions that require process, planning and Reasoning	3	
CO4	Apply various forms of learning and knowledge representation techniques for communication, perceiving and acting for robots.	3	

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, Stuart Russell, Peter Norvig, 3, Pearson Education.
- 2 Artificial Intelligence, Negnevitsky, M, 1, Harlow: Addison-Wesley.
- 3 Artificial Intelligence, David Jefferis, 1, Crabtree Publishing Company.
- 4 Artificial Intelligence, Francis X. Govers, 1, Packt Publishing.
- 5 Robot Programming, Joe Jones, Daniel Roth, and Tucker Balch, 1, McGraw Hill.

25RAN3406 - HUMAN MACHINE INTERFACE AND BRAIN MACHINE INTERFACE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3406	HUMAN MACHINE INTERFACE AND BRAIN MACHINE INTERFACE	HMIBMI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply usability principles, Fitts law, Hick-Hyman law, and Normans interaction models to evaluate and design user friendly Human Machine Interfaces (HMI)	3	
CO2	Apply GUI design aesthetics and prototyping techniques to develop interactive software interfaces using industry-standard tools.	3	
CO3	Apply cognitive modeling techniques such as GOMS, KLM, and Hierarchical Task Analysis (HTA) for task analysis and dialog design in HMI applications.	3	
CO4	Apply signal acquisition and analysis techniques (EEG/ECOG/ARMA modeling) to design experimental frameworks for Brain-Computer Interface (BCI) applications.	3	

Syllabus

Introduction, history and relation to Ergonomics and Human Factors Problem 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 interaction, 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- rover, 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 EEG-Based Brain-Computer Interfaces: Cognitive Analysis and its Applications, Dipali Bansal, Rashima Mahajan, 1, Academic Press.
- 2 HCI Models, Theories, and Frameworks, John M. Carroll, 1st, Elsevier / Morgan Kaufmann.
- 3 The Psychology of Human-Computer Interaction, Stuart K. Card, Thomas P. Moran, Allen Newell, 1, Lawrence Erlbaum Associates.
- 4 The Design of Everyday Things, Donald A. Norman, 2, Basic Books.
- 5 Handbook of Human Factors and Ergonomics, Gavriel Salvendy (Editor), 1, Wiley.
- 6 Wearable Brain-Computer Interfaces: Prototyping EEG-Based Instruments for Monitoring and Control, Pasquale Arpaia, Antonio Esposito, Ludovica Gargiulo, 1st, CRC Press.
- 7 Brain Computer Interfaces 1 Foundations and Methods, Christoph Guger, Brendan Z Allison, etc, 1, Wiley.
- 8 Human Computer Interaction, Alan Dix, Janet E Finlay, Gregory D Abowd, Russell Beale, 3, Pearson Prentice Hall.

25RAN3507 - COMPUTER VISION AND APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RAN3507	COMPUTER VISION AND APPLICATIONS	CVA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply image processing techniques such as image formation, enhancement, segmentation, and feature extraction to analyze and interpret visual data for robotic applications	3	
CO2	Implement CNN architectures (LeNet, VGG, ResNet) for classification and evaluate their performance on benchmark datasets.	3	
CO3	Utilize autoencoder-based models (U-Net, SegNet, Mask R-CNN) to perform image segmentation and assess performance using metrics like mIoU and Dice score.	3	
CO4	Develop generative models (GANs, VAEs) to create synthetic datasets and apply them in improving robotic perception and decision-making.	3	

Syllabus

Image Fundamentals, Introduction to Image Formation and Capture: Light, optics, and camera models, Pinhole camera, perspective projection, and lens distortion, Image Representation: Grayscale, RGB, multispectral, and depth images, Image file formats and metadata Image Sampling and Quantization.

Linear Filtering and Convolution: Smoothing, sharpening, Gaussian blur, and edge enhancement, Feature Detection: Edges, Sobel, Canny, Corners, Harris, Shi-Tomasi, Blobs, Laplacian of Gaussian, Difference of Gaussians, Space and Scale Selection: Scale-space theory, multi-scale representation, Feature Descriptors: Histogram of Oriented Gradients (HoG), Local Binary Patterns (LBP), Deconvolution and Image Restoration, Image segmentation: Thresholding Techniques, Global and adaptive thresholding, Region-based Segmentation, Region growing, splitting, and merging, Color and Gray-scale Image Segmentation

CNN-based Image Classification: Building an Image Dataset, Horses vs Humans, Rock-Paper-Scissors, Flowers, MS COCO, Open Images; Data augmentation and preprocessing: CNN Architectures, LeNet-5, VGG, ResNet, Training, Testing, and Inferencing, Batch size, epochs, learning rate, overfitting, regularization, Performance Measurement, Accuracy, confusion matrix, precision, recall, F1-score; Visualization and Understanding CNNs: Visualizing kernels, feature maps, Grad-CAM, Calculating computational complexity (FLOPs, parameters)

Autoencoders for Image Segmentation and Generation: Autoencoders and Variants, Standard autoencoders, convolutional autoencoders; Segmentation Architectures: U-Net, SegNet, Mask R-CNN; Image Annotation and Ground Truth Modeling, Training and Testing Segmentation Models, Performance Metrics for Segmentation, Pixel Accuracy, Mean Intersection over Union (mIoU), Dice score; Deep Generative Models: Generative Adversarial Networks (GANs), Architecture, training stability, loss functions; Variational Autoencoders (VAEs): Encoder-decoder framework, latent space representation; Applications in Robotics, Synthetic data generation, image-to-image translation

Reference Books

- 1 Learning OpenCV 4, Adrian Kaehler, Gary Bradski, 3rd, O Reilly Media.
- 2 Programming Computer Vision with Python, Jan Erik Solem, 1st, O Reilly Media.
- 3 Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, 1st, MIT Press.

25RFM3101 - MICROWAVE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RFM3101	MICROWAVE ENGINEERING	ME	R	3	0	2	0	4

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	
CO2	Apply the concept of Microwave Active components and Microwave tubes.	3	
CO3	Analyze the solid-state device concept and microwave oscillators	4	
CO4	Analyze the measurement techniques for Microwave solid-state devices	4	
CO5	Analyze advanced microwave equipment.	4	

Syllabus

Passive microwave devices Scattering matrix, microwave hybrid circuits, terminations, attenuators, directional couplers twohole directional couplers, Smatrix of a directional coupler, hybrid couplers, and isolators.

Microwave tubes: Limitations of conventional active devices at microwave frequency, two-cavity klystron, reflex klystron, magnetron, traveling wave tube (TWT), and backward wave oscillators.

Solid-state amplifiers and oscillators: Transferred electron devices such as Gunn-effect diodes and their modes of operation; avalanche transit-time devices including IMPATT diode, TRAPPAT diode, and PIN diode.

Microwave measurements and advanced microwave equipment: Microwave power measurement, insertion loss and attenuation measurement, return loss measurement using a reflectometer, VSWR measurement, frequency measurement, measurement of cavity Q, and electromagnetic radiation measurement. Advanced microwave equipment includes spectrum analyzer, network analyzer, tunable detector, and slotted line carriage.

Reference Books

- 1 Microwave engineering , Pozar, D. M. , 4, Wiley.
- 2 Microwave devices and circuits , Liao, S. Y. , 3, Pearson Education India.
- 3 Foundations for microwave engineering , Collin, R. E. , 2, Wiley-IEEE Press..
- 4 Microwave engineering , Das, A., & Das, S. K. , 4, McGraw Hill Education.
- 5 Introduction to radar systems, Skolnik, M. I. , 3, McGraw Hill Education.

25RFM3101A - MICROWAVE ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RFM3101A	MICROWAVE ENGINEERING	ME	A	4	1	2	0	6

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	
CO2	Apply the concept of Microwave Active components and Microwave tubes.	3	
CO3	Analyze the solid-state device concept and microwave oscillators.	4	
CO4	Analyze the measurement techniques for Microwave solid-state devices.	4	
CO5	Analyze advanced microwave equipment.	4	
CO6	Analyze and design the applications of microwave active and passive components using hardware.	5	

Syllabus

Passive microwave devices Scattering matrix, microwave hybrid circuits, terminations, attenuators, directional couplers two hole directional couplers, S matrix of a directional coupler, hybrid couplers, and isolators.

Microwave tubes Limitations of conventional active devices at microwave frequency, two cavity klystron, reflex klystron, magnetron, traveling wave tube TWT, and backward wave oscillators.

Solid state amplifiers and oscillators Transferred electron devices such as Gunn effect diodes and their modes of operation avalanche transit time devices including IMPATT diode, TRAPPAT diode, and PIN diode.

Microwave measurements and advanced microwave equipment Microwave power measurement, insertion loss and attenuation measurement, return loss measurement using a reflectometer, VSWR measurement, frequency measurement, measurement of cavity Q, and electromagnetic radiation measurement. Advanced microwave equipment includes spectrum analyzer, network analyzer, tunable detector, and slotted line carriage.

Reference Books

- 1 Microwave engineering , Pozar, D. M, 4th edition, Wiley..
- 2 Microwave devices and circuits , Liao, S. Y., 3rd edition, Pearson Education India..
- 3 Foundations for microwave engineering, Collin, R. E., 2nd edition, Wiley-IEEE Press..
- 4 Microwave engineering , Das, A., & Das, S. K., 4th edition, McGraw Hill Education..
- 5 Introduction to radar systems , Skolnik, M. I., 3rd edition, McGraw Hill Education..

25RFM3101E - MICROWAVE ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RFM3101E	MICROWAVE ENGINEERING	ME	E	4	1	2	0	6

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	
CO2	Apply the concept of Microwave Active components and Microwave tubes.	3	
CO3	Analyze the solid-state device concept and microwave oscillators.	3	
CO4	Analyze the measurement techniques for Microwave solid-state devices.	4	
CO5	Analyze advanced microwave equipment.	4	
CO6	Analyze and design the applications of microwave active and passive components using hardware.	5	

Syllabus

Passive microwave devices: Scattering matrix, microwave hybrid circuits, terminations, attenuators, directional couplers (two-hole directional couplers, S-matrix of a directional coupler), hybrid couplers, and isolators

Microwave tubes: Limitations of conventional active devices at microwave frequency, two-cavity klystron, reflex klystron, magnetron, traveling wave tube (TWT), and backward wave oscillators.

Solid-state amplifiers and oscillators: Transferred electron devices such as Gunn-effect diodes and their modes of operation; avalanche transit-time devices including IMPATT diode, TRAPPAT diode, and PIN diode.

Microwave measurements and advanced microwave equipment: Microwave power measurement, insertion loss and attenuation measurement, return loss measurement using a reflectometer, VSWR measurement, frequency measurement, measurement of cavity Q, and electromagnetic radiation measurement. Advanced microwave equipment includes spectrum analyzer, network analyzer, tunable detector, and slotted line carriage.

Reference Books

- 1 Microwave engineering , Pozar, D. M. , 4, wiley.
- 2 Microwave devices and circuits , Liao, S. Y. , 3, Pearson Education India..
- 3 Foundations for microwave engineering, Collin, R. E. , 2, Wiley-IEEE Press..
- 4 Microwave engineering , Das, A., & Das, S. K. , 4, McGraw Hill Education.

25RFM3202 - ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RFM3202	ADVANCED ANTENNA DESIGN FOR WIRELESS AND 5G APPLICATIONS	AADW	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret Antenna design for wireless and 5G Applications	3	
CO2	Interpret the basic Concepts for 5G FR1 Single Band and Multi-Band Mobile Antenna Design	3	
CO3	Analyse the concept of the different MIMO-Based 5G FR1 Band Mobile Antennas for 5G and Wireless Applications	3	
CO4	Analyse the different Antenna-in-Package for 5G and Mobile Antennas	4	

Syllabus

Introduction: Frequency Characteristics and Channel Models, 5G Network Architecture, Evolution of Mobile Devices, Antenna Materials for 5G smartphone.

Basic Concepts for 5G FR1 Single Band and Multi-Band Mobile Antenna Design: 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.

MIMO-Based 5G FR1 Band Mobile Antenna: 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.

Antenna-in-Package: 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 Antennas: From Theory to Practice, Yi Huang, 2021, 2nd Edition, Wiley.
- 4 Fundamentals of 5G Mobile Networks, Jonathan Rodriguez,, 2015, Wiley, 1st Edition.

25RFM3303 - MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RFM3303	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	MRSN	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the principles of operation and design of radar systems	3	
CO2	Apply the target-based concept to various types of Radars for Air Traffic Control applications.	3	
CO3	Analyse the principles of various Radar tracking systems used in different applications	4	
CO4	Analyse the concepts related to different tracking systems and sensors for navigation.	4	
CO5	Analyse the principles of various Radars systems used in different applications	4	
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.

25RFM3303A - MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RFM3303A	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	MRSN	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	CO 1 Interpret the principles of operation and design of radar systems	3	
CO2	Apply the target-based concept to various types of Radars for Air Traffic Control applications	3	
CO3	Analyse the principles of various Radar tracking systems used in different applications	4	
CO4	Analyse the concepts related to different tracking systems and sensors for navigation	4	
CO5	Analyse the principles of various Radar systems used in different applications	4	
CO6	Apply and analyse the various automotive concepts to design the Modern RADAR system	5	
CO7	Apply the various adaptive techniques and automotive concepts to design the Modern RADAR system	5	

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: 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, Merrill I Skolnik, 3rd Edition, TMH.
- 2 Principles of Modern Radar, William L. Melvin, James A. Scheer, 1, SciTech Publishing.
- 3 Elements of Electronic Navigation Systems, ABC, 1, Tata McGraw-Hill.
- 4 Radar Principles, Peyton Z Peebles Jr, 1, John Wiley Inc..

25RFM3303E - MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RFM3303E	MODERN RADAR SYSTEMS & NAVIGATIONAL AIDS	MRSN	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Interpret the principles of operation and design of radar systems	3	
CO2	Apply the target-based concept to various types of Radars for Air Traffic Control applications	3	
CO3	Analyse the principles of various Radar tracking systems used in different applications	4	
CO4	Analyse the concepts related to different tracking systems and sensors for navigation	4	
CO5	Analyse the principles of various Radar systems used in different applications	4	
CO6	Apply and analyse the various automotive concepts to design the Modern RADAR system	5	
CO7	Apply the various adaptive techniques and automotive concepts to design the Modern RADAR system	5	

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: 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.

25RFM3404 - RF AND MILLIMETER-WAVE CIRCUIT DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RFM3404	RF AND MILLIMETER-WAVE CIRCUIT DESIGN	RMWCD	R	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	
CO2	Interpret the concept of Mixers design for RF & mm-Wave	3	
CO3	Analyse the concept of Oscillators to design RF Oscillators for mm-Wave.	4	
CO4	Analyse the concepts of RF and Millimetre-Wave circuits for various synthesizers.	4	

Syllabus

Introduction to RF & Millimeter-Wave Circuit Design: Wireless Systems - history of wireless technologies, wireless system design, RF system specifications. Concepts of transceivers - path loss, interference signals, receiver sensitivity, and transmitter output power. Design specifications of low noise amplifiers (LNAs) and power amplifiers (PAs).

Design of Mixers: 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, advantages and drawbacks of using All-Digital PLL, RF phase-locked loop: impact of the PLL frequency synthesizer on the signal's noise performance. Architecture and usage of Fractional-N PLL frequency synthesizers, design specifications of a frequency divider and a phase detector.

Reference Books

- 1 Introduction to RF Circuits and Design Techniques, Robert Sobot, 1, Springer.
- 2 RF Circuits for 5G Applications: Designing with mm-Wave Circuitry, Sangeeta Singh, Rajeev Kumar Arya, B. C. Sahana, Ajay Kumar Vyas, 1, Wiley.
- 3 Handbook of RF, Microwave, and Millimeter-Wave Components, Leonid A. Belov, Sergey M. Smolskiy, Victor N. Kochemasov, 1, Artech House Publications.
- 4 Microwave Engineering, David M Pozar, 4, Wiley.
- 5 Microwave and Millimeter Wave Circuits and Systems: Emerging Design, Technologies and Applications, Apostolos Georgiadis, Hendrik Rogier, Luca Roselli, Paolo Arcioni, 1, Wiley.
- 6 Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design, Matthew M. Radmanesh, 1, Author House Publications.

25RFM3505 - SATELLITE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25RFM3505	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	
CO2	Analyse the subsystems and payload requirements of a satellite	3	
CO3	Understand and Analyse Structural requirements and specifications of a satellite	3	
CO4	Apply the concepts for mission planning and designing of cubesats	4	

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.

25SCI3101 - SPATIAL DATA VISUALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3101	SPATIAL DATA VISUALIZATION	SDV	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SCI3101A - SPATIAL DATA VISUALIZATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3101A	SPATIAL DATA VISUALIZATION	SDV	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SCI3101E - SPATIAL DATA VISUALIZATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3101E	SPATIAL DATA VISUALIZATION	SDV	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SCI3202 - SPATIAL COMPUTING FOR MULTIPLAYER GAMES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3202	SPATIAL COMPUTING FOR MULTIPLAYER GAMES	SCMG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and discuss Web Security Concepts.	2	
CO2	Identify different techniques involved in protecting privacy and the principles of Web Security.	2	
CO3	Deploy SSL server Certificates, client-side digital certificates.	3	
CO4	Apply ethical hacking techniques to identify and exploit security.	3	

Syllabus

Introduction: Introduction to 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.

25SCI3303 - SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3303	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	SCPD	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying Spatial Computing concepts in different fields.	3	
CO2	Understanding Spatial Computing Techniques using Unity Tool.	2	
CO3	Applying Spatial Interaction Design for AR/VR Environments	3	
CO4	Applying Spatial Computing Development Workflow in Applications.	3	
CO6	Applying spatial computing ideas in Unity tool	3	

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

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 .

25SCI3303A - SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3303A	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	SCPD	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Applying Spatial Computing concepts in different fields.	4	
CO2	Understanding Spatial Computing Techniques using Unity Tool	4	
CO3	Applying Spatial Interaction Design for AR/VR Environments	4	
CO4	Applying Spatial Computing Development Workflow in Applications	4	
CO5	Applying advanced interaction techniques in Spatial Computing	4	
CO6	Applying different concepts for spatial computing platforms.	4	

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.

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.

25SCI3303E - SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3303E	SPATIAL COMPUTING PLATFORMS AND DEVELOPMENT	SCPD	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SCI3404 - SPATIAL AND SOCIAL IMPLICATIONS OF IMMERSIVE TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3404	SPATIAL AND SOCIAL IMPLICATIONS OF IMMERSIVE TECHNOLOGIES	SSIIT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SCI3405 - SPATIAL AUDIO DESIGN FOR GAMES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3405	SPATIAL AUDIO DESIGN FOR GAMES	SADG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SCI3506 - SPATIAL USER INTERFACE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3506	SPATIAL USER INTERFACE DESIGN	SUID	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SCI3507 - INTRODUCTION TO SPATIAL COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SCI3507	INTRODUCTION TO SPATIAL COMPUTING	ITSC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SDM3101 - SENTIMENT ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3101	SENTIMENT ANALYSIS	SA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the sentiment analysis techniques for classifying opinions and emotions from text data	3	
CO2	Choose the methods for identifying subjective sentences, classifying sentiment and extracting aspects of that sentiment within text data.	3	
CO3	Analyze the sentiment lexicons, compare sentiment within text data, and techniques for summarizing opinions on specific aspects.	4	
CO4	Analyze the concept of debate analysis, intention mining, and fake-opinion detection.	4	
CO5	Outline the concepts of language constructs, express opinions, sentiments and emotions, intention mining, fake opinion detection	4	
CO6	Examine sentiment analysis techniques in Python using NLTK, TextBlob, and VADER, exploring feature importance with Random Forest, installation and lexicon setup	4	

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 and Opinion Mining, Bing Liu., May2012., Morgan & Claypool.
- 2 Sentiment Analysis in Social Networks , Federico Pozzi, Elisabetta Fersini, Enza Messina, Bing Liu , 2016, Morgan & Claypool.
- 3 Sentiment Analysis for Social Media, Antonio Moreno, Carlos A. Iglesias, 2020, MDPI.
- 4 New Opportunities for Sentiment Analysis and Information Processing, Aakansha Sharaaff, G.R. Sinha, Surbhi Bhatia, 2021, IGI Global.

25SDM3101A - SENTIMENT ANALYSIS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3101A	SENTIMENT ANALYSIS	SA	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the sentiment analysis techniques for classifying opinions and emotions from text data	3	
CO2	Choose the methods for identifying subjective sentences, classifying sentiment and extracting aspects of that sentiment within text data.	3	
CO3	Analyze the sentiment lexicons, compare sentiment within text data, and techniques for summarizing opinions on specific aspects.	4	
CO4	Analyze the concept of debate analysis, intention mining, and fake-opinion detection.	4	
CO5	Outline the concepts of language constructs, express opinions, sentiments and emotions, intention mining, fake opinion detection	4	
CO6	Examine sentiment analysis techniques in Python using NLTK, TextBlob, and VADER, exploring feature importance with Random Forest, installation and lexicon setup	4	
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	

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 and Opinion Mining , Bing Liu, May2012., Morgan & Claypool Publishers.
- 2 Sentiment Analysis in Social Networks , Federico Pozzi, Elisabetta Fersini, Enza Messina, Bing Liu , 2016, Morgan & Claypool Publishers.

- 3 Sentiment Analysis for Social Media, Antonio Moreno, Carlos A. Iglesias, 2020, MDPI.
- 4 New Opportunities for Sentiment Analysis and Information Processing, Aakansha Sharaff, G.R. Sinha, Surbhi Bhatia, 2021, IGI GLOBAL.

25SDM3101E - SENTIMENT ANALYSIS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3101E	SENTIMENT ANALYSIS	SA	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the sentiment analysis techniques for classifying opinions and emotions from text data	3	
CO2	Choose the methods for identifying subjective sentences, classifying sentiment and extracting aspects of that sentiment within text data.	3	
CO3	Analyze the sentiment lexicons, compare sentiment within text data, and techniques for summarizing opinions on specific aspects.	4	
CO4	Analyze the concept of debate analysis, intention mining, and fake-opinion detection.	4	
CO5	Outline the concepts of language constructs, express opinions, sentiments and emotions, intention mining, fake opinion detection	4	
CO6	Examine sentiment analysis techniques in Python using NLTK, TextBlob, and VADER, exploring feature importance with Random Forest, installation and lexicon setup	4	
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	

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 and Opinion Mining, Bing Liu., MAY, 2012, Morgan & Claypool Publishers.
- 2 Sentiment Analysis in Social Networks , Federico Pozzi, Elisabetta Fersini, Enza Messina, Bing Liu , 2016, Morgan & Claypool Publishers.

- 3 Sentiment Analysis for Social Media, Antonio Moreno, Carlos A. Iglesias, 2020, MDPI.
- 4 New Opportunities for Sentiment Analysis and Information Processing, Aakansha Sharaff, G.R. Sinha, Surbhi Bhatia, 2021, IGI Global.

25SDM3202 - OPINION MINING AND RECOMMENDER SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3202	OPINION MINING AND 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	
CO2	Apply evaluation metrics and opinion mining techniques by using VADER and NLTK tools in opinion mining	3	
CO3	Make use of data mining methods for recommender systems, classifiers, optimization of recommender systems	3	
CO4	Examine the optimization methods for different recommender systems	3	

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 , S,LDA , D,LDA , PLDA , S,PLDA , D,PLDA , 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 weightcomputation, 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 Sentiment Analysis and Opinion Mining, Bing Liu, May2012, Morgan & Claypool Publishers.
- 2 Recommender Systems , C.C. Aggarwal , 2016, Springer.
- 3 Recommender systems handbook , Federico Pozzi, Elisabetta Fersini, Enza Messina Bing Liu , 2016, Springer.

- 4 Sentiment Analysis for Social Media, Antonio Moreno, Carlos A. Iglesias, 2020, MDPI.
- 5 New Opportunities for Sentiment Analysis and Information Processing, Aakansha Sharaff, G.R. Sinha, Surbhi Bhatia, 2021, IGI GLOBAL.

25SDM3203 - META SOCIAL MEDIA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3203	META SOCIAL MEDIA ANALYTICS	MSMA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the structure and working of Meta's social media platforms and advertising algorithms.	2	
CO2	Identify, interpret, and analyze key metrics and data sources for marketing performance on Meta platforms.	2	
CO3	Design, implement, and optimize marketing campaigns using strategic targeting and A/B testing.	4	
CO4	Use tools, APIs, and automation to generate insights and dashboards for decision-making tools	4	

Syllabus

Introduction to Meta Ecosystem and Digital Marketing, Overview of Meta and its platform evolution Core platforms: Facebook, Instagram, WhatsApp, Messenger. Role of each platform in digital marketing. Case studies of brand presence across Meta platforms.

Meta Advertising Algorithms and Targeting. Introduction to Metas ad delivery algorithm. Machine learning in ad placement and delivery. Audience segmentation Core, Custom, and Lookalike Audiences. Real-time bidding and auction dynamics

Metrics, KPIs, and Performance Analytics. Key performance indicators: CTR, engagement, reach, conversions. Using Meta Insights, Ads Manager dashboards. Attribution models and conversion tracking. Data interpretation and reporting.

A/B Testing, Campaign Optimization, and Tools. Concept and setup of A/B split testing. Elements to test: creatives, copy, CTA, audience. Budget allocation strategies. Campaign optimization using Meta Business Suite and Ads Manage.

Reference Books

- 1 Digital Marketing, Chaffey, D., & Ellis-Chadwick, F, 8th Edition, Pearson Education.
- 2 Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Ryan, D, 5th Edition, Kogan Page.
- 3 Marketing Management, Marshall, G. W., & Johnston, M. W, 3rd Edition, McGraw Hill.
- 4 Social Media Marketing, Tuten, T. L., & Solomon, M. R, 3rd Edition, Sage Publications.

25SDM3304 - SOCIAL MEDIA MARKETING ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3304	SOCIAL MEDIA MARKETING ANALYTICS	SMMA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand to the basic concepts of social network analysis	2	
CO2	Understand Apply Python Language for Data Analytics and Visualization	2	
CO3	Annotate and Analyze the Twitter Data using Python, and to draw meaningful insights and provide Graphical representation of data analysis	3	
CO4	Summarize and Analyze the Facebook Data using Python, and native	3	
CO5	Discover the use of technologies and consumer generated content that are influencing the direction of social media marketing	3	

Syllabus

Introduction to Social Marketing, Social Marketing: Concepts, Principles, and Applications, Social Marketing in India: Challenges and Opportunities. Social Marketing Planning and Strategy Social Marketing Planning Process, Market Segmentation and Targeting in Social Marketing,

Formative Research in Social Marketing, Developing Social Marketing Strategies and Programs, Social Marketing Ethics and Social Responsibility. Social Marketing Analysis and Research, Social Marketing Research Methods and Techniques, Assessing the Social Marketing Environment in India Social Marketing Audience

Social Marketing Tools and Techniques, Product, Price, Place, and Promotion Strategies in Social Marketing, Designing Effective Social Marketing Campaigns, Social Marketing, Communication: Message Development and Channel Selection, Social Marketing Advocacy and Policy Change.

Social Marketing Applications Social Marketing for Health Promotion and Disease Prevention, Social Marketing for Environmental Conservation and Sustainability, Social Marketing for Behaviour Change in Education and Development, Social Marketing for Social Issues and Social Change

Reference Books

- 1 Social Marketing: Behavior Change for Social Good, Kotler, P., & Lee, N. R, 6th Edition, SAGE Publications.
- 2 Strategic Marketing for Nonprofit Organizations, Andreasen, A. R., & Kotler, P, 2010, Pearson.
- 3 Social Marketing and Public Health: Theory and Practice, French, J., Blair-Stevens, C., McVey, D., & Merritt, R, 1st Edition, Oxford University Press.
- 4 Social Marketing Research for Global Public Health: Methods and Technologies., Evans, W. D, 2008, Oxford University Press.
- 5 Strategic Social Marketing., Dann, S., & Dann, S, 2013, Oxford University Press.

25SDM3304A - SOCIAL MEDIA MARKETING ANALYTICS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3304A	SOCIAL MEDIA MARKETING ANALYTICS	SMMA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand to the basic concepts of social network analysis	2	
CO2	Understand Apply Python Language for Data Analytics and Visualization	2	
CO3	Annotate and Analyze the Twitter Data using Python, and to draw meaningful insights and provide Graphical representation of data analysis	3	
CO4	Summarize and Analyze the Facebook Data using Python, and native	3	
CO5	Discover the use of technologies and consumer generated content that are influencing the direction of social media marketing	3	

Syllabus

Introduction to Social Marketing, Social Marketing: Concepts, Principles, and Applications, Social Marketing in India: Challenges and Opportunities. Social Marketing Planning and Strategy Social Marketing Planning Process, Market Segmentation and Targeting in Social Marketing,

Formative Research in Social Marketing, Developing Social Marketing Strategies and Programs, Social Marketing Ethics and Social Responsibility. Social Marketing Analysis and Research, Social Marketing Research Methods and Techniques, Assessing the Social Marketing Environment in India Social Marketing Audience

Social Marketing Tools and Techniques, Product, Price, Place, and Promotion Strategies in Social Marketing, Designing Effective Social Marketing Campaigns, Social Marketing, Communication Message Development and Channel Selection, Social Marketing Advocacy and Policy Change

Social Marketing Applications Social Marketing for Health Promotion and Disease Prevention, Social Marketing for Environmental Conservation and Sustainability, Social Marketing for Behaviour Change in Education and Development.

Social Marketing for Social Issues and Social Change Sustainability, Social Marketing for Behaviour Change in Education and Development, Social Marketing for Social Issues and Social Change

Reference Books

- 1 Social Marketing: Behavior Change for Social Good, Kotler, P., & Lee, N. R, 6th ed., SAGE Publications.
- 2 Social Marketing and Public Health: Theory and Practice, French, J., Blair-Stevens, C., McVey, D., & Merritt, R, 2010, Oxford University Press.
- 3 Social Marketing Research for Global Public Health: Methods and Technologies , Evans, W. D, 2008, Oxford University Press.
- 4 Innovations in Social Marketing and Public Health Communication, Wymer, W, 2015, Springer.

25SDM3304E - SOCIAL MEDIA MARKETING ANALYTICS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3304E	SOCIAL MEDIA MARKETING ANALYTICS	SMMA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand to the basic concepts of social network analysis	2	
CO2	Understand Apply Python Language for Data Analytics and Visualization	2	
CO3	Annotate and Analyze the Twitter Data using Python, and to draw meaningful insights and provide Graphical representation of data analysis	3	
CO4	Summarize and Analyze the Facebook Data using Python, and native	3	
CO5	Discover the use of technologies and consumer generated content that are influencing the direction of social media marketing	3	

Syllabus

Introduction to Social Marketing, Social Marketing: Concepts, Principles, and Applications, Social Marketing in India: Challenges and Opportunities. Social Marketing Planning and Strategy Social Marketing Planning Process, Market Segmentation and Targeting in Social Marketing,

Formative Research in Social Marketing, Developing Social Marketing Strategies and Programs, Social Marketing Ethics and Social Responsibility. Social Marketing Analysis and Research, Social Marketing Research Methods and Techniques, Assessing the Social Marketing Environment in India Social Marketing Audience

Social Marketing Tools and Techniques, Product, Price, Place, and Promotion Strategies in Social Marketing, Designing Effective Social Marketing Campaigns, Social Marketing, Communication Message Development and Channel Selection, Social Marketing Advocacy and Policy Change

Social Marketing Applications Social Marketing for Health Promotion and Disease Prevention, Social Marketing for Environmental Conservation and Sustainability, Social Marketing for Behaviour Change in Education and Development.

Social Marketing for Social Issues and Social Change Sustainability, Social Marketing for Behaviour Change in Education and Development, Social Marketing for Social Issues and Social Change

Reference Books

- 1 Social Marketing: Behavior Change for Social Good, Kotler, P., & Lee, N. R, 6th ed., SAGE Publications.
- 2 Social Marketing and Public Health: Theory and Practice, French, J., Blair-Stevens, C., McVey, D., & Merritt, R, 2010, Oxford University Press.
- 3 Social Marketing Research for Global Public Health: Methods and Technologies, Evans, W. D, 2008, Oxford University Press.
- 4 Innovations in Social Marketing and Public Health Communication, Wymer, W, 2015, Springer.

25SDM3405 - DIGITAL MEDIA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3405	DIGITAL MEDIA ANALYTICS	DMA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To develop an understanding of data ethics, privacy concerns, and the basic concepts of algorithm-driven media environments.	2	
CO2	To develop an understanding of key metrics and tools for analyzing digital media performance.	3	
CO3	To apply digital data analysis techniques to support strategic decision-making.	3	
CO4	To gain hands-on experience with tools like Google Analytics and social media dashboards.	3	

Syllabus

Marketing & Digital Marketing Fundamentals :Introduction to Marketing, Digital Channels Overview, Customer Journey and Persona Building, Digital Marketing Fundamentals and Strategies Content Creation Using AI Tools: Introduction to AI in Content Marketing, Introduction to AI in Content Marketing, Content Ideation and Copywriting, AI-Powered Content Creation, Content Optimization, AI Content Development.

Social Media and Influencer Marketing :Social Media Landscape, Content Strategies for Social Media, Influencer Marketing, Social Media Advertising, Monitoring Social Media Performance, Workshop: Planning a Social Media Campaign.

SEO and SEM: Introduction to SEO, On-Page and Off-Page SEO, Technical SEO, Introduction to SEM, Performance Metrics for SEO and SEM.

Data Analytics in Marketing, Introduction to Marketing Analytics, Google Analytics Basics, Advanced Analytics Tools, A/B Testing and Experimentation, Attribution Models and ROI Calculation. Campaign Management and Automation: Introduction to Campaign Management, Marketing Automation Tools, AI in Campaign Management, Programmatic Advertising.

Reference Books

- 1 Digital Marketing Analytics: Making Sense of Consumer Data in a Digital World, Chuck Hemann & Ken Burbary, 2nd Edition (2018)., Que Publishing.
- 2 Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, Marshall Sponder, 1st Edition (2012), Pearson Education.
- 3 Digital Analytics 101: Your Shortcut to Marketing Analytics, Kevin Hartman, 2020, Kevin Hartman.
- 4 Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, Avinash Kaushik, 2009, Wiley.
- 5 Marketing Analytics: A Practical Guide to Real Marketing Science, Mike Grigsby, Kogan Page, 2015, INDEPENDENT.
- 6 Advanced Web Metrics with Google Analytics, Brian Clifton, 3rd Edition (2012), Wiley.

25SDM3406 - ETHICAL SOCIAL MEDIA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3406	ETHICAL SOCIAL MEDIA	ESM	R	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, PSO1
CO4	Analyze ethical considerations and challenges in Ethical social media mining research.	4	PO1, PO3, PO4, PSO1

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, Impact of Social Media Mining on Society.

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, User Consent and Privacy in Data Collection.

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, Opinion Mining in Social Media.

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, Detection of Fake Accounts and Misinformation in Social Networks.

Reference Books

- 1 Social Media Mining: An Introduction, Zafarani, R., Abbasi, M. A., & Liu, H., 1st Edition, 2014, Cambridge University Press..
- 2 Social Network Data Analytic, Aggarwal, C. C., 1st Edition, 2016, Springer.
- 3 Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Hansen, D., Shneiderman, B., & Smith, M. A., 2nd Edition, 2020, Morgan Kaufmann.

25SDM3507 - INTELLIGENT SOCIAL MEDIA MONITORING SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3507	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.

25SDM3508 - SEARCH ENGINE OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SDM3508	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
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
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
CO4	Analyze detailed profile of your ideal customer to laser-focus your marketing efforts.	4	PO2, PO4

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..
- 4 SEO for Dummies,, Peter Kent, 2016, John Wiley & Sons.

25SGT3101 - DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3101	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	DERSG	R	3	0	2	0	4

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	
CO2	Analyze distributed energy resources considering load demand, renewable sources, and grid interconnection.	4	
CO3	Analyze smart grid technologies for optimizing energy efficiency, reliability, and sustainability.	4	
CO4	Analyze Smart Grid Monitoring and AMI Infrastructure for enhanced grid management, efficiency, and consumer engagement.	4	
CO5	Analyze and test distributed energy resources for their integration, performance, and impact on the grid.	4	

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 Smart Grid Technology, S.N. Singh, 2013, PHI Learning Pvt. Ltd.
- 2 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, IEEE Computer Society Press.
- 3 Smart Grid: Technology and applications, Ekanayake J., Jenkins N, Liyanage, Wu, J, Yokoyama A, 2012, Wiley Publications.

25SGT3101A - DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3101A	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	DERSG	A	3	1	2	0	5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of distributed energy resources (DERs) and their impact on grid decentralization and efficiency.	3	
CO2	Analyze microgrid configurations, interconnection, and control strategies for reliable integration of DERs.	4	
CO3	Evaluate smart grid components, architecture, and enabling technologies for enhanced efficiency and sustainability	4	
CO4	Assess smart grid monitoring tools including WAMS, PMU, and AMI for effective grid management.	4	
CO5	Examine and test DER integration, performance, and protection aspects in smart grids.	4	

Syllabus

Distributed Energy Resources Introduction to DERs; CHP systems; PV systems; Wind energy systems; Small-scale hydro; Storage technologies (batteries, ultracapacitors, flywheels).

Microgrids and Integration Concepts of microgrid Configurations AC DC microgrids Interconnection Protection and control issues

Smart Grid Fundamentals Introduction Architecture Smart grid standards and policies Core components and enabling technologies

Smart Grid Monitoring and AMI Load dispatch centers Wide Area Monitoring System WAMS Phasor Measurement Units PMUs Smart sensors AMI and smart metering Demand side management

Testing and Integration of DERs Performance analysis of DERs Testing for grid integration Protection stability and impact assessment on traditional systems

Reference Books

- 1 Smart Grid Technology, S.N. Singh, 2013, PHI Learning Pvt. Ltd..
- 2 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, IEEE Computer Society Press.
- 3 Smart Grid: Technology and applications, Ekanayake J., Jenkins N, Liyanage, Wu, J, Yokoyama A, 2012, Wiley Publications.

25SGT3101E - DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3101E	DISTRIBUTED ENERGY RESOURCES AND SMART GRIDS	DERSG	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of distributed energy resources (DERs) and their impact on grid decentralization and efficiency.	3	
CO2	Analyze microgrid configurations, interconnection, and control strategies for reliable integration of DERs.	4	
CO3	Evaluate smart grid components, architecture, and enabling technologies for enhanced efficiency and sustainability	4	
CO4	Assess smart grid monitoring tools including WAMS, PMU, and AMI for effective grid management.	4	
CO5	Examine and test DER integration, performance, and protection aspects in smart grids.	4	

Syllabus

Distributed Energy Resources Introduction to DERs; CHP systems; PV systems; Wind energy systems; Small-scale hydro; Storage technologies (batteries, ultracapacitors, flywheels).

Microgrids and Integration Concepts of microgrid Configurations AC DC microgrids Interconnection Protection and control issues

Smart Grid Fundamentals Introduction Architecture Smart grid standards and policies Core components and enabling technologies

Smart Grid Monitoring and AMI Load dispatch centers Wide Area Monitoring System WAMS Phasor Measurement Units PMUs Smart sensors AMI and smart metering Demand side management

Testing and Integration of DERs Performance analysis of DERs Testing for grid integration Protection stability and impact assessment on traditional systems

Reference Books

- 1 Smart Grid Technology, S.N. Singh, 2013, PHI Learning Pvt. Ltd..
- 2 Smart Grid: Fundamentals of Design and Analysis, James Momoh, 2012, IEEE Computer Society Press.
- 3 Smart Grid: Technology and applications, Ekanayake J., Jenkins N, Liyanage, Wu, J, Yokoyama A, 2012, Wiley Publications.

25SGT3202 - DISTRIBUTION SYSTEM PRACTICES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3202	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	
CO2	Apply the small signal stability to power systems.	3	
CO3	Analyze Excitation control and Voltage Stability.	4	
CO4	Analyze power system security contro	4	

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.

Reference Books

- 1 Electrical Power Distribution and Transmission, Luces M. Faulkenberry, Walter Coffey, 1, Pearson.
- 2 Electric Power Distribution Equipment and Systems, Thomas Allen Short, 1, CRC Press.
- 3 Distribution System Modeling and Analysis, William H. Kersting, 4, CRC Press.

25SGT3203 - MICROGRID DYNAMICS AND CONTROL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3203	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	
CO2	To apply the dynamic modelling of microgrids	3	
CO3	To apply the different hierarchical control schemes for microgrid system and communication implementation of hierarchical control.	3	
CO4	To apply the stability in microgrids and alternate options for stability improvement in microgrids.	3	

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 Microgrids Architecture and control, N. D. Hatziaargyriou, 2014, John Wiley & Sons.
- 2 Power System Stability and Control, P. Kundur, 1994, McGraw-Hill.
- 3 Smart Grid Protection, Ali Chowdhury, 2020, CRC Press.

25SGT3304 - ENERGY MANAGEMENT SYSTEMS AND SCADA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3304	ENERGY MANAGEMENT SYSTEMS AND SCADA	EMS&SCADA	R	3	0	0	2	3.5

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	
CO2	Understand the Utility applications, Energy management applications in Transmission sector and Energy management applications in Distribution sector, operations, monitoring, analysis and improvement.	2	
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	
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	
CO5	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	

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, W. C. Turner, 1st Edition, Fairmont Press, Inc..
- 2 A Guide to Utility Automation: AMR, SCADA, and IT Systems, Michael Wiebe, 1st Edition, Pennwell Books.
- 3 Practical SCADA for Industry, D. Bailey, E. Wright, 1st Edition, Newnes.

25SGT3304A - ENERGY MANAGEMENT SYSTEMS AND SCADA (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3304A	ENERGY MANAGEMENT SYSTEMS AND SCADA	EMS&SCADA	A	4	1	0	2	5.5

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	
CO2	Understand the Utility applications, Energy management applications in Transmission sector and Energy management applications in Distribution sector, operations, monitoring, analysis and improvement.	2	
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	
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	
CO5	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	

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.

Smart substations, Substation Automation, Feeder Automation, SCADA, Remote Terminal Unit, Protocols, Phasor Measurement Unit.

Smart integration of energy resources, Renewable and intermittent power sources, Energy Storage, VoltVAR control, Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage Management System, CIS and GIS, Load Management Systems: Load analysis and forecasting, remote automatic meter reading.

Reference Books

- 1 Energy Management Handbook, W. C. Turner, 1st Edition, Fairmont Press, Inc..
- 2 A Guide to Utility Automation: AMR, SCADA, and IT Systems, Michael Wiebe, 1st Edition, Pennwell Books.
- 3 Practical SCADA for Industry, D. Bailey, E. Wright, 1st Edition, Newnes.

25SGT3304E - ENERGY MANAGEMENT SYSTEMS AND SCADA (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3304E	ENERGY MANAGEMENT SYSTEMS AND SCADA	EMS&SCADA	E	4	1	0	2	5.5

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	
CO2	Understand the Utility applications, Energy management applications in Transmission sector and Energy management applications in Distribution sector, operations, monitoring, analysis and improvement.	2	
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	
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	
CO5	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	

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.

Smart substations, Substation Automation, Feeder Automation, SCADA, Remote Terminal Unit, Protocols, Phasor Measurement Unit.

Smart integration of energy resources, Renewable and intermittent power sources, Energy Storage, VoltVAR control, Fault Detection, Isolation and Service Restoration, Network Reconfiguration, Outage Management System, CIS and GIS, Load Management Systems: Load analysis and forecasting, remote automatic meter reading.

Reference Books

- 1 Energy Management Handbook, W. C. Turner, 1st Edition, Fairmont Press, Inc..
- 2 A Guide to Utility Automation: AMR, SCADA, and IT Systems, Michael Wiebe, 1st Edition, Pennwell Books.
- 3 Practical SCADA for Industry, D. Bailey, E. Wright, 1st Edition, Newnes.

25SGT3405 - SMART GRID COMMUNICATION AND CYBERSECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3405	SMART GRID COMMUNICATION AND CYBERSECURITY	SGCCS	R	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	
CO2	Analyze the various security measures and potential threats associated with communication technologies in smart grids.	4	
CO3	Analyze the specific communication protocols and their roles in enhancing substation operations.	4	
CO4	Analyze the various hacking techniques and potential threats targeting smart grid infrastructures.	4	

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, SGCCG reference architecture, ISA62443: zones and conduits and Smart Grids.

Reference Books

- 1 Cyber Security for Smart Grid Systems, Dr. S. S. Tyagi , -, Springer.
- 2 Smart Grid Communication and Cybersecurity, Dr. Brijesh Kumar Singh, -, CRC Press.
- 3 Smart Grid, James Momoh, 2012, IEEE Computer Society Press.

25SGT3406 - SMART METERS AND SMART CITIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3406	SMART METERS AND SMART CITIES	SMSC	R	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	
CO2	Apply the key standards and initiatives relevant to smart city development and effectively apply them to enhance urban infrastructure and services.	3	
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	
CO4	Analyze the functionalities of smart meters and assess their benefits in enhancing energy management and efficiency within smart city infrastructures.	4	

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 Grid.

Smart Cities Introduction 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, Hafizur Rahaman , 2017, John Wiley sons Limited .
- 2 Smart Grid, James Momoh, 2012, IEEE Computer Society Press .
- 3 Smart Cities, Claude Rochet, 2012, Wiley.

25SGT3507 - INTERNET OF THINGS AND SMART GRID ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3507	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	
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	
CO3	Analyze the various applications of IoT technologies in smart grids to enhance monitoring, control, and optimization of energy distribution and consumption.	4	
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	

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, 1st Edition, CRC Press.
- 2 Smart Grid Technology: A Cloud Computing and Data Management Approach, Misra, Sudip, and Samaresh Bera, 1st Edition, Cambridge University Press.
- 3 Internet of Things and Data Analytics Handbook, Geng, Hwaiyu (ed.), 1st Edition, John Wiley & Sons.
- 4 Internet of Things and Big Data Analytics for Smart Generation, Valentina E. Balas, Sangeeta Mohanty, Raghvendra Kumar, Rajshree Srivastava, 1st Edition, Springer.

25SGT3508 - SMART GRID PROTECTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SGT3508	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	
CO2	To Apply relay algorithms and associated hardware.	3	
CO3	To understand the principles of modern protection systems for substation, transformer, generator and motor.	2	
CO4	To apply the advanced Protection for Smart Grid.	3	

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, 1st Edition, John Wiley & Sons.
- 2 Wide Area Monitoring, Protection and Control Systems: The Enabler for Smarter Grids, Alfredo Vaccaro, Ahmed F. Zobaa, 1st Edition, IET.
- 3 Fundamentals of Power System Protection, Y. G. Paithankar and S. R. Bhide, 1st Edition, Prentice Hall of India.
- 4 Smart Grids: Infrastructure, Technology, and Solutions, Stuart Borlase, 1st Edition, CRC Press.

25SMD3101 - SOFTWARE VERIFICATION & VALIDATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3101	SOFTWARE VERIFICATION & VALIDATION	SVV	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate fundamental concepts, terminologies, and techniques used in software verification and validation	2	
CO2	Identify different stages and activities involved in the software verification and validation process.	3	
CO3	Apply the principles and theories underlying software verification and validation	3	
CO4	Analyze various software verification and validation artifacts, such as test plans, test cases, and defect reports.	4	
CO5	Analyze and execute manual, automated test cases by using various testing tools to verify the software.	4	

Syllabus

Software Testing Fundamentals, Testing objectives, Testing life cycle, Test cases, Human-Error, testing and debugging, general principles of testing, test metrics, Agile methodology and Its Impact on Testing, Software 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 Use-Case, Advanced black box and white box techniques.

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 Use-Case, Advanced black box and white box techniques.

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, 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. Tests. Test Driven Development (TDD): Agile Model Driven Development, Acceptance TDD, Developer TDD.

Reference Books

- 1 Software Verification and Validation: An Engineering and Scientific Approach, Richard Leach, first, CRC Press / Taylor & Francis.
- 2 Applied Software Measurement: Global Analysis of Productivity and Quality, Capers Jones, second, Springer.
- 3 ISO/IEC 12207 & ISO/IEC 25010 Standards, ISO/IEC, first, Cengage Learning.

25SMD3101A - SOFTWARE VERIFICATION & VALIDATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3101A	SOFTWARE VERIFICATION & VALIDATION	SVV	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate fundamental concepts, terminologies, and techniques used in software verification and validation	2	PO1, PO2, 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	PO5
CO4	Analyze various software verification and validation artifacts, such as test plans, test cases, and defect reports.	4	PO3, PO5
CO5	Analyze and execute manual , automated test cases by using various testing tools to verify the software.	4	PO8, PO9

Syllabus

Software Testing Fundamentals, Testing objectives, Testing life cycle, Test cases, Human-Error, testing and debugging, general principles of testing, test metrics, Agile methodology and Its Impact on Testing, Software Verification and Validation. Failure, Error, Fault, and Defect

Gray box testing, intuitive and experience-based testing, verification and validation planning, Top-Down verses 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

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 Use-Case, Advanced black box and white box techniques.

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. Tests. Test Driven Development (TDD): Agile Model Driven Development, Acceptance TDD, Developer TDD.

Reference Books

- 1 software testing, Paul Ammann and Jeff Offutt, first edition, pearson edition.
- 2 An Engineering and Scientific Approach, Marcus S. Fisher, 1st Edition (2007), springer.
- 3 Process, Principles, and Techniques, Mauro Pezz? and Michal Young, 1st Edition (2008), John Wiley & Sons.

25SMD3101E - SOFTWARE VERIFICATION & VALIDATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3101E	SOFTWARE VERIFICATION & VALIDATION	SVV	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals, principles, and terminology of software verification and validation (V&V).	2	
CO2	Apply various V&V techniques and methods (static/dynamic, testing, inspection, formal methods) to real software artifacts.	3	
CO3	Design, execute, and evaluate verification and validation plans (test suites, coverage criteria, test oracles) in experiential settings.	3	
CO4	Assess and improve the quality, reliability, and correctness of software systems by interpreting V&V results and recommending corrective actions.	4	
CO5	Develop comprehensive V&V documentation, reports, and process improvement recommendations aligned with industry standards and best practices.	4	

Syllabus

Importance of software quality; definition of verification vs validation; software errors, faults, and failures; role of V&V in SDLC; standards (IEEE 1012, ISO 9001)

Reviews, walkthroughs, inspections, and audits; static analysis tools; formal specification and verification; peer review checklists

Testing levels (unit, integration, system, acceptance); test case design techniques (black box, white box); test data and oracles

Coverage analysis (statement, branch, path, MC/DC); regression and performance testing; test automation frameworks; CI/CD integration for testing

V&V planning; metrics and measurements; defect tracking; risk-based testing; reporting and documentation; process improvement and certification

Reference Books

- 1 Software Testing and Analysis: Process, Principles and Techniques, Mauro Pezzè & Michal Young, 1st Edition, 2008, John Wiley & Sons, 2008.
- 2 Software Testing: Principles and Practices, Srinivasan Desikan & Gopalaswamy Ramesh, 1st Edition, 2006, Pearson Education.
- 3 Software Quality Assurance, Testing and Metrics, Naresh Chauhan, 2nd Edition, 2015, Oxford University Press.
- 4 Introduction to Software Testing, Paul Ammann & Jeff Offutt, 2nd Edition, 2017, Cambridge University Press.

25SMD3202 - DESIGN PATTERNS & CLEAN CODING TECHNIQUES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3202	DESIGN PATTERNS & CLEAN CODING TECHNIQUES	DPCT	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate how Test Driven Development and Refactoring work in software design and maintenance	2	
CO2	Understand Structural and Creational Patterns for effective design of a system	3	
CO3	compare the Behavioural design patterns and Anti-patterns for system design	3	
CO4	Analyze the design patterns in an object oriented language along with clean coding principles to a real world application.	4	

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, 2015, Pearson Education .
- 2 Refactoring, Improving the design of existing Code, Martin Fowler, Kent Beck, 2008, wesley.
- 3 Java Enterprise Design Patterns, Mark Grand,, 1999, Wiley Dream Tech.
- 4 Clean code:A handbook of agile software craftsmanship, Robert C.Martin,, 2002, PHI.

25SMD3303 - CONTINUOUS DELIVERY & DEVOPS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3303	CONTINUOUS DELIVERY & DEVOPS	CDD	R	3	0	0	2	3.5

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	
CO2	Apply Continuous Integration and Continuous Deployment using Infrastructure as Code using Pipeline.	3	
CO3	Analyze the need for Containerization in Devops and Examine the Kubernetes Pod Configuration.	4	
CO4	Analyze continuous monitoring and container orchestration process.	4	
CO5	Analyze the Tools associated with the DevOps Life Cycle.	4	
CO6	Evaluate existing knowledge to develop new hypotheses.	5	

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.

Reference Books

- 1 Enterprise DevOps on Amazon Web Services: Releasing Software to Production at Any Time with AWS, Paul Duvall,, 1 ST, Addison Wesley..
- 2 DevOps for Web Development, Mitesh Soni, 1 ST, Packt Publishing Ltd.
- 3 Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation,, Jez Humble, David Farley,, 1 ST, Addison Wesley..
- 4 DevOps: Continuous Delivery, Integration, and Deployment with DevOps,, Sricharan Vadapalli,, 1 ST, Packt Publishing Ltd..

25SMD3303A - CONTINUOUS DELIVERY & DEVOPS (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3303A	CONTINUOUS DELIVERY & DEVOPS	CDD	A	4	1	0	2	5.5

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	
CO2	Apply Continuous Integration and Continuous Deployment using Infrastructure as Code using Pipeline.	3	
CO3	Analyze the need for Containerization in Devops and Examine the Kubernetes Pod Configuration.	4	
CO4	Analyze continuous monitoring and container orchestration process.	4	
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	

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

- Enterprise DevOps on Amazon Web Services: Releasing Software to Production at Any Time with AWS, Paul Duvall, 1 ST, Addison Wesley.
- DevOps for Web Development,, Mitesh Soni,, 1 ST, Packt Publishing Ltd..
- Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation,, Jez Humble David Farley,, 1 ST, Addison-Wesley..
- DevOps: Continuous Delivery, Integration, and Deployment with DevOps,, Sricharan Vadapalli,, 1 ST, Packt Publishing.

25SMD3303E - CONTINUOUS DELIVERY & DEVOPS (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3303E	CONTINUOUS DELIVERY & DEVOPS	CDD	E	4	1	0	2	5.5

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	
CO2	Apply Continuous Integration and Continuous Deployment using Infrastructure as Code using Pipeline.	3	
CO3	Analyze the need for Containerization in Devops and Examine the Kubernetes Pod Configuration.	4	
CO4	Analyze continuous monitoring and container orchestration process.	4	
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	

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.

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- 1 Enterprise DevOps on Amazon Web Services: Releasing Software to Production at Any Time with AWS, Paul Duvall,, 1 ST, Addison Wesley.
- 2 DevOps for Web Development, Mitesh Soni,, 1 ST, Packt Publishing Ltd..
- 3 Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation,, Jez Humble, David Farley,, 1 ST, Addison-Wesley..
- 4 DevOps: Continuous Delivery, Integration, and Deployment with DevOps, Sricharan Vadapalli,, 1 ST, Packt Publishing Ltd.

25SMD3404 - SOFTWARE PROJECT MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3404	SOFTWARE PROJECT MANAGEMENT	SPM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SMD3405 - SOFTWARE ARCHITECTURE & DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3405	SOFTWARE ARCHITECTURE & DESIGN	SAD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand about software architecture and architectural drivers	2	
CO2	Apply the quality attributes and their scenarios	3	
CO3	Apply architectural styles and the knowledge various real time applications	3	
CO4	Analyse and create the documenting the architecture and apply to web services	4	

25SMD3506 - SOFTWARE RELIABILITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3506	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	
CO2	Analyze software system failures and develop convincing solutions	2	
CO3	Estimate Software Reliability parameters using Markovian Modelling, Maximum Likelihood and Least Square Method.	2	
CO4	Evaluate performance of Binomial-Type, Poison-Type and Markovian Models and Predict Software Reliability using SQA Intelligent Techniques	2	

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

25SMD3507 - CROSS-PLATFORM USER INTERFACE DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMD3507	CROSS-PLATFORM USER INTERFACE DESIGN	CPUIF	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SMF3101 - AI AND IOT IN MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3101	AI AND IOT IN MANUFACTURING	AIM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply AI algorithms for optimizing manufacturing processes and improving operational efficiency.	3	PO1, PO2, PSO1
CO2	Develop machine learning models for predictive maintenance in industrial equipment.	2	PO1, PO2, PSO1
CO3	Integrate IoT devices for real-time monitoring and control of manufacturing systems.	2	PO3, PO5, PSO2
CO4	Use data acquisition systems and cloud platforms to enable data-driven decision-making in smart factories.	3	PO2, PO5, PSO1
CO5	Analyze and evaluate real-world experiments/case studies implementing AI and IoT in digital manufacturing environments.	4	PO2, PSO1

Syllabus

AI Algorithms for Process Optimization Overview of AI in manufacturing, neural networks, fuzzy logic, genetic algorithms. Optimization of production scheduling, quality control, and material flow.

Machine Learning for Predictive Maintenance Supervised and unsupervised learning techniques. Predictive analytics, failure prediction, and anomaly detection in machinery using sensor data.

IoT for Real-Time Monitoring IoT architecture, sensors, actuators, microcontrollers. Industrial protocols (MQTT, Modbus), edge computing, and real-time status dashboards.

Data Acquisition and Cloud Platforms Data collection methods, interfacing sensors, use of cloud services (AWS, Azure, Google Cloud), data storage, analytics, and visualization tools.

Case Studies in Smart Factories Application of AI-IoT integration in smart factories. Case studies on digital twins, adaptive control, and intelligent automation systems.

Reference Books

- 1 , Internet of Things: A Hands-On Approach, A. Bahga & V. Madisetti, 3, VPT.
- 2 Industrial AI, Jay Lee, Behrad Bagheri, Hung-An Kao, 2, Springer.
- 3 Artificial Intelligence for Business: A Roadmap for Getting Started with AI, Al Naqvi, 2, Productivity Press.

25SMF3101A - AI AND IOT IN MANUFACTURING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3101A	AI AND IOT IN MANUFACTURING	AIM	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply AI algorithms for optimizing manufacturing processes and improving operational efficiency	3	PO1, PO2, PSO1
CO2	Develop machine learning models for predictive maintenance in industrial equipment.	2	PO1, PO2, PSO1
CO3	Integrate IoT devices for real-time monitoring and control of manufacturing systems	2	PO3, PO5, PSO2
CO4	Use data acquisition systems and cloud platforms to enable data-driven decision-making in smart factories.	3	PO2, PO5, PSO1
CO5	Analyze and evaluate real-world experiments/case studies implementing AI and IoT in digital manufacturing environments.	4	PO2, PSO1

Syllabus

AI Algorithms for Process Optimization Overview of AI in manufacturing, neural networks, fuzzy logic, genetic algorithms. Optimization of production scheduling, quality control, and material flow.

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- 2 Industrial AI, Jay Lee, Behrad Bagheri, Hung-An Kao, 2, Springer.
- 3 Artificial Intelligence for Business: A Roadmap for Getting Started with AI, Al Naqvi, 2, Productivity Press.

25SMF3101E - AI AND IOT IN MANUFACTURING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3101E	AI AND IOT IN MANUFACTURING	AIM	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply AI algorithms for optimizing manufacturing processes and improving operational efficiency	3	PO1, PO2, PSO1
CO2	Develop machine learning models for predictive maintenance in industrial equipment.	2	PO1, PO2, PSO1
CO3	Integrate IoT devices for real-time monitoring and control of manufacturing systems.	2	PO3, PO5, PSO2
CO4	Use data acquisition systems and cloud platforms to enable data-driven decision-making in smart factories.	3	PO2, PO5, PSO1
CO5	Analyze and evaluate real-world experiments/case studies implementing AI and IoT in digital manufacturing environments.	4	PO2, PSO1

Syllabus

AI Algorithms for Process Optimization Overview of AI in manufacturing, neural networks, fuzzy logic, genetic algorithms. Optimization of production scheduling, quality control, and material flow.

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- 1 Internet of Things: A Hands-On Approach, A. Bahga & V. Madiseti, 3, VPT.
- 2 Industrial AI, Jay Lee, Behrad Bagheri, Hung-An Kao, 2, Springer.
- 3 Artificial Intelligence for Business: A Roadmap for Getting Started with AI, Al Naqvi, 2, Productivity Press.

25SMF3202 - FLEXIBLE MANUFACTURING SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3202	FLEXIBLE MANUFACTURING SYSTEMS	FMS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply FMS concepts to improve manufacturing flexibility, productivity, and quality in a given scenario	3	PO1, PSO2
CO2	Apply part classification, coding, and layout techniques to design efficient manufacturing cells using Group Technology	3	PO2, PSO2
CO3	Apply automation tools and continuous improvement techniques to enhance productivity and efficiency in FMS environments	3	PO5, PSO2
CO4	Apply FMS applications and simulation techniques to analyze performance and improve smart manufacturing and future factories	3	PO5, PSO2

Syllabus

FMS INTRODUCTION AND DESCRIPTION Need for FMS, Types of flexibility in manufacturing, Types and Basic components of FMS, General Layout and Configuration of FMS, Principal Objectives, Advantages and limitations of FMS, Various Hardware and Software required for an FMS, Data communication and networking in FMS, Scheduling in FMS

GROUP TECHNOLOGY AND MANUFACTURING CELLS Group Technology, Part classification and coding, Production flow analysis, Design and layout of manufacturing cells, Benefits and limitations of GT and CM, Cellular Manufacturing, Rank order clustering, Description and Classifications of Cell, Unattended Machining, Cellular versus Flexible Manufacturing

FACTORY AUTOMATION AND CONTINUOUS IMPROVEMENT Automated Guided Vehicles (AGVs), Robots in FMS, Automated Storage and Retrieval Systems (AS/RS), Material handling systems and devices used in FMS, Automatic parts identification systems and data capture, Shop floor control systems, Total Preventive maintenance, Kanban system, value engineering, JIT, lean manufacturing, Six sigma

APPLICATIONS OF FMS AND FACTORY OF THE FUTURE FMS application in machining, sheet metal fabrication, prismatic component production, aerospace application Case studies. FMS development towards factories of the future, artificial intelligence and expert systems in FMS, FMS simulation tools and techniques, Performance measures in FMS, Recent trends in Flexible Manufacturing

Reference Books

- 1 Automation Production Systems & Computer Integrated manufacturing, Mikell P. Groover, , 4th edition, 2015, Pearson.
- 2 Flexible Manufacturing: Theory and Practice, Zubair M. Mohamed and Jamal A. A. Khan, 1st Edition, 2017, CRC Press, .
- 3 Lean Manufacturing: Tools, Techniques, and How to Use Them, David Hobbs, 1st Edition, 2004. , Productivity press.
- 4 Flexible Manufacturing, David J. Parrish, , 1990, Butterworth-Heinemann.
- 5 Flexible Manufacturing Systems, John A. Buzacott and David D. Yao, 1st edition 1995, Elsevier Science.
- 6 Computer Integrated Manufacturing, James A. Rehg and Henry W. Kraebber, 3rd Edition, 2004, pearson

25SMF3203 - PRECISION AND MICRO MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3203	PRECISION AND MICRO MANUFACTURING	PMM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the working principles of precision machining tools and techniques.	2	PO1, PSO1
CO2	Discuss the operations and applications of micro-EDM, micro-milling, and laser-based processes.	2	PO1, PSO1
CO3	Describe various measurement methods and quality assurance techniques used in micro-manufacturing.	2	PO1, PO5, PSO1
CO4	Summarize nano-finishing techniques and their applications in electronics and medical devices.	2	PO1, PSO1

Syllabus

Introduction to Precision Manufacturing Overview and need for precision; Principles and types of precision machining tools; Accuracy, repeatability, and resolution of precision tools.

Fundamentals of Micro-Manufacturing Working principles, setup, and process parameters of Micro-EDM, Micro-Milling; Introduction to Laser-Based Processing for micro-features.

Measurement and Quality Assurance Types of precision measurement tools; Contact and non-contact measurement techniques; Surface roughness, form, and dimensional accuracy; Quality control methods.

Nano-Finishing and Applications Introduction to nano-finishing techniques like MAF, AFM, and CMP; Applications of precision and micro-manufacturing in electronics and medical devices.

Reference Books

- 1 Fundamentals of Microfabrication: The Science of Miniaturization, Madou, M. J, 2002, CRC Press.
- 2 Introduction to Micromachining, Jain, V. K., 2010, Narosa Publishing House .
- 3 Micromachining of Engineering Materials, McGeough, J. A, 2001, CRC Press .

25SMF3304 - ADDITIVE AND HYBRID MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3304	ADDITIVE AND HYBRID MANUFACTURING	AHM	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand reverse engineering and rapid prototyping concepts, processes and associated technologies	2	PO1, PSO1
CO2	Apply knowledge of liquid and solid-based RP techniques to select suitable processes for specific applications	3	PO1, PSO2
CO3	Apply powder-based RP techniques and rapid tooling methods to real-world industrial applications through case studies	3	PO5, PSO2
CO4	Apply principles of hybrid manufacturing processes to analyze applications, industry trends, and future technological developments	3	PO9, PSO2

Syllabus

Reverse Engineering: Introduction, benefits, and applications of reverse engineering. Steps involved in the reverse engineering process. 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, Classification of rapid prototyping systems. Fundamentals of rapid prototyping, including the advantages and disadvantages

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 used in aerospace industries, automotive industries, and biomedical applications, Case Studies: Wind Tunnel Testing with Rapid Prototyped Models, RP applied to investment casting, Integration of Reverse Engineering and Rapid Prototyping

Definition and benefits of hybrid manufacturing, Overview of different hybrid manufacturing processes, Applications and industry trends, Hybrid additive-subtractive manufacturing processes, Principles of welding-based additive manufacturing, Hybrid Machining, Applications of Hybrid Manufacturing, Future Trends and Developments

Reference Books

- 1 Reverse Engineering Technology of Reinvention, W. Eric Boothroyd, Alok N. Choudhury, 2nd edition, 2011, CRC Press.
- 2 Rapid Prototyping Theory and Practice, Ali K. Kamrani, Emad Abouel Nasr, 1st edition, 2006, Springer.

25SMF3304A - ADDITIVE AND HYBRID MANUFACTURING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3304A	ADDITIVE AND HYBRID MANUFACTURING	AHM	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand reverse engineering and rapid prototyping concepts, processes and associated technologies	2	PO1, PSO1
CO2	Apply knowledge of liquid and solid-based RP techniques to select suitable processes for specific applications	3	PO1, PSO1
CO3	Apply powder-based RP techniques and rapid tooling methods to real-world industrial applications through case studies	3	PO5, PSO2
CO4	Apply principles of hybrid manufacturing processes to analyze applications, industry trends, and future technological developments	3	PO5, PSO2
CO5	Apply the theoretical concepts of Reverse Engineering to develop 3D model and analyze	3	PO9, PSO2

Syllabus

Reverse Engineering: Introduction, benefits, and applications of reverse engineering. Steps involved in the reverse engineering process. 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, Classification of rapid prototyping systems. Fundamentals of rapid prototyping, including the advantages and disadvantages

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 used in aerospace industries, automotive industries, and biomedical applications, Case Studies: Wind Tunnel Testing with Rapid Prototyped Models, RP applied to investment casting, Integration of Reverse Engineering and Rapid Prototyping

Definition and benefits of hybrid manufacturing, Overview of different hybrid manufacturing processes, Applications and industry trends, Hybrid additive-subtractive manufacturing processes, Principles of welding-based additive manufacturing, Hybrid Machining, Applications of Hybrid Manufacturing, Future Trends and Developments

Apply Reverse Engineering steps to develop a 3D object using Fusion 360/ Solid Works software for modelling and various manufacturing processes and Analyze the developed 3D model for its functionality

Reference Books

- 1 Rapid Prototyping: Principles and Applications, Chua Chee Kai, Leong Kah Fai, Lim Chu Sing, 5th edition, 2019, World Scientific Publishing.
- 2 Additive Manufacturing Technologies, Ian Gibson, David Rosen, Brent Stucker`, 2nd edition, 2015, Springer.
- 3 Rapid Prototyping: Theory and Practice, Ali K. Kamrani, Emad Abouel Nasr, 1st edition, 2006. , Springer.

25SMF3304E - ADDITIVE AND HYBRID MANUFACTURING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3304E	ADDITIVE AND HYBRID MANUFACTURING	AHM	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand reverse engineering and rapid prototyping concepts, processes and associated technologies	2	
CO2	Apply knowledge of liquid and solid-based RP techniques to select suitable processes for specific applications	3	
CO3	Apply powder-based RP techniques and rapid tooling methods to real-world industrial applications through case studies	3	
CO4	Apply principles of hybrid manufacturing processes to analyze applications, industry trends, and future technological developments	3	
CO5	Apply the theoretical concepts of Reverse Engineering to develop 3D model and analyze	3	

Syllabus

Reverse Engineering: Introduction, benefits, and applications of reverse engineering. Steps involved in the reverse engineering process. 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, Classification of rapid prototyping systems. Fundamentals of rapid prototyping, including the advantages and disadvantages

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 used in aerospace industries, automotive industries, and biomedical applications, Case Studies: Wind Tunnel Testing with Rapid Prototyped Models, RP applied to investment casting, Integration of Reverse Engineering and Rapid Prototyping

Definition and benefits of hybrid manufacturing, Overview of different hybrid manufacturing processes, Applications and industry trends, Hybrid additive-subtractive manufacturing processes, Principles of welding-based additive manufacturing, Hybrid Machining, Applications of Hybrid Manufacturing, Future Trends and Developments

Apply Reverse Engineering steps to develop a 3D object using Fusion 360/ Solid Works software for modelling and various manufacturing processes and Analyze the developed 3D model for its functionality

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- 2 Reverse Engineering, W. Eric Boothroyd, Alok N. Choudhury, 2nd edition, 2011, CRC Press.
- 3 Rapid Prototyping, Ali K. Kamrani, Emad Abouel Nasr, 1st edition, 2006. , Springer.

25SMF3405 - DIGITAL MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3405	DIGITAL MANUFACTURING	DM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the DM Model and the possibility to extend to the industry	2	PO1, PSO1
CO2	Identify the technological change and future of Industry 4.0	3	PO3, PSO1
CO3	Apply the Various technology models to Implementing Digital Manufacturing	3	PO3, PSO1
CO4	Identify the supply chain, challenges in digital transformation, and business models in the industry	3	PO2, PSO1

Syllabus

Introduction to Digital Manufacturing Science, Definition, benefits, Operation mode and architecture, Operation reference model, System Architecture, Computation in Digital Manufacturing, PLM- Elements in PLM and System Architecture, Digital Product Life Cycle, PLM Platform-Overview, Integration of Computer-aided technologies in PLM, Connectivity of ERP and PLM

The pace of technological change. Industry 4.0 - definitions, components, characteristics, design principles, the building blocks of the fourth industrial revolution, value chain, today's factory Vs Industry 4.0. Government initiatives.

Emerging technologies and trends in the industry - Additive manufacturing technologies for on demand production of personalized goods. Self-configuration and self-diagnosis methods based on Internet of Things technologies. Machine Learning and Artificial Intelligence for manufacturing processes. Big Data analytics for reconfigurable manufacturing systems, augmented reality, virtual reality and collaborative robots, and their role in production, design, and logistics.

Smart and future supply chains - Control algorithms for smart part logistic. Digital transformation challenges. New and successful business models in the industry. Additional resources and external organizations that can support on digital manufacturing needs.

Reference Books

- 1 Fundamentals of Digital Manufacturing Science, Zude Zhou, Shane (Shengquan) Xie, Dejun Chen, 2012, Springer-Verlag London Limited.
- 2 Digital Manufacturing: Prospects and Challenges, Christoph Haag, Torsten Niochoj, 2016, Metropolis Verlag.
- 3 Digital Manufacturing and Assembly Systems in Industry 4.0, Kaushik Kumar, Divya Zindani, J. Paulo Davim, 2019, CRC Press.

25SMF3406 - PRECISION INNOVATION & ENTREPRENEURSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3406	PRECISION INNOVATION & ENTREPRENEURSHIP	PIE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand how to identify an unmet need through market research	2	PO1, PSO1
CO2	Apply the DTI concepts for Product testing & Quality	3	PO3, PSO1
CO3	Understand the various funding schemes related to start-up incubation.	2	PO3, PSO1
CO4	Understand the various responsibilities related to business pathways and social responsibilities on Stat-up- incubation	2	PO6, PSO1

Syllabus

Role of entrepreneurship in economic development Entrepreneurial mindset motivation and competencies Market pull and technology push factors New product development lifecycle Technology readiness levels Product market fit validation Commercialization pathways Business vision and leadership Team composition and management

Opportunity scanning market survey need identification and problem definition Creative design thinking for concept generation Detailed design and prototyping Functionality and manufacturability Bill of materials and components supply chain Manufacturing and assembly plan Product testing and quality assurance Intellectual property rights management

Market segmentation and market sizing Customer persona and value proposition Marketing Go to market strategy Distribution channels and sales network Funding requirement based on stage Source of funding for startup ventures Financial projections and accounting Startup to scale up financing

Sustainable business options and pathways Business model and business canvas Startup team and business partners Startup ecosystem and stakeholders Technology business incubators and parks Proposal pitching and agreements Startup company incorporation Social impact and responsibility

Reference Books

- 1 Technology Entrepreneurship, Bill Aulet, 4th Edition, 2014, Tata McGraw Hill.
- 2 Innovation and Entrepreneurship, Peter F. Drucker, 1st Edition, 2006, Harper Business.
- 3 Innovision, Chelat Bhuvanachandran, 2022, Khanna Book Publishing.

25SMF3507 - SUSTAINABLE MANUFACTURING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3507	SUSTAINABLE MANUFACTURING	SM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts of sustainability and principles of green design in manufacturing.	2	PO1, PO6, PSO1
CO2	Describe the stages and significance of Life Cycle Assessment (LCA) in evaluating environmental impact.	2	PO1, PO6, PSO1
CO3	Discuss the approaches for waste minimization and cleaner production practices.	2	PO1, PO6, PSO1
CO4	Summarize energy-efficient manufacturing methods and the role of ISO standards and circular economy.	2	PO1, PO11, PSO1

Syllabus

Sustainability Concepts and Green Design Introduction to sustainable development principles of sustainability basics of green design and eco friendly products

Life Cycle Assessment and Waste Minimization Definition and stages of Life Cycle Assessment LCA environmental impact assessment waste minimization methods cleaner production strategies

Energy Efficient Manufacturing Basics of energy consumption in manufacturing energy saving techniques role of automation and smart manufacturing in energy efficiency

ISO Standards and Circular Economy Overview of ISO 14000 standards environmental management systems fundamentals of circular economy sustainable material reuse and product life extension

Reference Books

- 1 Sustainable Manufacturing: Processes, Systems and Metrics, Jawahir, I. S., and O. W. Dillon Jr., 2012, SME.
- 2 Green Manufacturing: Fundamentals and Applications, Dornfeld, D. A, 2013, Springer.
- 3 Sustainable Manufacturing, Gupta, S. M., and A. Gunasekaran, 2013, Momentum Press .

25SMF3508 - MACHINE TO MACHINE COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SMF3508	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	2	PO1, PO2, PSO1
CO2	Understand main standards, protocols, algorithms, and research activities for machine-to-machine communication with sensors	2	PO1, PO2, PSO1
CO3	Apply protocols to develop machine to machine communication and to understand Hardware interfaces in a sensor network	3	PO1, PO5, PSO1
CO4	Analyze and evaluate different protocols and technologies utilized in machine-to-machine communication systems	4	PO1, PO2, PSO1

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..

25STE3101 - ADVANCED CONCRETE TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25STE3101	ADVANCED CONCRETE TECHNOLOGY	ACT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to analyse the Characteristics of the concrete-making materials	4	
CO2	Able to design Concrete Mixes as per the Different Codal Provisions	6	
CO3	Able to design Concrete Mixes for Special Concretes	6	
CO4	Able to analyse the Durability Issues of Concrete and the Service Life of Concrete.	4	
CO5	Able to Design the Concrete Mix for various structures and able to cast and test the structural elements	6	

Syllabus

Concrete Ingredients Composition of OPC Manufacture Modified Portland Cements Hydration Process of Portland Cements Structure of Hydrated Cement Pastes Mineral Admixtures Slags Pozzolanas and Fillers Chemical Admixtures Solutes Retarders Air Entraining Agents Water Proofing Compounds Plasticizers and Super Plasticizers Aggregates Properties and testing of fine and coarse aggregates combining of aggregates Substitute material for aggregates recent advancements

Concrete Mix Design Mix Proportioning As per IS method ACI method British Method Mixes incorporating Fly ash Silica fume GGBS Mechanical Properties of Concrete Interfacial Transition Zone Fracture Strength Compressive strength Tensile strength Impact strength Bond strength modulus elasticity modulus of rupture

High Performance Concrete High strength concrete variations in concrete strength Fibre Reinforced Concrete Self Compacting Concrete Polymer Concrete High performance concrete lightweight concrete pervious Concrete Introduction to heavy weight aggregate concrete Introduction to geo polymer concrete

Durability of Concrete Factors affecting durability Chemical Attack Permeability chloride penetration water absorption creep Shrinkage carbonation corrosion Service Life Prediction Introduction to service life prediction Design of Concrete for the required Service Life

Reference Books

- 1 Concrete Technology, Santhakumar A.R., 2007, Oxford University Press, New Delhi.
- 2 Concrete Structure Properties and Materials, Metha P.K., Montreio P.J.M., 1998, Prentice Hall.
- 3 Concrete Technology, Gupta B.L., Amit Gupta, 2004, Standard Publishers Distributers, New Delhi.

25STE3101A - ADVANCED CONCRETE TECHNOLOGY (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25STE3101A	ADVANCED CONCRETE TECHNOLOGY	ACT	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to analyse the Characteristics of the concrete-making materials	4	
CO2	Able to design Concrete Mixes as per the Different Codal Provisions	6	
CO3	Able to design Concrete Mixes for Special Concretes	6	
CO4	Able to analyse the Durability Issues of Concrete and the Service Life of Concrete.	4	
CO5	Able to Design the Concrete Mix for various structures and able to cast and test the structural elements	6	

Syllabus

Concrete Ingredients Composition of OPC Manufacture Modified Portland Cements Hydration Process of Portland Cements Structure of Hydrated Cement Pastes Mineral Admixtures Slags Pozzolanas and Fillers Chemical Admixtures Solutes Retarders Air Entraining Agents Water Proofing Compounds Plasticizers and Super Plasticizers Aggregates Properties and testing of fine and coarse aggregates combining of aggregates Substitute material for aggregates recent advancements

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- 3 Concrete Technology, Gupta B.L., Amit Gupta, 2004, Standard Publishers Distributers, New Delhi.

25STE3101E - ADVANCED CONCRETE TECHNOLOGY (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25STE3101E	ADVANCED CONCRETE TECHNOLOGY	ACT	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Able to analyse the Characteristics of the concrete-making materials	4	
CO2	Able to design Concrete Mixes as per the Different Codal Provisions	6	
CO3	Able to design Concrete Mixes for Special Concretes	6	
CO4	Able to analyse the Durability Issues of Concrete and the Service Life of Concrete.	4	
CO5	Able to Design the Concrete Mix for various structures and able to cast and test the structural elements	6	

Syllabus

Concrete Ingredients Composition of OPC Manufacture Modified Portland Cements Hydration Process of Portland Cements Structure of Hydrated Cement Pastes Mineral Admixtures Slags Pozzolanas and Fillers Chemical Admixtures Solutes Retarders Air Entraining Agents Water Proofing Compounds Plasticizers and Super Plasticizers Aggregates Properties and testing of fine and coarse aggregates combining of aggregates Substitute material for aggregates recent advancements

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- 1 Concrete Technology, Santhakumar A.R., 2007, Oxford University Press, New Delhi.
- 2 Concrete Structure Properties and Materials, Metha P.K., Montreio P.J.M., 1998, Prentice Hall.
- 3 Concrete Technology, Gupta B.L., Amit Gupta, 2004, Standard Publishers Distributers, New Delhi.

25STE3202 - ADVANCED STRUCTURAL ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25STE3202	ADVANCED STRUCTURAL ANALYSIS	ASA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analysis of Determinate Structures for Various Loads and Load combinations.	4	
CO2	Analysis of Indeterminate Structures Using Matrix Methods.	4	
CO3	Analysis of Hinged Arches.	4	
CO4	Analysis of Indeterminate Beams Plastic Analysis Methods.	4	

Syllabus

- Basic concepts: Structural elements, joints and supports. Shear force, bending moment. Static indeterminacy, kinematic indeterminacy. Force-displacement relations. Applications of principle of virtual work and displacement-based and force-based energy principles. Influence Line Diagrams for Determinate Structures: Influence line for reactions of cantilever, simply supported and continuous beams. Influence Line Diagram for shear force in cantilever and simply supported beams

Influence Line Diagram for bending moment in cantilever and simply supported beams. Position and magnitude of maximum shear force and bending moment for concentrated load and uniformly distributed load, series of concentrated loads.

- Analysis of Structure by Flexibility Matrix Method: Matrix, vector; basic matrix operations; Concept of flexibility coefficients, analysis of indeterminate beams and rigid frames by Flexibility Matrix method. Analysis of Structure by Stiffness Matrix Method: Concept of degrees of freedom, degree of indeterminacy and stiffness coefficients, analysis of indeterminate beams and rigid frames by Stiffness Matrix method.

Analysis of Hinged Arches: types of arches, analysis of one hinge arch, analysis of two hinge arch, analysis of three hinged arch. Plastic Analysis of Structures: Idealized stress-strain diagram, Plastic Moment of resistance, plastic modulus, shape factors for different sections, load factor, Plastic hinge and mechanism, plastic analysis of indeterminate beams and frames

Reference Books

- 1 Theory of Structures , S. Ramamrutham, R. Narayanan, 2002, Dhanpat Rai Publishing Company .
- 2 Basic Structural Analysis , C S Reddy, Tata McGraw , 2nd edition 2010. , Hill publishing Company Ltd. Delhi.
- 3 Intermediate Structural Analysis , Wang, McGraw , 2010 , Hill Book Company.

25STE3303 - PRESTRESSED CONCRETE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25STE3303	PRESTRESSED CONCRETE	PSC	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Define Pre-Stressed concrete and specify the applications of Pre-Stressed Concrete	2	
CO2	Specify the Losses of Prestress and factors influencing deflections	2	
CO3	Specify the types of failures and forces induced in members subjected to flexure, shear and torsion	4	
CO4	Specify the ways of transmission of prestress and end block stresses in Prestressed members	4	

Syllabus

Basic Terminology and Materials Basic terminology and concepts of prestressing Need for high strength steel and high strength concrete as material for prestressed concrete Advantages of prestressed concrete

Prestressing Systems and Stress Analysis Prestressing systems: pretensioning, post tensioning, thermo electric prestressing, chemical prestressing Analysis of prestress and bending stresses: resultant stresses, pressure or thrust line and internal resisting couple, concept of load balancing, stresses in tendons, cracking moment

Losses, Deflections, and Ultimate Strength Losses of prestress: due to elastic deformation, shrinkage, creep of concrete, relaxation of stress in steel, friction and anchorage slip, total losses allowed for in design Deflections: factors influencing deflections, short term deflections of uncracked members, effect of tendon profile on deflections Ultimate flexural strength of simple sections using simplified IS code recommendations

Design of Prestressed Concrete Members Design of prestressed concrete beam: design of sections for flexure, stress condition, minimum section modulus, stresses at transfer, service loads, prestressing force, eccentricity, check for stresses, initial and final conditions, limit state of collapse in flexure, shear IS code recommendations: ultimate shear resistance, design of shear reinforcement Design of end blocks: transmission of prestress in pretensioned members, transmission length, anchorage stress in post tensioned members, bearing stress and bursting tensile force stresses in end blocks, methods IS code provisions for the design of end block reinforcement

Reference Books

- 1 Prestressed Concrete , N. Krishna Raju, 6th, Tata Mc.Graw-Hill Publishing Company Limited, New Delhi.
- 2 Pre-stressed Concrete, P. Dayarathnam, new, Oxford and IBH Publishing Co..
- 3 Indian standard code of practice for prestressed concrete , Govt, IS -1343-1980/2016, Bureau of Indian standards New Delhi.

25STE3303A - PRESTRESSED CONCRETE (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25STE3303A	PRESTRESSED CONCRETE	PSC	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Define Pre-Stressed concrete and specify the applications of Pre-Stressed Concrete	2	
CO2	Specify the Losses of Prestress and factors influencing deflections	2	
CO3	Specify the types of failures and forces induced in members subjected to flexure, shear and torsion	4	
CO4	Specify the ways of transmission of prestress and end block stresses in Prestressed members	4	

Syllabus

Part 1: Basic Terminology and Materials Basic terminology and concepts of prestressing Need for high strength steel and high strength concrete as material for prestressed concrete Advantages of prestressed concrete

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25STE3303E - PRESTRESSED CONCRETE (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25STE3303E	PRESTRESSED CONCRETE	PSC	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Define Pre-Stressed concrete and specify the applications of Pre-Stressed Concrete	2	
CO2	Specify the Losses of Prestress and factors influencing deflections	2	
CO3	Specify the types of failures and forces induced in members subjected to flexure, shear and torsion	4	
CO4	Specify the ways of transmission of prestress and end block stresses in Prestressed members	4	

Syllabus

Basic Terminology and Materials Basic terminology and concepts of prestressing Need for high strength steel and high strength concrete as material for prestressed concrete Advantages of prestressed concrete

Prestressing Systems and Stress Analysis Prestressing systems: pretensioning, post tensioning, thermo electric prestressing, chemical prestressing Analysis of prestress and bending stresses: resultant stresses, pressure or thrust line and internal resisting couple, concept of load balancing, stresses in tendons, cracking moment

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- 2 Pre-stressed Concrete, P. Dayarathnam, new, Oxford and IBH Publishing Co..
- 3 Indian standard code of practice for prestressed concrete , Govt, IS -1343-1980/2016, Bureau of Indian standards New Delhi.

25STE3404 - SUSTAINABLE CONSTRUCTION TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25STE3404	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	
CO2	Understanding the modern construction methods basics of construction Modular Construction Precast concrete.	2	
CO3	Compute the sustainable construction materials technologies and project management strategies.	2	
CO4	Convert the process of the new construction rating system for LEED certification	2	

Syllabus

Construction methods for Conventional Framed Structures: (10 Lectures) o 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 (10 Lectures) o 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 (10 Lectures) o 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. (09 Lectures) o 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 Practical handbook of Material Flow Analysis, Taylor & Francis, Helmut Rechberger, 2010.
- 2 Sustainable construction; green building design and delivery , Charles J, Kibert edition 4, 2015 .
- 3 Underground Storage of CO2 and Energy , Michael Z. Hou, Heping Xie, Jeoungseok , . LEED for India: Reference Guide, 2011.

25STE3505 - CONSTRUCTION PLANNING AND SCHEDULING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25STE3505	CONSTRUCTION PLANNING AND SCHEDULING	CPS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To understand the Communicate effectively with project stakeholders, including owners, contractors, and suppliers, to ensure project goals	2	
CO2	Understand the project management principles and techniques to plan and execute construction projects, including project initiation, planning, execution, monitoring, and control	2	
CO3	Understand about construction project plans and schedules to identify potential risks and develop strategies to mitigate them	2	
CO4	Understand about the project costs using a variety of methods, such as bottom-up estimating and parametric estimating	2	

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

Reference Books

- 1 Construction Project Management: Planning, Scheduling and Control, K. K. Chitkara, 2nd Edition, Tata McGraw-Hill Education.
- 2 Project Planning and Control with PERT and CPM, Dr. B.C. Punmia, K.K. Khandelwal, and S.P. Jain, 10th Edition, Laxmi Publications.
- 3 Construction Project Scheduling and Control, Saleh A. Mubarak, 3rd Edition, Wiley.

25VLS3101 - ANALOG VLSI DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25VLS3101	ANALOG VLSI DESIGN	AVD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of MOSFET operation, including I-V characteristics, small and large signal models, and second-order effects to analyze and design amplifier stages.	3	
CO2	Design and analyze current mirrors, biasing circuits, and differential amplifier configurations including degeneration, MOS loads, and active current mirrors.	4	
CO3	Analyse the performance of single-stage and multi-stage operational amplifiers based on gain, slew rate, noise, Input limitations, and stability with compensation techniques.	4	
CO4	Analyze the frequency response and noise behavior of analog circuits, and understand the function and structure of RF mixer circuits.	4	
CO5	Analysis of various MOS analog circuits using Cadence environment for real time applications	4	

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 - Quantitative 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 Analysis & Design of Analog Integrated Circuits, Gray and Mayer, 2, Wiley.
- 3 Analog Design for CMOS VLSI Systems, Franco Maloberti, 3, Springer.

25VLS3101A - ANALOG VLSI DESIGN (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25VLS3101A	ANALOG VLSI DESIGN	AVD	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of MOSFET operation, including I-V characteristics, small and large signal models, and second-order effects to analyze and design amplifier stages (CS, CD, CG, Cascode).	3	
CO2	Realize the active & passive current Mirrors and analyze the differential amplifiers with qualitative and quantitative approaches.	4	
CO3	Analyze the CMOS Op Amps, and various types of Op Amps with qualitative and quantitative approaches.	4	
CO4	Analyze the high frequency response of CS, CG and CD amplifiers and noise analysis of various amplifiers and mixers.	4	
CO5	Analysis of real time circuits like switched capacitor circuits, voltage controlled oscillators, and phase locked loops.	4	
CO6	Design and analysis of various MOS analog circuits using Cadence/ LT-Spice/ Qsim environment for real time applications.	4	

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 nodesfrequency response of common source stageStatistical characteristics of noise, noise in single stage amplifiersnoise 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 Analog Circuit Design , Phillip Allen and Douglas Holmberg, 2, Oxford University Press.
- 4 Bipolar and MOS Analog Integrated circuit design , Grebene, 2, John Wiley & sons .
- 5 Analog Design for CMOS VLSI Systems , Franco Maloberti , 2, Springer.

25VLS3101E - ANALOG VLSI DESIGN (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25VLS3101E	ANALOG VLSI DESIGN	AVD	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the fundamentals of MOS transistors for the design of single stage amplifiers.	3	
CO2	Realize the active & passive current Mirrors and analyze the differential amplifiers with qualitative and quantitative approaches.	4	
CO3	Analyze the CMOS Op Amps, and various types of Op Amps with qualitative and quantitative approaches.	4	
CO4	Analyze the high frequency response of CS, CG and CD amplifiers and noise analysis of various amplifiers and mixers.	4	
CO5	Analysis of real time circuits like switched capacitor circuits, voltage controlled oscillators, and phase locked loops	4	
CO6	Design and analysis of various MOS analog circuits using Cadence/ LT-Spice/ Qsim environment for real time applications	4	

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 nodesfrequency response of common source stageStatistical characteristics of noise, noise in single stage amplifiersnoise 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 Analog Design for CMOS VLSI Systems , Franco Maloberti , 2, Springer.
- 4 CMOS Analog Circuit Design , Phillip Allen and Douglas Holmberg, 2, Oxford University Press .
- 5 Bipolar and MOS Analog Integrated circuit design , Grebene, 2, John Wiley & sons .

25VLS3202 - TESTING AND VERIFICATION OF VLSI CIRCUITS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25VLS3202	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	
CO2	Apply the set of fault modeling approaches to realize the various algorithms for fault simulation	3	
CO3	Analyze the concepts of functional coverage	4	
CO4	Demonstrate the randomization in System Verilog.	3	

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.

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.

25VLS3303 - VLSI PHYSICAL DESIGN AUTOMATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25VLS3303	VLSI PHYSICAL DESIGN AUTOMATION	VPDA	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Conceptualize the process flow of VLSI design and map the hierarchy levels to graph-like structures	2	
CO2	Apply well-established partitioning algorithms to cluster the VLSI circuit into smaller subcircuit successively	3	
CO3	Apply slicing plan and tree approaches to optimize the layout of circuit components on the chip	3	
CO4	Apply conventional algorithms to analyze and solve VLSI placement and routing problems, aiming to minimize objective functions	4	
CO5	Design and analyze the effectiveness of different STA regularizations in achieving optimal timing closure.	4	

Syllabus

Physical Design and Graph Theory Introduction to the physical design cycle Topdown flow 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 BigO notation Class P class NP NPhard NPcomplete

Partitioning Introduction and Terminology, Objective, and goals Types of partitioning algorithms Group migration algorithms KernighanLin Algorithm, Extensions of KernighanLin 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.

Reference Books

- 1 Graph Theory & Applications, Ganesh M. Magar, Swati R. Maurya, 2, Technical Publications.
- 2 VLSI Physical Design: From Graph Partitioning to Timing Closure, Andrew B. Kahng, Jens Lienig, Igor L. Markov, JinHu, 2, Springer.
- 3 Design and Analysis of Algorithms, S. Sridhar, 2, Paperback OUP.

25VLS3303A - VLSI PHYSICAL DESIGN AUTOMATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25VLS3303A	VLSI PHYSICAL DESIGN AUTOMATION	VPDA	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Conceptualize the process flow of VLSI design and map the hierarchy levels to graph-like structures	2	
CO2	Apply well-established partitioning algorithms to cluster the VLSI circuit into smaller subcircuit successively	3	
CO3	Apply slicing plan and tree approaches to optimize the layout of circuit components on the chip	3	
CO4	Apply conventional algorithms to analyze and solve VLSI placement and routing problems, aiming to minimize objective functions	4	
CO5	Design and analyze the effectiveness of different STA regularizations in achieving optimal timing closure.	4	
CO6	Design and realize the effective physical design automation with STA over Combinational and Sequential Circuits	4	

Syllabus

Physical Design and Graph Theory Introduction to the physical design cycle Topdown flow 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 BigO notation Class P class NP NPhard NPcomplete

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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.

Static Timing Analysis: Introduction, Timing Arc, Timing Unateness, Critical Path, Faults Path, Shortest Path, STA for Combinational Circuits, STA for Sequential Circuits, Setup time, Hold Time, Clock Skew, Clock Jitter.

Reference Books

- 1 Graph Theory & Applications, Ganesh M. Magar, Swati R. Maurya, 2, Technical Publications.
- 2 VLSI Physical Design: From Graph Partitioning to Timing Closure, Andrew B. Kahng, Jens Lienig, Igor L. Markov, JinHu, 2, Springer.
- 3 Design and Analysis of Algorithms, S. Sridhar, 2, Paperback OUP.

25VLS3303E - VLSI PHYSICAL DESIGN AUTOMATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25VLS3303E	VLSI PHYSICAL DESIGN AUTOMATION	VPDA	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Conceptualize the process flow of VLSI design and map the hierarchy levels to graph-like structures	2	
CO2	Apply well-established partitioning algorithms to cluster the VLSI circuit into smaller subcircuit successively	3	
CO3	Apply slicing plan and tree approaches to optimize the layout of circuit components on the chip	3	
CO4	Apply conventional algorithms to analyze and solve VLSI placement and routing problems, aiming to minimize objective functions	4	
CO5	Design and analyze the effectiveness of different STA regularizations in achieving optimal timing closure.	4	
CO6	Design and realize the effective physical design automation with STA over Combinational and Sequential Circuits	4	

Syllabus

Physical Design and Graph Theory Introduction to the physical design cycle Topdown flow 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 BigO notation Class P class NP NPhard NPcomplete

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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.

Static Timing Analysis: Introduction, Timing Arc, Timing Unateness, Critical Path, Faults Path, Shortest Path, STA for Combinational Circuits, STA for Sequential Circuits, Setup time, Hold Time, Clock Skew, Clock Jitter.

Reference Books

- 1 Graph Theory & Applications, Ganesh M. Magar, Swati R. Maurya, 2, Technical Publications.
- 2 VLSI Physical Design: From Graph Partitioning to Timing Closure, Andrew B. Kahng, Jens Lienig, Igor L. Markov, JinHu, 2, Springer.
- 3 Design and Analysis of Algorithms, S. Sridhar, 2, Paperback OUP.

25VLS3404 - MIXED SIGNAL IC DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25VLS3404	MIXED SIGNAL IC DESIGN	MSID	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To apply the principles of submicron CMOS technology by interpreting process flow, analyzing passive components, and implementing basic digital and analog circuits focusing on MOSFET behavior, delay elements, and circuit noise.	3	
CO2	To apply concepts of analog signal processing to design and analyze integrator circuits and filter topologies including MOSFET-C, gm-C, discrete-time integrators, and transfer functions such as bilinear, biquadratic, and noise-shaping filters.	3	
CO3	To analyze sampling theory, quantization noise, and SNR enhancement methods in data converters, and examine the design and behavior of oscillators and PLLs, including the impact of non-idealities and performance improvements using filters and feedback mechanisms.	4	
CO4	To analyze and compare various DAC and ADC architectures such as resistor string, R-2R, current-steering, cyclic, pipeline DACs, and flash, SAR, and integrating ADCs based on their structure, performance, and application suitability.	4	

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.

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.

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.

Reference Books

- 1 CMOS Analog Circuit Design, Phillip E. Allen, Douglas R. Holberg, Second, Oxford University Press.
- 2 Design with Operational Amplifiers and Analog Integrated Circuits, Sergio Frankco, Third, Mc Graw Hill.
- 3 Analog and Mixed-Signal Electronics, Karl Stephan, First, Wiley.

25VLS3505 - SYSTEM-ON-CHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25VLS3505	SYSTEM-ON-CHIP	SOC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the flow and methodology of hardware-software co-design and system-level SoC development.	2	
CO2	Apply platform-based and bus-based design principles in the development of efficient SoC communication architectures.	3	
CO3	Apply design strategies to interpret energy-efficient multiprocessor SoC systems by integrating processor, memory, and communication components.	3	
CO4	Apply the knowledge of computer network topologies to assess the performance of Network-on-Chip (NoC) architectures.	3	

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 Multiprocessor Systems-on-Chip, Ahmed Amine Jerraya, Wayne Wolf, 2, Morgan Kaufmann, Elsevier.
- 3 Low Power NoC for High-Performance SoC Design, Hoi-Jun Yoo, Kangmin Lee, and Kyong Kim, 2, CRC Press.

25WLT3101 - 4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WLT3101	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	4GW	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize their understanding of 4G architecture, including the Evolved Packet System (EPS), to apply principles of LTE integration with existing 2G/3G networks.	3	
CO2	Implement multiuser modulations and the principles of Orthogonal Frequency Division Multiplexing (OFDM), to analyse and evaluate LTE transceiver operations, channel estimation techniques, and issues related to OFDM.	3	
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	
CO4	Analyze the unique features and diverse applications of Ultra-Wideband (UWB) technology, including its performance within indoor environments, and evaluate the factors influencing UWB capacity.	4	
CO5	Analyze and evaluate the conceptualization and application of multi-antenna operations, MIMO systems, and various multicarrier and multi-access systems (such as OFDMA, MC-CDMA, MIMO-OFDM, and multiband OFDM Ultra-Wideband) within the architecture of 4G networks.	4	
CO6	Employ their understanding of 4G architecture, interfaces, user equipment categories, and core functionalities such as Quality-of-Service (QoS), security, and mobility within the 3GPP standards framework to critically 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	
CO7	Evaluate the fundamental interplay between 4G architecture and its underlying protocols, and subsequently analyze advanced techniques such as advanced antenna systems, security measures for risk mitigation, multi-factor authentication protocols for user verification, and efficiency improvements within 4G LTE-Advanced networks, to assess their impact on enhancing user experience and network performance.	5	

Syllabus

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

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, Single-Carrier Frequency Division Multiple Access (SC-FDMA)

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).

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

- 1 Mobile cellular Telecommunications, William C.Y.Lee, 1, TMH Publications 2006.
- 2 LTE and the Evolution to 4G Wireless Design and Measurement Challenges, Moray Rumney, 1, wiley.

25WLT3101A - 4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WLT3101A	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	4GW	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize their understanding of 4G architecture, including the Evolved Packet System (EPS), to apply principles of LTE integration with existing 2G/3G networks.	3	
CO2	Implement multiuser modulations and the principles of Orthogonal Frequency Division Multiplexing (OFDM), to analyse and evaluate LTE transceiver operations, channel estimation techniques, and issues related to OFDM.	3	
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	
CO4	Analyze the unique features and diverse applications of Ultra-Wideband (UWB) technology, including its performance within indoor environments, and evaluate the factors influencing UWB capacity.	4	
CO5	Analyze and evaluate the conceptualization and application of multi-antenna operations, MIMO systems, and various multicarrier and multi-access systems (such as OFDMA, MC-CDMA, MIMO-OFDM, and multiband OFDM Ultra-Wideband) within the architecture of 4G networks.	4	
CO6	Employ their understanding of 4G architecture, interfaces, user equipment categories, and core functionalities such as Quality-of-Service (QoS), security, and mobility within the 3GPP standards framework to critically 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	
CO7	Evaluate the fundamental interplay between 4G architecture and its underlying protocols, and subsequently analyze advanced techniques such as advanced antenna systems, security measures for risk mitigation, multi-factor authentication protocols for user verification, and efficiency improvements within 4G LTE-Advanced networks, to assess their impact on enhancing user experience and network performance.	5	

Syllabus

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

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, Single-Carrier Frequency Division Multiple Access (SC-FDMA)

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).

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.

- 1 1. Mobile cellular Telecommunications, William C.Y.Lee, 1, TMH Publications 2006.
- 2 2. LTE and the Evolution to 4G Wireless Design and Measurement Challenges, Moray Rumney, 1, wiley.

25WLT3101E - 4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WLT3101E	4G WIRELESS TECHNOLOGIES AND CELLULAR COMMUNICATION	4GW	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Utilize their understanding of 4G architecture, including the Evolved Packet System (EPS), to apply principles of LTE integration with existing 2G/3G networks.	3	
CO2	Implement multiuser modulations and the principles of Orthogonal Frequency Division Multiplexing (OFDM), to analyse and evaluate LTE transceiver operations, channel estimation techniques, and issues related to OFDM.	3	
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	
CO4	Analyze the unique features and diverse applications of Ultra-Wideband (UWB) technology, including its performance within indoor environments, and evaluate the factors influencing UWB capacity.	4	
CO5	Analyze and evaluate the conceptualization and application of multi-antenna operations, MIMO systems, and various multicarrier and multi-access systems (such as OFDMA, MC-CDMA, MIMO-OFDM, and multiband OFDM Ultra-Wideband) within the architecture of 4G networks.	4	
CO6	Employ their understanding of 4G architecture, interfaces, user equipment categories, and core functionalities such as Quality-of-Service (QoS), security, and mobility within the 3GPP standards framework to critically 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	
CO7	Evaluate the fundamental interplay between 4G architecture and its underlying protocols, and subsequently analyze advanced techniques such as advanced antenna systems, security measures for risk mitigation, multi-factor authentication protocols for user verification, and efficiency improvements within 4G LTE-Advanced networks, to assess their impact on enhancing user experience and network performance.	5	

Syllabus

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.

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, Single-Carrier Frequency Division Multiple Access (SC-FDMA)

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).

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

- 1 1. Mobile cellular Telecommunications, William C.Y.Lee, 1, TMH Publications 2006.
- 2 2. LTE and the Evolution to 4G Wireless Design and Measurement Challenges, Moray Rumney, 1, wiley.

25WLT3202 - MODERN SATELLITE COMMUNICATION SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WLT3202	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.	3	
CO2	To identify the functions of major satellite subsystems and distinguish them from various types of payloads	2	
CO3	To design satellite links considering factors like noise, signal strength, and impairments like rain attenuation	3	
CO4	Interpret working of satellite communications in 5G ecosystem	3	

Syllabus

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.

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.

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.

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.

Reference Books

- 1 Satellite Communications , Timothy Pratt, Charles Bostian and Jeremy Allnutt , Second Edition, Wiley.
- 2 Satellite Communication Systems Engineering, L.Pritchard, Robert A Nelson and Henri G.Suyderhoud , 1, Prentice Hall.

25WLT3303 - 5G NR-WIRELESS TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WLT3303	5G NR-WIRELESS TECHNOLOGIES	5GWT	R	3	0	0	2	3.5

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	
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	
CO3	Analyze and evaluate multi-antenna transmission techniques, beam management strategies, and millimeter wave characteristics relevant to 5G mobile systems.	4	
CO4	Analyze 5G core components, protocols, and security mechanisms in the context of Quality-of-Service (QoS) management.	4	
CO5	Analyze and assess the application of private wireless network architectures, using case studies to evaluate their effectiveness in real-world industrial settings.	4	
CO6	Analyze the 3GPP standards 5G architecture and call process using 5G testbed.	4	
CO7	Design and Analyze the QoS requirements with respective use-case scenario to enable information exchange between devices with hardware realization.	5	

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,

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.

Reference Books

- 1 Wireless communication standards, Todor cooklev, 1, IEEE press,2004.
- 2 Emerging wireless lans, wireless pans, and wireless mans, yang xiao yi pan, 1, John Wiley & sons, inc., publication, 2009.

- 3 A Comprehensive Survey of RAN Architectures Toward 5G Mobile Communication System, A Comprehensive Survey of RAN Architectures Toward 5G Mobile Communication System, 1, Wiley.
- 4 Signal Processing for 5G: Algorithms and Implementations, Fa-Long Luo and Charlie Jianzhong Zhang, Wiley-Blackwell, 1, Wiley.

25WLT3303A - 5G NR-WIRELESS TECHNOLOGIES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WLT3303A	5G NR-WIRELESS TECHNOLOGIES	5GWT	A	4	1	0	2	5.5

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	
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	
CO3	Analyze and evaluate multi-antenna transmission techniques, beam management strategies, and millimeter wave characteristics relevant to 5G mobile systems.	4	
CO4	Analyze 5G core components, protocols, and security mechanisms in the context of Quality-of-Service (QoS) management.	4	
CO5	Analyze and assess the application of private wireless network architectures, using case studies to evaluate their effectiveness in real-world industrial settings.	4	
CO6	Analyze the 3GPP standards 5G architecture and call process using 5G testbed.	4	
CO7	Design and Analyze the QoS requirements with respective use-case scenario to enable information exchange between devices with hardware realization.	5	

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.

Reference Books

- 1 Wireless communication standards, Todor cooklev, 1, IEEE press,2004.

- 2 Emerging wireless lans, wireless pans, and wireless mans, yang xiao yi pan, 1, John Wiley & sons, inc., publication, 2009.
- 3 A Comprehensive Survey of RAN Architectures Toward 5G Mobile Communication System, Mohammad Asif Habibi, Meysam Nasimi, Bin Han, 1, Wiley.
- 4 Signal Processing for 5G: Algorithms and Implementations, Fa-Long Luo and Charlie Jianzhong Zhang, Wiley-Blackwell, 1, Wiley.

25WLT3303E - 5G NR-WIRELESS TECHNOLOGIES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WLT3303E	5G NR-WIRELESS TECHNOLOGIES	5GWT	E	4	1	0	2	5.5

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	
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	
CO3	Analyze and evaluate multi-antenna transmission techniques, beam management strategies, and millimeter wave characteristics relevant to 5G mobile systems.	4	
CO4	Analyze 5G core components, protocols, and security mechanisms in the context of Quality-of-Service (QoS) management.	4	
CO5	Analyze and assess the application of private wireless network architectures, using case studies to evaluate their effectiveness in real-world industrial settings.	4	
CO6	Analyze the 3GPP standards 5G architecture and call process using 5G testbed.	4	
CO7	Design and Analyze the QoS requirements with respective use-case scenario to enable information exchange between devices with hardware realization.	5	

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.

Reference Books

- 1 Wireless communication standards, Todor cooklev, 1, IEEE press,2004.

- 2 Emerging wireless lans, wireless pans, and wireless mans, yang xiao yi pan, 1, John Wiley & sons, inc., publication, 2009.
- 3 A Comprehensive Survey of RAN Architectures Toward 5G Mobile Communication System, Mohammad Asif Habibi, Meysam Nasimi, Bin Han, 1, Wiley.
- 4 Signal Processing for 5G: Algorithms and Implementations, Fa-Long Luo and Charlie Jianzhong Zhang, Wiley-Blackwell, 1, Wiley.

25WLT3404 - OPTICAL WIRELESS COMMUNICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WLT3404	OPTICAL WIRELESS COMMUNICATIONS	OWC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understanding the behavior of light in a propagation channel and the atmospheric effects.	2	
CO2	Understanding various channel models for estimation of losses in optical wireless communication.	2	
CO3	Understanding and interception of modulation techniques utilized in VLC.	3	
CO4	Understanding and application of optical source detectors	3	

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, VLC 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 NRZ-OOK, 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

- Optical Wireless Communications: System and Channel Modelling with MATLAB, 1. Rajbhandari, S., Ghassemlooy, Z., Popoola, W, Second Edition, CRC Press.
- Advanced Optical and Wireless Communications Systems, 2. Djordjevic, I. B, First Edition, Springer International Publishing..

25WLT3505 - MACHINE LEARNING FOR WIRELESS COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WLT3505	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	
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	
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	
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	

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, Luo.F, 1, Wiley.
- 2 Applications of Machine Learning in Wireless Communications, 1. Ruisi He, Z Ding, 1, IET.
- 3 Machine Learning and Cognitive Computing for Mobile Communications and Wireless Networks, 2. K. K. Singh, A. Singh, K. Cengiz, Dac-Nhuong Le, 1, Wiley.

25WRE3101 - ADVANCED FOUNDATION ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WRE3101	ADVANCED FOUNDATION ENGINEERING	AFE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and Design of foundation in problematic soils	4	
CO2	Analyze and Design of open and pile foundations	4	
CO3	Analyze and Design of rectangular, trapezoidal, and strap footings	4	
CO4	Design and Analyze Mat foundations and machine foundations	4	

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.

Types of piles Load carrying capacity of piles based on static pile formulae Dynamic pile formulae Pile load tests Load carrying capacity of pile groups in sands and clays Negative skin friction (NSF), Settlement analysis of shallow and pile foundation

: 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 Foundation analysis and design , J.E. Bowles, 1988., Mc Graw-Hill International Editions.
- 2 Soil Mechanics and Foundation Engineering, VNS Murthy, 1987., CBS publishers & distributors.
- 3 Basic and applied soil mechanics , Gopal Ranjan and ASR Rao, 1987, Wiley Eastern Limited.

25WRE3101A - ADVANCED FOUNDATION ENGINEERING (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WRE3101A	ADVANCED FOUNDATION ENGINEERING	AFE	A	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and Design of foundation in problematic soils	4	
CO2	Analyze and Design of open and pile foundations	4	
CO3	Analyze and Design of rectangular, trapezoidal, and strap footings	4	
CO4	Design and Analyze Mat foundations and machine foundations	4	
CO5	Apply the index and engineering properties of soils from various laboratory tests and prepare the soil investigation report	3	

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.

Types of piles, Load carrying capacity of piles based on static pile formulae, Dynamic pile formulae, Pile load tests, Load carrying capacity of pile groups in sands and clays, negative skin friction (NSF), Settlement analysis of shallow and pile foundation.

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. Foundation analysis and design, J.E. Bowles, Mc GrawHill International Editions, Mc GrawHill.
2. Soil Mechanics and Foundation Engineering, VNS Murthy, 2017, CBS publishers & distributors.
3. Basic and applied soil mechanics, Gopal Ranjan and ASR Rao, 1993, Wiley Eastern Limited.

25WRE3101E - ADVANCED FOUNDATION ENGINEERING (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WRE3101E	ADVANCED FOUNDATION ENGINEERING	AFE	E	4	1	2	0	6

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Analyze and Design of foundation in problematic soils	4	
CO2	Analyze and Design of open and pile foundations	4	
CO3	Analyze and Design of rectangular, trapezoidal, and strap footings	4	
CO4	Design and Analyze Mat foundations and machine foundations	4	
CO5	Apply the index and engineering properties of soils from various laboratory tests and prepare the soil investigation report	3	

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.

Types of piles, Load carrying capacity of piles based on static pile formulae, Dynamic pile formulae, Pile load tests, Load carrying capacity of pile groups in sands and clays, negative skin friction (NSF), Settlement analysis of shallow and pile foundation.

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 Foundation analysis and design , J.E. Bowles, 1996, Mc Graw-Hill International .
- 2 Soil Mechanics and Foundation Engineering , VNS Murthy, 2017, CBS publishers & distributors.
- 3 Basic and applied soil mechanics , Gopal Ranjan , 1993, Wiley Eastern Limited.

25WRE3202 - INTELLIGENT TRANSPORTATION SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WRE3202	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	
CO2	Demonstrate the ability to apply various ITS technologies	2	
CO3	Construct transportation data for improving decision-making processes in transportation planning and operations.	2	
CO4	Design and propose sustainable and efficient transportation solutions	2	

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 Transportation Systems Problems and Perspectives Studies in Systems, Decision and Control, Aleksander Sladkowski, Wieslaw Pamula, 2003, Springer Series.
- 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.

25WRE3303 - GROUND IMPROVEMENT TECHNIQUES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WRE3303	GROUND IMPROVEMENT TECHNIQUES	GIT	R	3	0	0	2	3.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify difficult ground conditions in engineering practice	4	
CO2	Identify different ground improvement techniques and there uses as per the site specific.	4	
CO3	Ground improvement by using geosynthetics and its applications	4	
CO4	Promote wider use of techno economical construction techniques such as Reinforced soil structures, Gabion walls, Geo cells, Crib walls and fabric form work.	4	

Syllabus

Compaction: Theory of compaction, Shallow Surface Compaction - Equipment, Placement water content, factors affecting shallow compaction; Deep compaction.

Stabilization: Introduction, objectives, Methods of stabilization Mechanical, Cement, Lime, Bituminous, Calcium chloride; construction methods, factors affecting stabilization of soils; Deep Mixing methods Soil lime Columns and Cement Lime Columns, applications.

Soil Replacement techniques: Stone columns Rammed, vibratory Dewatering: Definition, necessity, Methods of dewatering Interceptor ditch, Single, Multistage and Vacuum well points, Horizontal wells, Electro osmosis. Permanent drainage by Foundation drains and Blanket drains

Grouting: Definition, Objectives of grouting, Grouts and their properties, Categories of Grouting, Grouting methods: Ascending, Descending and Stage Grouting in Soils,

Reference Books

- 1 Principles and Practice of Ground Improvement, Jie Han, 2010, Cengage Publications.
- 2 Ground Improvement Techniques, P. Purushothama Raj, 2006, New Age International.
- 3 Soil Mechanics in Engineering Practice, Karl Terzaghi, Ralph B. Peck, Gholamreza Mesri, 2010, McGraw Hill Education.

25WRE3303A - GROUND IMPROVEMENT TECHNIQUES (A)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WRE3303A	GROUND IMPROVEMENT TECHNIQUES	GIT	A	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify difficult ground conditions in engineering practice	4	
CO2	Identify different ground improvement techniques and there uses as per the site specific.	4	
CO3	Ground improvement by using geosynthetics and its applications	4	
CO4	Promote wider use of techno economical construction techniques such as Reinforced soil structures, Gabion walls, Geo cells, Crib walls and fabric form work	4	

Syllabus

Compaction: Theory of compaction, Shallow Surface Compaction - Equipment, Placement water content, factors affecting shallow compaction; Deep compaction.

Stabilization: Introduction, objectives, Methods of stabilization Mechanical, Cement, Lime, Bituminous, Calcium chloride; construction methods, factors affecting stabilization of soils; Deep Mixing methods Soil lime Columns and Cement Lime Columns, applications.

Soil Replacement techniques: Stone columns Rammed, vibratory Dewatering: Definition, necessity, Methods of dewatering Interceptor ditch, Single, Multistage and Vacuum well points, Horizontal wells, Electro osmosis. Permanent drainage by Foundation drains and Blanket drains

Grouting: Definition, Objectives of grouting, Grouts and their properties, Categories of Grouting, Grouting methods: Ascending, Descending and Stage Grouting in Soils,

Reference Books

- 1 Principles and Practice of Ground Improvement, Jie Han, 2010, Cengage Publications.
- 2 Ground Improvement Techniques, P. Purushothama Raj, 2006, New Age International.
- 3 Soil Mechanics in Engineering Practice, Karl Terzaghi, Ralph B. Peck, Gholamreza Mesri, 2010, McGraw Hill Education.

25WRE3303E - GROUND IMPROVEMENT TECHNIQUES (E)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WRE3303E	GROUND IMPROVEMENT TECHNIQUES	GIT	E	4	1	0	2	5.5

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify difficult ground conditions in engineering practice	4	
CO2	Identify different ground improvement techniques and there uses as per the site specific.	4	
CO3	Ground improvement by using geosynthetics and its applications	4	
CO4	Promote wider use of techno economical construction techniques such as Reinforced soil structures, Gabion walls, Geo cells, Crib walls and fabric form work	4	

Syllabus

Compaction: Theory of compaction, Shallow Surface Compaction - Equipment, Placement water content, factors affecting shallow compaction; Deep compaction.

Stabilization: Introduction, objectives, Methods of stabilization Mechanical, Cement, Lime, Bituminous, Calcium chloride; construction methods, factors affecting stabilization of soils; Deep Mixing methods Soil lime Columns and Cement Lime Columns, applications.

Soil Replacement techniques: Stone columns Rammed, vibratory Dewatering: Definition, necessity, Methods of dewatering Interceptor ditch, Single, Multistage and Vacuum well points, Horizontal wells, Electro osmosis. Permanent drainage by Foundation drains and Blanket drains

Grouting: Definition, Objectives of grouting, Grouts and their properties, Categories of Grouting, Grouting methods: Ascending, Descending and Stage Grouting in Soils,

Reference Books

- 1 Principles and Practice of Ground Improvement, Jie Han, 2010, Cengage Publications.
- 2 Ground Improvement Techniques, P. Purushothama Raj, 2006, New Age International.
- 3 Soil Mechanics in Engineering Practice, Karl Terzaghi, Ralph B. Peck, Gholamreza Mesri, 2010, McGraw Hill Education.

25WRE3404 - RIVER ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WRE3404	RIVER ENGINEERING	REG	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Computation of incipient motion and flow regime	3	
CO2	Computation of hydraulically smooth and rough surface	3	
CO3	Application of river training works for riverbed and bank protection	3	
CO4	Analysis of flow discharge and sediment transport using similitude	4	

Syllabus

: Sediment characteristics and Incipient motion: Origin of sediments, Types of sediment, Cohesionless and cohesive sediment, Alluvial channel; Impact of sediment transport, Concept of Incipient motion, Shields diagram; Equations for incipient motion; Concept of bed load, suspended load, wash load, and total load.

Bed forms and hydraulic surface: 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; Computation of hydraulic smooth and rough surface.

River equilibrium and training works: River aggradation and degradation; River equilibrium; River dynamics; River meandering, Braided channel, Importance of river training works; Types of river training; 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 similitude model: Methods for the computation of bed load and suspended load; Hydraulic similitude; Dimensional analysis for distorted and undistorted models; Fluid flow and sediment transport equations. Turbulence: Turbulence theory, Turbulence Intensity, Bed Shear Stress, Turbulent Kinetic Energy, Concept of Burst, Velocity distribution, ADV.

Reference Books

1. Mechanics of Sediment Transportation and Alluvial Stream Problems, R. J. Garde and K. G. Ranga Raju, 2000, New Age International.
2. Hydraulics of Sediment Transport, Walter Hans Graf, 1984, Water Resources Publication, LLC.
3. Mechanics of Sediment Transport, A. Mueller and B. Mutlu Sumer, 2020, CRC Press.

25WRE3505 - ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25WRE3505	ENVIRONMENTAL IMPACT ASSESSMENT AND LIFE CYCLE ANALYSIS	EIALCA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the principles and importance of Environmental Impact Assessment (EIA) in various industries and sectors	2	
CO2	Understand the methods and tools used in conducting Environmental Impact Assessments, including screening, scoping, baseline studies, impact prediction, and mitigation measures	2	
CO3	Understand the concept of Life Cycle Analysis (LCA) and its role in assessing the environmental impacts of products, processes, and systems throughout their entire life cycle	2	
CO4	Understand the qualitative and quantitative methodologies to assess the potential environmental impacts of proposed projects or activities on air, water, soil, biodiversity, and human health	2	

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

Environmental Management: Preventive policy of environment, waste minimisation, conservation of water and energy, use of renewable, sources, pollution audit, pollution control strategy, disposal of treated effluents, solid waste disposal concept of green cities, green belt development Case history.

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: Theory and Practice, Peter Morris, 2000, Peter Morris.
- 2 Methods of Environmental and Social Impact Assessment, Riki Therivel, 2010, Routledge.
- 3 Introduction to Environmental Impact Assessment, John Glasson Riki, Therivel, Andrew Chadwick, 2016, UCL Press.



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

Y25: B.Tech. - Mechanical Engineering

Category: Bridge Courses (BRIDGE)

25UC0018 - FUNDAMENTALS OF MATHEMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC0018	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.



(DEEMED TO BE UNIVERSITY)

Y25: B.Tech. - Mechanical Engineering

Category: Minor Skill Development Courses (MSDC)

25MRAC05M - AI APPLICATIONS FOR BUSINESS SUCCESS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAC05M	AI APPLICATIONS FOR BUSINESS SUCCESS	AIA	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAG05 - DIGITAL ART (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAG05	DIGITAL ART	DTA	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAP05M - SOCIAL CULTURE ANTHROPOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAP05M	SOCIAL CULTURE ANTHROPOLOGY	SCA	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAR05 - SOCIAL GEOGRAPHY AND CARTOGRAPHY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAR05	SOCIAL GEOGRAPHY AND CARTOGRAPHY	SGC	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRBA05M - LOGISTICS AND SUPPLY CHAIN MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBA05M	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	LSCM	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRBN05M - ADVANCED BUSINESS ANALYTICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBN05M	ADVANCED BUSINESS ANALYTICS	ABA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCA05 - SCULPTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCA05	SCULPTURE	SCP	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCL05 - COMMERCIAL CONTRACT DRAFTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCL05	COMMERCIAL CONTRACT DRAFTING	CCD	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCM06 - TRANSFORM TECHNIQUES FOR ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCM06	TRANSFORM TECHNIQUES FOR ENGINEERING	TTE	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCM07 - STATISTICS WITH R PROGRAMMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCM07	STATISTICS WITH R PROGRAMMING	SWRP	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCM08 - MATRIX COMPUTATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCM08	MATRIX COMPUTATION	MCT	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCY05 - CYBER SECURITY: TOOLS, TECHNIQUES & COUNTERMEASURES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCY05	CYBER SECURITY: TOOLS, TECHNIQUES & COUNTERMEASURES	CSTTCM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRDM05M - CONTENT MARKETING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRDM05M	CONTENT MARKETING	CM	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFA05M - TRADING ALGORITHMNS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFA05M	TRADING ALGORITHMNS	TA	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFM05 - DIGITAL PHOTOGRAPHY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFM05	DIGITAL PHOTOGRAPHY	DPG	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFT05 - FOOD PACKAGING TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFT05	FOOD PACKAGING TECHNOLOGY	FPT	R	2	0	2	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRGD05 - PUBLICATION DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRGD05	PUBLICATION DESIGN	PUDG	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIB05M - PROFESSIONAL SKILLS FOR INTERNATIONAL BUSINESS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIB05M	PROFESSIONAL SKILLS FOR INTERNATIONAL BUSINESS	PIB	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRID05 - DESIGN PRESENTATION AND COMMUNICATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRID05	DESIGN PRESENTATION AND COMMUNICATION	DPC	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIM05 - PROJECT INNOVATE: STRATEGIES FOR ENTREPRENEURIAL GROWTH (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIM05	PROJECT INNOVATE: STRATEGIES FOR ENTREPRENEURIAL GROWTH	PISEG	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIP05 - LAW OF DESIGNS, GEOGRAPHICAL INDICATIONS AND PLANT VARIETIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIP05	LAW OF DESIGNS, GEOGRAPHICAL INDICATIONS AND PLANT VARIETIES	LODGP	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRME05M - HOW TO FINANCE YOUR VENTURE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRME05M	HOW TO FINANCE YOUR VENTURE	HTFYV	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MROB05M - TEAM BUILDING AND COLLABORATION SKILLS FOR MANAGERS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MROB05M	TEAM BUILDING AND COLLABORATION SKILLS FOR MANAGERS	TBCM	M	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPA05 - MODERN FARMING TECHNIQUES AND INNOVATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPA05	MODERN FARMING TECHNIQUES AND INNOVATIONS	AELP	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPS05M - POSITIVE PSYCHOLOGY: RESILIENCE SKILLS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPS05M	POSITIVE PSYCHOLOGY: RESILIENCE SKILLS	PPRS	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPY05 - PRACTICAL PHARMACOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPY05	PRACTICAL PHARMACOLOGY	PRI	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRTP05 - TECH INNOVATION PROJECT FOR ENTREPRENEURS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRTP05	TECH INNOVATION PROJECT FOR ENTREPRENEURS	TIPFE	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO



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

Y25: B.Tech. - Mechanical Engineering

Category: Minor Degree Courses (MIN)

25MRAC01M - AI FOR BUSINESS STRATEGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAC01M	AI FOR BUSINESS STRATEGY	ABS	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAC02M - AI STRATEGY AND GOVERNANCE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAC02M	AI STRATEGY AND GOVERNANCE	ASG	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAC03M - SUCCESSFUL AI STRATEGIES : A CEO'S PERSPECTIVES (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAC03M	SUCCESSFUL AI STRATEGIES : A CEO'S PERSPECTIVES	SAI	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAC04M - CRAFTING A COMPETITIVE ADVANTAGE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAC04M	CRAFTING A COMPETITIVE ADVANTAGE	CCA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAG01 - INTRODUCTION TO GAME MATH (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAG01	INTRODUCTION TO GAME MATH	IGM	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAG02 - DRAWING BASICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAG02	DRAWING BASICS	DBS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAG03 - GRAPHIC DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAG03	GRAPHIC DESIGN	GDS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAG04 - CONCEPTS OF 3D (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAG04	CONCEPTS OF 3D	C3D	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAP01M - INTRODUCTION TO ANTHROPOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAP01M	INTRODUCTION TO ANTHROPOLOGY	ITA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAP02M - CULTURAL EVOLUTION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAP02M	CULTURAL EVOLUTION	CET	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAP03M - HUMAN ECOLOGY AND ECOLOGICAL ANTHROPOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAP03M	HUMAN ECOLOGY AND ECOLOGICAL ANTHROPOLOGY	HEEA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAP04M - FUNDAMENTALS IN ARCHEOLOGICAL ANTHROPOLOGY CHRONOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAP04M	FUNDAMENTALS IN ARCHEOLOGICAL ANTHROPOLOGY CHRONOLOGY	FAAC	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAR01 - FUNDAMENTALS OF MACRO-ECONOMICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAR01	FUNDAMENTALS OF MACRO-ECONOMICS	FME	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAR02 - BASICS OF ECONOMETRICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAR02	BASICS OF ECONOMETRICS	BOE	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAR03 - INTERNATIONAL RELATIONS: THEORIES AND CONCEPTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAR03	INTERNATIONAL RELATIONS: THEORIES AND CONCEPTS	IRTC	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRAR04 - BEHAVIOURAL ECONOMICS AND POLICY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRAR04	BEHAVIOURAL ECONOMICS AND POLICY	BEP	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRBA01M - ORGANIZATIONAL BEHAVIOUR (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBA01M	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	
CO2	To analyze the complexities associated with management of individual behavior in the organization.	4	
CO3	To analyze the complexities associated with management of group behavior in the organization	4	
CO4	To analyze the facets of organizational culture and manage organizational change and work stress	4	
CO5	To analyse the cross-cultural aspects of OB and the underlying challenges and opportunities for international organisations	4	
CO6	Assessment of NPTEL course	5	

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

Assessment of NPTEL MCQs

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 Managing across cultures, Schneider S., Barsoux J., 2, Prentice Hal.

25MRBA02M - MARKETING MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBA02M	MARKETING MANAGEMENT	MMG	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRBA03M - FINANCIAL MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBA03M	FINANCIAL MANAGEMENT	FMG	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRBA04M - HUMAN RESOURCE MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBA04M	HUMAN RESOURCE MANAGEMENT	HRM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRBN01M - INTRODUCTION TO BUSINESS ANALYTICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBN01M	INTRODUCTION TO BUSINESS ANALYTICS	IBA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRBN02M - FOUNDATIONS OF BUSINESS INTELLIGENCE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBN02M	FOUNDATIONS OF BUSINESS INTELLIGENCE	FBI	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRBN03M - POWER BI FOR DATA SCIENCE AND ANALYTICS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBN03M	POWER BI FOR DATA SCIENCE AND ANALYTICS	PBDSA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRBN04M - BUSINESS ANALYTICS WITH EXCEL: ELEMENTARY TO ADVANCE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRBN04M	BUSINESS ANALYTICS WITH EXCEL: ELEMENTARY TO ADVANCE	BAWEEA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCA01 - INTRODUCTION TO CREATIVE ARTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCA01	INTRODUCTION TO CREATIVE ARTS	ICA	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCA02 - DRAWING AND SKETCHING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCA02	DRAWING AND SKETCHING	DAS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCA03 - PAINTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCA03	PAINTING	PNT	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCA04 - CREATIVE WRITING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCA04	CREATIVE WRITING	CWT	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCL01 - PRINCIPLES OF COMPANIES ACT AND CORPORATE GOVERNANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCL01	PRINCIPLES OF COMPANIES ACT AND CORPORATE GOVERNANCE	PCACG	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCL02 - MERGERS, ACQUISITIONS AND PRIVATE EQUITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCL02	MERGERS, ACQUISITIONS AND PRIVATE EQUITY	MAPE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCL03 - INSOLVENCY AND BANKRUPTCY LAW (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCL03	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.

25MRCL04 - COMPETITION LAW AND PRACTICE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCL04	COMPETITION LAW AND PRACTICE	CLP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCM01 - LINEAR ALGEBRA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCM01	LINEAR ALGEBRA	LAG	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCM02 - ADVANCED NUMERICAL ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCM02	ADVANCED NUMERICAL ANALYSIS	ANA	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCM03 - MATHEMATICAL MODELLING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCM03	MATHEMATICAL MODELLING	MML	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCM04 - STOCHASTIC PROCESSES & OPTIMIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCM04	STOCHASTIC PROCESSES & OPTIMIZATION	SPO	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCM05 - FUZZY MATHEMATICS AND ITS APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCM05	FUZZY MATHEMATICS AND ITS APPLICATIONS	FMAA	R	2	2	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCY01 - INTRODUCTION TO CYBERLAW AND CYBERSPACE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCY01	INTRODUCTION TO CYBERLAW AND CYBERSPACE	ITCLCS	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCY02 - CYBERLAW AND E-COMMERCE IMPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCY02	CYBERLAW AND E-COMMERCE IMPLICATIONS	CLECI	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCY03 - CYBERCRIMES IN INDIA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCY03	CYBERCRIMES IN INDIA	CCII	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRCY04 - INTRODUCTION TO CYBERSECURITY, INCIDENTAL RESPONSE AND DIGITAL FORENSIC (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRCY04	INTRODUCTION TO CYBERSECURITY, INCIDENTAL RESPONSE AND DIGITAL FORENSIC	ITCIRDF	R	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRDM01M - FUNDAMENTALS OF DIGITAL MARKETING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRDM01M	FUNDAMENTALS OF DIGITAL MARKETING	FDM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRDM02M - SOCIAL MEDIA MARKETING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRDM02M	SOCIAL MEDIA MARKETING	SMM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRDM03M - SERACH ENGINE OPTIMIZATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRDM03M	SERACH ENGINE OPTIMIZATION	SEO	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRDM04M - ARTIFICIAL INTELLIGENCE IN MARKETING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRDM04M	ARTIFICIAL INTELLIGENCE IN MARKETING	AIM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFA01M - FOUNDATIONS AND APPLICATIONS OF FINANCIAL TECHNOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFA01M	FOUNDATIONS AND APPLICATIONS OF FINANCIAL TECHNOLOGY	AFT	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFA02M - DECENTRALISED FINANCE: THE FUTURE OF FINANCE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFA02M	DECENTRALISED FINANCE: THE FUTURE OF FINANCE	DFFF	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFA03M - FINTECH INNOVATIONS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFA03M	FINTECH INNOVATIONS	FIV	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFA04M - USING MACHINE LEARNING IN TRADING AND FINANCE (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFA04M	USING MACHINE LEARNING IN TRADING AND FINANCE	ML	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFM01 - FILM AESTHETICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFM01	FILM AESTHETICS	FAS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFM02 - SCREEN WRITING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFM02	SCREEN WRITING	SWT	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFM03 - CINEMATIC LIGHTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFM03	CINEMATIC LIGHTING	CML	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFM04 - SOUND DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFM04	SOUND DESIGN	SDS	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFT01 - INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFT01	INTRODUCTION TO FOOD SCIENCE AND TECHNOLOGY	IFST	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFT02 - FOOD ANALYSIS AND QUALITY ASSURANCE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFT02	FOOD ANALYSIS AND QUALITY ASSURANCE	FAQA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFT03 - FOOD SAFETY AND REGULATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFT03	FOOD SAFETY AND REGULATIONS	FSR	R	3	1	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRFT04 - FOOD ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRFT04	FOOD ENGINEERING	FEG	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRGD01 - INTRODUCTION TO GRAPHIC DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRGD01	INTRODUCTION TO GRAPHIC DESIGN	IGD	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRGD02 - TYPOGRAPHY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRGD02	TYPGRAPHY	TPY	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRGD03 - VISUAL IDENTITY AND BRANDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRGD03	VISUAL IDENTITY AND BRANDING	VIB	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRGD04 - PRINT DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRGD04	PRINT DESIGN	PRDG	R	0	0	6	4	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIB01M - INTERNATIONAL BUSINESS ESSENTIALS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIB01M	INTERNATIONAL BUSINESS ESSENTIALS	IBET	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIB02M - INTERNATIONAL BUSINESS ENVIRONMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIB02M	INTERNATIONAL BUSINESS ENVIRONMENT	IBEV	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIB03M - INTERNATIONAL BUSINESS OPERATIONS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIB03M	INTERNATIONAL BUSINESS OPERATIONS	IBO	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIB04M - INTERNATIONAL BUSINESS MODELS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIB04M	INTERNATIONAL BUSINESS MODELS	IBM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRID01 - INTRODUCTION TO INTERIOR DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRID01	INTRODUCTION TO INTERIOR DESIGN	IID	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRID02 - SPACE PLANNING AND LAYOUT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRID02	SPACE PLANNING AND LAYOUT	SPL	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRID03 - INTERIOR MATERIAL AND FINISHES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRID03	INTERIOR MATERIAL AND FINISHES	IMF	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRID04 - FURNITURE AND ACCESSORIES DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRID04	FURNITURE AND ACCESSORIES DESIGN	FAD	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIM01 - APPLIED DESIGN THINKING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIM01	APPLIED DESIGN THINKING	ADT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIM02 - BUSINESS MODEL INNOVATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIM02	BUSINESS MODEL INNOVATION	BMI	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIM03 - VENTURE MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIM03	VENTURE MANAGEMENT	VMT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIM04 - BUSINESS AND LEADERSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIM04	BUSINESS AND LEADERSHIP	BL	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIP01 - EMERGENCE AND DEVELOPMENT OF IPR (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIP01	EMERGENCE AND DEVELOPMENT OF IPR	EDIPR	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIP02 - LAW OF COPYRIGHT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIP02	LAW OF COPYRIGHT	LOCR	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIP03 - LAW OF PATENTS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIP03	LAW OF PATENTS	LOPS	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRIP04 - LAW OF TRADEMARK (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRIP04	LAW OF TRADEMARK	LOTM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRME01M - MICROECONOMICS - THE POWER OF MARKETS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRME01M	MICROECONOMICS - THE POWER OF MARKETS	MEPM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRME02M - FUNDAMENTALS OF ACCOUNTING (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRME02M	FUNDAMENTALS OF ACCOUNTING	FOA	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRME03M - FINANCIAL MANAGEMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRME03M	FINANCIAL MANAGEMENT	FM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRME04M - FINANCIAL MARKETS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRME04M	FINANCIAL MARKETS	FM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MROB01M - ORGANIZATIONAL BEHAVIOUR (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MROB01M	ORGANIZATIONAL BEHAVIOUR	POM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MROB02M - ORGANIZATIONAL BEHAVIOUR MODELS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MROB02M	ORGANIZATIONAL BEHAVIOUR MODELS	OBM	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MROB03M - ORGANIZATIONAL CHANGE AND DEVELOPMENT (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MROB03M	ORGANIZATIONAL CHANGE AND DEVELOPMENT	OCD	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MROB04M - LEADERSHIP IN ORGANIZATION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MROB04M	LEADERSHIP IN ORGANIZATION	LIO	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPA01 - FUNDAMENTALS OF AGRONOMY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPA01	FUNDAMENTALS OF AGRONOMY	FOA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPA02 - INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPA02	INTRODUCTORY AGROMETEOROLOGY AND CLIMATE CHANGE	IACC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPA03 - GEOINFORMATICS AND NANOTECHNOLOGY FOR PRECISION FARMING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPA03	GEOINFORMATICS AND NANOTECHNOLOGY FOR PRECISION FARMING	GNPF	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPA04 - PROTECTED CULTIVATION AND POST-HARVEST TECHNOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPA04	PROTECTED CULTIVATION AND POST-HARVEST TECHNOLOGIES	PCPHT	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPS01M - INTRODUCTION TO PSYCHOLOGY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPS01M	INTRODUCTION TO PSYCHOLOGY	ITP	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPS02M - PSYCHOLOGY OF EVERYDAY (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPS02M	PSYCHOLOGY OF EVERYDAY	POE	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPS03M - SOCIAL COGNITION (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPS03M	SOCIAL COGNITION	SC	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPS04M - THE SCIENCE OF WELL-BEING FOR TEENS (M)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPS04M	THE SCIENCE OF WELL-BEING FOR TEENS	TSOWBFT	M	4	0	0	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPY01 - BASICS OF PHARMACOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPY01	BASICS OF PHARMACOLOGY	BOP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPY02 - ADVANCED PHARMACOLOGY - I (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPY02	ADVANCED PHARMACOLOGY - I	AP-I	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPY03 - EXPERIMENTAL PHARMACOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPY03	EXPERIMENTAL PHARMACOLOGY	EPC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRPY04 - ADVANCED PHARMACOLOGY - II (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRPY04	ADVANCED PHARMACOLOGY - II	AP-II	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRTP01 - INTRODUCTION TO TECHNOLOGICAL ENTREPRENEURSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRTP01	INTRODUCTION TO TECHNOLOGICAL ENTREPRENEURSHIP	ITEP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRTP02 - LEAN STARTUP LAUNCHPAD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRTP02	LEAN STARTUP LAUNCHPAD	LSLP	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRTP03 - ENTREPRENEURSHIP AND VENTURE CAPITAL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRTP03	ENTREPRENEURSHIP AND VENTURE CAPITAL	EVC	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRTP04 - BUILDING AND SUSTAINING A SUCCESSFUL ENTERPRISE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRTP04	BUILDING AND SUSTAINING A SUCCESSFUL ENTERPRISE	BSSE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRWS02 - SOIL AND WATER CONSERVATION ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRWS02	SOIL AND WATER CONSERVATION ENGINEERING	SWCE	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRWS03 - IRRIGATION WATER MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRWS03	IRRIGATION WATER MANAGEMENT	IWM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25MRWS04 - RAINFED AGRICULTURE AND WATERSHED MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25MRWS04	RAINFED AGRICULTURE AND WATERSHED MANAGEMENT	RAWM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO



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

Y25: B.Tech. - Mechanical Engineering

Category: Audit Courses (AUC)

25UC0008 - INDIAN CONSTITUTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC0008	INDIAN CONSTITUTION	CON	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	PO1
CO2	To understand the basic features of the Indian Constitution.	2	PO3, PO4
CO3	To understand the structure of the Federal government as defined by the Indian Constitution.	2	PO2
CO4	To understand the Indian Judicial system and election commission of india	2	PO4

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 and the Preamble, Fundamental Rights, Directive Principles of State Policy

Fundamental Duties Government of the Union and Fundamental Duties Government of the Union

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, 2017, Vitasta Publishing Pvt.Ltd.
- 3 Indian Administration, M. Sharma, 2004, Anmol Publisher.
- 4 Indian Constitutional Law, M P Jain, 2018, LexiNexis.

25UC0009 - ECOLOGY AND ENVIRONMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC0009	ECOLOGY AND ENVIRONMENT	ENE	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 depiction. 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, 4th (2010), United Grants Commission, Universities Press (India) Pvt. Ltd., Hyderabad.
- 2 Environmental Studies, Benny Joseph, 5th (2009), The McGraw-Hill Companies, New Delhi.
- 3 Textbook of Environmental Studies, Deeksha Deve, S.S. Kateswa, 3rd (2009), Cengage Learning India Pvt. Ltd., New Delhi.
- 4 Environmental Studies, Anubha Kaushik, C.P. Kaushik, 4th (2007), New Age International.
- 5 Environmental Biology, P.D. Sharma, 7th (2009), Rastogi Publications, Meerut.

25UC0017 - INDIAN ANCIENT KNOWLEDGE SYSTEMS : VEDIC MATHEMATICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC0017	INDIAN ANCIENT KNOWLEDGE SYSTEMS : VEDIC MATHEMATICS	IAKS-VM	R	2	0	0	0	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply logical reasoning principles and problem solving strategies to solve related Shakuntala Devi Puzzles.	3	PO1, PO7, PO11
CO2	Apply the concept of reasoning in solving puzzles.	3	PO1
CO3	Understand the interdisciplinary nature of Indian philosophy, mathematics, and their significant contributions to global mathematics.	2	PO1
CO4	Apply the vedic maths sutras in Addition, Subtraction, Multiplications and Devision.	3	PO1

Syllabus

Mastery of Basic Arithmetic and Algebraic Concepts: Introduction of the concept of Numbers System, Ratio, Proportion, Variation, Averages, Percentages, Profit & loss, Time & Distance, Time & Work, and related Shakuntala Devi Puzzles.

Introduction to Timekeeping: Clocks History and evolution of clocks Mechanical vs. digital clocks Practical problems involving time calculations Organizing Time: Calendars Different calendar systems and their history Structure and function of various calendars Date calculations and calendar conversions Geometric Shapes: Cubes Properties and characteristics of cubes Calculating surface area and volume Real-world applications and puzzles Reasoning Skills: Deductions Types of deductive reasoning Structure of logical arguments Exercises on valid arguments and fallacies. Building Logic: Logical Connectives Meaning and usage of logical connectives Truth tables and logical equivalence. Creating and analyzing logical statements Organizing Elements

Introduction to Indian Knowledge System, Indian Mathematicians and their Contribution to the World. Vedic Mathematics: Origin and Background, 16 Sutras of Vedic Mathematics by Swami Bharati Krishna Tirthji Maharaj. Fundamentals of Vedic Mathematics: Ekadhikena Purvena, Nikhilam Navatacharamam Dasatah, Antyayoradaskaepi, Base Method for Multiplication with Base 10, 100, 1000, 10000, Base Method for Multiplication with Base 50 Urdhvatiryagbhyam Method

Basic Arithmetic Operations using Vedic Sutras: Addition: Shubh Method Subtraction: Nikhilam Navatacharamam Dasatah Divison: Paravartya Yojayet Nikhilam Method, General Method for Divison (Dhwajank Method/Flag Method). Square of numbers by Base Method and Cube of number by formula method and Anurupya Method

Reference Books

- 1 Learning Vedic Mathematics, , S. K. Kapoor, 2, Lotus Press Publications.
- 2 A Modern Introduction to Ancient Indian Mathematics, T S Bhanumurthy, 1, Wiley Eastern.
- 3 A Modern Approach To Verbal & Non-Verbal Reasoning, R. S. Aggarwal, 1, S. CHAND.

25UC0032 - INSIGHTS TO SUSTAINABLE DEVELOPMENT GOALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25UC0032	INSIGHTS TO SUSTAINABLE DEVELOPMENT GOALS	SDG	R	2	0	0	0	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the concept and importance of sustainable development and the SDGs	2	PO1, PO7, PO11
CO2	Analyze the interconnections among different SDGs and their global/local implications.	4	PO2, PO7, PO11
CO3	Identify practical strategies for contributing towards the achievement of SDGs.	3	PO3, PO6, PO7, PO11
CO4	Demonstrate awareness through participation in campus/community sustainability initiatives.	3	PO6, PO7, PO8, PO11

Syllabus

Sustainable development concept and principles, triple bottom line economic, social, environmental dimensions, evolution from Brundtland Report to SDGs, overview of 17 goals and 169 targets, global and local sustainability perspectives.

SDG 1 no poverty, SDG 3 good health and well-being, SDG 4 quality education, SDG 5 gender equality, interlinkages among social development goals, policies and strategies for inclusive growth.

SDG 6 clean water and sanitation, SDG 7 affordable and clean energy, SDG 13 climate action, SDG 14 life below water, SDG 15 life on land, environmental protection measures, renewable energy solutions, climate change mitigation and adaptation.

SDG 8 decent work and economic growth, SDG 9 industry, innovation and infrastructure, SDG 11 sustainable cities and communities, SDG 17 partnerships for the goals, stakeholder roles and responsibilities, best practices and case studies, student led sustainability projects.

Reference Books

- 1 The Sustainable Development Goals Report, latest edition, UN Publications., United Nations Department of Economic and Social Affairs (UN DESA), 2025, UN DESA.
- 2 The Age of Sustainable Development, Columbia University Press, Jeffrey D. Sachs, 2015, Columbia University Press.
- 3 Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist, Kate Raworth, 2017, Chelsea Green Publishing.
- 4 Global Environmental Politics, Pamela S. Chasek and David L. Downie, 2017, Westview Press.
- 5 Sustainability Assessment, Selma Hassan, Susan Holtz, James Tansey, and Graham Whitelaw., 2006, Earthscan.

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	PO1
CO2	Apply their understanding of vocabulary, grammar, and logical reasoning to analyze complex texts, evaluate arguments, and solve challenging verbal reasoning problems.	3	PO2

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	PO2
CO2	Apply advanced problem-solving and strategic decision-making techniques to manage complex projects within the core domain.	3	PO3

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	PO3
CO2	Apply industry-relevant practices to implement innovation and manage organizational change while fostering a culture of continuous improvement.	3	PO3

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	PO2
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	PO3

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	PO3
CO2	Apply their understanding of verbal ability, numerical ability, and general awareness to solve problems in a variety of contexts	3	PO3

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	PO2
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	PO2

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	PO3
CO2	Understanding the basics of Indian Geography	2	PO3
CO3	Understanding the Evolution of Indian Constitution.	2	PO3
CO4	Understanding the evolution of Indian Economy	2	PO3

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 it's influence in contemporary society	2	PO10
CO2	Understand and assess the interactions between human activities and economic systems in shaping geographic landscapes.	2	PO10
CO3	Understand and analyze the structure and functioning of India's parliamentary and federal systems, including the intricacies of centre-state relations.	2	PO10
CO4	Understand and able to critically evaluate the key components of the Indian economy.	2	PO10

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 ,Subcidies, 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	PO3
CO2	Identify various logical reasoning techniques to solve complex problems, identify patterns, and draw valid conclusions	3	PO3

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	PO9
CO2	Apply the knowledge of trees, graphs, heaps, and hash tables to design and implement efficient algorithms for complex data-intensive applications	3	PO9

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	PO5
CO2	Design and implement dynamic programming algorithms to solve problems with overlapping subproblems	3	PO5

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	PO9
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	PO10

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	applyi and practice empathy, critical thinking, problem-solving, decision-making, effective communication, and interpersonal skills through real-life scenarios and interactive activities.	3	PO9, 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, PO10

Syllabus

Critical thinking, problem soving, 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	PO8, PO9
CO2	Develop foundational technical skills by applying theoretical concepts in hands-on tasks, enabling them to contribute effectively in a professional environment.	3	PO8

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	PO5
CO2	Enhance professional communication skills by effectively presenting technical information and collaborating with industry professionals, demonstrating an understanding of workplace dynamics.	3	PO5

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	PO5
CO2	Apply digital tools to create professional-quality content and presentations.	3	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
CO2	Critically evaluate and apply specialized digital tools to solve real-world problems and improve workflow efficiency.	3	PO5

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	PO9, PO10, PO11
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	PO9, PO10, PO11

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, PO11
CO2	Apply principles of quantitative techniques to solve problems on Divisibility, Functions, Surds & Indices etc	3	PO9, PO10, PO11

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, PO11
CO2	Apply principles of inductive logic to solve problems on assumptions and conclusions	3	PO9, PO10, PO11

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)

Y25: B.Tech. - Mechanical Engineering

Category: Value Added Courses (VAC)

25CC3001 - 3D MODELLING USING CATIA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3001	3D MODELLING USING CATIA	3MUC	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25CC3008 - AUTOCAD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3008	AUTOCAD	ACAD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the basic commands required to Create a skecher part	3	
CO2	Apply the basic modify commands to give the model with desirable way of representation	3	
CO3	Apply the various feature based commands to create a object in Three dimensional Model	3	

Syllabus

Basic two dimensional commands like Line, Circle, Arc and others to create a two dimensional in Sketcher mode

using Edit Feature based commands like Copy, erase, Array -linear / Circular pattern, Move, Mirror etc to modify the model with required shape and dimensions

Conversion of 2d to 3d modeling by using Extrude, Revolve, Extrude Cut and other commands to model an object in Three dimensional representation, Using Layering and other special features like Hatching, Cross hatching and others color codes techniques create a perfect assemble model of given Component on computer graphics

Reference Books

- 1 Autodesk AutoCAD Certified User Study Guide, Daniel John Stine AIA, IES, CSI, CDT, Well AP, William G. Wyatt Ed.D., CET, 2025, SDC Publications.
- 2 Engineering Graphics Essentials with AutoCAD 2025 Instruction, Kirstie Plantenberg, 2024, SDC Publications .
- 3 AutoCAD 2025 Tutorial First Level 2D Fundamentals, Luke Jumper, Randy H. Shih, 2024, SDC Publications.
- 4 Principles and Practice An Integrated Approach to Engineering Graphics and AutoCAD 2024, Randy H. Shih, 2023, SDC Publications.

25CC3009 - AUTODESK FUSION 360 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3009	AUTODESK FUSION 360	ADF	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25CC3071 - PROGRAMMING USING PYTHON (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3071	PROGRAMMING USING PYTHON	PUP	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25CC3084 - STATIC ANALYSIS USING ANSYS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3084	STATIC ANALYSIS USING ANSYS	SAUA	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25CC3085 - STATIC AND DYNAMIC ANALYSIS USING ALTAIR HYPERWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3085	STATIC AND DYNAMIC ANALYSIS USING ALTAIR HYPERWORKS	SDAAH	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25CC3114 - STATIC AND FLOW ANALYSIS USING ANSYS CFD (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3114	STATIC AND FLOW ANALYSIS USING ANSYS CFD	SFAUCFD	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25CC3115 - ANSYS THERMAL MODELLING PROGRAMME (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25CC3115	ANSYS THERMAL MODELLING PROGRAMME	ATMP	R	0	0	0	8	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO

25SP2101 - ATHLETICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2101	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	
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	

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.

25SP2102 - BASKETBALL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2102	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	
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	

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.

25SP2103 - BADMINTON (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2103	BADMINTON	BMT	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Badminton and History	2	
CO2	badminton summary	2	

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 ?ulations 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.

25SP2104 - CRICKET (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2104	CRICKET	CRKT	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Cricket and History	2	
CO2	Cricket summary	2	

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 Cricket and History, Melaine D, 1st 2014, S.L.Y.M.
- 2 Cricket, C Kinan, 3rd 2019, Sports.
- 3 CRICKET FOR BEGINNERS, SAMUEL NOAH, 1st 2018, Sports.
- 4 the cricket Book, David Stein, 1st 2014, Phaidon Press.

25SP2105 - CHESS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2105	CHESS	CHS	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Chess and History	2	
CO2	chess summary	2	

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.

25SP2108 - KABADDI (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2108	KABADDI	KBD	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction to Kabaddi	2	
CO2	Kabaddi Summary	2	

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.

25SP2109 - KHO-KHO (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2109	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	
CO2	khokho summary	2	

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 Buddhe, 2nd 2019, Lakshay Publishers.
- 4 Kho-Kho Avlokan, Gauri Chakravarthi, 3rd 2020, Sports Publications.

25SP2110 - TENNIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2110	TENNIS	TNS	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Tennis and History	2	
CO2	Tennis summary	2	

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.

25SP2111 - TABLE TENNIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2111	TABLE TENNIS	TTS	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Table Tennis and History	2	
CO2	table tennis summary	2	

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, Richard Ernest McAfee, 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.

25SP2113 - THROW BALL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2113	THROW BALL	THB	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Throwball and History	2	
CO2	Throwball summary	2	

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.

25SP2114 - VOLLEYBALL (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2114	VOLLEYBALL	VOB	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction about Volleyball and History	3	
CO2	Volletball summary	2	

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.

25SP2116 - YOGA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25SP2116	YOGA	YOG	R	0	0	0	2	0

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Introduction of Yoga and Asanas	2	
CO2	yoga summary	2	

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 UNIVERSITY)

Y25: B.Tech. - Mechanical Engineering

Category: Open Elective Courses (OEC)

OEAD1001 - FUNDAMENTALS OF BIG DATA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEAD1001	FUNDAMENTALS OF BIG DATA	FBD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of big data to grasp its significance in today's data-driven world, comprehending the challenges and opportunities associated with big data, and setting the stage for further exploration into big data infrastructure, data analysis, and ethical considerations in subsequent parts of the course.	2	
CO2	Apply knowledge of the underlying infrastructure and technologies enabling big data processing to effectively store, manage, and process large volumes of data using distributed file systems, Spark, and NoSQL databases, preparing for subsequent exploration into data analysis, machine learning, and ethical considerations in the context of big data.	3	
CO3	Apply data analysis and machine learning techniques for big data to preprocess, wrangle, and analyze large datasets, apply algorithms, and evaluate models, preparing to tackle challenges and leverage opportunities in big data analytics, paving the way for ethical and legal considerations in the final part of the course.	3	
CO4	Apply knowledge of ethical and legal considerations in big data analytics to navigate data privacy, security, bias, and intellectual property rights, making ethical decisions and ensuring responsible data usage in future careers, enhancing contribution to the evolving field of big data analytics.	3	

Syllabus

Introduction to Big Data Overview of Big Data: Definition, characteristics, and challenges. Evolution of Big Data: Historical context and the role of technology. Applications of Big Data: Industry examples and case studies. Data Sources and Types: Structured, unstructured, and semi-structured data. Introduction to Data Science: Key concepts, methodologies, and the data science lifecycle.

Big Data Infrastructure and Technologies Big Data Storage and Processing: Introduction to Hadoop, HDFS, and MapReduce. Distributed File Systems: Hadoop Distributed File System (HDFS) and its architecture. Introduction to Apache Spark: Resilient Distributed Datasets (RDDs) and Spark ecosystem. NoSQL Databases: Overview of non-relational databases (e.g., MongoDB, Cassandra). Data Streaming and Real-time Analytics: Introduction to Apache Kafka and stream processing frameworks.

Data Analysis and Machine Learning for Big Data Data Preprocessing and Wrangling: Techniques for data cleaning, transformation, and integration. Exploratory Data Analysis: Visualizing and summarizing large datasets. Big Data Analytics: Introduction to machine learning algorithms for big data. Feature Engineering and Selection: Techniques for extracting relevant features. Model Evaluation and Deployment: Performance metrics, cross-validation, and deployment considerations.

Ethical and Legal Considerations in Big Data Data Privacy and Security: Ethical considerations, privacy risks, and best practices. Bias and Fairness in Big Data: Understanding algorithmic bias and mitigating strategies. Regulatory Landscape: Overview of legal frameworks and privacy laws (e.g., GDPR). Intellectual Property Rights: Copyright, patents, and data ownership. Ethical Decision-Making: Ethical frameworks and guidelines for responsible data usage

Reference Books

- 1 Big Data: A Revolution That Will Transform How We Live, Work, and Think, Viktor Mayer-Schönberger and Kenneth Cukier, Reprint 1st edition (2013), Eamon Dolan/Mariner Books.
- 2 Big Data: A Very Short Introduction, Dawn E. Holmes, 1st Edition (2017), Oxford University Press.

- 3 Big Data: A Practical Guide for Data Scientists, Peter Bruce and Andrew Bruce, 1st Edition (2023), O'Reilly Media.

OEAD2006 - DATA SCIENCE AND VISUALIZATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEAD2006	DATA SCIENCE AND VISUALIZATION	DSV	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic terminology of Data Science and its application	2	
CO2	Apply various regression models on given data set and perform prediction	3	
CO3	Applying of Time series concepts and analysis of data using various time series models	3	
CO4	Apply & Analyze recent data science tools to solve recent problems on Different types of Data Using Python	4	

Syllabus

Artificial Intelligence (AI), Machine Learning (ML), and Data Science are interrelated fields that have revolutionized how we analyze data and make decisions. These disciplines use algorithms, statistical models, and computational techniques to extract insights from data, predict outcomes, and automate tasks.

Introduction to simple Linear Regression: The Regression Equation, Fitted value and Residuals, Least Square Introduction to Multiple Linear Regression: Assessing the Model, Cross-Validation, Model Selection and Stepwise Regression, Prediction Using Regression --Logistic Regression: Logistic Response function and logit, Logistic Regression and GLM, Generalized Linear model, Predicted values from Logistic Regression, Interpreting the coefficients and odds ratios, Linear and Logistic Regression: similarities and Differences, Assessing the models.

Overview of Time Series Analysis Box-Jenkins Methodology, ARIMA Model Autocorrelation Function (ACF), Autoregressive Models, Moving Average Models, ARMA and ARIMA Models, Building and Evaluating an ARIMA Model, Reasons to Choose and Cautions

These concepts and techniques are essential for effective data visualization and analysis: Visualization Errors: Avoiding common pitfalls that can mislead or confuse viewers. Simple Metrics for Data Analytics: Using basic statistical measures to summarize data. Data Types for Plotting: Selecting appropriate data types for various plots. Simple Line Plots: Displaying trends and patterns in continuous data. Scatter Plots: Analyzing relationships between two numerical variables. Density and Contour Plots: Visualizing data distributions and density in two dimensions. Together, these visualization tools and methods enable data scientists and analysts to present data clearly and accurately, facilitating better understanding and decision-making.

Reference Books

- 1 Visualizing Data, Fry, 2008, O'Reilly Media.
- 2 Visualization Analysis and Design, Munzner, 2008, CRC Press.
- 3 Data Visualization: A Practical Introduction, Kieran Healy, 2018, Princeton university press.

OEAD3011 - MEDICAL DATA ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEAD3011	MEDICAL DATA ANALYTICS	MDA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand Healthcare Management and Analytics	2	
CO2	Demonstrate Python program techniques for Healthcare Analytics	3	
CO3	Apply Artificial Intelligence in Healthcare data analysis	3	
CO4	Analyse Management in Healthcare data	4	

Syllabus

General Management in Healthcare: Introduction to Healthcare Management and Analytics, Public Health Management Challenges, Healthcare Policy, Health Management Information Systems, Healthcare Economics, Human Resource Management in Healthcare, Healthcare Financial Reporting

Healthcare Analytics: statistics and EDA with python , and Data Visualisation, Exploring Healthcare Analytics and Correlation Analysis, Predictive Analytics in Healthcare, Healthcare Optimisation Practice, Six Sigma in Healthcare, Demand Forecasting in Healthcare

AI and Digital Transformation in Healthcare: Introduction to Artificial Intelligence in Healthcare, Digital Patient Experience, Digital Transformation Strategy, Implementing Artificial Intelligence in Healthcare

Management in Healthcare: Supply Chain Management in Healthcare, Capacity Management in Healthcare, Lean Management, Process improvement, Service Excellence and Business Process Re-Engineering, Quality Measurement & Benchmarking in Healthcare, Project Management in Healthcare

Reference Books

- 1 Statistics for Healthcare Professionals: An Introduction, Ian Scott, 1st, Edition,2005, WILEY.
- 2 Data Science for Effective Healthcare Systems, HariSingh, 1st, Edition,2023, ebook.
- 3 Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Laura A. Kirkwood and Eugene Kolker, 1st, Edition,2016, ebook.

OEAG1001 - AGRICULTURE CROP PRODUCTION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEAG1001	AGRICULTURE CROP PRODUCTION	ACP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain fundamental principles of crop production, including classification and agroclimatic adaptation	2	PO1, PO6, PSO2
CO2	Apply knowledge of soil, water, nutrient, and weed management in crop cultivation	3	PO1, PO6, PSO2
CO3	Analyze modern methods in pest and disease management for increased yield and sustainability	4	PO1, PO6, PSO2
CO4	Evaluate different cropping systems and sustainable agricultural practices for various agro-ecosystems	5	PO1, PO6, PSO2

Syllabus

Fundamentals of Agronomy: Scope, seeds and sowing, tillage, crop density, basic crop nutrition, manures/fertilizers

Soil-Plant-Water Relationship: Irrigation methods, water use, soil properties, scheduling and quality of irrigation

Weed Management: Classification, crop-weed competition, principles and methods (cultural, mechanical, chemical, bio

Crop Growth and Development: Growth analysis, factors influencing crop growth, crop ideotypes, rotation principles

Crop Systems: Types (mono, multiple, sequential), adaptation to agro-climatic zones, intercropping

Harvesting and Post-harvest: Signs of maturity, methods of harvesting, storage and threshing of crops

Farm Management and Agricultural Extension: Farm planning, record-keeping, economics, and extension principles

Reference Books

- 1 Principles of Agronomy, Yellamanda Reddy, T., & Sankara Reddi, G.H. (2016), Latest, Kalyani Publishers.
- 2 Fundamentals of Agronomy, Gopal Chandra De, Latest, Oxford & IBH Publishing Pvt. Ltd..

OEAG2006 - INTRODUCTION TO HORTICULTURE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEAG2006	INTRODUCTION TO HORTICULTURE	ITH	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	To Understand the scope and importance of horticulture, divisions of horticulture, classification of horticultural crops, climate and soil requirements	2	
CO2	Understand the basics of the fruit and plantation crop industry	2	
CO3	Understanding the production practices of Tomato, Brinjal & Chilli, Okra & Leafy vegetables	2	
CO4	Understand the importance and scope of ornamental crops and landscaping	2	
CO5	To analyze uses of garden tools, Identification of horticultural crops, Preparation of seed bed/nursery bed, Practice of sexual and asexual methods of propagation, Layout and planting of orchard plants	4	

Syllabus

Horticulture-Its definition and branches, Importance and scope of horticulture, Horticultural and botanical classification, Climate and soil for horticultural crops, Plant propagation-methods (sexual & asexual), propagating structures; separation, division, grafting, budding, layering), High density planting; Use of rootstocks; Orchard establishment

Importance and scope of fruit and plantation crop industry in India, Production technologies for the cultivation of major fruits-Mango, Banana, Citrus, Grape, Guava, Litchi, Papaya, Apple, Pear, Peach, Minor fruits- Pineapple, Pomegranate, Jackfruit, Strawberry, Nut crops

Importance of vegetables spices in human nutrition and national economy, Tomato origin, area, production, improved varieties and cultivation practices such as time of sowing, sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting, storage, physiological disorders, disease and pest control and seed production

Importance and scope of ornamental crops and landscaping Landscape uses of trees, shrubs and climbers. Principles of landscaping

Reference Books

- 1 Handbook of Horticulture., 1. Chadha, K.L. 2001., 1, ICAR, New Delhi.
- 2 Fruits Tropical and Sub-tropical., Bose, T.K. and Mitra, S.K. 1990., 1, NayaPrakashan,.
- 3 Modern Technology in Vegetable Production, Pranab Hazra, A. Chattopadhyay, K. Karmakar and S. Dutta. 2010., 1, ICAR, New Delhi.

OEAR1001 - ARCHITECTURAL JOURNALISM (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEAR1001	ARCHITECTURAL JOURNALISM	AJ	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the terminologies related to Journalism, to understand architectural photography and articles, understanding differences between Journal, magazine, article, blog etc.	2	PO1, PO2, PO11
CO2	Understand ethics in journalism, law legal boundaries, public relations and impacts	2	PO1, PO2, PO11
CO3	Apply the writing skills, blogs, and books, reviewing an article and familiarizing oneself with pioneer architectural Journalists at Local, National, and international platforms.	3	PO1, PO2, PO11
CO4	Understand techniques of photojournalism, photojournalism in perspectives, and contemporary architectural journalism, and develop an article based on research	2	PO1, PO2, PO11

Syllabus

Definition of Photojournalism Brief History Photographs as social Documentaries Birth of modern Photojournalism since the 1950s visual awareness visual survey EDFAT methods in using the camera Equipment required for Photojournalism.

Usage of language and Vocabulary and grammar introduction to the methodology of writing essays, news writing, precis writing, writing in architectural blogs listening comprehension, analysing talks, and information gathered and editing gathered information to build an article. The originality of the topic. Collecting clippings from articles, blogs, and books.

PRODUCTION AND PRESENTATION LEGAL BOUNDARIES: Key texts concerning architectural journalism and journalists; to critically contrast their outputs in terms of production, content, and/or presentation; to develop an ability to critically appraise selected individual pieces of journalism. Awards for Architectural Journalism and some of the important recipients. People journalism and law legal boundaries-issues libel and invasions of privacy ethics- the photojournalist on scene

PRODUCTION OF CONTEMPORARY ARCHITECTURAL JOURNALISM Building pictures Instant, Report Editing Editorial thinking the picture Editor Editing practices, creating drama Photo editing Documentary evolution of the word document methods and techniques RESEARCH AND PRESENTATION: Assignments should include an article based on the ability to originate, plan, research, present, and produce a piece of architectural journalism. The techniques and processes used in the production should be identified by the student.

Reference Books

- 1 How to photograph buildings and interiors, 3rd ed. New York, Kopelow, Gerry., 2002, Princeton Architectural Press.
- 2 Architectural photography, De Mare, Eric Samuel, 1975, London: Batsford.
- 3 The photography of architecture: twelve views, Busch, Akiko, 1987, New York: Van Nostrand Reinhold Co..

OEBA1001 - INTERNATIONAL RELATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBA1001	INTERNATIONAL RELATIONS	IR	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept of International Relations	2	
CO2	Understand the role of International Organizations	2	
CO3	Understand the basic structure of Indian foreign policy	2	
CO4	Apply the factors determinants of Indian foreign policy. .	3	

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 Today, Aneek Chatterjee, 2nd Edition, 2018, Pearson Education.
- 2 International Relations, Vinay Kumar Malhotra, 5th Edition, 2016, SURJEET PUBLICATIONS.
- 3 International Organization: Theories and Institutions, J. Samuel Barkin, 3rd Edition, 2023, Palgrave Macmillan.

OEBA2006 - INTERNAL SECURITY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBA2006	INTERNAL SECURITY	IS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts related to Internal security.	2	PO1, PO4, PO8, PSO1
CO2	Understand the Indian security challenges and management in the country.	2	PO1, PO4, PO8, PSO1
CO3	Analyse the concepts of Organized Crimes, Indian Security Mandate.	4	PO1, PO4, PO8, PSO1
CO4	Analyse the issues of Money Laundering, Cyber Crimes, and Cyber Security in the society.	4	PO1, PO4, PO8, PSO1

Syllabus

Internal Security, External Security, Challenges and Threats on Indian Security (Internal), External Security Threats and Challenges, Communal Violence, The Polarity dominance depends Communal Violence.

Terrorism, Insurgency, The Rise of Insurgency in North East India, Left Wing Extremism, Maoist Modus Operandi, and Development and Spread of Extremism

Security Challenges in Indian Boarder Areas, Security Forces and its mandate: Dealing with External Threats, Organized Crimes, Types of Organized Crimes, Linkages Between Organized Crimes and Terrorism, Organized Crime and India

Money Laundering and Black Money, Cyber Crimes, Treats, & Cyber Security, Cyber Security, Types of Cyber Security, Legal frame work, International Cooperation, and Cyber Security, social media and Key Issues.

Reference Books

- 1 Challenges to Internal Security of India., Ashok Kumar IPS (2020), (5th Edition), MG Graw Grill Publication.
- 2 Internal security, pavneet singh, 5th edition, MG Graw Grill Publication.
- 3 Internal Security of India and Disaster Management, Sayed Waquar Raza (IPS), 4th, Oxford University press.

OEBA3011 - INTRODUCTION TO PUBLIC ADMINISTRATION (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBA3011	INTRODUCTION TO PUBLIC ADMINISTRATION	IPA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the basic concepts of Public Administration	2	PO7, PO8, PO10
CO2	Gain basic knowledge in the Principles of Administration and Public relations	2	PO7, PO8, PO9, PO10, PO11
CO3	Gain Knowledge in the concept of Governance	2	PO7, PO8, PO9, PO10, PO11
CO4	Acquire Knowledge in the Modern Public Administration.	2	PO7, PO8, PO9, PO11

Syllabus

Meaning, Nature, Scope and importance of Public Administration, Public Administration and Private Administration, Evolution of Public Administration and Politics and Administration Dichotomy Woodrow Wilson and F.J. Goodknow, Relation with other Social Sciences: Political Science, Economics, Sociology, Psychology Organization

Organization Meaning and forms of Organization Basis of Organization Hierarchy, Span of Control, Unity of Command, Co-ordination, Supervision, Communication, Centralization and Decentralization.

New Public Administration: Minnow Brook I and II, New Public Management, Public Policy, E-Governance and Good Governance

Public Administration in the Context of Liberalization, Globalization and Privatization, Administrative Reforms Commissions and Second ARC, Public Private Partnership

Reference Books

- 1 Public Administration: , : Awasthi & Maheshwari, Laximinarayan Agrawal, , 5, Agarwal Publication, New Delhi.
- 2 Modern Public Administration: , Felix Nigro & Lyod Nigro,, 6, Harper and Row Publication, New York..

OEBB1001 - FINANCE FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBB1001	FINANCE FOR ENGINEERS	FE	R	3	0	0	0	3

Course Outcomes

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

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.

OEBB1002M - FINANCIAL MATHEMATICS & RISK ANALYTICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBB1002M	FINANCIAL MATHEMATICS & RISK ANALYTICS	FMRA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

OEBB2006 - MARKETING FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBB2006	MARKETING FOR ENGINEERS	ME	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand marketing fundamentals and how they apply to technology and engineering sectors	2	PO1, PO8, PO10
CO2	Apply marketing mix strategies to engineering products and innovations	3	PO2, PO10
CO3	Conduct basic market research and interpret consumer behavior in technical fields	3	PO3, PO10
CO4	Develop product marketing strategies using data-driven and customer-centric approaches Analyze real-world engineering marketing cases and prepare basic go-to-market plans	4	PO4, PO10

Syllabus

Fundamentals of Marketing - Definition and importance of marketing in engineering context - Core concepts: Needs, wants, demand, value, satisfaction - Marketing vs Selling - Marketing environment and trends in technology markets - Product Life Cycle (PLC) in technical products

Marketing Mix and Technology Products - 4Ps: Product, Price, Place, Promotion - Product decisions for engineering innovations - Branding and packaging of industrial products - Pricing strategies for B2B and tech startups - Distribution channels in digital and traditional markets - Promotion tools (ATL/BTL), online marketing

Market Research and Consumer Behavior for Engineers - Introduction to market research and data collection methods - Technical product positioning and segmentation - B2B vs B2C behavior - Role of engineers in identifying customer needs - Design Thinking and User-Centered Product Design

Strategic Marketing & Case Studies in Engineering - Technology commercialization and go-to-market strategies - Product portfolio management and innovation diffusion - Digital marketing and analytics tools (Google Analytics, CRM) - Marketing plans and engineering project pitches - Case studies: Tesla, Apple, 3M, Indian Startups (Zoho, Byju's)

Reference Books

- 1 Marketing Management: A South Asian Perspective, Philip Kotler, Kevin Lane Keller, Abraham Koshy, Mithileshwar Jha, 15th Edition, Pearson Education India, 2022.
- 2 Marketing Management for Engineers, Prof. K. Rajagopal, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2019.
- 3 Techno-Marketing: Strategies for Engineers and Entrepreneurs, Dr. R. Srinivasan, 1st Edition, PHI Learning Pvt. Ltd., 2018.
- 4 Marketing Management, Philip Kotler & Kevin Lane Keller, 16th Global Edition, Pearson Education, 2022.
- 5 High-Tech Marketing: Concepts, Continuity, and Change, William L. Shanklin & John K. Ryans Jr., 3rd Edition, Free Press / Macmillan, 2017.

OEBB2007M - FOUNDATIONS OF FINANCIAL SYSTEMS & MARKETS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBB2007M	FOUNDATIONS OF FINANCIAL SYSTEMS & MARKETS	FFSM	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

OEBB3011M - ACCOUNTING, COMPLIANCE & FINANCIAL STATEMENT ANALYSIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBB3011M	ACCOUNTING, COMPLIANCE & FINANCIAL STATEMENT ANALYSIS	ACFSA	R	3	0	2	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO

OEBT1001 - IPR AND PATENT LAWS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBT1001	IPR AND PATENT LAWS	IPRPL	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the concepts of intellectual property rights to protect innovations and creative works in biotechnology and allied fields.	3	PO6, PO7
CO2	Demonstrate the procedure for filing patents, trademarks, and copyrights through appropriate legal and administrative channels.	3	PO6, PO7
CO3	Apply patent search and analysis tools to evaluate the novelty and patentability of research ideas or inventions.	3	PO6, PO7
CO4	Utilize knowledge of national and international IPR laws to develop strategies for technology transfer and commercialization.	3	PO6, PO7

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. Case Studies on Patents. Case Studies on - Patents (Basmati rice, turmeric, Neem, and related medicinal plants and byproducts)

Reference Books

- 1 Good manufacturing practices for Pharmaceuticals, , S. H. Willig, 2000, Informa Healthcare.
- 2 Industrial Property Rights: Vol. III-4, , Kogan Pate, 1998, Kogan Page.

OEBT1002 - ENVIRONMENTAL BIOTECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBT1002	ENVIRONMENTAL BIOTECHNOLOGY	EB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Illustrate environmental issues, focusing on pollution types, sources, effects, climate change, acid rain, biodiversity, and microbial ecology.	3	
CO2	Evaluate waste management strategies, focusing on waste characterization, treatment, composting, wastewater stages, bioreactors, recycling, and waste-to-energy processes.	4	
CO3	Apply bioremediation and phytoremediation strategies using microorganisms, plants, and PGPR to detoxify pollutants like metals, radionuclides, and xenobiotics.	3	
CO4	Explore biofuel production processes, focusing on biogas, bioethanol, biodiesel, microbial fuel cells, MEOR, bioleaching, bioplastics, and biotechnology applications.	3	

Syllabus

Introduction to the environment: Introduction to environment; Pollution types, sources, effects, Air-water, land, Noise, Thermal, Pesticide, Radioactive, greenhouse effect, ozone and its importance, global warming, Acid rain, Bio-accumulation, Bio-magnification. Biological control. Principles of Environment Impact. Climate change, Biodiversity and its conservation; biogeochemical cycles; microbial ecology.

Waste management: domestic, industrial, and hazardous wastes (Characterization i.e. COD, BOD, dissolved solids, color, chlorolignin etc, storage, transportation, treatment and disposal); solid waste management, Composting and vermicomposting. Wastewater characteristics, Primary, secondary and tertiary treatment of waste water, aerobic and anaerobic treatment;

Bioreactors for wastewater treatment, waste to energy, recycling, and reuse. Bioremediation: Fundamentals, technological aspects and strategies, bioremediation of metals, radionuclides, organic pollutants/xenobiotic; Application of bacteria and fungi in bioremediation; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration, phytostabilization). Symbiotic systems between plants, microorganisms

Plant growth promoting rhizobacteria (PGPR), uses, practical aspects and problems in application. Biofuels: production of biogas; bioethanol; biodiesel; Utilizable biomass, microorganisms and biotechnological interventions for optimization of production, Microbial Fuel Cells, Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Bioplastic.

Reference Books

- 1 Environmental Biotechnology , Alan Scragg, 2005, Oxford University Press,.
- 2 Industrial Microbiology, Prescott & Dunn, 2004, CBS Publishers.

OEBT2006 - COMPUTER AIDED DRUG DESIGN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBT2006	COMPUTER AIDED DRUG DESIGN	CADD	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply computational methods to analyze molecular structures and predict drug target interactions.	3	
CO2	Utilize molecular docking and molecular dynamics simulations to design potential drug candidates.	3	
CO3	Apply QSAR, pharmacophore modeling, and virtual screening approaches in drug discovery.	3	
CO4	Apply bioinformatics tools to analyze protein targets, ligand libraries, and binding sites.	3	

Syllabus

Introduction to Computer Aided Drug Design: Overview of drug discovery and development process, Role of CADD in modern pharmaceutical research ,Software tools and databases (PubChem, ChEMBL, PDB), Application: Identifying potential drug targets and ligands using databases

Molecular Modeling and Visualization: Molecular structures: 2D and 3D representations, Energy minimization and molecular mechanics ,Visualization tools: PyMOL, Chimera, and Maestro, Application: Preparing and analyzing protein-ligand structures

Quantitative Structure Activity Relationship (QSAR) ,Pharmacophore modeling, Similarity and substructure searches, Application: Designing and predicting activity of new ligands using QSAR

Structure-Based Drug Design: Protein-ligand docking principles ,Molecular dynamics simulations, Binding site analysis and scoring functions ,Application: Performing docking studies to predict binding affinity

Reference Books

- 1 Introduction to Computational Chemistry, Frank Jensen, 3rd Edition, Wiley, 2017.
- 2 Molecular Docking: Principles, Methods and Applications, Rajender S. Varma, David R. F. Carter, 1st Edition, Wiley, 2015.

OEBT2007 - BIOMATERIALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBT2007	BIOMATERIALS	BM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply knowledge of materials science to classify and select biomaterials for specific medical applications.	3	PO1
CO2	Apply mechanical, chemical, and thermal principles to evaluate biomaterial properties.	3	PO1
CO3	Utilize surface modification techniques to improve material tissue interactions.	3	PO1
CO4	Apply biocompatibility testing methods to assess host response to biomaterials.	3	PO1

Syllabus

Introduction to Biomaterials: Definition, classification, and scope , Historical development and current applications, Requirements for biomaterials in the human body , Application: Selecting biomaterials for orthopedic and cardiovascular implants

Metallic Biomaterials: Stainless steel, titanium, cobalt-chromium alloys, Mechanical properties and corrosion resistance, Application: Evaluating metals for load-bearing implants

Polymeric Biomaterials: Biodegradable and non-biodegradable polymers, Properties, processing, and applications, Application: Designing polymeric scaffolds for tissue engineering

Ceramic and Composite Biomaterials: Bioinert and bioactive ceramics, Composites for orthopedic and dental applications, Application: Selecting ceramic materials for bone replacement

Reference Books

- 1 An Introduction to Biomaterials, Jeffrey O. Hollinger, Thomas A. Einhorn, 2nd Edition, CRC Press, 2011.
- 2 Tissue Engineering, Bernhard O. Palsson, Sangeeta N. Bhatia, 1st Edition, Pearson Education, 2004.

OEBT3011 - BIOLOGY FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEBT3011	BIOLOGY FOR ENGINEERS	BE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Relate and understand the basics of biology	2	
CO2	List and summarise the systems of life	2	
CO3	Recognise and understand the importance of diet and nutrition	2	
CO4	Describe and categorise the microorganisms and their applications	2	

Syllabus

BASIC BIOLOGY: Introduction, Living organisms: prokaryotes, eukaryotes, cell structure, and organelle, Human anatomy

Systems of Life: Digestion, Respiration, Circulation, Excretion, Reproduction, Thinking and coordination and defence

Diet and Nutrition: Macro (Carbohydrates, proteins, lipids) and Micronutrients (vitamins), Essential minerals and their role; Deficiency symptoms; and their role; Deficiency symptoms.

Microorganisms Classification of Microorganisms, beneficial and harmful effects of Bacteria, Fungi and Viruses
Biosensors, Applications of Biosensor in Food and Agriculture.

Reference Books

- 1 Biology for Engineers, G. K. Suraishkumar, First edition, 2019, Oxford University Press;.
- 2 Biochemistry, David Hames & Nigel Hooper, Third Edition, Taylor & Francis Group.

OECE1001 - SOLID AND HAZARDOUS WASTE MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE1001	SOLID AND HAZARDOUS WASTE MANAGEMENT	SHWM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Outline the sources, composition, handling, and storage of municipal, industrial, and hazardous wastes.	2	PO1, PO2, PSO1
CO2	Explain the process of collection, transport, and separation of municipal and hazardous solid wastes.	2	PO1, PO2, PSO1
CO3	Assess various techniques for treatment, disposal, and resource recovery from solid and hazardous wastes.	2	PO1, PO2, PSO1
CO4	Design landfill facilities, energy recovery systems, and leachate management solutions for waste handling.	2	PO1, PO2, PSO1

Syllabus

Introduction to Solid and Hazardous Waste: Types, sources, composition, generation, and storage methods

Collection, Transportation, and Handling: Systems for municipal, industrial, and hazardous wastes

Waste Treatment Technologies: Physical, chemical, biological, thermal treatment and stabilization

Disposal and Landfilling: Design and operation of landfills, site selection, environmental considerations

Reference Books

- 1 Integrated Solid Waste Management: Engineering Principles and Management Issues, G., Theisen, H., & Vigil, , Latest, McGraw-Hill Education.

OECE1002 - ENVIRONMENTAL POLLUTION CONTROL METHODS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE1002	ENVIRONMENTAL POLLUTION CONTROL METHODS	EPCM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the fundamental concepts and principles relevant to the course subject	2	PO1, PO7, PSO1
CO2	Understanding the theoretical knowledge to practical and problem-solving scenarios	2	PO1, PO7, PSO1
CO3	Understanding the, processes, or case studies to draw meaningful conclusions	2	PO1, PO7, PSO1
CO4	Understanding the methods, systems, or solutions for effectiveness and efficiency	2	PO1, PO7, PSO1

Syllabus

Introduction: Basics, scope, and importance of the subject

Core Concepts: Fundamental theories, classifications, and processes

Techniques and Methodologies: Practical methods, tools, and strategies

Application Areas: Case studies, real-world applications, and contemporary practices

Reference Books

- 1 Environmental Pollution Control Engineering, C.S. Rao, Latest, New Age International Publishers.

OECE1003 - INDUSTRIAL WASTE WATER TREATMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE1003	INDUSTRIAL WASTE WATER TREATMENT	IWWT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the sources, types, and characteristics of industrial wastewater	2	PO1, PO2, PSO1
CO2	Describe various physical, chemical, and biological treatment methods used in industrial wastewater treatment	2	PO1, PO2, PSO1
CO3	understanding appropriate treatment techniques to design and optimize wastewater treatment systems	2	PO1, PO2, PSO1
CO4	understanding the effectiveness of different treatment processes through data interpretation and case studies	2	PO1, PO2, PSO1

Syllabus

Introduction to Industrial Waste Water: Sources, types, characteristics, and impact on environment

Physical Treatment Methods: Screening, sedimentation, flotation, filtration

Chemical Treatment Methods: Coagulation and flocculation, chemical oxidation and reduction processes

Biological Treatment Methods: Activated sludge process, trickling filters, bio-towers, anaerobic digestion

Reference Books

- 1 Industrial Water Pollution Control, Eckenfelder, latest, McGraw Hill.

OECE2006 - REMOTE SENSING & GIS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE2006	REMOTE SENSING & GIS	RSGIS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop basic knowledge of Remote Sensing and its diverse applications	2	PO1, PO2, PSO1
CO2	Gain understanding of GIS concepts and its applications	2	PO1, PO2, PSO1
CO3	Understand map-making techniques and cartography	2	PO1, PO2, PSO1
CO4	Understand digitization, data editing, and spatial data structuring	2	PO1, PO2, PSO1

Syllabus

Introduction to Remote Sensing: Principles, history, and types of remote sensing systems

Electromagnetic Spectrum and Radiation: Interaction with atmosphere and earth surfaces

Remote Sensing Sensors and Platforms: Types of sensors, satellite and aerial platforms

Image Processing Techniques: Image classification, enhancement, and interpretation

Reference Books

- 1 Remote Sensing and Image Interpretation, Lillesand, Latest, Wiley sons.

OECE2007 - DISASTER MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE2007	DISASTER MANAGEMENT	DM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of disaster management, types of disasters, and their consequences	2	PO1, PO2, PSO1
CO2	Describe emergency planning and preparedness for various disaster scenarios	2	PO1, PO2, PSO1
CO3	Understand causes, impacts, and mitigation strategies of natural and man-made disasters	2	PO1, PO2, PSO1
CO4	Understand disaster response mechanisms, rehabilitation, and recovery processes	2	PO1, PO2, PSO1

Syllabus

Introduction to Disaster Management: Concepts, types, and significance

Natural Disasters: Earthquakes, floods, cyclones, droughts

Man-made Disasters: Industrial accidents, chemical spills, nuclear hazards

Disaster Risk Reduction: Vulnerability assessment, hazard mapping, mitigation strategies

Reference Books

- 1 Disaster Administration and Management, Goel, Latest, Deep & Deep Publishers.

OECE2008 - WATER MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE2008	WATER MANAGEMENT	WM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the planning and management of water resources	2	PO1, PO2, PSO1
CO2	Understand water resource potential in global and Indian scenarios	2	PO1, PO2, PSO1
CO3	Explain hydrological cycle components and precipitation measurement techniques	2	PO1, PO2, PSO1
CO4	Understand various methods for stream flow measurement, flood analysis, and groundwater hydrology	2	PO1, PO2, PSO1

Syllabus

Water Resources Planning: Multi-dimensional resource management, global and Indian scenario

Precipitation Analysis: Measurement techniques and variability

Stream Flow and Flood Analysis: Measurement, hydrograph analysis, flood frequency and routing

Groundwater Hydrology: Aquifer characteristics, Darcy's law, pumping tests

Irrigation Systems: Methods, canal design, irrigation efficiency

Reference Books

- 1 Engineering Hydrology, K. Subramanya, Latest, Tata MC GRILL.

OECE2009 - TRANSPORTATION SYSTEM MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE2009	TRANSPORTATION SYSTEM MANAGEMENT	TSM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concept, scope, and importance of transportation systems and their role in urban and regional development.	2	PO1, PO10, PSO1
CO2	Understand traffic situations using fundamental concepts such as demand, capacity, level of service, and queuing theory.	2	PO1, PO10, PSO1
CO3	Understand tools and methods for transportation planning, traffic data collection, and interpretation to support decision making.	2	PO1, PO10, PSO1
CO4	Model and simulate transportation systems, including signal timing, corridor management, and safety considerations.	4	PO1, PO10, PSO1

Syllabus

Transportation planning fundamentals: planning levels, growth trends, and linkages to land use.

Transportation systems: characteristics of modes (road, rail, transit), their planning and operation.

Travel demand forecasting: surveys, OD studies, trip generation, trip distribution, mode choice, and forecasting methods.

Planning methodologies and systems analysis: demand-capacity analysis, traffic assignment, and evaluation techniques.

Reference Books

- 1 Traffic Engineering and Transportation Planning, Michael P. Abdel-Aty, Latest, Michael P. Abdel-Aty publication.

OECE3011 - CONSTRUCTION MANAGEMENT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE3011	CONSTRUCTION MANAGEMENT	CM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Plan and develop project organization for executing construction projects	2	PO1, PO2, PSO1
CO2	Prepare work breakdown structure and estimate resource requirements	2	PO1, PO2, PSO1
CO3	Use techniques for project planning, scheduling, and control	2	PO1, PO2, PSO1
CO4	understanding project progress and implement monitoring and control measures	2	PO1, PO2, PSO1

Syllabus

Introduction to Construction Management: Project phases, stakeholders, and organizational structure

Construction Planning: Work breakdown structure, scheduling techniques (CPM, PERT, Line of Balance)

Project Monitoring and Control: Time-cost trade-off, earned value analysis, progress reporting

Resource Management: Allocation, leveling, and optimization of resources

Reference Books

- 1 Construction Project Scheduling and Control, Saleh A. Mubarak, latest, JohnWiley.

OECE3012 - GREEN BUILDING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE3012	GREEN BUILDING	GB	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Describe the concepts of green building and sustainable design	2	PO1, PO10, PSO1
CO2	Comprehend properties of green building materials and their contribution to sustainable construction	2	PO1, PO10, PSO1
CO3	Understand the principles of energy efficiency, water conservation, and waste management in green buildings	2	PO1, PO10, PSO1
CO4	Understand the green building rating systems like LEED, USGBC, and TERI-GRIHA	2	PO1, PO10, PSO1

Syllabus

Introduction to Green Buildings: Concepts, need, and benefits

Green Building Materials: Sustainable materials, properties, and applications

Energy Efficiency: Solar energy basics, energy-efficient systems, HVAC, and lighting

Water Conservation: Rainwater harvesting, water recycling, and efficient fixtures

Reference Books

- 1 Sustainable Construction: Green Building Design and Delivery, Kiber , latest, wiley.

OECE3013 - BUILDING MATERIALS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE3013	BUILDING MATERIALS	BM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand and classify various building materials such as stones, bricks, cement, and timber	2	PO1, PO2, PSO1
CO2	Demonstrate properties and tests of cement, aggregates, and other construction materials	2	PO1, PO2, PSO1
CO3	Explain manufacturing processes and quality control of concrete and other materials	2	PO1, PO2, PSO1
CO4	Discuss the types, properties, and applications of miscellaneous building materials like paints, varnishes, and flooring	2	PO1, PO2, PSO1

Syllabus

Introduction to Building Materials: Classification and general properties

Stones and Bricks: Types, properties, manufacturing processes, and applications

Cement and Concrete Materials: Types, properties, testing, and quality control

Aggregates: Classification, characteristics, testing, and grading

Reference Books

- 1 Building Materials, Varghese, latest, prentice hall of india.

OECE3014 - TRAFFIC AND ROAD SAFETY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE3014	TRAFFIC AND ROAD SAFETY	TRS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamentals of traffic engineering and road safety, including the road safety problem, data types, and safety measures.	2	PO1, PO10, PSO1
CO2	Understand traffic flow characteristics and perform basic traffic data collection and interpretation.	2	PO1, PO10, PSO1
CO3	Design and evaluate safe road elements (alignments, sight distance, intersections, pedestrian facilities) and apply road safety principles.v	4	PO1, PO10, PSO1
CO4	Conduct road safety audits, identify safety issues, and propose mitigations.	4	PO1, PO10, PSO1

Syllabus

Scope and objectives of traffic engineering

Traffic volume studies, speed studies, and travel time studies

Road Safety and Accident Prevention

Road Safety Policies and Education

Reference Books

- 1 Traffic Engineering and Transport Planning, Kadiyali, L.R., LATEST, KHANNA.

OECE3015 - EXPLORING OUR RESPONSES TO CLIMATE CHANGE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE3015	EXPLORING OUR RESPONSES TO CLIMATE CHANGE	ERCC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the scientific basis and evidence of climate change, including greenhouse gas effects and global temperature trends.	2	PO1, PO10, PSO1
CO2	Identify the major environmental, economic, and social impacts of climate change at global, national, and local levels.	2	PO1, PO10, PSO1
CO3	Evaluate the effectiveness of technological, behavioral, and policy responses for reducing carbon emissions and enhancing sustainability	2	PO1, PO10, PSO1
CO4	Understand international frameworks and national policies	2	PO1, PO10, PSO1

Syllabus

Climate System and Evidence of Change

Impacts of Climate Change

Mitigation and Adaptation Strategies

Global and National Policy Frameworks

Reference Books

- 1 The Science and Politics of Global Climate Change: A Guide to the Debate, Andrew Dessler & Edward A. Parson (2020), LATEST, Cambridge University Press.

OECE3016 - GEOGRAPHIC INFORMATION SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE3016	GEOGRAPHIC INFORMATION SYSTEMS	GIS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts, components, and data models of GIS	2	PO1, PO2, PSO1
CO2	Identify and utilize different types of spatial data, coordinate systems, and map projections	2	PO1, PO2, PSO1
CO3	Analyze spatial data using GIS tools for thematic mapping, overlay, buffering, and spatial queryinG	2	PO1, PO2, PSO1
CO4	Evaluate the suitability and accuracy of spatial datasets for various applications	2	PO1, PO2, PSO1

Syllabus

Introduction to GIS and Spatial Concepts

Spatial Data Models and Data Input

Spatial Database Management and Query

Spatial Analysis and Modeling

Reference Books

- 1 Introduction to Geographic Information Systems, Chang, K.T. (2019), LATEST, McGraw-Hill Education.

OECI1001 - FUNDAMENTALS OF SOFTWARE ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECI1001	FUNDAMENTALS OF SOFTWARE ENGINEERING	FSE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Comprehend software development life cycle and prepare SRS document	2	
CO2	Implementing software design and development techniques using UML	3	
CO3	Identify verification and validation methods in a software engineering project	3	
CO4	Optimize the development process using CMMI Levels	3	

Syllabus

Software and Software Engineering: Nature of software, software application domains, unique nature of web applications, softwareengineering,software 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. Agile development: Agility, agile process,extreme programming

Design issues:Software architecture, architectural styles, architectural design. Use cases, Classes, Relationships,common Mechanisms and their diagrams. Interfaces, modellingtechniques for Class and Object Diagrams. Behavioural Modelling: Interactiondiagrams. Activity Diagrams

Software testing: A strategic approach to softwaretesting, strategic issues, test strategies for conventionalsoftware, Black-Box and White-Box testing, validation testing, system testing. Recovery testing, securitytesting, stress testing System testing-performance, deployment testing

Software Process Improvement, SPI, The SPI process, SPI Process of Assessment andgraph analysisEducation and training, selection and justification of SPI, Installation/Migration and evaluation of SPI Process, Risk management of SPI andcriticalsuccess factors, The CMMI

Reference Books

- 1 Software Engineering A Practitioners Approach, Roger S. Pressman and Bruce R. Maxim, 9th Edition (2019), McGraw-Hill Education.
- 2 Fundamentals of Software Engineering, Rajib Mall, 5th Edition, PHI Learning Pvt. Ltd.
- 3 Software Engineering: Theory and Practice, Shari Lawrence Pfleeger and Joanne M. Atlee, 4th Edition (2010), Pearson Education.
- 4 Software Engineering, Ian Sommerville, 10th Edition (2015), Pearson Education Limited.
- 5 Object-Oriented Software Engineering: Practical Software Development using UML and Java, Timothy C. Lethbridge and Robert Laganiere, 2nd Edition (2004), McGraw-Hill Education.

OECI2006 - FOUNDATIONS OF INFORMATION SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECI2006	FOUNDATIONS OF INFORMATION SYSTEMS	FIS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basics of Operating Systems and managing its resources.	2	
CO2	Apply the IS tools using MS Excel and Access for basic data management in organizations	3	
CO3	Identify the effectiveness of the decision-making process and apply the same using various tools	3	
CO4	Analyze various parameters for MIS application, for data analysis uses.	4	

Syllabus

Operating Systems - An Overview- Managing System Resources-Managing CPU Processes-Managing Input/Output Processes-Memory Management-Operating System as a User Interface-Functions of User Interfaces-Types of User Interfaces-Types of Operating Systems-UNIX, MS-DOS, Mac OS, Microsoft Windows, Novell NetWare, Linux

An Overview of Information- Classification of Information-Basic Classification -Based on Nature-Based on Usage-Based on Application-Based on Structure-Based on Form- Presentation of Information-Methods of Data Collection-Transmission of Information-Summarization and Message Routing-Information Discretion-Benefits of Information-Quality of Information-Errors-Bias-Basics of Information Systems-Functions of Information Systems-Components of Information Systems-Use of Information Systems in Business-Limitations of Information Systems-Information System Design.

Internet-The World Wide Web-Intranet-Advantages of Intranet-Disadvantages of Intranet-Extranet- Enterprise Collaboration Systems and Groupware-Groupware-Types of Groupware-Enterprise Communication Tools-Enterprise Conferencing Tools-Collaborative Work Management Tools.

Information Systems for Business Operations-Transaction Processing Systems-Data Entry-Transaction Processing-Database Updating-Report Generation-Inquiry Processing-Functional Information Systems Marketing Information Systems-Manufacturing Information Systems-Human Resource Information Systems-Accounting Information Systems-Financial Information Systems-Management Information Systems-Evolution of MIS-Characteristics of MIS-Functions of MIS-Importance of MIS-Management Reporting Systems-Decision Support Systems-Characteristics of a DSS-Types of DSS-Applications of DSS Geographic Information Systems (GIS).

Reference Books

- 1 Analysis and Design of Information Systems , James & Senn , 2, MCGRAW-Hill Edu .
- 2 System Analysis and Design , Preeti Gupta , 2, Firewall Media, 2008 .
- 3 Microsoft Office System Plain & Simple, Marianne Moon, Jerry Joyce, 4, MCGRAW-Hill Edu .
- 4 Information Systems for Business Operations , Michael Price, 1, MCGRAW-Hill Edu.
- 5 MIS: Managing Information Systems in Business , Rahul D, 3, Wiley .

OECI3011 - FUNDAMENTALS OF SOFTWARE TESTING METHODOLOGIES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECI3011	FUNDAMENTALS OF SOFTWARE TESTING METHODOLOGIES	FSTM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamentals, objectives, and process of software testing and quality assurance.	2	
CO2	Apply different testing methodologies and techniques for verification and validation of software systems.	3	
CO3	Design effective test cases using black box and white box testing approaches.	3	
CO4	Analyze test results, measure testing effectiveness using test metrics, and suggest improvements.	4	

Syllabus

Introduction to Software Quality and Testing, Objectives and Principles of Testing, Software Development Life Cycle (SDLC) and Testing Life Cycle (STLC), Verification vs. Validation, Types of Testing: Manual and Automated, Role of Testing in Software Quality Assurance

Static Testing and Dynamic Testing, Unit Testing, Integration Testing, System Testing, Acceptance Testing Regression Testing and Re-Testing, Alpha and Beta Testing, Agile and Model-Based Testing, Test Planning, Test Strategy, and Test Policy

Test Case Design and Documentation, Equivalence Partitioning, Boundary Value Analysis, Decision Table Testing, State Transition Testing, White Box Testing: Statement, Branch, and Path Coverage, Test Data Generation and Test Execution

Test Measurement and Metrics: Defect Density, Test Effectiveness, Test Efficiency, Test Management Tools (JIRA, TestLink overview), Automation Tools: Selenium, QTP, LoadRunner (introductory concepts), Continuous Testing in DevOps, Test Reporting, Reviews, and Continuous Improvement

Reference Books

- 1 Foundations of Software Testing: ISTQB Certification, Rex Black, Erik van Veenendaal, Dorothy Graham, 3rd Edition, Cengage Learning.
- 2 Software Testing: Principles and Practices, Naresh Chauhan, 2nd Edition, Oxford University Press.
- 3 Software Testing: A Craftsman's Approach, Paul C. Jorgensen, 4th Edition, CRC Press.

OECM1001 - ACCOUNTING FOR ENGINEERS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECM1001	ACCOUNTING FOR ENGINEERS	AE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

OECM2006 - COST ACCOUNTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECM2006	COST ACCOUNTING	CA	R	3	0	0	0	3

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	
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	
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	
CO4	Apply the Job costing and contract costing. Various Types of Standards - Installation of Standard Costing System for Material, Labour and Overhead	3	

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:

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.

OECS1001 - FUNDAMENTALS OF DBMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECS1001	FUNDAMENTALS OF DBMS	FDBMS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

OECS1002 - SUSTAINABILITY AND ENVIRONMENTAL AWARENESS IN THE DIGITAL ERA (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECS1002	SUSTAINABILITY AND ENVIRONMENTAL AWARENESS IN THE DIGITAL ERA	SEADE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Define key concepts such as digitalization, sustainable development, and digital sustainability	1	
CO2	Analyze the environmental impacts of digital technology, including energy consumption, e-waste, and carbon footprint.	4	
CO3	Evaluate how digital tools like AI, IoT, and cloud computing can be leveraged for environmental monitoring, conservation, and resource management.	5	
CO4	Examine the policy frameworks and ethical considerations surrounding digital technology and the environment.	4	

Syllabus

Introduction to the course and the relationship between digital transformation and environmental sustainability. Defining sustainability in the digital era, the concept of digital sustainability, and examining technology as both a problem and a solution for environmental challenges.

A deep dive into the negative environmental consequences of the digital world. E-waste The lifecycle of electronic devices, from raw material extraction to disposal. Digital carbon footprint The energy consumption of data centers, networks, and personal devices. Cloud computing The hidden environmental costs of the cloud. Internet of Things (IoT) The environmental implications of mass produced sensors and devices.

Digital tools for a sustainable future Overview Exploring the ways technology can be used to accelerate progress toward environmental goals. Smart grids Using digital technology for more efficient energy management. Precision agriculture Optimizing resource use through IoT and AI. Environmental informatics Using data analysis and modeling to monitor and manage environmental systems. Citizen science How digital platforms and mobile apps enable public participation in environmental monitoring. Sustainable business practices How companies use technology for sustainability reporting and supply chain management.

Digital citizenship and behavior change Overview How digital literacy and responsible online behavior can drive environmental awareness and action. Eco conscious digital practices Actions individuals can take to reduce their digital footprint. Online activism Using social media and digital campaigns for environmental advocacy. Gamification Applying game design principles to promote sustainable habits. Environmental communication Using digital storytelling and visualization to raise awareness.

Reference Books

- 1 Handbook of Technological Sustainability: Innovation and Environmental Awareness, Pankaj Bhambri and Paula Bajdor, 1, CRC press.

OECS2006 - FUNDAMENTALS OF CYBER SECURITY AND CLOUD COMPUTING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECS2006	FUNDAMENTALS OF CYBER SECURITY AND CLOUD COMPUTING	FCSCC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

OECS2007 - DESIGNING RESILIENT AND SUSTAINABLE URBAN SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECS2007	DESIGNING RESILIENT AND SUSTAINABLE URBAN SYSTEMS	DRSUS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Foundations of urban sustainability and resilience.	1	
CO2	Climate risk and vulnerability assessment	5	
CO3	Resilient and sustainable infrastructure	6	
CO4	Governance, policy, and practice	4	

Syllabus

The urban opportunity and challenges An introduction to global urbanization trends and their impact. Defining urban resilience Moving from bouncing back to bouncing forward in the face of shocks and stresses. Dimensions of sustainability Exploring the environmental social and economic pillars in an urban context. The urban metabolism Analyzing the flows of energy, water, and resources within cities.

Climate threats to urban systems Understanding risks like heatwaves, flooding, sea-level rise, and other extreme events. Vulnerability mapping Using geospatial tools GIS to identify high risk urban areas and assets. Social vulnerability Investigating how socioeconomic factors (poverty, inequality) affect a community's capacity to adapt.

Water systems: Designing for water resilience, including stormwater management, permeable surfaces, and water retention strategies. Sustainable energy and transport: Planning for renewable energy systems and resilient transport networks. Green and blue infrastructure: Incorporating natural systems to provide multiple benefits, such as flood control and biodiversity. Building resilience: Exploring sustainable design and construction practices for the built environment.

Urban policy and governance: Examining institutional frameworks for disaster risk reduction and climate resilience. Financing resilient urban development: Exploring financial options, public- Community engagement and social resilience: The role of citizens and grassroots initiatives in building resilient communities. Case studies and final project: Applying learned concepts to a real-world urban challenge, with presentations of resilient and sustainable design proposals.

Reference Books

- 1 the sustainable urban design handbook, Nico larco and kaarin knudson, 1, Routledge.

OECS3011 - FUNDAMENTALS OF INFORMATION TECHNOLOGY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECS3011	FUNDAMENTALS OF INFORMATION TECHNOLOGY	FIT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand basic concepts and terminology of information technology	2	
CO2	Have a basic understanding of personal computers and their operations.	2	
CO3	apply software programming	3	
CO4	understand communication types	2	

Syllabus

Introduction, Definition, .Characteristics of computer, Evolution of Computer, Block Diagram Of a computer, Generations of Computer, Classification Of Computers, Applications of Computer, Capabilities and limitations of computer Role of I/O devices in a computer system. Input Units: Keyboard, Terminals and its types. Pointing Devices, Scanners and its types, Voice Recognition Systems, Vision Input System, Touch Screen, Output Units: Monitors and its types. Printers: Impact Printers and its types. Non Impact Printers and its types, Plotters, types of plotters, Sound cards, Speakers.

Primary Vs Secondary Storage, Data storage & retrieval methods. Primary Storage: RAM ROM, PROM, EPROM, EEPROM. Secondary Storage: Magnetic Tapes, Magnetic Disks. Cartridge tape, hard disks, Floppy disks Optical Disks, Compact Disks, Zip Drive, Flash Drives.

Software and its needs, Types of S/W. System Software: Operating System, Utility Programs Programming Language: Machine Language, Assembly Language, High Level Language their advantages & disadvantages. Application S/W and its types: Word Processing, Spread Sheets Presentation, Graphics, DBMS s/w

Communication Process, Data Transmission speed, Communication Types (modes), Data Transmission Medias, Modem and its working, characteristics, Types of Networks, LAN Topologies, Computer Protocols, Concepts relating to networking.

Reference Books

- 1 Computer Fundamentals by P.K.Sinha, pk sinha, 6, hampton.

OECS3012 - ENVIRONMENTAL IMPACTS OF THE DIGITAL LIFESTYLE (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECS3012	ENVIRONMENTAL IMPACTS OF THE DIGITAL LIFESTYLE	EIDL	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Identify and analyze the direct, indirect, and systemic environmental impacts of digital technologies.	2	
CO2	Quantify the carbon footprint of ICT systems and digital behaviors	3	
CO3	Explain the concepts of circular economy and digital sobriety as they relate to consumer technology and data consumption	2	
CO4	Evaluate and compare the ecological costs and benefits of various digital practices, such as cloud computing, streaming, and teleworking	5	

Syllabus

The hidden costs of the digital age Topic 1: Introduction to digital environmentalism Why a virtual life still has a physical footprint. The history of the green IT movement. Topic 2: Life-cycle of digital devices: Exploration of the resource-intensive process of manufacturing smartphones, laptops, and other consumer electronics. The issue of planned obsolescence. Topic 3: Raw materials and extraction: The environmental and social impacts of mining rare-earth metals and other critical components for ICT. Topic 4: E-waste: The digital landfill: Understanding the growing problem of electronic waste, its toxic components, and formal vs. informal recycling practices

Energy, data, and the carbon footprint The energy demands of the internet Analysis of energy consumption by data centers, telecommunications networks, and end-user devices. The cloud is not a cloud The reality of massive data server farms, their energy and water consumption, and the use of AI and machine learning. The digital diet Examining the ecological impact of data heavy online activities, such as video streaming, online gaming, and excessive data storage. Case study Cryptocurrency Exploring the extreme energy consumption and carbon emissions associated with blockchain technologies like Bitcoin.

Rebound effects of digital efficiency Investigating how efficiency gains from digital solutions can be offset or outweighed by increased overall consumption and demand. The dark side of smart cities Critically evaluating the sustainability promises of smart technology, including potential issues with e-waste management and energy grids. Connectivity and climate action The dual role of digital technology as both an environmental problem and a potential tool for monitoring climate and promoting sustainability. The psychology of digital consumption Discussion of digital habits and consumer behaviors that contribute to the environmental impact, including social media use and instant gratification

Principles of green computing Learning about strategies for designing, manufacturing, and using IT equipment to minimize environmental harm. The circular digital economy Exploring approaches for extending the lifespan of devices, improving recycling, and fostering new business models for reuse and refurbishment. Digital sobriety and responsible practices Developing individual strategies for reducing one's digital footprint through data cleanup, mindful online habits, and conscious consumption. Policy and regulation Analysis of existing standards, eco labels, and policy interventions aimed at improving digital sustainability.

Reference Books

- 1 E-Waste Management: Challenges and Opportunities in India, Edited By Srijan Goswami, Moharana Choudhury, Sangita Agarwal, 1, crc press.

OEEC1001 - IMAGE PROCESSING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC1001	IMAGE PROCESSING	IP	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of a digital image processing system and transformation techniques	2	PO1, PO2
CO2	Understand image enhancement techniques in spatial and frequency domains.	2	PO1, PO2
CO3	Apply image restoration and compression techniques	3	PO1, PO2
CO4	Apply image segmentation, representations, and description	3	PO1, PO2

Syllabus

INTRODUCTION Origin of Digital Image Processing, Fields that uses Digital Image Processing, Fundamental steps in Digital Image Processing, Components of an Image Processing System. **DIGITAL IMAGE FUNDAMENTALS:** Elements of Visual perception, Image sampling and Quantization, Basic relationships between Pixels, Linear and Non-linear operations. **IMAGE TRANSFORMS** The Discrete Fourier Transform, The FFT, Walsh, Hadamard, Discrete Cosine Transform, The Haar Transform, and Slant Transform.

IMAGE ENHANCEMENT IN SPATIAL DOMAIN Some basic Gray transformations, histogram processing, enhancement using Arithmetic Logic operations, Smoothing Spatial Filters, Sharpening Spatial Filters. **IMAGE ENHANCEMENT IN FREQUENCY DOMAIN** Introduction on Fourier Transform and the Frequency Domain, Smoothing Frequency Domain Filters, Sharpening Frequency Domain Filters.

IMAGE RESTORATION Noise models, Restoration in the presence of Noise, only Spatial Filtering, Periodic Noise reduction by Frequency Domain Filtering, Linear, Position Invariant Degradation, Inverse Filtering, Wiener Filtering, least mean square Filtering. **IMAGE COMPRESSION** Fundamentals Image Compression models Error-Free Compression, Lossy Compression.

IMAGE SEGMENTATION Detection of discontinuities, Thresholding, Edge based Segmentation, and Region-based Segmentation. **IMAGE REPRESENTATIONS AND DESCRIPTION** Representation schemes, Boundary Descriptors, Regional Descriptor

Reference Books

- 1 Image Processing Analysis and Machine Vision, Milan Sonka, 2001, McGraw Hill.
- 2 Digital Image Processing, William J Prati, 2002, Cambridge University Press.
- 3 Image Processing Principles and Applications Principles and Applications, Tinku Acharya, 3e, 2004, PHI.
- 4 Digital Image Processing, Rafael C Gonzalez, 2008, pearson.

OEEC1002 - ML FOR ENGINEERING AND SCIENTIFIC APPLICATIONS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC1002	ML FOR ENGINEERING AND SCIENTIFIC APPLICATIONS	MLESA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the fundamental concepts, techniques, and real-world applications of Machine Learning as a foundational area in modern technology.	2	PO1, PO2
CO2	Describe the principles and differences between linear and logistic regression, and explain how variations such as polynomial and multinomial logistic regression are applied to handle non-linear and multi-class problems.	2	PO1, PO2
CO3	Apply Convolutional Neural Networks (CNNs) to demonstrate how hierarchical features are learned through convolution, pooling, and activation layers for tasks such as image classification, object detection, and segmentation.	3	PO1, PO2
CO4	Analyze data using machine learning algorithms to uncover patterns and evaluate their impact on improving efficiency and decision-making across various domains such as finance, healthcare, and marketing.	4	PO1, PO2

Syllabus

Introduction to Machine Learning Linear Algebra, Mathematical Basics 1 Introduction to Machine Learning Linear Algebra Mathematical Basics 2 Probability Computational Basics Numerical computation and optimization Introduction to Machine learning packages

Linear and Logistic Regression Bias/Variance Tradeoff Regularization Variants of Gradient Descent MLE MAP Applications Neural Networks Multilayer Perceptron Back propagation Applications

Convolutional Neural Networks CNN Operations CNN architectures Training Transfer Learning Applications Recurrent Neural Networks RNN LSTM GRU Applications

Classical Techniques Bayesian Regression Binary Trees Random Forests SVM Naïve Bayes Applications k-Means KNN GMM Expectation Maximization Applications Advanced Techniques Structured Probabilistic Models Monte Carlo Methods Autoencoders Generative Adversarial Network

Reference Books

- 1 Deep Learning, Goodfellow et al, 2017, MIT Press.
- 2 Pattern Recognition and Machine Learning, Christopher Bishop, 2009, Springer.
- 3 Introduction to Machine Learning, Ethem Alpaydin, 4th, MIT Press.
- 4 Probability and Statistics for Engineers and Scientists, Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying E. Ye, 9th, Pearson.

OEEC1003 - DATA SCIENCE: DL AND NN (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC1003	DATA SCIENCE: DL AND NN	DSDLNN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply fundamental concepts of mathematical tools in data science	3	PO1, PO2
CO2	Illustrate and apply data analysis techniques for applications handling large data	3	PO1, PO2
CO3	Analyse the performance various machine learning algorithms used in data science application	4	PO1, PO2
CO4	Apply DL algorithms with their associated mathematical foundations for problem in data science	3	PO1, PO2

Syllabus

Introduction, terminology, data science process, data science toolkit, Types of data, Example applications, Mathematical Foundations for Data Science: mean, median, mode, skewness and kurtosis, variance, standard deviation

Introduction, Terminology and concepts, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Data visualization: Introduction, Types of data visualization, Data encodings, examples of Data Encodings.

Introduction of machine learning, Features of ML, types of ML, Linear regression, clustering and classification, K-means, k-nearest neighbour (KNN) classifier, SVM, Decision tree.

Introduction to Deep Learning, DL Architectures, Artificial Neural Networks (ANNs), Convolution Neural Network (CNN) and Popular CNN Architectures, Recurrent Neural Network (RNN), Activation function, different types of layers, data set

Reference Books

- 1 Doing Data Science, Straight Talk from The Frontline, Cathy O Neil, Rachel Schutt, 1st Edition, O'Reilly Media.
- 2 Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Second edition, Dreamtech Press.
- 3 Data Science from Scratch First Principles with Python, Joel Grus, 2nd edition, O'Reilly Media.
- 4 An Introduction to Statistical Learning with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, 1st Edition, Springer.
- 5 Data Science Concepts and Practice, Vijay Kotu, Bala Deshpande, 2nd edition, Morgan Kaufmann.

OEEC2006 - NANO ELECTRONICS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC2006	NANO ELECTRONICS	NE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Acquire knowledge about nanoelectronics and shrink down approach	1	
CO2	Understand concept behind nanomofets and nano devices	2	
CO3	Apply and Analyze the Schrodinger equation for differenttypes of potentials in one dimension	3	
CO4	Understand the nanofabrication and characterization facilities	2	

Syllabus

Introduction: Recent past, the present and its challenges, Future, Overview of basic Nano electronics. Nano electronics
 Nanocomputer architectures: Introduction to Nanocomputers, Nanocomputer Architecture, Quantum DOT cellular Automata (QCA), QCA circuits, Single electron circuits, molecular circuits, Logic switches Interface engineering
 Properties (Self organization, Size dependent) Limitations

Nanoelectronic Architectures: Nanofabrication Nanopatterning of Metallic/Semiconducting nanostructures (e beam/X ray, Optical lithography, STM/AFMSEM & Soft lithography) Nano phase materials Self assembled Inorganic/Organic layers.

Spintronics: Introduction, Overview, History & Background, Generation of Spin Polarization Theories of spin Injection, spin relaxation and spin dephasing, Spintronic devices and applications, spin filters, spin diodes, spin transistors

Memory Devices And Sensors: Memory devices and sensors Nano ferroelectrics Ferroelectric random access memory Fe RAM circuit design ferroelectric thin film properties and integration calorimetric sensors electrochemical cells surface and bulk acoustic devices gas sensitive FETs resistive semiconductor gas sensors electronic noses identification of hazardous solvents and gases semiconductor sensor array

Reference Books

- 1 Nanoelectronics & Nanosystems: From Transistor to Molecular & Quantum Devices:, Karl Goser, JanDienstuhl and others., Springer-Verlag Berlin Heidelberg 2004, Springer Berlin, Heidelberg.
- 2 Nano Electronics and Information Technology, Rainer Waser, 3rd, Wiley-VCH.
- 3 Nanoelectronics: Devices, Circuits and Systems (Micro & Nano Technologies), Brajesh Kumar Kaushik, 1st, Elsevier Science Publishing Co Inc.
- 4 Advanced Nanoelectronics: Post-Silicon Materials and Devices, Muhammad Mustafa Hussain, 1st, Wiley.

OEEC2007 - SATELLITE SUB-SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC2007	SATELLITE SUB-SYSTEMS	SSS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply their knowledge of satellite types, orbits, launch technologies, and mission phases to analyze and understand satellite systems.	3	
CO2	Apply their understanding of critical satellite subsystems, including attitude control, power, propulsion, telemetry, and thermal management, to analyze satellite functionality.	3	
CO3	Apply their knowledge of physical measurement principles to analyze the functionality of optical and microwave satellite payloads, including transponders and antennas.	3	
CO4	Analyze considerations for ground station design based on orbital regimes (LEO, MEO, GEO) and satellite communication applications (deep space, in-flight, maritime).	4	

Syllabus

Types of Satellites, Keplers Laws, Orbital Parameters, Orbits in Common Use, Geostationary, Orbit, Low Earth Orbit, Medium Earth Orbit, Highly Elliptical Orbit, Polar Orbit, Satellite, Service. Launch Technology and Systems: Typical Launch Vehicles - Ariane, Atlas, Delta, H-1 and H-2, Long March, Proton, Zenit, PSLV, GSLV, GSLV MK III and Sounding Rockets. The Launch Mission: The Boost Phase, Non-GEO Missions, Geostationary Transfer Orbit, Drift Orbit for GEO Operation, Deployments and In-Orbit Testing, On-orbit satellite servicing, RCS Fuel Allocation.

Attitude-Control Subsystem, Solar Cells and Panels, Battery Design and Configuration, Liquid, Propulsion System, Electric and Ion Propulsion, Solid-Fuel Rocket Motors, Tracking, Telemetry, and Command (TT&C), Thermal Control, Physical Structural, Spin Stabilization, Three Axis Stabilization, Power Subsystem, Orbit Control, Thermal Control.

Satellite Payload (Optical and Microwave): Physical Measurement Principles, Transponder, Frequency Translation Transponder, On-Board Processing Transponder, Antennas.

Orbital Spacing, LEO, MEO and GEO Satellite Ground Station design Concepts, Deep Space, communications, In-flight Satellite Communications, Marine Satellite Communications.

Reference Books

- 1 The Satellite Communication Ground Segment and Earth Station Handbook. , Elbert, B. , 2014, United Kingdom: Artech House. .
- 2 Ground Station Design and Analysis for LEO Satellites: Analytical, Experimental and Simulation Approach , Cakaj, S. , 2022, United States: Wiley .
- 3 Deep Space Telecommunications Systems Engineering , Joseph H. Yuen, National Aeronautics Administration, , 2014, CreateSpace Independent Publishing Platform .
- 4 Introduction to Satellite Remote Sensing: Atmosphere, Ocean, Land and Cryosphere Applications , William Emery, Adriano Camps , 2017, Elsevier Science .
- 5 Satellite Communications , Timothy Pratt, Jeremy E. Allnutt , 2019, Wiley.
- 6 Satellite Communications , Anil Kumar Maini, Varsha Agrawal , 2010, Wiley India Pvt. Limited .
- 7 Handbook for Marine Radio communication , Williamson, W., Lees, G , 2020, Taylor & Francis .

OEEC2008 - INTRODUCTION TO MEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC2008	INTRODUCTION TO MEMS	IM	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the convergence of MEMS and microsystems, tracing the evolution of microfabrication techniques, integrating microelectronics, miniaturization principles, industrial applications, and the working principles of microsensors, actuators, MEMS devices, and microfluidics	3	
CO2	Apply the law of miniaturization, foundational materials and substrates crucial for MEMS and Microsystems fabrication in device design and integration	3	
CO3	Analyze the various fabrication techniques involved including photolithography, oxidation and chemical vapor deposition in design of MEMS	4	
CO4	Analyze the MEMS systems & products by adapting various micromanufacturing process and Packaging Technologies including real time case studies	4	

Syllabus

"Introduction to Microsystems: MEMS and Microsystems, Evolution of Microfabrication, Microsystems and Microelectronics, Microsystems and Miniaturization, Application of Microsystems in Industry, Working Principle of Microsystems, Micro Sensors, Micro Actuators, MEMS with Micro Actuators, Microfluidics.

Materials for MEMS: Substrate and Wafer, Silicon as Substrate, Miller Indices, Silicon Piezoresistors, Gallium Arsenide, quartz, Piezoelectric crystals, Polymer for MEMS and Microsystems, Packaging materials.

MEMS fabrication techniques: Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapor Deposition, Physical Vapor deposition, Deposition by Epitaxy, Etching. Bulk Micromanufacturing, Surface Micromachining, LIGA Process

Microsystem packing: Three level of Microsystem Packing, Essential Packaging Technologies, Three Dimensional Packing, Signal Mapping and Transduction, Design case: Pressure sensor Packaging, case studies (sensors and actuators).

Reference Books

- 1 Microsensors MEMS and smart devices, Julian W Gardner, 1st Edition, 2001, John Wiley and Sons.
- 2 Microsystems Design, Stephen Santuria, 1st Edition, 2000, Kluwer publishers.
- 3 RF MeMS- Theory Design and Technology, Gabriel M Rebeiz, 1st Edition, 2003, John Wiley and Sons.
- 4 Foundation of MEMS, Chiang Liu, 2nd Edition, 2006, Pearson International.

OEEC2009 - ENERGY HARVESTING TECHNOLOGIES FOR IOT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC2009	ENERGY HARVESTING TECHNOLOGIES FOR IOT	EHTIOT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of renewable energy systems and energy harvesting for	3	
CO2	Understand the solar energy harvesting technologies and designing of solar power systems for IoT. protocols for standards	2	
CO3	Apply mechanical energy harvesting technology for WSN and design a system for real-world problems	2	
CO4	Apply Electromagnetic energy harvesting technologies for small- power application and current research on hybrid systems.	4	

Syllabus

:Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. Introduction to energy harvesting for autonomous systems; energy requirements and power sources.

The role of materials in energy harvesting. Energy storage- Primary and Secondary batteries, Supercapacitors. Energy harvesting circuits and architectures. Power management electronics, Relevant circuits and systems. Solar Energy Harvesting: Characteristics of Photovoltaic (PV) Systems, PV Models and Equivalent Circuits, Sun Tracking Systems, Maximum Power Point Tracking (MPPT) Techniques, Power Electronic Interfaces for PV Systems, Sizing the PV Panel and Battery Pack in a Stand-alone PV Applications.

Evolution of PV materials and devices. Nano structuring as a route to cheap and efficient PV technologies. Mechanical Energy Harvesting: Transduction mechanisms - Physics and Characteristics of Piezoelectric Effects, Materials, and Mathematical Description of Piezoelectricity Effect, Piezoelectric Parameters, and Modelling Piezoelectric Generators, Power Electronic Interfaces for Piezoelectric Energy Harvesting.

Nano-piezoelectric generators: materials, performance, and example devices. New-generation triboelectric nanogenerators. Electromagnetic Energy Harvesting: Linear Generators, Physics, Mathematical Models, and Structures, Recent Applications and Projects on Electromagnetic Energy Harvesting.

Thermoelectric energy harvesting, Basic thermoelectric theory, Thermoelectric figures of merit, Thermodynamic cycles for pyroelectric energy harvesting. Novel nanostructured thermoelectric materials and devices. Hybrid: Solar PV- Piezoelectric-Electromagnetic- Thermoelectric Energy Harvesting.

Reference Books

- 1 Energy Harvesting Systems for IoT Applications: Generation, Storage, and Power Management,, Yen Kheng Tan, Mark Wong,, 2019., crc.
- 2 CMOS Indoor Light Energy Harvesting System for Wireless Sensing Applications, Carlos Manuel Ferreira Carvalho, Nuno Filipe Silva Ver?ssimoPaulino,, 2019, springer.
- 3 Microelectronic Circuit Design for Energy Harvesting Systems,, Di Paolo Emilio, Maurizio,, 2017., Springer,.
- 4 Energy Harvesting Technologies,, Shashank Priya, Daniel J. Inman,, 2007, Springer.
- 5 Renewable Energy, Power for a sustainable future, Godfrey Boyle,, 2004, Oxford University Press, in association with The Open University.
- 6 Handbook of Power Management Circuits,, Haruo Kobayashi, Takashi Nabeshima, 2016, Jenny Stanford Publishing.
- 7 Energy Harvesting for Self-Powered Wearable Devices, Mohammad Alhawari, 2018, Springer.

- 8 Solar Photovoltaics - Fundamentals, Technologies and Applications, Solanki C.S, 2015, PHI, .
- 9 Fundamentals of Renewable Energy Systems, 5. D. Mukherjee, S.Chakrabarti, New Age International, 2004, New Age International.

OEEC3011 - WIRELESS AD-HOC NETWORKS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC3011	WIRELESS AD-HOC NETWORKS	WAHN	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the knowledge of Communication networks and wireless technologies to realize Wireless Adhoc Networks	3	
CO2	Apply the concepts of different routing protocols in real scenarios.	3	
CO3	Analyze the concepts of MAC, transport layer and security protocols	4	
CO4	Analyze the concepts of wireless sensor network and implementation of hardware architecture	4	

Syllabus

Introduction to WAN, Difference between cellular and Adhoc network, Necessity and Applications of WAN, Challenges, and Issues for WAN: Medium Access Scheme, Transport Layer Protocol, Routing, Multicasting, Energy Management, SelfOrganization, Security, Addressing & Service discovery, Deployment considerations, Scalability, Pricing Scheme, Quality of Service Provisioning, Dynamic Topology of WAN, Classification based on Topology, Adhoc wireless interne

Routing Protocols of WAN, Classifications with examples, Classification based on Routing Topology Utilization: Table Driven Routing Protocol, On Demand Routing Protocol, Adhoc on demand distance Vector Routing Protocol, Classification based on Specific Resources: Flat topology routing protocols, Hierarchical topology routing protocols, Classification based on Routing Information update mechanism: Power-aware routing, Geographical information assisted

MAC Protocols, Types of protocols used in MAC, Fixed Allocation MAC, Demand Based MAC, Content based MAC, Challenges of MAC, Issues and Design goals of TLP, Network security of WAN, Issues and Network Security attacks and various approaches for key management

Introduction to WSN, Application of WSN, Challenges of WSN: Characteristic requirements and Required mechanisms, Hardware description and block diagram for single-node architecture, Architecture of WSN: layered architecture and clustered architecture.

Reference Books

- 1 wireless networks-Architectures and protocols, wireless networks-Architectures and protocols, 1, Pearson Education.
- 2 Sensor Networks: Management, Performance, and Applications, By Jing (Selina) He, Mr. Shouling Ji, Yingshu Li, Yi Pan, 1, CRC press.
- 3 Networking: Personal-Area, Local-Area, and the Sensory-Area Networks (Wireless Networks and Mobile Communications), Shih-Lin Wu, Yu-Chee Tseng, 1, Auerbach Publications.

OEEC3012 - SWAM ROBOTICS CONTROL SYSTEMS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC3012	SWAM ROBOTICS CONTROL SYSTEMS	SRCS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Apply the principles and various Swam Robotics Control Systems to reach the robots with the required position and orientation	3	
CO2	Apply multi-agent systems, parallel, scalable, stable to perform different types of tasks with more accuracy	3	
CO3	Apply concepts of Swam Robotics Control Systems and Creating Advanced behavior module.	3	
CO4	Apply the Cooperative algorithms, earlier progress of swarm robotics algorithms, Features of swarm robotics algorithm for navigate and control swarm Movements effectively	3	

Syllabus

Swarm and robotics, several aspects. Definition swarm robotics, Characteristics of nature swarms, special features of the swarm robotics, single robot and other multi-individual systems, nature swarm to swarm intelligence, Advantages of swarm robotics

calable, Stable, Economical, Energy efficient, Different multi-agent systems: Tasks cover large area robot, Tasks dangerous to robot, scaling population and redundancy, Swarm robotics system in real life. Modelling swarm robotics, General model of swarm robotics, Information exchange module, Direct communication, Communication through environment-Sensing, Basic behavior module.

Swarm robotics. Sensor-based modelling, microscopic modelling, Macroscopic modelling, Modelling swarm intelligence algorithms, Cooperation schemes between robots, Architecture of swarm, Locating, Physical connections, Self-organization and self-assembly, Entity projects and simulations.

Earlier progress of swarm robotics algorithms, Features of swarm robotics algorithm, Simple, Scalable, Decentralization, Local, Parallel, Fundamental tasks of swarm robotics,

Reference Books

- 1 Swarm Robotics: A Formal Approach, Elhadi Shakshuki, 2019, 1st Edition, Springer.
- 2 Swarm Robotics: Synchronization and Control, Alejandro Ribeiro and Pramod Varshney, 2018, 2nd Edition, Wiley.
- 3 Swarm Robotics: A Comprehensive Guide, Sabine Hauert, Vito Trianni, and ElioTuci, 2018, 2nd Edition, CRC Press.
- 4 Principles of Robot Motion: Theory, Algorithms, and Implementations, Howie Choset, Kevin M.Lynch,etal., 2005, 2nd Edition, The MIT Press.
- 5 Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies, Dario Floreano and Claudio Mattiussi, 2008, 2nd Edition, The MIT Press.

OEEC3013 - ELECTRONIC WARFARE, EMI & EMC (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEC3013	ELECTRONIC WARFARE, EMI & EMC	EWEMIEMC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental concepts of EMI and EMC, identify sources and victims of EMI, and analyze various types of electromagnetic interferences including conducted and radiated emissions.	2	
CO2	Explain and evaluate different electromagnetic coupling mechanisms such as common mode, differential mode, inductive, capacitive, and radiative coupling in complex electronic systems.	3	
CO3	Apply EMI mitigation techniques including shielding, grounding, filtering, and transient protection in the design of electronic systems to ensure electromagnetic compatibility.	3	
CO4	Demonstrate knowledge of national and international EMI/EMC standards and perform EMI testing using various methods and instruments such as spectrum analyzers, TEM cells, and shielding effectiveness tests.	3	

Syllabus

BASIC THEORY: Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories, EMC Engineering Application.

COUPLING MECHANISM: Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radiative coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.

EMI MITIGATION TECHNIQUES: Working principle of Shielding and Murphys Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketing and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient protection.

STANDARDS AND REGULATION: Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards. EMI Test Methods and Instrumentation Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber, Shielded anechoic chamber, EMI test receivers, Spectrum analyser, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.

Reference Books

- 1 Introduction to Electromagnetic Compatibility, Clayton Paul, 2006, Wiley Interscience.
- 2 Engineering Electromagnetic Compatibility, V Prasad Kodali, 2001, IEEE Press, Newyork, 2001..
- 3 Electromagnetic Compatibility Engineering, , Henry W. Ott, 2009 , John Wiley & Sons Inc, Newyork, .

OECE1001 - RENEWABLE ENERGY RESOURCES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OECE1001	RENEWABLE ENERGY RESOURCES	RER	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the different solar thermal applications and solar photovoltaic cells	2	PO4, PSO2
CO2	Understand the operation of wind turbine ,different types of wind turbines and wave energy conversion	2	PO4, PSO2
CO3	Understand the energy conversion of Tidal, ocean thermal and various the geo thermal power plants	2	PO4, PSO2
CO4	Understand the operation of Bio energy conversion method and the different bio gas plants	2	PO4, PSO2

Syllabus

Solar Radiation: Extraterrestrial solar radiation, terrestrial solar radiation, solar thermal conversion, solar ponds, solar heating/cooling technique, solar distillation, photovoltaic energy conversion, solar cells

Wind Energy: Planetary and local winds, vertical axis and horizontal axis wind mills, principles of wind power, maximum power, actual power, wind turbine operation

Energy from Oceans: Ocean temperature differences, principles of OTEC plant operations, wave energy, devices for energy extraction, tides, simple single pool tidal system.

Geothermal Energy: Origin and types Energy from Bio mass: Bio fuels, classification, direct combustion for heat and electricity generator, anaerobic digestion for biogas, biogas digester, and power generation. Biomass energy conversion technologies, Biogas generation ,classification of Biogas plants

Reference Books

- 1 Renewable Energy, Godfrey Boyle, 2nd, Oxford Publications.
- 2 Non-Conventional Energy Sources, G. D. Rai, 2022, KHANNA PUBLISHERS.

OEEE1002M - SELF-DRIVING CARS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEE1002M	SELF-DRIVING CARS	SDC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the detailed architecture and components of a self-driving car software stack	2	PO1
CO2	Use realistic vehicle physics, complete sensor suite: camera, LIDAR, GPS/INS, wheel odometry, depth map, semantic segmentation, object bounding boxes	2	PO2
CO3	Implement methods for static and dynamic object detection, localization and mapping, behaviour and maneuver planning, and vehicle control	2	PO3
CO4	Demonstrate skills in CARLA and build programs with Python	2	PO4

Syllabus

Self-driving cars present an extremely rich and inter-disciplinary problem. Introduces the language and structure of the problem definition, defining the most salient elements of the driving task and the driving environment.

System architectures for self-driving vehicles. The describes both the hardware and software architectures commonly used and some of the tradeoffs in terms of cost, reliability, performance and complexity that constrain autonomous vehicle design.

The self-driving domain matures the requirement for safety assurance on public roads become more critical to self-driving developers. The automating an driverless vehicle is to define a model for how the vehicle moves given steering, throttle and brake commands.

This module progresses through a sequence of increasing fidelity physics-based models that are used to design vehicle controllers and motion planners that adhere to the limits of vehicle capabilities.

Reference Books

- 1 Introduction to Self-Driving Vehicle Technology , Hanky Sjafrie, 2023, CRC Press/Chapman & Hall.

OEEE2006 - ENERGY ESTIMATION & AUDIT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEE2006	ENERGY ESTIMATION & AUDIT	EEA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the present power scenario in India and the need for energy estimation and Audit.	2	PO1, PO5
CO2	Understand the operation of Induction motors and its energy conservation opportunities	2	PO1, PO5
CO3	Understand the basics of transformers, cables, and their energy conservation opportunities.	2	PO1, PO5
CO4	Understand Lighting systems, pumping systems, and their energy conservation opportunities.	2	PO1, PO5

Syllabus

Basics of Electrical Systems Electrical power scenario in India, Structure of Electrical System, Energy billing, Electrical load management, Maximum demand control, Case studies on Domestic, Commercial and Industrial applications. General Aspects of Energy Auditing Introduction, Types of Energy Auditing, Benefits of Energy Audit, Requirements to conduct Energy Audit, Methodology for Energy Audit, Energy Audit Report, Energy Conservation Building Code.

Induction Motors Operation of Induction Motor, Special Design feature for high efficiency motor, Torque Speed Characteristics, Operating parameters of motor Losses, Measurement of efficiency, Determination of energy saving determination of Load, Assessment of economic feasibility, choice of energy, efficient motor, Effect of variation of voltage on the performance of motor, effect of load variations on efficiency and power factor unbalanced phase voltage, insulation system.

Transformers and Cables, Transformers Introduction, Transformer Losses, Fixed Losses, Load Losses. Evaluation of Transformer Losses, Case Studies, reduction in Transformer Losses. Energy conservation opportunities in transformers. Cables, Introduction, Selection of Cable, Construction, Insulation, inner sheath, armouring, outer sheath, specifications, Tests, Installation. Energy conservation aspects.

Lighting Lighting terminology, Aspects of Lighting System Designing, Various means for Energy Saving, use of natural day light, reduction in light fixture, high efficiency lamps and luminaries, Constructional details of incandescent lamp, Construction and operation of Fluorescent tube light, Lighting energy audit. Pumping Systems, Pumps classification, Pumping System characteristics, Pump curves, pump operating point, Factors affecting pump performance, Assessment of pumps, Energy Conservation Opportunities in Pumping Systems.

Reference Books

- 1 Electrical Wiring, Estimating and Costing , Dr.S.L.Uppal., 5, Khanna Publishers.
- 2 Electrical Design Estimating and Costing, K.B.Raina&S.K.Battacharya, 1, New age international (p) limited.
- 3 Energy Auditing in Electrical Utilities, Rajiv Shankar, 1, Viva Books Private Limited.
- 4 ENERGY ENGINEERING AND MANAGEMENT, CHAKRABARTI, AMLAN, 2, PHI.

OEEE2007M - ENERGY PRODUCTION, DISTRIBUTION & SAFETY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEE2007M	ENERGY PRODUCTION, DISTRIBUTION & SAFETY	EPDS	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand energy basics and working of electrical power generation, transmission, and distribution systems.	2	PO1, PO3, PSO2
CO2	Apply knowledge of personal protective equipment (PPE) guidelines and regulatory safety policies to ensure compliance and enhance safety management within utility operations.	3	PO1, PO3
CO3	Apply understanding of various energy sources and their economic and environmental impacts to develop sustainable energy strategies that mitigate greenhouse gas emissions and global warming.	3	PO1, PO3
CO4	Apply innovative energy solutions and demand response strategies to optimize the integration of distributed networks and improve energy storage infrastructure for current and future utility customers.	3	PO1, PO3

Syllabus

Basic Electricity, Concepts, properties, Simple Circuits, Ohms Law, AC and DC Currents, Generation of Electrical power overview, Transmission and Distribution systems, Substations, transformers, System Design and Switching, Circuit Breakers, Double Busbar, Switching sequence, Smart Grid Risks, Utilities and Consumers, Renewable Energy.

Safety in the Utility Industry: Basics, Dangers, Utility Workplace Culture, Responsibilities. Hazards& Response: Hazards, Non-electrical Hazards, First Aid Symptoms, First Aid Treatment. Preparing for Hazards in the Workplace: Personal Protective Equipment (PPE) for General Industry, PPE for Electric Utility Industry, Use-case PPE, Equipment Guidelines. Safety Administration & Management: Federal Agencies, Environmental Policies, Community Safety Legislation, OSHA regulations, Company Safety Policies.

Energy: The Enterprise- Energy uses, Greenhouse gases & Global Warming. Energy Sources- Stored Sunlight, reflecting Energy, natural Gas & Hydrofracking, Economics & Environment.

Energy and Utility Solutions Innovations, Moving and Storing Energy, Batteries and Infrastructure, Supply and Demand, Demand Response, Business Strategies, Distributed Network Integration, Embodied Energy, Customers of Today and tomorrow .

Reference Books

- 1 Electric Power Systems: A Conceptual Introduction,, Alexandra von Meier, 2006, Wiley-IEEE Press..
- 2 Natural Gas Engineering Handbook, , Boyun Guo, William C. Lyons, Ali Ghalambor,, 2005,, Gulf Professional Publishing..
- 3 Safety and Health for Engineers,, Roger L. Brauer, 1990,, Wiley..
- 4 Energy Systems Engineering: Evaluation and Implementation, Francis Vanek, Louis Albright, Largus Angenent,, 2008, McGraw-Hill Education..
- 5 Energy Management and Conservation Handbook,, Frank Kreith, D. Yogi Goswami, 2007, CRC Press..

OEEE3011 - ELECTRICAL POWER ENGINEERING (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEEE3011	ELECTRICAL POWER ENGINEERING	EPE	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand working of various generating stations and economical aspects of generation	2	PO1, PO5
CO2	Apply the kirchhoffs laws to calculate the electrical parameters in the given networks	3	PO1, PO2
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. .

OEFA1001 - ART & IDEAS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEFA1001	ART & IDEAS	AI	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO

OEFA2006 - PHOTOGRAPHY TECHNIQUES (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEFA2006	PHOTOGRAPHY TECHNIQUES	PT	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the historical evolution and technological advancements in photography, including the role of AI in modern digital imaging and scene enhancement.	2	PO2
CO2	Apply knowledge of camera components, exposure settings, lens types, and AI-assisted features to capture technically sound photographs in diverse shooting conditions.	3	PO3
CO3	Use principles of composition, lighting, and framing effectively, incorporating both traditional and AI-based tools to create visually compelling images.	3	PO4
CO4	Develop skills in various genres of photography, such as portrait, landscape, wildlife, and street photography, utilizing genre-specific techniques and AI-enhanced functionalities.	3	PO7

Syllabus

Develop skills in various genres of photography, such as portrait, landscape, wildlife, and street photography, utilizing genre-specific techniques and AI-enhanced functionalities.

Camera components and their functions, shooting modes (auto, manual, aperture priority, shutter priority), exposure triangle (aperture, shutter speed, ISO), white balance, metering and focus modes, types of lenses, depth of field, AI-assisted autofocus and smart exposure systems.

Principles of composition and framing, rule of thirds, leading lines, patterns and textures, balance and symmetry, foreground and background, perspective, natural light (golden hour, blue hour), artificial light (flash, studio lighting), Lighting Composition, lighting tools (diffusers, reflectors), AI tools for composition and exposure correction.

Portrait photography, posing and lighting for portraits, landscape photography, Wildlife Photography, Fashion Photography, Product Photography, Food Photography, Street Photography use of filters and long exposures, street photography, macro photography techniques and focus stacking, AI features in genre-specific photography.

Reference Books

- 1 Digital Photography Complete Course, DK Publishing, 2015, DK Publishing.
- 2 The Digital Photography Book, Scott Kelby, 2020, New Riders.
- 3 Understanding Exposure: How to Shoot Great Photographs with Any Camera, Bryan Peterson, th Edition (2016), Amphoto Books.

OEGN1001 - NATIONAL CADET CORPS - 1 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEGN1001	NATIONAL CADET CORPS - 1	NCC-1	R	2	0	4	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Define the aims, organization, and functioning of the NCC and its role in nation building.	1	PO7, PO8
CO2	Describe the basic military subjects such as drill, map reading, and field signals.	2	PO7, PO8
CO3	Apply the principles of discipline and leadership in NCC activities and campus life	3	PO7, PO8
CO4	Demonstrate basic weapon training and social service participation through practical sessions.	4	PO7, PO8
CO5	Display teamwork, physical fitness, and civic responsibility through NCC drills and camps.	5	PO7, PO8

Syllabus

Introduction to NCC and National Integration: Aims, organization, and motto of NCC. Structure and functioning of NCC. National Integration and Awareness: importance and challenges. History and achievements of NCC.

Drill and Discipline: Types of drill and their importance. Word of command and formation. Saluting and reporting procedures. Importance of discipline and punctuality.

Weapon Training: Introduction to weapons and safety measures. Stripping and assembling of a rifle (demonstration). Firing positions (theoretical component).

Social Service and Community Development: Role of NCC in community service. Swachh Bharat Abhiyan, Tree plantation, Blood donation. Disaster management awareness.

Foot drill practice, saluting, and parade. Map reading and field signals. Participation in local social service activities. Physical training and obstacle course basics.

Reference Books

- 1 Directorate General NCC, , Cadets Hand Book (Common for Army, Navy & Air Wing), Ministry of Defence, Govt. of India.,, Cadets Hand Book (Common for Army, Navy & Air Wing), Ministry of Defence, , Govt. of India.,.
- 2 NCC Training Syllabus - Part I (First Year), , DG NCC,, Ministry of Defence, , New Delhi., .
- 3 Lt. Col. A.K. Singh, , National Cadet Corps -, Handbook for Cadets, , Kalyani Publishers..
- 4 Dr. V. Raghavan,, Youth and National Integration, , Deep & Deep Publications., , ., ., ...

OEGN1002 - NATIONAL SERVICE SCHEME - 1 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEGN1002	NATIONAL SERVICE SCHEME - 1	NSS-1	R	2	0	4	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles, objectives, and organizational structure of NSS, including the significance of its emblem, flag, motto, song, and badge.	2	PO6, PO8
CO2	Identify Planning and executing regular activities, special camps, and day camps, and will be skilled in adopting villages or slums for long-term development projects.	2	PO6, PO8
CO3	Report effective community surveys, analyze data, and use findings to develop impactful community service initiatives	2	PO6, PO8
CO4	Contribute meaningfully to NSS programs, fostering leadership, teamwork, and social responsibility.	2	PO6, PO8
CO5	Analyze various house hold surveys and conduction of social activities	4	PO6, PO8

Syllabus

Introduction and Basic Concepts of NSS. Emblem, flag, motto, song, badge, etc. Organizational structure, roles and responsibilities of various NSS functionaries.

Concept of regular activities, special camping, Day Camps. Basis of adoption of village/slums, Methodology of conducting Survey.

Maintenance of the Diary. Issues, challenges and opportunities for youth. Indian Tradition of volunteerism.

Needs & importance of volunteerism Motivation and Constraints of Volunteerism. Shramdan as a part of volunteerism.

Implementation of various programs in adopted villages

Reference Books

- 1 National Service Scheme in India: A Case Study of Karnataka, Dr. V. S. Babu , 1 st ,2001, Ashish Publishing House.
- 2 National Service Scheme: A Youth Volunteer Programme, B.L. Gupta, 1st,2009, ABD Publishers.
- 3 NSS Manual , Ministry of Youth Affairs and Sports, , 1st,2006 Government of India, Government of India.

OEGN2006 - NATIONAL CADET CORPS - 2 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEGN2006	NATIONAL CADET CORPS - 2	NCC-2	R	2	0	4	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the structure and role of Indian Armed Forces and their relation with NCC.	2	PO7, PO8
CO2	Apply map reading, fieldcraft, and first-aid techniques in practical contexts.	3	PO7, PO8
CO3	Demonstrate leadership, discipline, and decision-making in group activities and camps.	4	PO7, PO8
CO4	Analyze disaster management and social welfare strategies implemented by NCC.	4	PO7, PO8
CO5	Exhibit commitment to environmental protection and community service through NCC programs.	5	PO7, PO8

Syllabus

Armed Forces and Leadership: Organization of Indian Army, Navy, and Air Force. Leadership traits and types. Command responsibilities and group dynamics.

Map Reading and Fieldcraft: Conventional signs and symbols. Setting a map and finding directions. Field signals, judging distance, and ground formations.

Health, Hygiene, and First Aid: Personal hygiene and sanitation. Basic first aid and life-saving techniques. Stress management and mental well-being

Environment and Social Awareness: Waste management, renewable energy, conservation activities. Role of youth in environmental protection. Participation in community development projects.

Rifle drill and aiming exercises. Fieldcraft practice and map reading. Leadership and team-building exercises. Social awareness campaign participation

Reference Books

- 1 Directorate General NCC, Training Syllabus - Part II (Second Year), Ministry of Defence., ., ., ..
- 2 Col. M.P. Bhagat, Leadership and Personality Development for Cadets, Himalaya Publishing House., ., ., ..
- 3 DG NCC, Map Reading and Fieldcraft Manual (Army Wing), Ministry of Defence., ., ., ..

OEGN2007 - NATIONAL SERVICE SCHEME - 2 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEGN2007	NATIONAL SERVICE SCHEME - 2	NSS-2	R	2	0	4	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand about environmental issues and plantation programs	2	PO6
CO2	Identify Planning and executing regular activities, special camps, and day camps, and will be skilled in adopting villages or slums for long-term development projects.	2	PO6
CO3	Contribute meaningfully to NSS programs, fostering leadership, teamwork, and social responsibility.	2	PO6
CO4	Contribute in environmental issues and disaster management as NSS Volunteer	2	PO6
CO5	Analyze various house hold surveys and conduction of social activities	4	PO6

Syllabus

Plantation Awareness, Waste management awareness, Awareness for self-Employment in adapted village.

Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.

Definition and importance of life competencies; communication and soft skills; Using the Internet; Youth leadership

Introduction; Classification of disasters; Role of NSS in disaster management with more emphasis on disasters specific to NE India; Civil defence

Reference Books

- 1 National Service Scheme in India: A Case Study of Karnataka, Dr. V. S. Babu, 1st, 2001, Ashish Publishing House.
- 2 Environmental Studies, PK Pandey, 1st, 2020, MAHAVEER Publications.
- 3 NSS Manual, Ministry of Youth Affairs and Sports, Government of India, 1st, 2006, ..

OEGN3011 - NATIONAL CADET CORPS - 3 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEGN3011	NATIONAL CADET CORPS - 3	NCC-3	R	2	0	4	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Explain the roles of defense organizations and security forces in national security.	2	PO7, PO8
CO2	Apply advanced fieldcraft and weapon training principles during camps and drills.	3	PO7, PO8
CO3	Demonstrate leadership and planning skills in organizing NCC and social activities.	4	PO7, PO8
CO4	Evaluate disaster management strategies and participate in relief activities.	5	PO7, PO8
CO5	Design and execute civic projects contributing to national development and discipline.	6	PO7, PO8

Syllabus

National Defense and Security: Defense services: organization and operations. Border management and internal security. Role of NCC in national defense awareness

Advanced Drill and Weapon Training: Weapon handling (simulator/demonstration). Range firing. Ceremonial drill and guard of honor.

Disaster Management and Civil Defense: Types of disasters and preparedness plans. Role of NCC in disaster relief and rehabilitation. First response and resource mobilization

Leadership and Personality Development: Time management, communication, and problem-solving. Career guidance in armed and civil services. NCC values and lifelong discipline.

Advanced drill, weapon simulation, and range practice Leadership and management exercises Disaster mock drills Organization of social, environmental, and national events.

Reference Books

- 1 Directorate General NCC, Training Syllabus - Part III (Third Year), Ministry of Defence, New Delhi., ., ., ..
- 2 Brig. K. K. Khanna, National Defence and Security: An Overview, Pointer Publishers., ., ., ..
- 3 DG NCC, Disaster Management and Civil Defence Manual, Ministry of Defence., ., ., ..

OEGN3012 - NATIONAL SERVICE SCHEME - 3 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEGN3012	NATIONAL SERVICE SCHEME - 3	NSS-3	R	2	0	4	0	4

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand community and society, Human Values , Gender Justice	2	PO6, PO7
CO2	Identify Planning and executing regular activities, special camps, and day camps on Food and Nutrition National health programme Healthy Lifestyles	2	PO6, PO7
CO3	Contribute meaningfully to NSS programs, Drugs and Substance abuse Blood donation camp importance , Fire safety Program, Need of Blood grouping	2	PO6, PO7
CO4	Contribute to community by promoting yoga, Yoga as a tool for healthy lifestyle.	2	PO6, PO7
CO5	Analyze various house hold surveys and conduction of social activities	4	PO6, PO7

Syllabus

Concept of community and society, Human Values, Gender Justice.

Food and Nutritio National health programme Healthy Lifestyles.

Drugs and Substance abuse Blood donation camp importance, Fire safety Program, Need of Blood grouping.

Concept of yoga, Yoga as a tool for healthy lifestyle.

Reference Books

- 1 National Service Scheme in India: A Case Study of Karnataka, Dr. V. S. Babu, 1st, 2001, Ashish Publishing House.
- 2 Yoga Mind, Body & Spirit, Donna Farhi, 1st, 2000, Henry Holt and Company.
- 3 Community Health Nursing, C. V. Jacob, 1st, 2017, Jaypee Brothers Medical Publishers.

OEPY1001 - ADVANCED ORGANIC CHEMISTRY (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEPY1001	ADVANCED ORGANIC CHEMISTRY	AOC	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand stereoisomerism and racemic modification of compound	2	
CO2	Illustrate stereospecific reactions and its nomenclature of given organic compounds	2	
CO3	Outline the preparation, properties and nomenclature of heterocyclic compounds	2	
CO4	Relate the synthesis and medicinal uses of different organic compounds and some name reactions	2	

Syllabus

Stereo isomerism: Optical isomerism, Optical activity, enantiomerism, diastereoisomerism, meso compounds Elements of symmetry, chiral and achiral molecules DL system of nomenclature of optical isomers, sequence rules, RS system of nomenclature of optical isomers Reactions of chiral molecules, Racemic modification and resolution of racemic mixture. Asymmetric synthesis: partial and absolute

Geometrical isomerism: Nomenclature of geometrical isomers (Cis Trans, EZ, Syn Anti systems) Methods of determination of configuration of geometrical isomers. Conformational isomerism in Ethane, n-Butane and Cyclohexane. Stereo isomerism in biphenyl compounds (Atropisomerism) and conditions for optical activity. Stereospecific and stereoselective reactions

Heterocyclic compounds: Nomenclature and classification Synthesis, reactions and medicinal uses of following compounds/derivatives Pyrrole, Furan, and Thiophene Relative aromaticity and reactivity of Pyrrole, Furan and Thiophene

Synthesis, reactions and medicinal uses of following compounds/derivatives Pyrazole, Imidazole, Oxazole and Thiazole. Pyridine, Quinoline, Isoquinoline, Acridine and Indole. Basicity of pyridine Synthesis and medicinal uses of Pyrimidine, Purine, azepines and their derivatives. Reactions of synthetic importance Metal hydride reduction NaBH₄ and LiAlH₄, Clemmensen reduction, Birch reduction, Wolff Kishner reduction. Oppenauer oxidation and Dakin reaction. Beckmanns rearrangement and Schmidt rearrangement. Claisen Schmidt condensation

Reference Books

- 1 Organic chemistry- Volume I & II , I.L. Finar , 6th, Pearson .
- 2 Organic Chemistry , Morrison and Boyd , 7th, Pearson .
- 3 Heterocyclic Chemistry , T.L. Gilchrist , 3rd, Pearson .

OEPY2006 - REGULATORY AFFAIRS (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
OEPY2006	REGULATORY AFFAIRS	RA	R	3	0	0	0	3

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the concepts of innovator and generic drugs in drug development process	2	PO1, PO2
CO2	Understand Regulatory requirements for new drug application approval in pharmaceuticals	2	PO1, PO2
CO3	Understand ICH guidelines for filing and approval process of drug products in different countries	2	PO1, PO2
CO4	Understand the post-approval regulatory requirements for products and submission of global documents in Common Technical Document/ eCTD formats	2	PO1, PO2

Syllabus

Drug development concepts- Documentation in Pharmaceutical industry Master formula record, DMF Drug Master File, distribution records, Generic drugs product development Introduction, Hatch Waxman act and amendments, CFR CODE OF FEDERAL REGULATION , drug product performance, in-vitro, ANDA regulatory approval process, NDA approval process, BE and drug product assessment, in vivo, scale up process approval changes, post marketing surveillance, outsourcing BA and BE to CRO.

Product approval requirements-API, biologics, novel, therapies obtaining NDA, ANDA for generic drugs ways and means of US registration for foreign drugs

ICH guidelines- ICH Guidelines of ICH Q, S E, M. Regulatory requirements of EU, MHRA, TGA and ROW countries.

Post product approval documents- CMC, post approval regulatory affairs. Regulation for combination products and medical devices. CTD and ECTD format, industry and FDA liaison.

Reference Books

- 1 Generic Drug Product Development, Solid Oral Dosage forms, Leon Shargel and IsaderKaufer, 2 (2013), CRC Press.
- 2 The Pharmaceutical Regulatory Process, Ira R. Berry and Robert P. Martin, 2 (2019), CRC Press.
- 3 FDA Regulatory Affairs- A Guide for Prescription Drugs, Medical Devices, and Biologics, Douglas J. Pisano, 2 (2008), CRC Press.
- 4 New Drug Approval Process: Accelerating Global Registrations, Richard A Guarino, 4 (2004), CRC Press.



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

Y25: B.Tech. - Mechanical Engineering

Category: Project Research And Internship (PRI)

25IE2040 - SOCIAL INTERNSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE2040	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	2	PO3
CO2	Remember the water sustainability and water resilience of village, city, residential facilities and households using multi-level water scorecards	2	PO4
CO3	Apply the design thinking positive action plan for a village, campus, residential	3	PO5
CO4	Apply the water positive solutions within an urban watershed, a rural watershed	3	PO6

Syllabus

Science of Natural Water Cycle. Watershed death spiral that is the cause of climate change. Water Literacy - Know how water flows in your city, in your residential community and inside your own home.

Design Thinking Process. Water Accounting - Water Scorecard Tools to rapidly assess and account for water sustainability security & resilience of your own household, your residential community & your city. Basic Hydrology. Groundwater Fundamentals

Water Cycle and Biodiversity. Nature Based Solutions to Restore & Repair the Local Natural Water Cycle

Model prototype

Reference Books

- 1 The Social Work Skills Workbook, Barry R, 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.

25IE3041 - TECHNICAL INTERNSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE3041	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
CO2	Ability to integrate existing and new technical knowledge for industrial application	3	PO4
CO3	Ability to demonstrate the impact of the internship on their learning and professional development	3	PO5
CO4	Demonstrate the ability to harness resources by analyzing challenges	4	PO6

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, 3, SAGE.
- 2 Engineering Project Management for the Global High Technology Industry,, Sammy G. Shina, 3, McGraw-Hill Education.
- 3 Engineering Project Management, Nigel J. Smith, 3, Wiley-Blackwell.
- 4 Project Management for Engineering, Business and Technology, John M. Nicholas, Herman Steyn, 6, Pearson.

25IE4042 - INTERNSHIP (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4042	INTERNSHIP	INT	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO5	INTERNSHIP	5	PO1, PO2

Syllabus

INTERNSHIP

Reference Books

- 1 Cracking the Coding Interview, Gayle Laakmann McDowell, 6th Edition, CareerCup.
- 2 Elements of Programming Interviews, Adnan Aziz, Tsung-Hsien Lee, Amit Prakash, 2012, EPI.
- 3 Clean Code: A Handbook of Agile Software Craftsmanship, Robert C. Martin, 1st Edition, Pearson.

25IE4048 - ENGINEERING PROJECT (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4048	ENGINEERING PROJECT	EPJ	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop skills to conduct comprehensive searches, critically assess the credibility of sources, and apply research findings to support their academic or professional work.	4	PO1
CO2	Analyze situations critically, identify underlying causes, and articulate clear problem statements that guide effective problem-solving strategies.	4	PO2
CO3	Develop the ability to dissect research findings, identify strengths and weaknesses, and draw informed conclusions that contribute to their own academic or professional endeavors.	4	PO6
CO4	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.	4	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 , 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.

25IE4051 - INTERNSHIP-1 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4051	INTERNSHIP-1	INT-1	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO5	INTERNSHIP	5	PO1, PO2

Syllabus

INTERNSHIP-1

Reference Books

- 1 Cracking the Coding Interview, Gayle Laakmann McDowell, 6th Edition, CareerCup.
- 2 Elements of Programming Interviews, Adnan Aziz, Tsung-Hsien Lee, Amit Prakash, 2012, EPI.
- 3 Clean Code: A Handbook of Agile Software Craftsmanship, Robert C. Martin, 1st Edition , Pearson.

25IE4052 - INTERNSHIP-2 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4052	INTERNSHIP-2	INT-2	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO5	INTERNSHIP	5	PO1, PO2

Syllabus

INTERNSHIP-2

Reference Books

- 1 Cracking the Coding Interview, Gayle Laakmann McDowell, 6th Edition, CareerCup.
- 2 Elements of Programming Interviews, Adnan Aziz, Tsung-Hsien Lee, Amit Prakash, 2012, EPI.
- 3 Clean Code: A Handbook of Agile Software Craftsmanship, Robert C. Martin, 1st Edition , Pearson.

25IE4053 - ENGINEERING CAPSTONE PROJECT - 1 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4053	ENGINEERING CAPSTONE PROJECT - 1	ECP-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
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, an 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 realworld 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.

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.

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.

25IE4054 - ENGINEERING CAPSTONE PROJECT - 2 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4054	ENGINEERING CAPSTONE PROJECT - 2	ECP-2	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop skills to conduct comprehensive searches, critically assess the credibility of sources, and apply research findings to support their academic or professional work.	4	PO1
CO2	Analyze situations critically, identify underlying causes, and articulate problem statements that guide effective problem-solving strategies.	4	PO2
CO3	Develop the ability to dissect research findings, identify strengths and weaknesses, and draw informed conclusions that contribute to their own academic or professional endeavors.	4	PO6
CO4	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.	4	PO9

Syllabus

A literature survey involves a comprehensive review of existing scholarly works, such as books, academic papers, 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 realworld 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 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.

25IE4055 - INNOVATION PROJECT-1 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4055	INNOVATION PROJECT-1	IP-1	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Understand the fundamental principles and processes of innovation	2	PO3, PO4, PO5
CO2	Develop skills to identify and evaluate opportunities for innovation	3	PO3, PO4, PO5
CO3	Apply research methodologies to gather and analyze data for innovative solutions.	4	PO4, PO5, PO9
CO4	Enhance team collaboration and project management skills in an innovation context.	5	PO4, PO5, PO9

Syllabus

Definitions and types of innovation, Historical perspectives on innovation, Importance of innovation in various sectors, Case studies of successful innovations

Methods for identifying opportunities, Market needs and gaps analysis, SWOT analysis, User-centered design thinking

Qualitative and quantitative research methods, Data collection and analysis technique,s Survey design and implementation Ethics in research

Idea generation techniques, Concept development and validation, Prototyping and testing, Iterative design process and presentation.

Reference Books

- 1 Innovation and Entrepreneurship, Peter F. Drucker,, 2nd Edition, HarperBusiness.
- 2 Research Design: Qualitative, Quantitative, and Mixed Methods Approaches,, John W. Creswell, 5th Edition, SAGE Publications.
- 3 Design Thinking: Integrating Innovation, Customer Experience, and Brand Value, Thomas Lockwood, 1st Edition, Allworth.

25IE4056 - INNOVATION PROJECT-2 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4056	INNOVATION PROJECT-2	IP-2	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Develop advanced project management skills for innovation projects.	2	PO3, PO4, PO5
CO2	Apply advanced analytical tools to refine innovative ideas.	3	PO3, PO4, PO5
CO3	Create detailed business plans for innovative solutions.	4	PO4, PO5, PO6
CO4	Present and defend innovation projects effectively to stakeholders.	5	PO4, PO5, PO6

Syllabus

Agile and lean methodologies, Project planning and scheduling, Risk management, Team dynamics and leadership

Advanced statistical analysis, Data visualization techniques, Predictive analytics, Financial modeling for innovation

Business model development, Market entry strategies, Financial projections and budgeting, Intellectual property and legal considerations

Effective presentation, skills Storytelling for impact, Stakeholder management, Feedback and iteration

Reference Books

- 1 The Innovation Book: How to Manage Ideas and Execution for Outstanding Results, Max Mckeown, 1st Edition, Pearson.
- 2 Project Management: A Systems Approach to Planning, Scheduling, and Controlling, Harold Kerzner, 12th Edition, Wiley.
- 3 Qualitative Research Design: An Interactive Approach, Joseph A. Maxwell, 1st Edition, SAGE Publications.

25IE4057 - RESEARCH PROJECT-1 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4057	RESEARCH PROJECT-1	RP-1	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Demonstrate the basic principles of research methodology.	2	PO3, PO4, PO5
CO2	Conduct a literature review and identify simple research problems.	3	PO3, PO4, PO5
CO3	Formulate basic research questions and hypotheses.	4	PO4, PO5, PO6
CO4	Develop a straightforward research proposal including methodology and expected outcomes	5	PO4, PO5, PO6

Syllabus

Introduction to Research Methodology Basics of research methodology Types of research Qualitative vs Quantitative Ethical considerations in research

Conducting a basic literature review, Identifying research problems, Summarizing literature findings

Defining basic research questions, Developing straightforward hypotheses, Constructing a theoretical framework, Components of a basic research proposal, methodology design Timeline and resource planning

Designing professional academic presentations, Effective communication of complex ideas, Handling questions and feedback from experts

Reference Books

- 1 A Step-by-Step Guide for Beginners, Ranjit Kumar, 2nd Edition, SAGE Publications.
- 2 Practical Research: Planning and Design, Paul D. Leedy and Jeanne Ellis Ormrod, 1st Edition, Pearson.
- 3 Research Methodology: Methods and Techniques, C.R. Kothari, 1st Edition, New Age International Publishers.

25IE4058 - RESEARCH PROJECT-2 (R)

CourseCode	Course Title	Acronym	Mode	L	T	P	S	CR
25IE4058	RESEARCH PROJECT-2	RP-2	R	0	0	8	16	8

Course Outcomes

CO#	CO Description	BTL	PO/PSO
CO1	Implement advanced research methodologies for data collection and analysis.	2	PO3, PO4, PO5
CO2	Interpret complex research findings and discuss their implications.	3	PO3, PO4, PO5
CO3	Develop advanced skills in academic writing and publication.	4	PO3, PO4, PO9
CO4	Present research findings effectively to an academic and professional audience.	5	PO3, PO4, PO9

Syllabus

Advanced data collection techniques, Complex quantitative and qualitative data analysis, Using statistical tools and software

Interpreting complex research findings, Discussing advanced implications of the results, Identifying advanced limitations and future research directions

Structuring a comprehensive research, paper Advanced citation and referencing styles, Writing detailed abstracts and conclusions

Designing professional academic presentations, Effective communication of complex ideas, Handling questions and feedback from experts

Reference Books

- 1 Writing the Research Paper: A Handbook, Anthony C. Winkler and Jo Ray Metherell, 9th Edition, University of Chicago Press.
- 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, 1st Edition, Pearson.