STUDENT HAND BOOK

Applicable for students admitted into
B.Tech Program from 2015-2016

K L University

(Deemed to be University estd. u/s. 3 of the UGC Act, 1956)
(NAAC Accredited "A" Grade University)

Inside

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Note: While every effort has been made to ensure that this book is accurate and up to date, it may include typographical or other errors. Changes are periodically made to this publication and will be incorporated in new editions.

About University

VISION:

To be a globally renowned University.

MISSION:

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

OBJECTIVES:

Focus	Objective
Academics	1. To offer academic flexibility by means of Choice based credit systems and the like.
	2. To identify and introduce new specializations and offer programs in emerging areas therein
	3. To incorporate into the curriculum the Application orientation and use high standards of competence for academic delivery
	4. To design and implement educational system adhering to outcome based International models.
	5. To introduce and implement innovation in teaching and learning process to strengthen academic delivery
	6. To offer academic programs at UG, PG, doctoral, Post-Doctoral which are industry focused, and incorporates Trans-discipline, inter-discipline aspects of the education system
	7. To deliver higher education that includes technologies and meeting the global requirements
Research	8. To promote inter-disciplinary studies and create needful facilities that enhance inter-disciplinary research and innovation
	9. To create an ambience that is conducive for undertaking sponsored research, internal funded research and offering consultancy services to wide spectrum of originations
	10. To establish centers of excellence in frontier areas of research, and design innovation centers with industry collaboration

OBJECTIVES:

Focus	Objective
	11. To create environment to innovate and incubate the products and services that addresses the societal requirements
	12. To integrate research into all academic programs
	13. To maintain high standards in achieving research outcomes
	14. To promote International conferences / Seminars / Workshops / in collaboration with professional bodies for creation of avenues for research exchange
Extramural and extension	15. To generate means and avenues for carrying out extramural research for Industry and Academia
	16. To organize extension activities covering literacy promotion, health awareness and improve the living standards of community
	17. To make the research outcomes useful and applicable for the societal needs
Infrastructure	18. To promote and maintain state of the art facilities for academic delivery, research and co & extra-curricular facilities and develop congenial and eco-friendly fully residential campus
	19. To create and strengthen focused and modern infrastructure that address the national needs through generation of dedicated funds from Industry, Government and research organizations,
Equity / Access	20. To provide and promote the opportunities to higher education to socially deprived communities and remove disparities by promoting women, differently baled and socially deprived
	21. To provide equal access to meritorious both in terms of admissions and financial support
ICT	22. To lay emphasis on effective usage of ICT, WEB–resources and train the faculty on the latest advancements thereof and develop effective e-content
	23. To develop and maintain world class ICT infrastructure and lay emphasis on its effective usage, extend regular training to both faculty and students on its latest advancements there by ensure interactive academic delivery
Examinations and evaluations	24. To introduce reforms in the examination and evaluation system that brings out knowledge application skills and competencies of the students and ensure transparency

OBJECTIVES:

Focus	Objective
Ecology and Environment	25. To Build into curriculum, issues related to social awareness about ecology and environment towards achieving greener society
Linkages	26. To promote collaborations with international and national organizations for advancements of academics, research, Technology transfer and Intellectual property rights.
	27. To Indigenize the global technological solutions and develop the products, and services that transforms the standard of living of rural India
	28. Design new products and services that address commercially attractive needs and opportunities while leveraging the available resources in the form of un-employed and under-employed Individuals
Employability	29. To provide skills through curriculum and training that are essential in fostering entrepreneurial thoughts, employability prospects and at the same time provides necessary support for incubating the innovations and assisting them for prospective commercialization.
	30. To provide necessary business infrastructure that allows attracting and sustaining the industry to commence their business establishments within the University Campus and aid in life long sustenance of employment.
	31. To develop industrial cluster that helps the students to start their industry after incubating the products at the incubating centers which will create Jobs
	32. To develop National depositories for meeting the goals of National skill development council
	33. Train people to profile neighborhood and communities for the needs and commercial opportunities that will support financially sustainable new businesses
Governance	34. To institute measures for transparent administration that aid in improving efficiency, accountability and reliance
	35. To comply with regulations of all the statutory bodies.
	36. To install professional managers who are global visionaries, thought leaders, and thinkers into the management of the University so as to contribute to the ideals of the University system
Quality	37. To continuously upgrade the faculty in curriculum design, teaching pedagogy, usage of ICT and various processes pertaining to academics, research and University administration

OBJECTIVES:

Focus	Objective
	38. To develop mechanism that attracts talented, qualified and experienced faculty from across the globe for pursuing their academic and research careers at the University.
	39. To consider and implement norms, metrics, standards, procedures and benchmarks for assessing and improving the quality in every aspect of University system and achieve quality certifications by National and International bodies.
	40. To establish Internal quality Assurance cell (IQAC) and install a quality systems that is integral part of all the University processes
	41. To continuously upkeep overall quality of the University based on aspects of regular feedback from the stake holders
	42. To improve the quality of faculty through faculty incentives, awards and recognitions
Value orientation	43. To mold the students to possess professional ethics, moral values and intrapersonal skills that shape them into effective leaders and who are having the thoughts of equality and unanimity towards all walks and sects of life.
	44. To inculcate the self-consistency, self-reliance and self-learning qualities for shaping the students to lead their life on their own.
	45. To sharpen the critical thinking and reasoning skills by making students tackle problems and ideas that are yet to be tackled through application of their intellectual discovery.
	46. Developing the students towards human intellectual achievement and make them rich in cultural experience
	47. Students to be encouraged and provided with necessary support enabling them to choose and pursue careers of their choice & interest that make them professionally satisfied.
National development	48. To expand the University in all its modes of delivery so as to contribute to the Nation's increase in Gross Enrolment Ratio
	49. To align the academic programs and courses to match the requirements of the National goals
	50. To develop technology that helps sustainable socio economic development

History

The President of Koneru Lakshmaiah Education foundation, Er.Koneru Satyanarayana, along with Late Sri Koneru Lakshmaiah, founded the K L College of Engineering in the Academic year 1980-81. With the mighty vision and restless efforts of Er. Koneru Satyanarayana K L College of Engineering carved a niche for itself through excellence in engineering education, discipline and record numbers of placements and was the leading college in the state of AP. K L College of Engineering achieved NBA Accreditation for all its B.Tech. programs in 2004 and later re-accredited in 2007. K L College of Engineering was transformed into an autonomous engineering college in the year 2006. In 2008 this college received a record grade of 3.76 on a 4 points scale with "A" Grade from NAAC; and in February 2009, the college, through its founding society "Koneru Lakshmaiah Education Foundation" was recognized as Deemed to be University by the MHRD-Govt. of India, Under Section 3 of UGC Act 1956. This Deemed to be University is named as "K L University".

Location

Vijayawada is located on the banks of river Krishna in the state of Andhra Pradesh and has been historically a cultural, political and educational center. It is also a part of Andhra Pradesh Capital Region. The city is well connected by National Highway and Rail with Chennai (440 km), Hyderabad (275 km), Vizag (385 km) and is a central junction for trains running from North to South India. Daily flights operate from Hyderabad and Bangalore.

K L University is situated in a spacious 100-acre campus on the banks of Buckingham Canal of river Krishna, eight kilometers from Vijayawada city. Built within a rural setting of lush green fields, the institute is a virtual paradise of pristine nature and idyllic beauty. The campus has been aptly named "Green Fields" and the splendid avenue of trees and gardens bear testimony to the importance of ecology and environment. The campus ambience is most befitting for scholastic pursuits. The University has been situated on a built up area of around 15, 00,000 S. Ft.

ACCREDITATIONS:

- Declared as Deemed to be University u/s 3 of UGC Act 1956.
- Accredited by National Assessment and Accreditation Council (NAAC) of UGC as 'A' Grade with 3.16 CGPA on 4 point scale.
- Approved by All India Council for Technical Education (AICTE), New Delhi.
- ISO 9001 - 2008 Certified Institution.

FACILITIES:

Central Library: E-Resources

The Central Library is the largest, and holds materials to serve the whole University community. It has materials relevant to the Engineering, Science & Humanities courses offered by the University.

The library system contains more than one lakh and fifty thousand books and periodicals on all subjects related to the teaching and research interests of the University staff and students. The library has over 15,000 electronic journal titles, academic databases and 5000 eBooks. Access is available on campus on student computers and remotely.

A new library building will be opened shortly on par with international standard with modern IT facilities.

Every department of the college maintains their library to cater the needs of students and faculty. All foreign and Indian journals are made available in the department library for the convenience of faculty and students.

The libraries render following library services.

- Circulation of library documentary
- Inter-library loan services
- Photo copying services
- Reference service
- CD-ROM search services
- Inter Net services
- OPAC
- WEB OPAC
- Audio visual
- Online lectures

The Data Center

A State-of-the-Art Data center with advanced servers provides highly interactive learning environment with full-fledged hardware and software training facilities.

Hardware

The configuration of high end stream of servers that provides various services is

Super Computer

HPC Infrastructure (Super Computer)

- 5.3 TERA Flops (CPU + GPU)
- HP SL 230 4* SL230s Gen8, (2 * 2.6 GHz, 32GB RAM, 2x500GB HD, 10G IB HCA) providing -1.3TF
- HP SL 250 2* SL250s Gen8, (2 * 2.6 GHz, 32GB RAM, 2x500GB HD, 10G IB HCA + 2 NVIDIA K20 GPU providing -4TF. Master Node:
- HP DL 380P 1* DL380p Gen8 (2* 2.6Ghz, 64GB RAM, 2x2TB HD, 10G IB HCA).
- Compute Switch (48 Port Low latency switch)QLogic IB QDR 36 Port Switch.
- Intel® Composer XE for Linux.

The data centers consists of BYOD Servers& Backup Server, Sun Servers, Dell and HP Blade Servers, Apple Server Xserve:

SPECIAL LABORATORIES

The institute is equipped with various Industry Collaborated Labs

S. No.	Discipline	Name of the Lab	Research Group Associated
1.	Computer Science and Engineering	CISCO	Computer Networks and security
2.	Computer Science and Engineering	IBM	Software Engineering
			Knowledge Engineering
3.	Computer Science and Engineering	Microsoft	Embedded Systems
			Software Engineering
			Knowledge Engineering
4.	Computer Science and Engineering	Adobe	Web technologies
			Image processing
5.	Computer Science and Engineering	Oracle	Knowledge Engineering
6.	Electronics Communication Engineering	NI Lab View	Communications Systems

Physical Education- Sports Facilities:

KL University encourages students to explore their latent talents by providing good games and sports facilities. The institute is equipped with the following.

- Athletic track
- Hockey Field
- Badminton Courts -4
- Tenni-koit Courts -2
- Cricket Field with Net practice - 3
- Volleyball Courts -4
- Tennis Courts - 2
- Handball Court
- Netball Courts - 2
- Throw ball courts - 2
- Beach Volleyball Court
- Football Field
- Basketball Courts – 2
- Kabaddi Courts – 2
- Table Tennis - 6
- Chess
- Caroms
- Kho Kho Court
- Soft Ball
- Archery

The University had State-of- the - Art Indoor stadium of 30000 sq.ft with:

- 4 wooden Shuttle Courts/ Basketball Court
- Yoga and Meditation Center
- Dramatics
- 8 Table Tennis Tables
- Hobby Center
- Gymnasium for Girls
- Gymnasium for Boys
- Multipurpose room with Chess, Carroms etc.
- Power lifting/Weight Lifting

Accommodation- Hostels

✓ KL University has separate hostels for boys and girls with well furnished rooms and modern amenities. The overall atmosphere is very conducive for the students to concentrate on studies.

✓ A state- of – the- art kitchen and spacious dining area has been provided for both the hostels.

✓ Generators have been provided as power back up.

✓ Emphasis has been laid on hygiene and cleanliness for healthy living. A customized menu caters to the student needs and it keeps changing according to their tastes.

✓ Teaching staff will have to address academic and personal problems of the students.

✓ Round-the-clock security, communication, dispensary facilities are also available.

✓ **The Girls Hostel**

The girl's hostel is within the campus with a capacity of 1192 in 500 rooms. Different rooms accommodating 2 per room, 3 per room with attached toilets as well as A.C. rooms are available. Suite rooms with modern furniture and separate study room are also available.

✓ The Boys Hostel

It is a short walk from the university with a capacity of 2040 in 780 rooms. Different rooms accommodating 2 per room, 3 per room with attached toilets as well as A.C. rooms are available.

✓ Facilities in the Hostels

Protected drinking water, state of the art kitchen, dining hall, newspapers, telephones, toilets and bathrooms are well maintained. Every student in the hostel is provided with a cot, study table, chair and a rack. Fan and light are also provided in each room.

- Gas & Steam based hygienic food preparation
- Palatable regional, national and international cuisines
- Cleanliness and Safety
- STD/ISD Facilities
- Medical Kits and First Aid Boxes
- Soft drinks, snacks, Fruits etc.
- Laundry
- Stationary shop

✓ Hostel Rules & Regulations

- Students are hereby informed that while staying in the hostel, it is essential to be responsible in maintaining dignity by upholding discipline. They must be obedient to the hostel warden/floor in – charges.
- Valuable items like jewelry etc., should not be kept with students while staying in the hostel. It is student's own responsibility to safeguard her/his Laptops, Money by locking suitcases and bags. If any loss is found, management will not take any responsibility.
- Student has to intimate to the hostel authorities before you giving police complaint against losses.
- Students are not allowed to indulge in smoking, consumption of Alcohol, Narcotic drugs etc., and defaulters will be strictly viewed upon.
- Students are directed that after locking their rooms they have to hand over the keys to security and can collect them on returning back to the hostel.
- Students must switch off Fans, Lights, Geysers, A/C's etc., before leaving their rooms.
- Visitors are not allowed inside the hostel at any time, however they are allowed into the visitor's hall with the prior permission of the warden. Only family members listed by the parents are allowed to contact the student. Visiting hours are up to 7.30 pm only and after 7.30 pm visitors are required to leave premises.
- Hostel students are not allowed to come into the hostel after 3.00 pm in case morning shift students and 6.00pm for day shift students. Those students who are utilizing computer lab, library etc., after the times specified have to submit the permission slip to the security while entering into the hostel.

- During public holiday outings, those who seek permission to leave the hostel will have to obtain a written permission from warden. Permission will be given only to those students who get permission from parents to leave the hostel during holidays/ outings. Moving out of campus without permission are strictly prohibited.
- Strict study hours from 7.30 to 10.30 pm shall be maintained in the hostel. The hostellers must be in their allotted rooms during study hours.
- The general complaints of any kind should be noted in the complaint register, which is available at the hostel office. Registered complaints only will be entertained.
- Any health problem should be brought to the notice of Warden/Floor In – charge for necessary treatment.

Transportation

- The institution runs 70 buses covering all the important points in Vijayawada City, Mangalagiri, Guntur & Tenali towns with a total seating capacity of 4000 students in two shifts.
- Transport is available 24 hrs in case of any emergency in the institute / hostels.
- Transportation is available for conducting industrial tours and visits etc.
- Regular transport facility available up to 10 PM.

Health Centre

A full-fledged health center with all the facilities is established to cater to the needs of the students, staff, Faculty and to the general public in the adopted villages. It consists of three doctors (Homoeopathy, Ayurvedic & Allopathy).

Cafeteria

- KL University has a spacious canteen with latest equipment and hygienic environment which provides quality food and prompts service and caters to needs of all the students and the staff.
- A central cafeteria of 1500 Sq.m. is available in the campus. Mini cafes and fast-food centers are available in various blocks.
- The canteen is open from 6:30 a.m. to 8:30 p.m. There is a wide variety of North-Indian and South-Indian cuisine and the students enjoy the pleasure of eating during the breaks. Cool aqua water for drinking is available.

Placements

K L University has meticulously planned to make all its outgoing students employed. The University had installed the infrastructure, employed well experienced faculty, designed and delivered programs that help enhancing the communication and soft skills which are required for making the students employable. An excellent system is in place that considers all the issues that make a student employable. The University has been successful for the last 7 years, in employing all the students who have registered and eligible for placement through its offices located across the country. About 50 trained personnel work extensively to make the students ready for recruitment by the Industry.

Counselling & Career Guidance

A special Counseling Cell consisting of professional student counselors, psychologists, senior professors counsels/helps the students in preparing themselves to cope with studies, perform well in the tests & various competitions. This Cell provides its services to the students in getting the solutions for their personal problems and also provides career guidance with the help of Industrial Relations and Placements (IRP) department.

A group of 20 students are allotted to a senior faculty member who counsels them regularly and acts as their mentor.

Social Service Wing

KL University has a social service wing which is used to channelizing the social service activities of the faculty, the staff and the students. It has adopted 5 nearby villages and conducts activities like medical camps, literacy camps and educates the villagers regarding hygiene and health care on a regular basis.

NSS Wing of Institute

Regularly organizes Blood donation camps, Blood grouping camps, Fund collection and distribution to poor children and old age homes, distribution of old clothes and free medicines to slum dwellers, tree plantations, AIDS awareness program, teaching basic computer skills to a target group of 500 people in villages.

Hobby Clubs

Wholly and solely managed by the students, the clubs have in the past contributed much to the cultural life of the campus and to the cultural evolution of the students, A number of student bodies and clubs operate in the campus like music society, dance club, drama society, literary and debating club, English press club, drawing club, painting club, mime club, computer club etc. Students manage entire activities and budget of the organization for the entire semester in advance. Around 4000 students are the active members of the Hobby Clubs.

Life Skills and Inner Engineering

KL University feels that it is its responsibility to mould the students as good human beings contributing to the country and to the society by producing responsible citizens. Along with the regular programs every student admitted into KLU undergoes a one week special life skills /orientation program. Through this program, KLU is producing the students with the clarity of thoughts and charity at hearts. Strict regularity, implicit obedience, courtesy in speech and conduct, cleanliness in dress and person is expected of each KLU student. Life skills and inner engineering teach a student his/her obligations towards GOD, himself /herself his/her country and fellow human beings. Every student is encouraged to practise his/her own religious faith and be tolerant and respectful towards other religions.

Technical Festival

KLU organizes various programs for the all round development of the students. The technical festival and project exhibition is being organized in the odd semester (October) every year to elicit the innovative ideas and technical skills of the students.

Cultural Festival

The cultural festival in the even semester (February) of every year is the best platform for the students for exhibiting their talents and creativity. Through these festivals KLU is imparting organizational skills, leadership skills, competitive spirit, and team behavior skills to our students. Along with the knowledge, KLU festivals are providing recreation to the student community.

INNOVATION, INCUBATION AND ENTREPRENEURSHIP CENTER

KLU being a pioneering institute supporting Academics and Research in Engineering, Science and Technology is endowed with all the infrastructure and highly experienced faculty, has an Innovation, Incubation and Entrepreneurship Centre (IIE) that comprises of:

- Innovation centre which aims to inculcate a spirit of innovation.
- Incubation centre which aims to incubate the innovations through prototype product development.
- Entrepreneurship Development Centre (EDC) which aims at fostering entrepreneurial skills among the students.

University Administration

Koneru Satyanarayana, President

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

Dr. M Ramamoorty, Chancellor

Dr. Ramamoorty assumed charge as Chancellor, K L University with effect from 30th March 2015 after successful career as a Professor in IIT Kanpur and also as first Director General of CPRI.

Dr. Ramamoorty obtained his B.E. (Honors) from Andhra University in 1957 and M.E. from IISc Bangalore in 1959. He obtained his MASc and PhD from Toronto University in 1965 and 1967 respectively.

He was a Commonwealth Fellow at U of T from 1964 to 1967. He then joined IIT Kanpur as a faculty member in the Electrical Engineering Department and became a professor in 1972. He had established the first graduate program in Power Electronics in India in 1968 at IIT Kanpur. He had supervised 12 doctoral projects and was associated with many sponsored research activities with industries like BHEL and Hindustan Steel Limited during his tenure at IIT Kanpur.

Dr. L S S Reddy, Vice Chancellor

Dr. L.S.S. Reddy is an eminent Professor in Computer Science and Engineering Department holding Ph.D in Computer Science Engineering from BITS Pilani. Dr. Reddy is an outstanding administrator, a prolific researcher and a forward looking educationist. Dr. Reddy has over 30 years of experience in Teaching, Research and Administration at prestigious institutes like BITS Pilani, CBIT etc.

Dr.L.S.S.Reddy had joined Koneru Lakshmaiah College of Engineering in December 1995 and proved his administrative excellence as a Head of Department of Computer Science and Engineering. Dr. Reddy was instrumental and a driving force as Principal (2002-2009) in promoting KLCE as one of leading Institutions in India.

Dr. A V S Prasad, Pro-Vice Chancellor

Dr. A V S Prasad, M.E (Hydraulics & Irrigation Engineering) and Ph.D (Environmental Sciences and Technology) from JNTU, Hyderabad is a Professor in Civil Engineering. He has a rich experience of 27 Years in academics and 20 years in administration at various caders ranging from Head of the Department, Dean, Principal and Director.

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Program Educational Objectives (PEO)
&
Student Outcomes (SO)

PROGRAM EDUCATIONAL OBJECTIVES (PEOS) :

To be a globally renowned university, as per our vision, we need to produce quality products (graduates) into the market who have potential strengths to meet all the professional and personal challenges prevailing at global levels and who can serve in all the possible positions of their respective job domains and contribute towards holistic growth of their respective employment providers as well as the nation, world. The graduates must also possess cutting edge R&D skills in their domain areas.

This, is exactly what has been framed into the University's Mission and thereby the Mission has converged into the following Program Educational Objectives (PEOs) which are best suited to Undergraduate Engineering programs, and are those that compliment the university vision, mission.

A. Practice engineering in a broad range of industrial, societal and real world applications.

B. Pursue advanced education, research and development, and other creative and innovative efforts in science, engineering, and technology, as well as other professional careers.

C. Conduct themselves in a responsible, professional, and ethical manner.

D. Participate as leaders in their fields of expertise and in activities that support service and economic development throughout the world.

These PEOs are designed to be attained by all the graduates within 3 to 5 years of their graduation.

STUDENT OUTCOMES:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The student outcomes have to be attained by the students in due course of the 4 years program either as part of their Core, Basic Sciences, Engineering Sciences or as part of their various levels of projects, compulsory courses of Humanities & Social Sciences areas.

Academic Rules & Regulations

for

B. Tech Program

2015- 16

ACADEMIC REGULATIONS FOR B.TECH. PROGRAM (2015 – 16)

This document supplements the University's rules and regulations to provide assistance to all B.Tech students. It is required that every individual has to abide by these regulations.

1.0 TERMINOLOGY

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. Academic Council is an authority as per UGC regulations and it has the right to take decisions on 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 semesters i.e., Even and Odd semester.

Audited Course: It is a course of study which neither has evaluation component nor a grade.

Backlog Course: A course is considered to be a backlog course if the student has obtained a failure grade (F).

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.)

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 other.

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 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.

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

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

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

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

Curriculum: Curriculum incorporates the planned interaction of students with instructional content, materials, resources, and processes for evaluating the attainment of Program Educational Objectives.

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

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 particular course.

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.

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 etc...

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.

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.

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 Elective: A course offered in the area of Liberal Arts.

Industrial Training: Training program undergone by the student as per the academic requirement in any company/firm. It is a credited course.

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

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

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

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

Mini project: Mini Project is a credit-based course that a student has to undergo during his/her academic term, which involves the student to explore in a discipline belonging to their research interest within their program area.

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.

Multi- Section Course: Course taught for more than one section.

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

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

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 7th or 8th semester of his/her Academic Year to meet the final requirements for a degree.

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

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.

Project: Course that a student has to 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 laboratory: Project Based Laboratory is a student-centric learning methodology that involve students in design, problem-solving, decision making, and investigative activities; gives students the opportunity to work in teams, over extended periods of time; and culminate in realistic products or presentations

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

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

Re-Registering: A student desiring to repeat a course is permitted to do so, subject to the regulations contained herein.

Semester: It is a period of study consisting of 15 to 18 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.

Single Section Course: Course taught for a single section.

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

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

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.

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

Withdraw from a Course: 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.

2.0 B.Tech. ENGINEERING PROGRAMS ON OFFER

2.1 B. Tech Programs

The students are admitted into 4- year full time B. Tech Programs as enlisted in this section. However these academic regulations provide various flexibilities in earning a) Honors b) Specialization and c) Minor Degrees listed out in the succeeding sections.

The student is awarded a B.Tech. degree provided s/he

a) Must successfully earn minimum of 157-170 credits, as stipulated in the program structure.

b) Must successfully complete a minimum of five (5) Professional Elective Courses, out of which three (3) must be from 3 different specialization areas offered by the program. However, in case of the program offering less than 3 specialization areas, s/he can complete more than one professional elective course from each of the specialization area but must ensure that s/he has completed a minimum of one course from each specialization area offered by the program.

c) Must successfully complete two (2) open electives courses

d) Must successfully undertake specific trainings 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.

e) Must successfully complete three (3) certificate courses (four (4) in case of CSE students) in discipline domain areas, in addition to one from yoga / sports & games / fine arts.

f) Must successfully complete the term paper and Minor Project.

g) Must successfully complete the industrial training (internship) of four weeks duration.

h) Must successfully complete Major project or practice school.

i) Must have successfully taken social service activities for a minimum duration of 30 hours starting from 3rd semester onwards

j) Must have successfully obtained a minimum CGPA of 4.5 at the end of the program.

k) Must have finished all the above-mentioned requirements in less than twice the period mentioned in the Academic structure for each program, which includes deceleration period chosen by the student, deceleration imposed by University or debarred from the University.

The following B.Tech. Degrees are offered by the University.

1. Bachelor of Technology in Biotechnology (BT)
2. Bachelor of Technology in Civil Engineering (CE)
3. Bachelor of Technology in Computer Science & Engineering (CSE)
4. Bachelor of Technology in Electronics and Communication Engineering (ECE)
5. Bachelor of Technology in Electrical and Electronics Engineering (EEE)
6. Bachelor of Technology in Electronics and Computer Engineering (ECM)
7. Bachelor of Technology in Mechanical Engineering (ME)
8. Bachelor of Technology in Petroleum Engineering (PE)

2.2 B.Tech Degree with Honors

A student is eligible for B. Tech Degree with honors subject to the following.

a) S/he should have a CGPA of 8.5 or higher at the end of semester - 4.

b) S/he must pursue 5 additional courses, (covering not less than 20 credits) other than the courses required as per program, by separately registering for those courses.

c) S/he must pursue the additional courses by overloading during a semester or summer term.

d) S/he is eligible for the degree with honors only if CGPA of 8.5 or higher is maintained in each subsequent semester/term without attempting betterment after registering for Degree with Honors.

e) In case a student fails to meet the CGPA requirement for Degree with Honors at any point after registration, s/he will be dropped from the list of students eligible for Degree with Honors and they will receive B.Tech Degree only. However such students will receive a separate grade sheet mentioning the additional courses completed by them.

The following are the list of B.Tech(Honors) programs offered by the University

1. Bachelor of Technology (Honors) in Biotechnology (BT)
2. Bachelor of Technology (Honors) in Civil Engineering (CE)
3. Bachelor of Technology (Honors) in Computer Science & Engineering (CSE)
4. Bachelor of Technology (Honors) in Electronics and Communication Engineering (ECE)
5. Bachelor of Technology (Honors) in Electrical and Electronics Engineering (EEE)
6. Bachelor of Technology (Honors) in Electronics and Computer Engineering (ECM)
7. Bachelor of Technology (Honors) in Mechanical Engineering (ME)
8. Bachelor of Technology (Honors) in Petroleum Engineering (PE)

2.3 B.Tech Degree with specialization

A student is eligible to receive B. Tech Degree with specialization subject to the following:

a) S/he must successfully complete five (5) professional electives courses from a single specialized area and six (6) credits are earned by the student in addition to B. Tech Degree requirements,.

b) Must have completed term paper and Minor project in the same area of specialization; but this is to be done as part of the B. Tech Degree program requirement only

c) Attain a minimum CGPA of 6.75 at the end of the Program.

Degree with specialization is offered in the following areas:

S.No.	Area of Specialization	Eligible Departments
1.	Bioinformatics	BT
2.	Genetic Engineering	BT
3.	Industrial and Food Bio Technology	BT
4.	Medical Bio Technology	BT
5.	Environmental and Water Resources Engineering	CE
6.	Geotechnical Engineering	CE
7.	Structural Engineering	CE
8.	Transportation Engineering	CE
9.	Software Engineering	CSE, ECM

10.	Networking &Communication	CSE, ECE, ECM
11.	Computational Intelligence	CSE, ECM
12.	Data Analytics	CSE, ECM
13.	Distributed & Cloud Computing	CSE, ECM
14.	e-Commerce	CSE, ECM
15.	Information Assurance & Security	CSE, ECM
16.	Internet of Things	CSE, ECM
17.	Platform- based Development	CSE, ECM
18.	Communication Systems	ECE, ECM
19.	Signal Processing	ECE, ECM, EEE
20.	VLSI	ECE, ECM, EEE
21.	Web Technologies	ECM, CSE
22.	Wireless Sensor Networks	ECM, CSE
23.	Embedded Systems	ECM, ECE, CSE, EEE
24.	Control Systems	EEE, ECE, ECM
25.	Energy Systems	EEE, ME
26.	Power Electronics	EEE
27.	Power Systems	EEE
28.	Automobile Engineering	ME
29.	Design & Manufacturing	ME
30.	Robotics & Mechatronics	ME, ECE, ECM, EEE
31.	Up-stream Engineering	PE
32.	Down-stream Engineering	PE

2.4 B.Tech Degree with a Minor

A student who fulfills the B. Tech program requirements of a discipline in which s/he was admitted, is awarded a B.Tech degree in that discipline. The University also offers flexibility for a student to successfully complete five (5) additional courses (necessarily comprising of professional core courses category) from another discipline, which collectively accounts to 20 credits. Having done so s/he gets eligibility for the award of a minor degree in that discipline.

3.0 ELIGIBILITY CRITERIA FOR ADMISSION INTO B.Tech. PROGRAMS

Candidates should have passed Intermediate or equivalent (10+2) Examination, from recognized school leaving certificate examination boards; with minimum of 60% marks or equivalent CGPA in Mathematics, Physics, and Chemistry in the case of all Engineering programs. In case of Bio Technology, the candidates who have passed with minimum of 60% or equivalent CGPA in Biology, Physics, and Chemistry are also eligible.

Apart from the above, the candidates should have secured a qualifying rank in the engineering admission eligibility test i.e., KLUEEE (Entrance Examination conducted by K L University) (or) EAMCET (or) JEE (Mains).

For foreign students who wish to study at the University, please refer to the "Foreign Student Admission Procedures" stated separately and comply with the study requirements of the Ministry of Human Resource Development, Govt.of India.

4.0 B.Tech PROGRAM CURRICULUM

For an academic program the curriculum is the basic framework that will stipulate the credits, category, course code, course title, course delivery (Lectures / Tutorials / Practice / Project/ Self Study / Capstone Design etc.), in the Choice Based Credit System. However all such are essentially designed, implemented and assessed on Outcome Based Education Framework.

4.1 Program Structure

a) B.Tech program is spread over a span of 8 semesters.

b) Each semester is of, approximately 18 weeks duration and each semester is classified as:
   - Odd Semester (July – December)
   - Even Semester (December/January – April/May).

c) In addition to the above mentioned semesters, the university may offer summer term during May and June.

d) All courses are offered under three categories vis-à-vis. even, odd and dual semester courses.

e) Subject to the maximum permissible limit in each course, as specified by the University from time to time, students have independence to choose courses of their own choice prescribed by the University.

f) From 3rd Semester, onwards a student can register for a maximum of 7 credited courses or 26 credits (whichever is less), this however is other than audited and certificate courses per semester. This is not applicable when student exercises the overloading option (while doing project work/practice school/Minor degree/ Honors degree program/specialization).

g) A student can choose Major Project/Practice school only during 7th or 8th semester.

4.2 Course Structure

a) Every course has a Lecture-Tutorial-Practice (L-T-P) component attached to it.

b) Based upon the LTP structure the credits are allotted to a course using the following criteria.
   i. Every lecture hour is equivalent to one credit.
   ii. Every Tutorial/Practice hour is equivalent to half credit.
   iii. If the calculated value of credit is a fraction, it is rounded to the lower number.

4.3 Course Classification

Any course offered under B.Tech program is classified as:

a) Compulsory Courses

i. Basic Sciences

ii. Engineering Sciences

iii. Humanities

iv. Professional core

b) Elective courses:

i. Professional Elective

ii. Open elective

iii. Management elective

iv. Humanities and Social science Elective

v. Science elective.

4.4 Course Precedence:

a) Every course can have one or more of its preceding course(s) as prerequisite(s).

b) To register for a course, the student must successfully complete the course(s) earmarked as pre-requisite(s) for that course.

c) In any course if a student appears for semester end exam or is declared eligible for the same, s/he is deemed to have met the prerequisite.

d) The Dean Academics after consulting with Department concerned has the prerogative to waive the prerequisite (if it is satisfied through a test) if the student has gained sufficient proficiency to take up the course.

e) Professional electives and compulsory core courses can be chosen by the students of the respective disciplines only. However, the students of a particular discipline can register for specialization/ discipline / interdisciplinary minor / compulsory discipline courses of other disciplines provided they have met the pre-requisite or when pre requisite is waived by Dean Academics.

f) A student is not permitted to choose an open elective, if it covers more than 30% of content already done by him in any other course that s/he registered/ completed.

g) An elective course may be offered, only if a minimum of 20 students register for the course.

4.5 Summer Term Courses

The University may offer summer term courses, as per the necessity from time to time.

a) A student may register for course/s in each summer term by paying the stipulated fee. Students registering for more than one (1) summer course have to ensure that there is no clash in the time table. In any case, a student can register only for a maximum of 14 credits during summer term.

b) Summer course is not a right of the student and will be offered based on availability of faculty and other institute resources.

5.0 Evaluation process

A student's academic progress is examined through one or more of the following methods as decided by the Course Coordinator and duly approved by the Dean, Academic.

- Assignment
- Quiz
- Sessional
- Project Report

- Review
- Seminar
- Group Discussion
- In Class Participation / Active Learning
- Case Study Report
- Capstone Design Project
- Simulation
- Comprehensive Exam

a) The Sessional tests and the Semester-End Examinations will be conducted as per the Academic Calendar.

b) As per the necessity, the Supplementary examinations will be conducted at the discretion of Vice Chancellor.

c) Students may have to take more than one examination in a day either during Semester End Examinations /Supplementary examination.

5.1 In-Semester Evaluation

a) The process of evaluation should be continuous throughout the semester and involves components as listed in section 5.0.

b) The maximum distribution of marks for In-Semester evaluation must not exceed 50% of aggregate marks of the course.

c) The distribution of weightage for various evaluation components will be decided and notified by the course coordinator through the course handout after approval by the Dean Academic, at the beginning of the semester.

d) In order to maintain transparency in evaluation, answer scripts will be 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.

e) The solution key and scheme of evaluation for all examinations will be displayed in the appropriate web portal of the course, within 2 days after the conduct of examination, by the course coordinator.

f) No correction is permitted once the course coordinator submits the marks/grades to the Controller of Examination.

g) In case the student is unable to appear for any such examination owing to medical grounds, participation in extra/ co curricular activities representing University/ state/ country; make up examination may be conducted as per the discretion of the Director / Principal of concerned College/ school.

5.1.1 Attendance Policy:

In every course, student has to maintain a minimum of 75% attendance to be eligible for appearing in Semester end examination of the course, for cases of medical issues and other unavoidable circumstances the students will be condoned if their attendance is between 65% to 75% in every course, subjected to submission of medical certificates, medical case file and other needful documents to the concerned departments. However in case of a student having less than 65% attendance in any course, S/He shall be detained in the course and in no case such process will be relaxed.

There are no specific marks attached to attendance as such, however if the course coordinator of a course desires to award certain marks, for attendance in a course She/He can do so based on following guidelines, which thereby must be clearly reflected in respective course handouts, well before the commencement of the course work for such courses, which must be duly approved by the Dean Academic: For any course, not more than 5% marks can be allotted for attendance.

The distribution of marks is as follows:

95 to 100%	**:**	**5 marks**
90 to 95%	**:**	**4 marks**
85 to 90%	**:**	**3 marks**
80 to 85%	**:**	**2 marks**
75 to 80%	**:**	**1 marks**

Below 75% (even in case of condonation "0" marks)

The marks, if allotted for attendance will have to be considered for all L-T-P components of a course cumulatively but not specifically for theory component for any course, however if the course is an elective, then the marks are for only theory owing to the L-T-P structure for such course being "X"-0-0.

5.2 Detention policy

a) In any course, a student has to maintain a minimum of 75% attendance and must secure a minimum of 40% marks in In-Semester Examinations to be eligible for appearing to the Semester End Examination, failing to fulfill these conditions will deem such student to have been detained in that course.

b) However the following are the special cases where the lack of attendance can be condoned:

   i. Up to a maximum of 10% on medical grounds, in which case the student must submit the medical certificate from any recognized medical practitioner.

   ii. Up to a maximum of 10% if the student represents the University / State / Country in any Extra / Co-curricular activities.

   iii. The maximum extent to which a student can be condoned is 10%, and any student with less than 65% is deemed to be detained.

5.3 Semester end examination

a) The minimum weightage for Semester End Examination is 50% of the aggregate marks in the ratio of credits allotted for Lecture (L) +Tutorial (T) to Practical (P).

b) The pattern and duration of such examination will be decided and notified by the Course Coordinator through the Course handout, after approval from the Dean Academic.

c) In order to maintain transparency in evaluation, answer scripts will be shown to the students for verification upon request. If there is any discrepancy in evaluation, the student can request the course coordinator to re-evaluate.

5.4 Reports/Grades

5.4.1. Grading Process

a) At the end of all evaluation components based on the performance of the student, each student is awarded based on absolute grading system. The list of absolute grades and its connotation are given below:

GRADE	GRADE	POINTS	RANGE
O (Outstanding)	10	85	100
A+(Excellent)	9	80	<85
A(Very Good)	8	65	<80
B+(Good)	7	60	<65
B(Above Average)	6	50	<60
C(Average)	5	45	<50
P (Pass)	4	40	<45
F(Fail)	0	<40	-
Ab (Absent)	0	-	-

b) The SGPA is the ratio of sum of the product of the number of credit s with the grade points scored by a student in all the courses and the sum of the number of credits of all the courses undergone by a student, in a semester.

i.e SGPA $(S_i) = \sum(C_i \times G_i) / \sum C_i$

where 'C_i' is the number of credits of the i^{th} course and 'G_i' is the grade point scored by the student in the i^{th} course.

c) The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a program,

i.e. CGPA $= \sum(C_i \times S_i) / \sum C_i$

where 'S'_i is the SGPA of the ith semester and 'C_i' is the total number of credits in that semester.

d) The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

e) CGPA can be converted to percentage of marks : 10 X CGPA - 7.5

f) A student get in less than 40% of overall score and 40% in the semester end examination will be considered to have earned "F" grade. Combined Theory and Lab courses the student should get independently 40% in both theory and lab components else treated as failed in both. A student who obtains 'F' grade has to reappear for all the components of Semester End examination.

g) Audit/Certificate courses are graded as satisfactory or non-satisfactory only.

h) At the end of each semester, the University issues grade sheet indicating the SGPA and CGPA of the student. However, grade sheet will not be issued to the student if he/she has any outstanding dues.

5.5 Betterment

a) A student may reappear for semester end examination only in the theory part of the course for improving the grade, subject to the condition that, her/his CGPA is $\leq$ 6.75. In the case of reappearing, the grade obtained in reappearance or the earlier grade whichever is better will be considered.

b) A Student can re-register in any course at any time before the completion of his/her program provided the University permits.

c) A student cannot reappear for semester end examination in courses like Industrial Training, courses with their L-T-P Structure 0-0-X, Minor Project, Major Project, Practice School and Term Paper.

d) The student ceases to be eligible for award of B.Tech. degree with Honors, B.Tech degree with First class and distinction, in case s/he takes up the betterment option.

6.0 REGISTRATION PROCESS

For every course, the student has to undertake the registration process prior to commencement of the course-work, based on the following conditions;

a) Registration into a course will be permitted only for such courses, which are offered by the program in that particular semester.

b) In case a course has pre-requisites, all of them must be fulfilled.

c) The University has the right to refuse registration process if a student does not turn up on the day of registration.

d) Registration shall not be permitted after the fifth working day from the scheduled date of commencement of classes.

e) Students can register for a maximum of 26 credits in a semester of their choice to meet their program requirements.

f) In case of students, who wish to register for more credits through Overloading or less credits through Under-loading, have to seek prior permission from Dean-Academic.

g) Students, who have opted for minor degree, Honors program or degree with specialisation, can register for more number of credits in a Semester through Overloading.

h) The University reserves the right to withdraw any elective course offered within one week of the commencement of the semester if sufficient numbers of students have not registered or for any other reasons. In such cases, the students are permitted to register for any other elective course of their choice provided they have fulfilled the eligibility conditions.

i) The University reserves the right to cancel the registration of a student from a course or a semester or debar from the degree on disciplinary grounds.

j) Within one week of the commencement of the semester, a student is permitted to substitute an elective course subject to availability with prior approval from Dean-Academic. However, a student is not permitted to withdraw from compulsory course and substitute the same with an elective course.

k) A student is solely responsible to ensure that all conditions for proper registration are satisfied, and there are no timetable clashes. The registration may be cancelled for a course or the entire semester either by the student or by the University if any irregularity is found at a later stage.

7.0 CHANGE OF BRANCH

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 University 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.

b) Apart from students mentioned in clause (a) above, those who have successfully completed all the first and second semester courses and with CGPA ≥ 8 are also eligible to apply, but the change of Branch in such case is purely at the discretion of the University.

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.

8.0 CREDIT TRANSFER

a) Credit transfer from other University to K L University or vice versa is permitted only for under graduate program.

b) Credit transfer from K L University to other University: Student studying in K L University can take transfer to another University under the following conditions:

   i. K L University has signed MOU with the University.

   ii. However, a student, after seeking transfer from K L University can return to K L University after a semester or year. Based on courses done in the other University, equivalent credits shall be awarded to such students.

c) Credit transfer from another University to K L University: A student studying in another University can take transfer to K L University under the following conditions:

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

   ii. The student, when transferred from other Universities, has to stick to the rules and regulations of K L University.

   iii. To graduate from K L University, a student must study at least half of the minimum duration prescribed for a program at KLU.

9.0 ACADEMIC COUNSELING BOARD (ACB)

Academic Counseling Board is constituted by the Dean, Academic, for each program separately. This board shall comprise of the Chairman, Board of Studies, of the relevant program, two (2) Professors and two (2) Associate Professors.

A student will be put under Academic Counseling Board in the following circumstances:

(i) Has CGPA of less than 6.00.

(ii) Has 'F' grade in multiple courses.

The students under Academic Counseling Board may not be allowed to register for all regular courses in the semester, based on the recommendation of Academic Counseling Board and decision of Dean, Academic.

10.0 BACKLOG COURSES

A course is considered to be a backlog if the student has obtained 'F' grade in the course; the student has to re-appear for all components of semester end examinations in that course. However, student must successfully complete such a course in a maximum of four (4) consecutive attempts, failing which s/he must re-register for that course or a substitute course. The decision for substitute course shall be obtained from the Dean, Academic, based on the recommendations of the Board of Studies.

11.0 RUSTICATION

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

12.0 AWARD OF DEGREES

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

1) CGPA between 4.5 to 5.5 will be awarded Pass class
2) CGPA $<$ 6.75 will be awarded second class
3) CGPA $\geq$ 6.75 will be awarded first class
4) CGPA $\geq$ 7.5 will be awarded first class with distinction provided the student has cleared all the courses in first attempt, and must have fulfilled all the program requirements in four (4) years duration.

13.0 AWARD OF MEDALS

University awards Gold and silver medals to the top two (2) students based on CGPA. However,

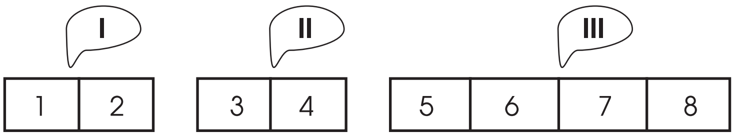
1. the grade obtained by betterment, will not be considered for this award.
2. s/he must have obtained first class with distinction for the award of Gold or silver medal.

Any of the above rules can be altered at the discretion of the Vice Chancellor in special situations.

Course Structure - 1

PROCEDURE FOR ALLOTMENT OF COURSE CODES

The Course code contains three main segments (I, II, III) as illustrated below.



Segment I:

The first two letters represent Year of beginning /approval of Regulations.

Ex. A course with code starting with 15 represents a course belonging to 2015 regulations.

Segment II:

Third and fourth letters represents the acronym of offering discipline of the course.

Acronym	Name of Discipline	Acronym	Name of Discipline
BT	BioTechnology	CY	Chemistry
CE	Civil Engineering	EN	English
CS	Computer Science and Engineering	MB	Management
EC	Electronics and Communications Engineering		Cm Commerce
EM	Electronics and Computers Engineering	HM	Hotel management
EE	Electrical and Electronics Engineering	GN	General
ME	Mechanical Engineering	AR	Architecture
PE	Petroleum Engineering	LA	Law
MT	Mathematics	PY	Pharmacy
PH	Physics	FA	Fine Arts
CH	Chemical Engineering	IE	Inter Disciplinary Engineering

Segment III:

✔ Fifth letter represents level of the course.

Ex: 1 represents level 1 course (normally will be completed in first year), 2 represents level 2 course (normally will be completed in Second year), 3 represents level 3 course (normally will be completed in third year), 4 represents level 4 course (normally will be completed in fourth year)

✔ Sixth letter represents offering semester.

Ex. 0 : indicates the course is offered in both odd and even semesters
1 : indicates the course is offered only in odd semester
2 : indicates the course is offered only in even semester

✔ Last two letters (7^{th} and 8^{th}) indicates serial number of the course.

- All compulsory courses to be sequenced from 01 to 50.
- Professional/ Management/ Foreign language electives to be sequenced from 51 to 99.
- Open electives to be sequenced from A1 to A9, B1 to B9 and so on…

Course Structure - 2

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
HUMANITIES & SOCIAL SCIENCES						
1	15 EN 1101	Rudiments of Communication Skills	0-0-4	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
2	15 EN 1202	Interpersonal Communication Skills	0-0-4	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
3	15 EN 2103	Professional Communication Skills	0-0-4	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
4	15 EN 2204	Employability Skills	0-0-4	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
5	15 EN 3105	Verbal and Quantitative Reasoning	0-0-4	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
6	15 EN 3206	Corporate Communication Skills	0-0-4	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
7	15 GN 1001	Ecology and Environment	2-0-0	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
8	15 GN 1002	Human Values	2-0-0	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
BASIC SCIENCES						
1	15 MT 1001	Single Variable Calculus and Matrix Algebra	2-2-2	4	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
2	15 MT 1203	Multivariate Calculus	2-2-2	4	NIL	CE,CSE,ECE,ECM,EEE,ME,PE
3	15 MT 2104	Probability and Optimization Techniques	2-2-2	4	NIL	ME,CE
4	15 MT 2005	Probability and Stochastic Models	2-2-2	4	NIL	CSE,ECM,ECE
5	15 ME 1001	Mechanics	2-2-2	4	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
6	15 PH 1001	Engineering Materials	2-2-2	4	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
7	15 CY 1001	Engineering Chemistry	2-2-2	4	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
8	15 BT 1001	Biology for Engineers	2-0-0	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
9	15 EE 1201	Fields & Networks	2-2-2	4	NIL	ECE,ECM,EEE
10	15 CE 2103	Engineering Geology	3-0-2	4	NIL	CE
11	15 MT 2106	Probability & Statistics	3-0-0	3	NIL	BT
12	15 MT 1102	Basic Mathematics	2-2-2	4	NIL	BT
ENGINEERING SCIENCES						
1	15 GN 1004	Introduction to Engineering	2-0-2	3	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
2	15 CS 1001	C Programming & Data Structures	2-4-2	5	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
3	15 ME 1002	Engineering Graphics	0-0-6	3	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
4	15 GN 1003	Measurements	0-0-4	2	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
5	15 CS 2002	Object Oriented Programming	2-2-2	4	NIL	BT,CE,CSE,ECE,ECM,EEE,ME,PE
6	15 EC 2002	Signal Analysis	2-2-2	4	NIL	CSE,ECE,ECM,ME
7	15 CS 2003	Discrete Mathematics	2-2-2	4	NIL	CSE,ECE,ECM
8	15 CS 2104	Advanced Data Structures	2-2-2	4	15 CS 1001	CSE
9	15 ME 1003	Thermodynamics	2-2-2	4	NIL	CE,CSE,ECE,ECM,EEE,ME,PE
10	15 EE 2202	Basic Electrical & Electronics Engineering	2-2-2	4	NIL	ME
11	15 ME 2104	Fluid Mechanics	2-2-2	4	NIL	ME
12	15 PE 2101	Momentum Transfer	2-2-2	4	NIL	PE
13	15 BT 2104	Fluid Mechanics and Heat Transfer	3-2-0	4	NIL	BT
14	15 BT 1102	Process Engineering Principles	3-2-0	4	NIL	BT
15	15 CE 2102	Mechanics of Fluids	2-2-2	4	15 ME 1001	CE
16	15 CE 1201	Solid Mechanics	3-0-2	4	15 ME 1001	CE
17	15 CE 2206	Construction Materials & Concrete Technology	3-0-2	4	NIL	CE
18	15 PE 2102	Material & Energy Flow Computation	3-2-0	4	NIL	PE
19	15 PE 2207	Chemical Engineering Thermodynamics	3-2-0	4	15 ME 1003	PE
20	15 BT 2218	Biochemical Thermodynamics	3-2-0	4	NIL	BT
DEPARTMENT OF BIO-TECHNOLOGY						
1	15 BT 1203	Cell Biology	3-2-0	4	NIL	BT
2	15 BT 2105	Microbiology	3-0-2	4	NIL	BT
3	15 BT 2106	Biochemistry	3-0-2	4	NIL	BT
4	15 BT 2207	Bio analytical techniques	3-0-2	4	NIL	BT
5	15 BT 2208	Molecular Biology	3-2-0	4	NIL	BT
6	15 BT 2209	Biochemical Reaction Engineering	3-0-2	4	NIL	BT
7	15 BT 3110	Immunology	3-0-2	4	NIL	BT
8	15 BT 3111	Genetic Engineering	3-0-2	4	NIL	BT
9	15 BT 3112	Bioinformatics	3-0-2	4	NIL	BT
10	15 BT 3113	Fermentation Technology	3-0-2	4	NIL	BT

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
11	15 BT 3114	Mass Transfer Operations	3-0-2	4	NIL	BT
12	15 BT 3215	Bioprocess Dynamics and Control	3-2-0	4	NIL	BT
13	15 BT 3216	Plant and Animal Biotechnology	3-0-2	4	NIL	BT
14	15 BT 3217	Down Stream Processing	3-0-2	4	NIL	BT
LIST OF PROFESSIONAL ELECTIVES						
GENETIC ENGINEERING						
1	15 BT 3251	Molecular Genetics & DNA forensics	3-0-0	3	15 BT 2208	BT
2	15 BT 4155	Transgenic Technology	3-0-0	3	15 BT 2208	BT
3	15 BT 4156	Genomics & Proteomics	3-0-0	3	15 BT 2208	BT
4	15 BT 4157	Molecular Expression Technology	3-0-0	3	15 BT 2208	BT
5	15 BT 4158	Biosafety & Bioethics	3-0-0	3	15 BT 2208	BT
INDUSTRIAL & FOOD BIOTECHNOLOGY						
1	15 BT 3252	Food Biotechnology	3-0-0	3	15 BT 2105	BT
2	15 BT 4159	Microbial Biotechnology	3-0-0	3	15 BT 2105	BT
3	15 BT 4160	Metabolic Engineering	3-0-0	3	15 BT 2105	BT
4	15 BT 4161	Bioprocess Plant Design and Economics	3-0-0	3	15 BT 2105	BT
5	15 BT 4162	Pharmaceutical Biotechnology	3-0-0	3	15 BT 2105	BT
BIOINFORMATICS						
1	15 BT 3253	Molecular Modelling and Drug Design	3-0-0	3	15 BT 3111	BT
2	15 BT 4163	Bioperl & Perl Programming	3-0-0	3	15 BT 3111	BT
3	15 BT 4164	Biomedical Informatics	3-0-0	3	15 BT 3111	BT
4	15 BT 4165	Systems Biology	3-0-0	3	15 BT 3111	BT
MEDICAL BIOTECHNOLOGY						
1	15 BT 3254	Cancer Biology	3-0-0	3	15 BT 1203	BT
2	15 BT 4167	Stem Cell Technology	3-0-0	3	15 BT 1203	BT
3	15 BT 4168	Nano Biotechnology	3-0-0	3	15 BT 1203	BT
4	15 BT 4169	Tissue Engineering	3-0-0	3	15 BT 1203	BT

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
5	15 BT 4170	Neuro Biology	3-0-0	3	15 BT 1203	BT
DEPARTMENT OF CIVIL ENGINEERING						
PROFESSIONAL CORE COURSES						
1	15 CE 2104	Structural Analysis	3-2-0	4	15 CE 1201	CE
2	15 CE 2105	Surveying	3-0-2	4	NIL	CE,PE
3	15 CE 2207	Building Planning and Construction	3-0-2	4	NIL	CE
4	15 CE 2208	Environmental Engineering	3-0-2	4	NIL	CE
5	15 CE 2209	Hydraulics and Hydraulic Machines	3-0-2	4	15 CE 2102	CE
6	15 CE 2210	Soil Mechanics	3-0-2	4	NIL	CE
7	15 CE 3111	Foundation Engineering	3-2-0	4	15 CE 2210	CE
8	15 CE 3112	Design of Reinforced Concrete Structures	3-0-2	4	15CE2206, 15CE2104	CE
9	15 CE 3113	Design of Steel Structures	3-2-0	4	15CE2206, 15CE2209	CE
10	15 CE 3114	Advanced Structural Analysis	3-0-2	4	15 CE 2104	CE
11	15 CE 3115	Transportation Engineering	3-0-2	4	NIL	CE
12	15 CE 3216	Quantity Surveying and Estimation	3-0-2	4	15 CE 2207	CE
13	15 CE 3217	Advanced Design of Reinforced Concrete Structures	3-0-2	4	15 CE 3112	CE
14	15 CE 3218	Water Resources Engineering	3-2-0	4	15 CE 2208	CE
LIST OF PROFESSIONAL ELECTIVES						
STRUCTURAL ENGINEERING						
1	15 CE 3251	Advanced Design of Steel Structures	3-0-0	3	15 CE 3113	CE
2	15 CE 4156	Bridge Engineering	3-0-0	3	15 CE 3112	CE
3	15 CE 4157	Earthquake Resistant Design of Structures	3-0-0	3	15 CE 3112	CE
4	15 CE 4158	Prestressed Concrete	3-0-0	3	15 CE 3112	CE
5	15 CE 4159	Prefabricated Structures	3-0-0	3	NIL	CE
GEOTECHNICAL ENGINEERING						
1	15 CE 3252	Ground Improvement Techniques	3-0-0	3	15 CE 2210	CE
2	15 CE 4160	Advanced Foundation Engineering	3-0-0	3	15 CE 3111	CE

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
3	15 CE 4161	Geotechnical Earthquake Engineering	3-0-0	3	15 CE 2210	CE
4	15 CE 4162	Design of Earth Retaining Structures	3-0-0	3	15 CE 3111	CE
5	15 CE 4163	Geo synthetics and reinforced soil structure	3-0-0	3	15 CE 3111	CE
ENVIRONMENTAL AND WATER RESOURCES ENGINEERING						
1	15 CE 3253	Design of Hydraulics Structures	3-0-0	3	15 CE 2102	CE
2	15 CE 4164	Advanced Water Resources Engineering	3-0-0	3	15 CE 2209	CE
3	15 CE 4165	Environmental impact assessment	3-0-0	3	15 CE 2209	CE
4	15 CE 4166	Solid waste management and landfills	3-0-0	3	NIL	CE
5	15 CE 4167	Advanced Environmental Engineering	3-0-0	3	NIL	CE
TRANSPORTATION ENGINEERING						
1	15 CE 3254	Advanced Highway Engineering	3-0-0	3	15 CE 3115	CE
2	15 CE 4168	Traffic Engineering	3-0-0	3	15 CE 3115	CE
3	15 CE 4169	Advanced Pavement Design Engineering	3-0-0	3	15 CE 3115	CE
4	15 CE 4170	Urban Transport Systems Planning	3-0-0	3	15 CE 3115	CE
5	15 CE 4171	Railways, Docks, Harbors and airports	3-0-0	3	NIL	CE
GENERAL						
1	15 CE 3255	Modern Construction Materials	3-0-0	3	15 CE 2206	CE
2	15 CE 4172	Advanced Concrete technology	3-0-0	3	15 CE 2206	CE
3	15 CE 4173	Advanced Surveying	3-0-0	3	15 CE 2105	CE
4	15 CE 4174	Green Buildings	3-0-0	3	NIL	CE
5	15 CE 4175	Construction Management	3-0-0	3	15 CE 2207	CE
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING						
PROFESSIONAL CORE COURSES						
1	15 EC 1101	Digital System Design	2-2-2	4	NIL	CSE,ECE,ECM,EEE
2	15EM2001	Computer Organization and Architecture	2-2-2	4	15EC1101	CSE,ECE,ECM,EEE
3	15 CS 2007	Database Systems	2-2-2	4	15CS1001	CSE,ECM
4	15 CS 2105	Software Engineering	2-2-2	4	NIL	CSE,ECM

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
5	15 CS 2206	Operating Systems	2-2-2	4	15EM2001	BT,CSE,ECM
6	15 CS 2208	Computer Networks	2-2-2	4	15CS1001	CSE,ECE,ECM
7	15 CS 3109	Theory of Computation	2-2-2	4	15CS2003	CSE
8	15 CS 3110	Algorithm Design and Analysis	2-2-2	4	15CS2104	CSE
9	15 CS 3111	Artificial Intelligence	2-2-2	4	15CS2104	CSE
10	15 CS 3112	Information Assurance & Security	2-2-2	4	15CS2208	CSE
11	15 CS 3113	Platform based development	2-2-2	4	15CS2002	CSE
12	15 CS 3214	Languages & Compilers	2-2-2	4	15CS3109	CSE
13	15 CS 3215	Parallel & Distributed Computing	2-2-2	4	15CS2208	CSE
14	15 CS 3216	Graphics & Visualization	2-2-2	4	15CS2104	CSE
LIST OF PROFESSIONAL ELECTIVES						
NETWORKING & SECURITY						
1	15 CS 3251	TCP/IP Protocol Suite	3-0-0	3	15CS 2208	CSE,ECE,ECM
2	15 CS 4159	Network Architecture and Design	3-0-0	3	15CS 2208	CSE,ECE,ECM
3	15 CS 4160	Network Security	3-0-0	3	15CS 2208	CSE,ECE,ECM
4	15 CS 4161	Wireless communications and Networks	3-0-0	3	15CS 2208	CSE,ECE,ECM
5	15 CS 4162	Computer Forensics	3-0-0	3	15CS 2208	CSE,ECE,ECM
SOFTWARE ENGINEERING						
1	15 CS 3252	Software Metrics and Measurements	3-0-0	3	15CS 1001	BT,CE,CSE,ECE,ECM,EEE,ME,PE
2	15 CS 4163	Software Verification and Validation	3-0-0	3	15CS 2101	CSE,ECM
3	15 CS 4164	Software Architecture and Design Patterns	3-0-0	3	15CS 2101	CSE,ECM
4	15 CS 4165	Software Project Management	3-0-0	3	15CS 2101	CSE,ECM
5	15 CS 4166	Fault Tolerant Computing	3-0-0	3	15CS 2101	CSE,ECM
DISTRIBUTED & CLOUD COMPUTING						
1	15 CS 3253	Enterprise Storage Systems	3-0-0	3	15 CS 2003	BT,CSE,ECM
2	15 CS 4167	Parallel Algorithms	3-0-0	3	15 CS 3211	CSE
3	15 CS 4168	Cloud Networking	3-0-0	3	15 CS 2208	CSE,ECE,ECM

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
4	15 CS 4169	Cloud Computing	3-0-0	3	15 CS 3211	CSE
5	15 CS 4170	High Performance Computing	3-0-0	3	15 CS 3211	CSE
COMPUTATIONAL INTELLIGENCE						
1	15 CS 3254	Soft Computing	3-0-0	3	15 CS 3107	CSE
2	15 CS 4171	Machine Learning	3-0-0	3	15 CS 3107	CSE
3	15 CS 4172	Natural Language Processing	3-0-0	3	15 CS 3107	CSE
4	15 CS 4173	Perception and Computer Vision	3-0-0	3	15 CS 3107	CSE
5	15 CS 4174	Multi Agent Systems	3-0-0	3	15 CS 3107	CSE
GRAPHICS & VISUALIZATION						
1	15 CS 3255	2D/3D Graphics	3-0-0	3	15 CS 2104	ME,CE
2	15 CS 4175	Multimedia Technologies	3-0-0	3	15 CS 3109	CSE
3	15 CS 4176	Game Graphics Programming	3-0-0	3	15 CS 3212	CSE
4	15 CS 4177	Animation & Visualization	3-0-0	3	15 CS 3212	CSE
5	15 CS 4178	Cross Platform Mobile Development	3-0-0	3	15 CS 3109	CSE
COMPUTATIONAL SCIENCE						
1	15 CS 3256	Modeling and Simulation for Sciences	3-0-0	3	15MT2005	CSE,ECM,ECE
2	15 CS 4179	Scientific Computing and Visualization	3-0-0	3	15 CS 1001	BT,CE,CSE,ECE,ECM,EEE,ME,PE
3	15 CS 4180	Parallel Computing	3-0-0	3	15EM2001	CSE,ECE,ECM
4	15 CS 4181	Optimization and Game Theory	3-0-0	3	15MT2005	CSE,ECM,ECE
5	15 CS 4182	Discrete Event Simulation	3-0-0	3	15MT2005	CSE,ECM,ECE
DATA ANALYTICS						
1	15 CS 3257	Data warehousing & Mining	3-0-0	3	15 CS 2003	BT,CSE,ECM
2	15 CS 4183	Big Data & Optimization	3-0-0	3	15 CS 2003	BT,CSE,ECM
3	15 CS 4184	Advanced Databases	3-0-0	3	15 CS 2003	BT,CSE,ECM
4	15 CS 4185	Information Visualization & Graph Analytics	3-0-0	3	15 CS 2003	BT,CSE,ECM
5	15 CS 4186	Data Science & Big Data Analytics	3-0-0	3	15 CS 2003	BT,CSE,ECM

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING						
PROFESSIONAL CORE COURSES						
1	15 EC 1101	Digital System Design	2--2--2	4	NIL	CSE,ECE,ECM,EEE
2	15 EM 2001	Computer Organization and Architecture		2--2--2	4	15 EC 1101 CSE,ECE,ECM,EEE
3	15 EC 2103	Analog Electronic Circuit Design	2--4--2	5	NIL	ECE,ECM,EEE
4	15 EM 2202	Processors and Controllers	2--2--2	4	15 EC 1101	ECE,ECM,EEE
5	15 EC 2204	Design with CPLD & FPGA	2--2--2	4	15 EC 1101	ECE,ECM
6	15 EC 2205	Communication Theory-1	2--2--2	4	15 EC 2103	ECE
7	15 EC 2206	Signal Processing	2--2--2	4	15 EC 2002	ECE,ECM,EEE
8	15 EE 2207	Control Systems	2--2--2	4	NIL	ECE,EEE
9	15 CS 2208	Computer Networks	2--2--2	4	15 CS 1001	CSE,ECE,ECM
10	15 EM 3103	Embedded Systems	2--2--2	4	15 EM2202	ECE,ECM
11	15 EC 3107	CMOS VLSI Design	2--2--2	4	15 EC 1101	ECE
12	15 EC 3108	Communication Theory-2	2--2--2	4	15 EC 2205	ECE
13	15 EC 3209	Communication Theory-3	2--2--2	4	15 EC 3108	ECE
14	15 EC 4110	Digital Image Processing	2--2--2	4	15 EC 2206	ECE
PROFESSIONAL ELECTIVES						
VLSI						
1	15 EC 3251	ANALOG VLSI DESIGN	3--0--0	3	15 EC 3107	ECE
2	15 EC 4154	APPLICATIONS OF MEMS TECHNOLOGY	3--0--0	3	15 EC 3107	ECE
3	15 EC 4155	CAD FOR VLSI DESIGN	3--0--0	3	15 EC 2204	ECE
4	15 EC 4156	DESIGN FOR TESTABILITY	3--0--0	3	15 EC 2204	ECE
5	15 EC 4157	DESIGN OF SEMI-CONDUCTOR MEMORIES	3--0--0	3	15 EC 3107	ECE
6	15 EC 4158	LOW POWER VLSI	3--0--0	3	15 EC 3107	ECE
7	15 EC 4159	NANOELECTRONICS	3--0--0	3	15 EC 3107	ECE
8	15 EC 4160	VLSI SUBSYSTEM DESIGN	3--0--0	3	15 EC 2204	ECE
9	15 EC 4161	VLSI TECHNOLOGY	3--0--0	3	15 EC 3107	ECE

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
Communication						
1	15 EC 3252	RF SYSTEM DESIGN	3--0--0	3	15 EC 3108	ECE
2	15 EC 4162	RADIATION SYSTEMS	3--0--0	3	15 EC 3108	ECE
3	15 EC 4163	RADAR AND NAVIGATIONAL AIDs	3--0--0	3	15 EC 3108	ECE
4	15 EC 4164	MICROWAVE AND MILLIMETER WAVE CIRCUITS	3--0--0	3	15 EC 3209	ECE
5	15 EC 4165	EMI/EMC	3--0--0	3	15 EC 3108	ECE
6	15 EC 4166	CELLULAR COMMUNICATIONS	3--0--0	3	15 EC 2205	ECE
7	15 EC 4167	SATELLITE COMMUNICATION	3--0--0	3	15 EC 3108	ECE
8	15 EC 4168	OPTICAL COMMUNICATIONS	3--0--0	3	15 EC 2205	ECE
9	15 EC 4169	INFORMATION THEORY& CODING	3--0--0	3	15 EC 2205	ECE
10	15 EC 4170	SOFTWARE DEFINED RADIO	3--0--0	3	15 EC 3209	ECE
11	15 EC 4171	FUNDAMENTALS OF ELECTRONIC WARFARE	3--0--0	3	15 EC 3209	ECE
12	15 EC 4172	ELECTRONIC NAVIGATION SYSTEMS	3--0--0	3	15 EC 3108	ECE
13	15 EC 4173	RADAR	3--0--0	3	15 EC 3108	ECE
14	15 EC 4174	COMPUTATIONAL ELECTROMAGNETICS	3--0--0	3	15 EC 2205	ECE
Signal Processing						
1	15 EC 3253	INTELLIGENT SYSTEMS AND CONTROL	3--0--0	3	15 EC 2206	ECE
2	15 EC 4175	ADAPTIVE SIGNAL PROCESSING	3--0--0	3	15 EC 2002	ECE
3	15 EC 4176	STATISTICAL SIGNAL PROCESSING	3--0--0	3	15 MT 2005	ECE
4	15 EC 4177	SPEECH SIGNAL PROCESSING	3--0--0	3	15 EC 2206	ECE
5	15 EC 4178	MULTIMEDIA SIGNAL PROCESSING	3--0--0	3	15 EC 2002	ECE
6	15 EC 4179	NEURAL NETWORKS AND FUZZY CONTROL	3--0--0	3	15 EC 2206	ECE
DEPARTMENT OF ELECTRONICS & COMPUTER ENGINEERING						
PROFESSIONAL CORE COURSES						
1	15 EC 1101	Digital System Design	2--2--2	4	NIL	CSE,ECE,ECM,EEE
2	15EM2001	Computer Organization and Architecture	2--2--2	4	15 EC 1101	CSE,ECE,ECM,EEE
3	15 CS 2007	Database Systems	2--2--2	4	15 CS 1001	BT,CSE,ECM

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
4	15 EC 2103	Analog Electronic Circuit Design	2--4--2	5	NIL	ECE,ECM,EEE
5	15 CS 2105	Software Engineering	2--2--2	4	NIL	CSE,ECM
6	15EM2202	Processors and Controllers	2--2--2	4	15 EC 1101	ECE,ECM,EEE
7	15 EC 2206	Signal Processing	2--2--2	4	15 EC 2002	ECE,ECM,EEE
8	15 CS 2206	Operating Systems	2--2--2	4	15 EM 2001	CSE,ECM
9	15 CS 2208	Computer Networks	2--2--2	4	15 CS 1001	CSE,ECE,ECM
10	15EM3103	Embedded Systems	2--2--2	4	15 EM2202	ECM
11	15EM3104	Communication Systems	2--2--2	4	15 EC 2103	ECM
12	15EM3105	Internet Programming	2--2--2	4	15 CS 2002	ECM
13	15EM3206	VLSI Design	2--2--2	4	15 EC 1101	ECM
PROFESSIONAL ELECTIVES						
EMBEDDED SYSTEMS						
1	15EM3251	Advanced Ambedded Processor Architecture	3--0--0	3	15EM2001	CSE,ECE,ECM
2	15EM4154	Embeeded Linux	3--0--0	3	15EM2001	CSE,ECE,ECM
3	15EM4155	Networking of Embedded Systems	3--0--0	3	15EM2001	CSE,ECE,ECM
4	15EM4156	System on Chip Architectures	3--0--0	3	15EM2001	CSE,ECE,ECM
5	15EM4157	Hardware Software Co Design	3--0--0	3	15EM2001	CSE,ECE,ECM
WIRELESS SENSOR						
1	15EM3252	Sensors and Sensing Principles	3--0--0	3	15 CS 2204	CSE,ECE,ECM
2	15EM4158	Wireless Communications & Networks	3--0--0	3	15 CS 2204	CSE,ECE,ECM
3	15EM4159	Wireless Sensor Networks	3--0--0	3	15 CS 2204	CSE,ECE,ECM
4	15EM4160	Sensor Networks Programming	3--0--0	3	15 CS 2204	CSE,ECE,ECM
5	15EM4161	Remote Sensing and GIS	3--0--0	3	15 CS 2204	CSE,ECE,ECM
WEB TECHNOLOGIES						
1	15EM3253	Web Services	3--0--0	3	15 CS 2002	ECE,ECM
2	15EM4162	Web Semantics	3--0--0	3	15 CS 2002	ECE,ECM
3	15EM4163	Enterprise Programming	3--0--0	3	15 CS 2002	ECE,ECM

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
4	15EM4164	Cloud Based Web Development	3--0--0	3	15 CS 2002	ECE,ECM
5	15EM4165	Web Analytics	3--0--0	3	15 CS 2002	ECE,ECM
INTERNET OF THINGS						
1	15-EM-3254	Principles of Micro Computer and Interfaces	3-0-0	3	15 EM 2001	CSE,ECE,ECM
2	15-EM-4166	Embedded Systems design using FPGA & Verilog	3-0-0	3	15 EM 2001	CSE,ECE,ECM
3	15-EM-4167	Machine to Machine Communications	3-0-0	3	15 CS 2204	CSE,ECE,ECM
4	15-EM-4168	RFID and Sensor Networks	3-0-0	3	15 CS 2204	CSE,ECE,ECM
5	15-EM-4169	Cloud of Things	3-0-0	3	15 CS 2204	CSE,ECE,ECM
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING						
PROFESSIONAL CORE COURSES						
1	15 EC 1101	Digital System Design	2--2--2	4	NIL	CSE,ECE,ECM,EEE
2	15EM2001	Computer Organization and Architecture	2--2--2	4	15 EC 1101	CSE,ECE,ECM,EEE
3	15 EE 2103	Electrical Circuits	2--2--2	4	15 EE 1201	ECE,ECM
4	15 EC 2103	Analog Electronic Circuit Design	2--4--2	5	NIL	ECE,ECM,EEE
5	15 EE 2104	DC Machines and Transformers	2--2--2	4	15 EE 2103	EEE
6	15EM2202	Processors and Controllers	2--2--2	4	15 EC 1101	ECE,ECM,EEE
7	15 EE 2205	AC Machines	2--2--2	4	15 EE 2104	EEE
8	15 EC 2206	Signal Processing	2--2--2	4	15 EC 2002	ECE,ECM,EEE
9	15 EE 2206	Generation, Transmission & Distribution	2--2--2	4	NIL	EEE
10	15 EE 2207	Control Systems	2--2--2	4	NIL	ECE,EEE
11	15 EE 3108	Power System Analysis	2--2--2	4	15 EE 2205	EEE
12	15 EE 3109	Power Electronics	2--2--2	4	NIL	EEE
13	15 EE 3210	Power System Protection	2--2--2	4	15 EE 3108	EEE
14	15 EE 3211	Electrical Drives	2-2-2	4	15 EE 3108	EEE

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
LIST OF PROFESSIONAL ELECTIVES						
POWER SYSTEMS						
1	15 EE 3251	Distribution System Planning & Automation	3--0--0	3	15 EE 3108	EEE
2	15 EE 4155	Restructured Power Systems	3--0--0	3	15 EE 3108	EEE
3	15 EE 4156	HVDC & FACTS	3--0--0	3	15 EE 3109	EEE
4	15 EE 4157	Power Quality	3--0--0	3	15 EE 3109	EEE
5	15 EE 4158	Smart Grid Technologies	3--0--0	3	15 EE 3210	EEE
POWER ELECTRONICS						
1	15 EE 3252	Advanced Power Electronics	3--0--0	3	15 EE 3109	EEE
2	15 EE 4159	Advanced Electrical Drives	3--0--0	3	15 EE 3211	EEE
3	15 EE 4160	HVDC & FACTS	3--0--0	3	15 EE 3109	EEE
4	15 EE 4161	Power Quality	3--0--0	3	15 EE 3109	EEE
5	15 EE 4162	Hybrid Electrical Vehicles	3--0--0	3	15 EE 3211	EEE
CONTROL SYSTEMS						
1	15 EE 3253	State Estimation & System Identification	3--0--0	3	15 EE 2207	ECE,EEE
2	15 EE 4163	Digital Control Systems	3--0--0	3	15 EE 2207	ECE,EEE
3	15 EE 4164	Non Linear Control Systems	3--0--0	3	15 EE 2207	ECE,EEE
4	15 EE 4165	Optimal Control Systems	3--0--0	3	15 EE 2207	ECE,EEE
5	15 EE 4166	Adaptive Control Systems	3--0--0	3	15 EE 2207	ECE,EEE
ENERGY SYSTEMS						
1	15 EE 3254	Energy Conservation & Audit	3--0--0	3	15 EE 2206	EEE
2	15 EE 4167	Utilization of Electrical Energy	3--0--0	3	15 EE 2206	EEE
3	15 EE 4168	Solar & Fuel cell Energy Systems	3--0--0	3	15 EE 2206	EEE
4	15 EE 4169	Wind & Biomass Energy Systems	3--0--0	3	15 EE 2206	EEE
5	15 EE 4170	Nuclear, Geothermal & Tidal Energy Systems	3--0--0	3	15 EE 2206	EEE

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
DIGITAL SYSTEMS						
1	15 EE 3255	Computer Architecture	3--0--0	3	15EC1101	EEE
2	15 EE 4171	PLD´s & FPGAs	3--0--0	3	15EC1101	EEE
3	15 EE 4172	VLSI Design	3--0--0	3	15EC1101	EEE
4	15 EE 4173	Embedded System Design	3--0--0	3	15EC1101	EEE
5	15 EE 4174	DSP Processors	3--0--0	3	15EC1101	EEE
DEPARTMENT OF MECHANICAL ENGINEERING						
PROFESSIONAL CORE COURSES						
1	15 ME 2105	Material Science & Metallurgy	2-2-2	4	15 PH 1001	ME
2	15 ME 2106	Strength of Materials	2-2-2	4	15 ME 1001	ME
3	15 ME 2207	Graphics And Visualization of Mechanical Components	2-2-2	4	15 ME 1002	ME
4	15 ME 2208	Manufacturing Science and Technology	2-2-2	4	NIL	ME
5	15 ME 2209	Kinematics and Dynamics of Machines	2-2-2	4	15 ME 1001	ME
6	15 ME 2210	Applied Thermodynamics	2-2-2	4	15 ME 1003	ME
7	15 ME 3111	Finite Element Method	2-2-2	4	15 ME 2207, 15 ME 2106	ME
8	15 ME 3112	Design of Machine Elements	2-2-2	4	15 ME 2106	ME
9	15 ME 3113	Advanced Manufacturing Technology	2-2-2	4	15 ME 2208	ME
10	15 ME 3114	Turbo Machines	2-2-2	4	15 ME 1003	ME
11	15 ME 3115	Feedback and Control Systems	2-2-2	4	15 GN 1003	ME
12	15 ME 3216	Design of Transmission Elements	2-2-2	4	15 ME 3112	ME
13	15 ME 3217	Production and Operations Management	2-2-2	4	NIL	ME
14	15 ME 3218	Heat Transfer	2-2-2	4	NIL	ME
LIST OF PROFESSIONAL ELECTIVES						
AUTOMOBILE ENGINEERING						
1	15 ME 3251	Automobile Engineering	3-0-0	3	15 ME 2210	ME
2	15 ME 4155	Automobile Engine Design	3-0-0	3	15 ME 3112	ME
3	15 ME 4156	Automotive Transmission	3-0-0	3	15 ME 3112	ME

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
4	15 ME 4157	Autotronics & Safety	3-0-0	3	15 ME 3115	ME
5	15 ME 4158	Alternative Energy Sources for Automobiles	3-0-0	3	NIL	ME
ROBOTICS & MECHATRONICS						
1	15 ME 3252	Industrial Automation and Controls	3-0-0	3	15 ME 3115	ME
2	15 ME 4159	Robotics: Modelling, Analysis and Control	3-0-0	3	15 ME 2209	ME
3	15 ME 4160	Modelling and Analysis of Dynamic Physical Systems	3-0-0	3	15 ME 2209	ME
4	15 ME 4161	Theory and Design of Control Systems	3-0-0	3	15 ME 3115	ME
5	15 ME 4162	Smart Materials for Mechatronic Applications	3-0-0	3	15 ME 2105	ME
DESIGN AND MANUFACTURING						
1	15 ME 3253	Fracture Mechanics	3-0-0	3	15 ME 3112	ME
2	15 ME 4163	Mechanical Vibrations	3-0-0	3	15 ME 1001	BT,CE,CSE,ECE,ECM,EEE,ME,PE
3	15 ME 4164	Product Design	3-0-0	3	15 ME 3112	ME
4	15 ME 4165	Flexible Manufacturing Systems	3-0-0	3	15 ME 3113	ME
5	15 ME 4166	Reverse Engineering and Rapid Prototyping	3-0-0	3	NIL	
GENERAL PROFESSIONAL ELECTIVES (MECH)						
1	15 ME 4167	Condition Monitoring and Fault Diagnostics	3-0-0	3	15 GN 1003	BT,CE,CSE,ECE,ECM,EEE,ME,PE
2	15 ME 4168	Experimental Stress Analysis	3-0-0	3	15 ME 2106	ME
3	15 ME 4169	Advanced Mechanisms Design	3-0-0	3	15 ME 2209	ME
4	15 ME 4170	Computational Fluid Dynamics	3-0-0	3	15 ME 2104	ME
5	15 ME 4171	Refrigeration and Airconditioning	3-0-0	3	15 ME 2210	ME
DEPARTMENT OF PETROLEUM ENGINEERING						
PROFESSIONAL CORE COURSES						
1	15 PE 2103	Geology for Petroleum Engineers	3-0-2	4	NIL	PE
2	15 PE 2104	Drilling Engineering & Well Completion	2-2-2	4	NIL	PE
3	15 CE 2105	Surveying	3-0-2	4	NIL	CE,PE
4	15 PE 2205	Petroleum Exploration Methods	2-2-2	4	15 PE 2103	PE
5	15 PE 2206	Reservoir Engineering	2-2-2	4	15 PE 2103	PE

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
6	15 PE 2208	Process Heat Transfer	2-2-2	4	NIL	PE
7	15 PE 3109	Chemical Reaction Engineering	2-2-2	4	NIL	PE
8	15 PE 3110	Natural Gas Engineering & Processing	2-2-2	4	NIL	PE
9	15 PE 3111	Petroleum Formation and Evaluation	2-2-2	4	NIL	PE
10	15 PE 3112	Pipeline Engineering & Transportation of Oil & Gas	2-2-2	4	NIL	PE
11	15 PE 3113	Mass Transfer	2-2-2	4	NIL	PE
12	15 PE 3214	Environmental Hazardous and Safety Management	2-2-2	4	NIL	PE
13	15 PE 3215	Petroleum Production Engineering	2-2-2	4	15 PE 2206	PE
14	15 PE 3216	Oil and Gas Well Testing	2-2-2	4	15 PE 2206	PE
LIST OF PROFESSIONAL ELECTIVES						
UPSTREAM						
1	15 PE 3251	Well intervention & Stimulation Techniques	3-0-0	3	15 PE 2104	PE
2	15 PE 4153	Reservoir Modelling & Simulation	3-0-0	3	15 PE 2103	PE
3	15 PE 4154	Enhanced Oil Recovery	3-0-0	3	15 PE 2103	PE
4	15 PE 4155	Coal Bed Methane (cbm), Gas Hydrates and Shale Gas	3-0-0	3	NIL	PE
5	15 PE 4156	Directional Drilling & Offshore Structures	3-0-0	3	15 PE 2104	PE
6	15 PE 4157	Petroleum Production System Design	3-0-0	3	15 PE 3215	PE
DOWNSTREAM						
1	15 PE 3252	Petroleum Refining & Petrochemical Technology	3-0-0	3	NIL	PE
2	15 PE 4158	Polymer Science & Technology	3-0-0	3	NIL	PE
3	15 PE 4159	Refining Process, Modeling & Simulation	3-0-0	3	15 PE 2102	PE
4	15 PE 4160	Petroleum Refining Engineering	3-0-0	3	NIL	PE
5	15 PE 4161	Chemical Process Equipment Design & Drawing	3-0-0	3	15 PE 2208	PE
LIST OF OPEN ELECTIVES						
1	15 BT 30A1	IPR & Patent Laws	3-0-0	3	NIL	BT
2	15 CE 30A2	Environmental Pollution Control Methods	3-0-0	3	NIL	CE
3	15 CE 30A3	Solid and Hazardous waste management	3-0-0	3	NIL	CE

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
4	15 CE 30A4	Remote Sensing & GIS	3-0-0	3	NIL	CE
5	15 CE 30A5	Disaster Management	3-0-0	3	NIL	CE
6	15 CS 30A6	Fundamentals of DBMS	3-0-0	3	NIL	CS
7	15 CS 30A7	Fundamentals of Software Engineering	3-0-0	3	NIL	CS
8	15 CS 30A8	Fundamentals of Information Technology	3-0-0	3	NIL	CS
9	15 EC 30A9	Image Processing	3-0-0	3	NIL	EC
10	15 EM 30B1	Linux Programming	3-0-0	3	NIL	EM
11	15 EM 30B2	E-Commerce	3-0-0	3	NIL	EM
12	15 EE 30B3	Renewable Energy Sources	3-0-0	3	NIL	EE
13	15 ME 30B4	Robotics	3-0-0	3	NIL	ME
14	15 ME 30B5	Mechatronics	3-0-0	3	NIL	ME
15	15 ME 30B6	Operations Research	3-0-0	3	NIL	ME
16	15 PH 30B7	Nano Materials & Technology	3-0-0	3	NIL	PH
17	15 PE 30B8	Subsea Engineering	3-0-0	3	NIL	PE
18	15 PE 30B9	Oil and Gas Management	3-0-0	3	NIL	PE
19	15 GN 30C1	Self Development	3-0-0	3	NIL	GN
20	15 GN 30C2	Indian Culture and History	3-0-0	3	NIL	GN
21	15 GN 30C3	Emotional Intelligence	3-0-0	3	NIL	GN
22	15 GN 30C4	Professional Ethics and Values	3-0-0	3	NIL	GN
23	15 GN 30C5	Behavioral Sciences	3-0-0	3	NIL	GN
LIST OF MANAGEMENT ELECTIVES						
1	15 MB 3051	Paradigms in Management thought	3-0-0	3	NIL	
2	15 MB 3052	Indian Economy	3-0-0	3	NIL	
3	15 MB 3053	Managing Personal Finances	3-0-0	3	NIL	
4	15 MB 3054	Basics of Marketing for Engineers	3-0-0	3	NIL	
5	15 MB 3055	Organization Management	3-0-0	3	NIL	
6	15 MB 3056	Resources Safety and Quality Management	3-0-0	3	NIL	

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR	PRE-REQ.	OFFERED TO
LIST OF FOREIGN LANGUAGES						
1	15 GN 3051	Arabic	3-0-0	3	NIL	
2	15 GN 3052	Bengali	3-0-0	3	NIL	
3	15 GN 3053	Chinese	3-0-0	3	NIL	
4	15 GN 3054	French	3-0-0	3	NIL	
5	15 GN 3055	German	3-0-0	3	NIL	
6	15 GN 3056	Hindi	3-0-0	3	NIL	
7	15 GN 3057	Italian	3-0-0	3	NIL	
8	15 GN 3058	Japanese	3-0-0	3	NIL	
9	15 GN 3059	Kannada	3-0-0	3	NIL	
10	15 GN 3060	Russian	3-0-0	3	NIL	
11	15 GN 3061	Simhali	3-0-0	3	NIL	
12	15 GN 3062	Spanish	3-0-0	3	NIL	
13	15 GN 3063	Tamil	3-0-0	3	NIL	
14	15 GN 3064	Urdu	3-0-0	3	NIL	
TERM PAPER & PROJECT						
1	15 IE 3250	Term Paper	0-0-4	2	NIL	
2	15 IE 4048	Practice School	0-0-16	8	NIL	
3	15 IE 4049	Minor Project	0-0-4	2	NIL	
4	15 IE 4050	Major Project	0-0-16	8	NIL	

Minor Degree Courses

Minor in Bio Technology (Applicable for CE, CSE, ECE, ECM, EEE, ME and PE)

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR
1	15 BT 1203	Cell Biology	3-2-0	4
2	15 BT 2208	Molecular Biology	3-2-0	4
3	15 BT 3112	Bioinformatics	3-0-2	4
4	15 BT 3113	Fermentation Technology	3-0-2	4
5	15 BT 3216	Plant and Animal Biotechnology	3-0-2	4

Minor in Civil Engineering (Applicable for BT, CSE, ECE, ECM,EEE, ME, and PE)

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR
1	15 CE 1201	Solid Mechanics	3-0-2	4
2	15 CE 2102	Mechanics of Fluid	2-2-2	4
3	15 CE 2105	Surveying	3-0-2	4
4	15 CE 2208	Environmental Engineering	3-0-2	4
5	15 CE 2206	Construction Mechanics and Concrete Technology	3-0-2	4

Minor in Computing (Applicable for CE, ECE, ECM, EEE, ME, and PE)

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR
1	15 CS 2206	Operating Systems	2-2-2	4
2	15 CS 3109	Theory of Computation	2-2-2	4
3	15 CS 3110	Algorithm Design and Analysis	2-2-2	4
4	15 CS 3111	Artificial Intelligence	2-2-2	4
5	15 CS 3215	Parallel & Distributed Computing	2-2-2	4

Minor in Electronics (Applicable for CSE, ME, CE and BT)

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR
1	15 EC 1101	Digital System Design	2-2-2	4
2	15 EC 2103	Analog Electronic Circuit Design	2-2-2	5
3	15 EC 2204	Design with CPLD & FPGA	2-2-2	4
4	15 EM 2202	Processors and Controllers	2-2-2	4
5	15 EM 3103	Embedded Systems	2-2-2	4

Minor in Communications (Applicable for CSE, ECM, EEE, ME, CE and BT)

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR
1	15 EC 2205	Communication Theory-1	2-2-2	4
2	15 EC 2206	Signal Processing	2-2-2	4
3	15 CS 2208	Computer Networks	2-2-2	4
4	15 EC 3108	Communication Theory-2	2-2-2	4
5	15 EC 3209	Communication Theory-3	2-2-2	4

Minor in Electrical Engineering (Applicable for CSE, ECM, ME, CE and BT)

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR
1	15 EE 2104	DC Machines and Transformers	2-2-2	4
2	15 EE 2205	AC Machines	2-2-2	4
3	15 EE 2206	Generation, Transmission & Distribution	2-2-2	4
4	15 EE 2207	Control Systems	2-2-2	4
5	15 EE 3109	Power Electronics	2-2-2	4

Minor in Mechanical Engineering (Applicable for CSE, ECM, EEE, CE and BT)

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR
1	15 ME 1003	Thermodynamics	2-2-2	4
2	15 ME 3218	Heat Transfer	2-2-2	4
3	15 ME 3112	Design of Machine Elements	2-2-2	4
4	15 ME 3216	Design of Transmission Elements	2-2-2	4
5	15 ME 2106	Strength of Materials	2-2-2	4

Minor in Petroleum Engineering (Applicable for BT, CE, ECE, ECM, EEE, and ME)

S.No.	COURSE CODE	COURSE NAME	L-T-P	CR
1	15 PE 2104	Drilling Engineering & Well Completion	2-2-2	4
2	15 PE 3112	Pipeline Engineering & Transportation of Oil & Gas	2-2-2	4
3	15 PE 4155	Coal Bed Methane(CBM),Gas Hydrates and Shale Gas	3-0-0	3
4	15 PE 3252	Petroleum Refining & Petrochemical Technology	3-0-0	3
5	15 PE 4161	Chemical Process Equipment Design & Drawing	3-0-0	3

HONORS DEGREE COURSES

S.No.	Course Code	Name Of The Course	L-T-P	Credits
Department of Bio Technology				
1	15 BT 5102	Biochemical Engineering	3-2-0	4
2	15 BT 5103	Molecular Biology and r-DNA Technology	3-0-2	4
3	15 BT 5104	Applied Bioinformatics	3-0-2	4
4	15 BT 5206	Immuno technology	3-0-2	4
5	15 BT 5207	Bioreactor modeling and Simulation	3-2-0	4
Department of Civil Engineering				
1	15 CE 5102	Theory of Elasticity	3-2-0	4
2	15 CE 5104	Advanced Prestressed Concrete	3-0-2	4
3	15 CE 5205	Finite Element Analysis	3-0-2	4
4	15 CE 5117	Construction Technology	3-0-2	4
5	15 CE 5221	Mechanized Construction and Machinery	3-0-2	4
Department of Computer Science and Engineering				
1	15 CS 5136	Software Security	3-0-2	4
2	15 CS 5205	Operating System Design	3-2-0	4
3	15 CS 5117	Enterprise Devices and Networks	3-0-2	4
4	15 CS 5230	Expert Systems	4-0-0	4
5	15 CS 5231	Big Data and Business Intelligence	3-0-2	4
Department of Electronics and Communication Engineering				
1	15 EC 5206	Antenna Measurements	3-0-2	4
2	15 EC 5216	Statistical Signal Processing	3-0-2	4
3	15 EC 5109	Wavelets, Filter Banks & Applications	3-0-2	4
4	15 EC 5112	Adaptive Signal Processing	3-0-2	4
5	15 EC 5234	VLSI System Design	3-2-0	4
Department of Electrical and Electronics Engineering				
1	15 EE 5102	Power Electronic Control Of Drives	3-0-2	4
2	15 EE 5103	Optimization Techniques	3-2-0	4
3	15 EE 5101	Design Of Power Converters	3-0-2	4
4	15 EE 5109	Power System Dynamics & Stability	3-0-2	4
5	15 EE 5213	Real Time Control Of Power Systems	3-0-2	4
Department of Electronics and Computer Engineering				
1	15 EM 5109	Micro Controllers For Embedded System Design	3-0-2	4
2	15 EM 5110	Real Time Concepts For Embedded Systems	3-2-0	4
3	15 EM 5214	Digital Signal Processors And Architectures	3-2-0	4
4	15 EM 5103	Sensors And Sensing Principles	3-2-0	4
5	15 EM 5206	Communication Protocols And Standards	3-0-2	4
Department of Mechanical Engineering				
1	15 ME 5112	Advanced Heat & Mass Transfer	3-2-0	4
2	15 ME 5213	Incompressible and compressible flows	3-2-0	4
3	15 ME 5214	Computational Fluid Dynamics	3-0-2	4
4	15 ME 5222	Mechanisms Design & Simulation	3-2-0	4
5	15 ME 5117	Advanced Mechanics of Solids	3-2-0	4

COURSE Vs STUDENT OUTCOMES MAPPING

DEPARTMENT OF BIOTECHNOLOGY

S.No.	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
HUMANITIES & SOCIAL SCIENCES																
1	15 GN 1001	Ecology and Environment	2-0-0	2	NIL								2	1		
2	15 GN 1002	Human Values	2-0-0	2	NIL						2					
3	15 EN 1101	Rudiments of Communication Skills	0-0-4	2	NIL							1				
4	15 EN 1202	Interpersonal Communication Skills	0-0-4	2	NIL				1			2				
5	15 EN 2103	Professional Communication Skills	0-0-4	2	NIL						1	3				
6	15 EN 2204	Employability Skills	0-0-4	2	NIL						2	3				
7	15 EN 3105	Verbal and Quantitative Reasoning	0-0-4	2	NIL									1		
8	15 EN 3206	Corporate Communication Skills	0-0-4	2	NIL						3	3				
BASIC SCIENCES																
9	15 MT 1001	Single Variable Calculus and Matrix Algebra	2-2-2	4	NIL					1						1
10	15 ME 1001	Mechanics	2-2-2	4	NIL	2				1						
11	15 PH 1001	Engineering Materials	2-2-2	4	NIL			1								
12	15 CY 1001	Engineering Chemistry	2-2-2	4	NIL		1	1								
13	15 BT 1001	Biology for Engineers	2-0-0	2	NIL								1		2	
14	15 MT 1102	Basic Mathematics	2-2-2	4	NIL	1				1						1
15	15 MT 2103	Probability & Statistics	3-0-0	3	NIL	2				2						
ENGINEERING SCIENCES																
16	15 CS 1001	C Programming & Data Structures	2-4-2	5	NIL	2				2						2
17	15 ME 1002	Engineering Graphics	0-0-6	3	NIL											2
18	15 GN 1004	Introduction to Engineering	2-0-2	3	NIL						3		2			
19	15 GN 1003	Measurements	0-0-4	2	NIL	2	2									
20	15 BT 1102	Process Engineering Principles	3-2-0	4	NIL	2				2						
21	15 BT 2218	Biochemical Thermodynamics	3-2-0	4	NIL	1	3									2
22	15 CS 2002	Object Oriented Programming	2-2-2	4	NIL					2						3

DEPARTMENT OF BIOTECHNOLOGY

S.No.	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
23	15 BT 2104	Fluid Mechanics and Heat Transfer	3-2-0	4	NIL		2			2						
PROFESSIONAL CORE COURSES																
24	15 BT 1203	Cell Biology	3-2-0	4	NIL	2										
25	15 BT 2105	Microbiology	3-0-2	4	NIL		2			2						3
26	15 BT 2106	Biochemistry	3-0-2	4	NIL			2								2
27	15 BT 2207	Bioanalytical techniques	3-0-2	4	NIL			3								3
28	15 BT 2208	Molecular Biology	3-2-0	4	NIL	2	2									
29	15 BT 2209	Biochemical reaction engineering	3-0-2	4	NIL		2			3						2
30	15 BT 3110	Immunology	3-0-2	4	NIL	1	2									2
31	15 BT 3111	Genetic Engineering	3-0-2	4	NIL		3			3						
32	15 BT 3112	Bioinformatics	3-0-2	4	NIL		2									3
33	15 BT 3113	Fermentation Technology	3-0-2	4	NIL					3						2
34	15 BT 3114	Mass Tranfer Operations	3-0-2	4	NIL		2									3
35	15 BT 3215	Bioprocess Dynamics and Control	3-2-0	4	NIL					3						2
36	15 BT 3216	Plant and Animal Biotechnology	3-0-2	4	NIL						2		3			
37	15 BT 3217	Down Stream Processing	3-0-2	4	NIL		3			2						2
38	15 IE 3250	Term Paper	0-0-4	2	NIL		2		3	3		3		2		
39	15 IE 4049	Minor Project	0-0-4	2	NIL 3						3					
40	15 IE 4050	Maj or Project	0-0-16	8	NIL	3		3			3	3	3	3		
41	Industrial Training ---2 CR (Summer Break in II/IV year) Professional Electives (3 CR X 5) - 15 CR Open Electives (3 CR X 2) - 6 CR Foreign Language --- 3CR Management Elective --- 3 CR Students can opt for Practice School in place of Major Project.			29												
	TOTAL CREDITS			**167**												

DEPARTMENT OF CIVIL ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
HUMANITIES & SOCIAL SCIENCES																
	15 GN 1001	Ecology and environment	2-0-0	2	NIL								2		1	
2	15 GN 1002	Human values	2-0-0	2	NIL						2					
3	15 EN 1101	Rudiments of communication skills	0-0-4	2	NIL							1				
4	15 EN 1202	Interpersonal communication skills	0-0-4	2	NIL				1			2				
5	15 EN 2103	Professional communication skills	0-0-4	2	NIL						1	3				
6	15 EN 2204	Employability skills	0-0-4	2	NIL						2	3				
7	15 EN 3105	Verbal and quantitative reasoning	0-0-4	2	NIL									1		
8	15 EN 3206	Corporate communication skills	0-0-4	2	NIL						3	3				
BASIC SCIENCES																
9	15 MT 1001	Single variable calculus and matrix algebra	2-2-2	4	NIL					1						1
10	15 ME 1001	Mechanics	2-2-2	4	NIL	2				1						
11	15 PH 1001	Engineering materials	2-2-2	4	NIL			1								
12	15 CY 1001	Engineering Chemistry	2-2-2	4	NIL		1	1								
13	15 BT 1001	Biology for engineers	2-0-0	2	NIL								1		2	
14	15 MT 1203	Multivariate calculus	2-2-2	4	NIL					2						2
15	15 CE 2103	Engineering geology	3-0-2	4	NIL								1			1
16	15 MT 2104	Probability and optimization techniques	2-2-2	4	NIL	2				2						
ENGINEERING SCIENCES																
17	15 CS 1001	C programming & data structures	2-4-2	5	NIL	2				2						2
18	15 ME 1002	Engineering graphics	0-0-6	3	NIL											2
19	15 GN 1003	Measurements	0-0-4	2	NIL	2	2									
20	15 GN 1004	Introduction to engineering	2-0-2	3	NIL						3		2			
21	15 CE 1201	Solid mechanics	3-0-2	4	15ME1001		2			2						2
22	15 CE 2102	Mechanics of fluids	2-2-2	4	15 ME1001		2			2						2

DEPARTMENT OF CIVIL ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
23	15 CE 2206	Construction materials & concrete technology	3-0-2	4	NIL		2			2						
PROFESSIONAL CORE COURSES																
24	15 CE 2104	Structural Analysis	3-2-0	4	NIL					2						2
25	15 CE 2105	Surveying	3-0-2	4	NIL	1										2
26	15 CE 2207	Building Planning and Construction	3-0-2	4	NIL			2								2
27	15 CE 2208	Environmental Engineering	3-0-2	4	NIL		2									2
28	15 CE 2209	Hydraulics and Hydraulic Machines	3-0-2	4	NIL		2									2
29	15 CE 2210	Soil Mechanics	3-0-2	4	15 CE 1201		3			2						2
30	15 CE 3111	Foundation Engineering	3-2-0	4	15 CE 2102		3			2						2
31	15 CE 3112	Design of Reinforced Concrete Structures	3-0-2	4	15 CE 2208			3								2
32	15 CE 3113	Design of Steel Structures	3-2-0	4	15CE2206, 15CE2104			2								3
33	15 CE 3114	Advanced Structural Analysis	3-0-2	4	15CE2206, 15CE2209					2						2
34	15 CE 3115	Transportation Engineering	3-0-2	4	15 CE 2210		2						2			
35	15 CE 3216	Quantity Surveying and Estimation	3-0-2	4	15 CE 2104					2						2
36	15 CE 3217	Advanced Design of Reinforced Concrete Structures	3-0-2	4	15 CE 3112		2			2						3
37	15 CE 3218	Water Resources Engineering	3-2-0	4	15 CE 2207		2									2
38	15 IE 3250	Term Paper	0-0-4	2	NIL		2		3	3		3		2		
39	15 IE 4049	Minor Project	0-0-4	2	NIL	3						3				
40	15 IE 4050	Major Project	0-0-16	8	NIL	3		3				3	3	3	3	
41	Industrial Training ---2 CR (Summer Break in II/IV year) Professional Electives (3 CR X 5) - 15 CR Open Electives (3 CR X 2) - 6 CR Foreign Language --- 3CR Management Elective --- 3 CR Students can opt for Practice School in place of Major Project.			29												
	TOTAL CREDITS			**167**												

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
HUMANITIES & SOCIAL SCIENCES																
1	15 GN 1001	Ecology and Environment	2-0-0	2	NIL								2	1		
2	15 GN 1002	Human Values	2-0-0	2	NIL						2					
3	15 EN 1101	Rudiments of Communication Skills	0-0-4	2	NIL							1				
4	15 EN 1202	Interpersonal Communication Skills	0-0-4	2	NIL				1			2				
5	15 EN 2103	Professional Communication Skills	0-0-4	2	NIL						1	3				
6	15 EN 2204	Employability Skills	0-0-4	2	NIL						2	3				
7	15 EN 3105	Verbal and Quantitative Reasoning	0-0-4	2	NIL									1		
8	15 EN 3206	Corporate Communication Skills	0-0-4	2	NIL						3	3				
BASIC SCIENCES																
9	15 MT 1001	Single Variable Calculus and Matrix Algebra	2-2-2	4	NIL					1						1
10	15 ME 1001	Mechanics	2-2-2	4	NIL	2				1						
11	15 PH 1001	Engineering Materials	2-2-2	4	NIL			1								
12	15 CY 1001	Engineering Chemistry	2-2-2	4	NIL		1	1								
13	15 BT 1001	Biology for Engineers	2-0-0	2	NIL								1		2	
14	15 MT 1203	Multivariate Calculus	2-2-2	4	NIL					2						2
15	15 MT 2005	Probability and Stochastic Models	2-2-2	4	NIL					2						2
ENGINEERING SCIENCES																
16	15 CS 1001	C Programming & Data Structures	2-4-2	5	NIL	2				2						2
17	15 ME 1002	Engineering Graphics	0-0-6	3	NIL											2
18	15 GN 1003	Measurements	0-0-4	2	NIL	2	2									
19	15 GN 1004	Introduction to Engineering	2-0-2	3	NIL						3		2			
20	15 CS 2002	Object Oriented Programming	2-2-2	4	NIL					2						3
21	15 EC 2002	Signal Analysis	2-2-2	4	NIL	2										2
22	15 CS 2003	Discrete Mathematics	2-2-2	4	NIL	2										2

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
23	15 CS 2104	Advanced Data Structures	2-2-2	4	15CS1001					2						3
PROFESSIONAL CORE COURSES																
24	15 EC 1101	Digital System Design	2-2-2	4	NIL					2						2
25	15 EM 2001	Computer Organization and Architecture	2-2-2	4	15 EC1101			2								2
26	15 CS 2007	Database Systems	2-2-2	4	NIL		3									2
27	15 CS 2105	Software Engineering	2-2-2	4	15EM2001					2						2
28	15 CS 2206	Operating Systems	2-2-2	4	15 CS 1001		2									3
29	15 CS 2208	Computer Networks	2-2-2	4	15 CS 1001					2						2
30	15 CS 3109	Theory of Computation	2-2-2	4	15 CS 2003	2				2						
31	15 CS 3110	Algorithm Design and Analysis	2-2-2	4	15 CS 2104					2						3
32	15 CS 3111	Artificial Intelligence	2-2-2	4	15 CS 2104			2		2						
33	15 CS 3112	Information Assurance & Security	2-2-2	4	15 CS 2208	2										2
34	15 CS 3113	Platform based Development	2-2-2	4	15 CS 2002	2				2						
35	15 CS 3214	Languages & Compilers	2-2-2	4	15 CS 3109					2						2
36	15 CS 3215	Parallel & Distributed Computing	2-2-2	4	15 CS 2208			2		2						
37	15 CS 3216	Graphics & Visualization	2-2-2	4	15 CS 2104			2								2
38	15 IE 3250	Term Paper	0-0-4	2	NIL		2		3	3		3		2		
39	15 IE 4049	Minor Project	0-0-4	2	NIL	3						3				
40	15 IE 4050	Major Project	0-0-16	8	NIL	3		3				3	3	3	3	
41	Industrial Training ---2 CR (Summer Break in II/IV year) Professional Electives (3 CR X 5) - 15 CR Open Electives (3 CR X 2) - 6 CR Foreign Language --- 3CR Management Elective --- 3 CR Students can opt for Practice School in place of Major Project.			29												
	TOTAL CREDITS			**168**												

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING																
S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
HUMANITIES & SOCIAL SCIENCES																
1	15 EN 1101	Rudiments of Communication Skills	0-0-4	2							1					
2	15 EN 1202	Interpersonal Communication Skills	0-0-4	2				1			2					
3	15 EN 2103	Professional Communication Skills	0-0-4	2						1	3					
4	15 EN 2204	Employability Skills	0-0-4	2						1	3					
5	15 EN 3105	Verbal and Quantitative Reasoning	0-0-4	2									1			
6	15 EN 3206	Corporate Communication Skills	0-0-4	2						3	3					
7	15 GN 1001	Ecology and Environment	2-0-0	2								2	1			
8	15 GN 1002	Human Values	2-0-0	2						2						
BASIC SCIENCES																
9	15 MT 1001	Single Variable Calculus and Matrix Algebra	2-2-2	4					1						1	
10	15 MT 1203	Multivariate Calculus	2-2-2	4					2						2	
11	15 MT 2005	Probability and Stochastic Models	2-2-2	4					2						2	
12	15 ME 1001	Mechanics	2-2-2	4	2				1							
13	15 PH 1001	Engineering Materials	2-2-2	4			1									
14	15 CY 1001	Engineering Chemistry	2-2-2	4		1	1									
15	15 BT 1001	Biology for Engineers	2-0-0	2								1		2		
16	15 EE 1201	Fields & Networks	2-2-2	4	2										1	
ENGINEERING SCIENCES																
17	15 GN 1004	Introduction to Engineering	2-0-2	3						3		2				
18	15 CS 1001	C Programming & Data Structures	2-4-2	5	2				2						2	
19	15 ME 1002	Engineering Graphics	0-0-6	3											2	
20	15 GN 1003	Measurements	0-0-4	2	2	2										
21	15 CS 2002	Object Oriented Programming	2-2-2	4					2						3	
22	15 EC 2002	Signal Analysis	2-2-2	4	2										2	

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING																
S.No	**Course code**	**Course Name**	**L-T-P**	**Cr**	**Pre-Req.**	**Mapping with SO**										
						a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
23	15 CS 2003	Discrete Mathematics	2-2-2	4	2										2	
PROFESSIONAL CORE COURSES																
24	15 EC 1101	Digital System Design	2-2--2	4					2						2	
25	15 EM 2001	Computer Organization and Architecture	2--2--2	4			2								2	
26	15 EC 2103	Analog Electronic Circuit Design	2--4--2	5			3								3	
27	15 EM 2202	Processors and Controllers	2--2--2	4					2						3	
28	15 EC 2204	Design with CPLD & FPGA	2--2--2	4			2								2	
29	15 EC 2205	Communication Theory-1	2--2--2	4		2									2	
30	15 EC 2206	Signal Processing	2--2--2	4					2						3	
31	15 EE 2207	Control Systems	2--2--2	4					2						2	
32	15 CS 2208	Computer Networks	2--2--2	4		2									2	
33	15 EM 3103	Embedded Systems	2--2--2	4			2								3	
34	15 EC 3107	CMOS VLSI Design	2--2--2	4		2									3	
35	15 EC 3108	Communication Theory-2	2--2--2	4		2									2	
36	15 EC 3209	Communication Theory-3	2--2--2	4		2									1	
37	15 EC 4110	Digital Image Processing	2--2--2	4		3									3	
38	15 IE 3250	Term Paper	0-0-4	2		2		3	3		3		2			
39	15 IE 4049	Minor Project	0-0-4	2	3						3					
40	15 IE 4050	Major Project	0-0-16	8	3		3				3	3	3	3		
41	Industrial Training ---2 CR (Summer Break in II/IV year) Professional Electives (3 CR X 5) - 15 CR Open Electives (3 CR X 2) - 6 CR Foreign Language --- 3CR Management Elective --- 3 CR Students can opt for Practice School in place of Major Project.			29												
	TOTAL CREDITS			**169**												

DEPARTMENT OF ELECTRONICS & COMPUTER ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	a	b	c	d	e	f	g	h	i	j	k
HUMANITIES & SOCIAL SCIENCES																
1	15 GN 1001	Ecology and Environment	2-0-0	2	NIL								2	1		
2	15 GN 1002	Human Values	2-0-0	2	NIL						2					
3	15 EN 1101	Rudiments of Communication Skills	0-0-4	2	NIL							1				
4	15 EN 1202	Interpersonal Communication Skills	0-0-4	2	NIL				1			2				
5	15 EN 2103	Professional Communication Skills	0-0-4	2	NIL						1	3				
6	15 EN 2204	Employability Skills	0-0-4	2	NIL						2	3				
7	15 EN 3105	Verbal and Quantitative Reasoning	0-0-4	2	NIL									1		
8	15 EN 3206	Corporate Communication Skills	0-0-4	2	NIL						3	3				
BASIC SCIENCES																
9	15 MT 1001	Single Variable Calculus and Matrix Algebra	2-2-2	4	NIL					1						1
10	15 ME 1001	Mechanics	2-2-2	4	NIL	2				1						
11	15 PH 1001	Engineering Materials	2-2-2	4	NIL			1								
12	15 CY 1001	Engineering Chemistry	2-2-2	4	NIL		1	1								
13	15 BT 1001	Biology for Engineers	2-0-0	2	NIL								1		2	
14	15 EE 1201	Fields & Networks	2-2-2	4	NIL	2										1
15	15 MT 1203	Multivariate Calculus	2-2-2	4	NIL					2						2
16	15 MT 2005	Probability and Stochastic Models	2-2-2	4	NIL					2						2
ENGINEERING SCIENCES																
17	15 CS 1001	C Programming & Data Structures	2-4-2	5	NIL	2				2						2
18	15 ME 1002	Engineering Graphics	0-0-6	3	NIL											2
19	15 GN 1003	Measurements	0-0-4	2	NIL	2	2									
20	15 GN 1004	Introduction to Engineering	2-0-2	3	NIL						3		2			
21	15 CS 2002	Object Oriented Programming	2-2-2	4	NIL					2						3
22	15 EC 2002	Signal Analysis	2-2-2	4	NIL	2										2

DEPARTMENT OF ELECTRONICS & COMPUTER ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
23	15 CS 2003	Discrete Mathematics	2-2-2	4	NIL	2										2
PROFESSIONAL CORE COURSES																
24	15 EC 1101	Digital System Design	2-0-2	4	NIL					2						2
25	15EM2001	Computer Organization and Architecture	2-2-2	4	15 EC 1101			2								2
26	15 CS 2007	Database Systems	2-2-2	4	15 CS 1001		3									2
27	15 EC 2103	Analog Electronic Circuit Design	2-4-2	5	NIL			3								3
28	15 CS 2105	Software Engineering	2-2-2	4	NIL					2						2
29	15EM2202	Processors and Controllers	2-2-2	4	15 EC 1101					2						3
30	15 EC 2206	Signal Processing	2-2-2	4	15 EC 2002					2						3
31	15 CS 2206	Operating Systems	2-2-2	4	15 EM2001	2										3
32	15 CS 2208	Computer Networks	2-2-2	4	15 CS 1001		2									2
33	15EM3103	Embedded Systems	2-2-2	4	15 EM2202			2								3
34	15EM3104	Communication Systems	2-2-2	4	15 EC 2103		2									2
35	15EM3105	Internet Programming	2-2-2	4	15 CS 2002					2						3
36	15EM3206	VLSI Design	2-2-2	4	15 EC 1101		2									3
37	15EM3207	Automata and Compiler Design	2-2-2	4	15 CS 2003	2										3
38	15 IE 3250	Term Paper	0-0-4	2	NIL		2		3	3		3		2		
39	15 IE 4049	Minor Project	0-0-4	2	NIL	3						3				
40	15 IE 4050	Major Project	0-0-16	8	NIL	3		3				3	3	3	3	
41	Industrial Training ---2 CR (Summer Break in II/IV year) Professional Electives (3 CR X 5) - 15 CR Open Electives (3 CR X 2) - 6 CR Foreign Language --- 3CR Management Elective --- 3 CR Students can opt for Practice School in place of Major Project.			29												
	TOTAL CREDITS			**169**												

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	a	b	c	d	e	f	g	h	i	j	k
HUMANITIES & SOCIAL SCIENCES																
1	15 GN 1001	Ecology and Environment	2-0-0	2								2	1			
2	15 GN 1002	Human Values	2-0-0	2						2				1		
3	15 EN 1101	Rudiments of Communication Skills	0-0-4	2						1	1					
4	15 EN 1202	Interpersonal Communication Skills	0-0-4	2				1			2					
5	15 EN 2103	Professional Communication Skills	0-0-4	2						1	3					
6	15 EN 2204	Employability Skills	0-0-4	2						2	3					
7	15 EN 3105	Verbal and Quantitative Reasoning	0-0-4	2									1			
8	15 EN 3206	Corporate Communication Skills	0-0-4	2						3	3					
BASIC SCIENCES																
9	15 MT 1001	Single Variable Calculus and Matrix Algebra	2-2-2	4					1						1	
10	15 ME 1001	Mechanics	2-2-2	4	2				1							
11	15 PH 1001	Engineering Materials	2-2-2	4			1									
12	15 CY 1001	Engineering Chemistry	2-2-2	4		1	1									
13	15 BT 1001	Biology for Engineers	2-0-0	2								1		2		
14	15 EE 1201	Fields & Networks	2-2-2	4	2										1	
15	15 MT 1203	Multivariate Calculus	2-2-2	4					2						2	
ENGINEERING SCIENCES																
16	15 CS 1001	C Programming & Data Structures	2-4-2	5	2				2						2	
17	15 ME 1002	Engineering Graphics	0-0-6	3											2	
18	15 GN 1003	Measurements	0-0-4	2	2	2										
19	15 GN 1004	Introduction to Engineering	2-0-2	3						3		2				
20	15 CS 2002	Object Oriented Programming	2-2-2	4					2						3	
21	15 EC 2002	Signal Analysis	2-2-2	4	2										2	2
22	15 CS 2003	Discrete Mathematics	2-2-2	4	2										2	2

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
PROFESSIONAL CORE COURSES																
23	15 EC 1101	Digital System Design	2-2-2	4					2						2	
24	15EM2001	Computer Organization and Architecture	2-2-2	4			2								2	
25	15 EE 2103	Electrical Circuits	2-2-2	4		3									2	
26	15 EC 2103	Analog Electronic Circuit Design	2-4-2	5			3								3	
27	15 EE 2104	DC Machines and Transformers	2-2-2	4		2			2						2	
28	15EM2202	Processors and Controllers	2-2-2	4					2						3	
29	15 EE 2205	AC Machines	2-2-2	4		2									2	
30	15 EC 2206	Signal Processing	2-2-2	4					2						3	
31	15 EE 2206	Generation, Transmission & Distribution	2-2-2	4			2								1	
32	15 EE 2207	Control Systems	2-2-2	4					2						2	
33	15 EE 3108	Power System Analysis	2-2-2	4					2						2	
34	15 EE 3109	Power Electronics	2-2-2	4			2								3	
35	15 EE 3210	Power System Protection	2-2-2	4					2						2	
36	15 EE 3211	Electrical Drives	2-2-2	4	2				2							
37	15 IE 3250	Term Paper	0-0-4	2		2		3	3		3		2			
38	15 IE 4049	Minor Project	0-0-4	2	3						3					
39	15 IE 4050	Major Project	0-0-16	8	3		3				3	3	3	3		
40	Industrial Training ---2 CR (Summer Break in II/IV year) Professional Electives (3 CR X 5) - 15 CR Open Electives (3 CR X 2) - 6 CR Foreign Language --- 3CR Management Elective --- 3 CR Students can opt for Practice School in place of Major Project.			29												
	TOTAL CREDITS			**167**												

DEPARTMENT OF MECHANICAL ENGINEERING																
S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
HUMANITIES & SOCIAL SCIENCES																
1	15 GN 1001	Ecology and Environment	2-0-0	2								2	1			
2	15 GN 1002	Human Values	2-0-0	2						2						
3	15 EN 1101	Rudiments of Communication Skills	0-0-4	2							1					
4	15 EN 1202	Interpersonal Communication Skills	0-0-4	2				1			2					
5	15 EN 2103	Professional Communication Skills	0-0-4	2						1	3					
6	15 EN 2204	Employability Skills	0-0-4	2						2	3					
7	15 EN 3105	Verbal and Quantitative Reasoning	0-0-4	2									1			
8	15 EN 3206	Corporate Communication Skills	0-0-4	2						3	3					
BASIC SCIENCES																
9	15 MT 1001	Single Variable calculus and Matrix Algebra	2-2-2	4					1						1	
10	15 PH 1001	Engineering Materials	2-2-2	4			1									
11	15 CY 1001	Engineering Chemistry	2-2-2	4		1	1									
12	15 BT 1001	Biology for Engineers	2-0-0	2								1		2		
13	15 MT 1203	Multivariate Calculus	2-2-2	4					2						2	
14	15 MT 2104	Probability and Optimization Techniques	2-2-2	4	2				2							
ENGINEERING SCIENCES																
15	15 CS 1001	C Programming & Data Structures	2-4-2	5	2				2						2	
16	15 GN 1003	Measurements	0-0-4	2	2	2										
17	15 GN 1004	Introduction to Engineering	2-0-2	3						2		2				
18	15 EC 2002	Signal Analysis	2-2-2	4	2										2	
19	15 EE 2202	Basic Electrical & Electronics Engineering	2-2-2	4	1				2							
PROFESSIONAL CORE COURSES																
20	15 ME 1001	Mechanics	2-2-2	4	2				1							
21	15 ME 1002	Engineering Graphics	0-0-6	3											2	

DEPARTMENT OF MECHANICAL ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
22	15 ME 1003	Thermodynamics	2-2-2	4	2										1	
23	15 ME 2104	Fluid Mechanics	2-2-2	4			2		2							
24	15 ME 2105	Material Science & Metallurgy	2-2-2	4	2	2										
25	15 ME 2106	Strength of Materials	2-2-2	4		3			2							
26	15 ME 2207	Graphics And Visualization of Mechanical Components	2-0-2	3								2				2
27	15 ME 2208	Manufacturing Science and Technology	2-2-2	4			2	2								
28	15 ME 2209	Kinematics and Dynamics of Machines	2-2-2	4						2						2
29	15 ME 2210	Applied Thermodynamics	2-2-2	4	2	2										
30	15 ME 3111	Finite Element Method	2-2-2	4					2						3	
31	15 ME 3112	Design of Machine Elements	2-2-2	4			2		3							
32	15 ME 3113	Advanced Manufacturing Technology	2-2-2	4			2									3
33	15 ME 3114	Turbo Machines	2-2-2	4		2			2							
34	15 ME 3115	Feedback and Control Systems	2-2-2	4		2	2									
35	15 ME 3216	Design of Transmission Elements	2-2-2	4			2		3							
36	15 ME 3217	Production and Operations Management	2-2-2	4			2	2								3
37	15 ME 3218	Heat Transfer	2-2-2	4					2						2	
38	15 IE 3250	Term Paper	0-0-4	2		2		3	3		3		2			
39	15 IE 4049	Minor Project	0-0-4	2	3						3					
40	15 IE 4050	Major Project	0-0-16	8	3		3				3	3	3	3		
41	Industrial Training ---2 CR (Summer Break in II/IV year) Professional Electives (3 CR X 5) - 15 CR Open Electives (3 CR X 2) - 6 CR Foreign Language --- 3CR Management Elective --- 3 CR Students can opt for Practice School in place of Major Project.			29												
		TOTAL CREDITS		**167**												

DEPARTMENT OF PETROLEUM ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
HUMANITIES & SOCIAL SCIENCES																
1	15 GN 1001	Ecology and Environment	2-0-0	2								2	1			
2	15 GN 1002	Human Values	2-0-0	2						2						
3	15 EN 1101	Rudiments of Communication Skills	0-0-4	2							1					
4	15 EN 1202	Interpersonal Communication Skills	0-0-4	2				1			2					
5	15 EN 2103	Professional Communication Skills	0-0-4	2						1	3					
6	15 EN 2204	Employability Skills	0-0-4	2						2	3					
7	15 EN 3105	Verbal and Quantitative Reasoning	0-0-4	2									1			
8	15 EN 3206	Corporate Communication Skills	0-0-4	2						3	3					
BASIC SCIENCES																
9	15 BT 1001	Biology for Engineers	2-0-0	2								1		2		
10	15 MT 1001	Single Variable Calculus and Matrix Algebra	2-2-2	4					1						1	
11	15 PH 1001	Engineering Materials	2-2-2	4			1									
12	15 CY 1001	Engineering Chemistry	2-2-2	4		1	1									
13	15 ME 1001	Mechanics	2-2-2	4	2				1							
14	15 MT 1203	Multivariate Calculus	2-2-2	4					2						2	
ENGINEERING SCIENCES																
15	15 CS 1001	C Programming & Data Structures	2-4-2	5	2				2						2	
16	15 ME 1002	Engineering Graphics	0-0-6	3											2	
17	15 ME 1003	Thermodynamics	2-2-2	4	2										1	
18	15 GN 1003	Measurements	0-0-4	2	2	2										
19	15 GN 1004	Introduction to Engineering	2-0-2	3						3		2				
20	15 CS 2002	Object Oriented Programming	2-2-2	4					2						3	
21	15 PE 2101	Momentum Transfer	2-2-2	4		2			2							
22	15 PE 2102	Material & Energy Flow Computation	3-2-0	4					2						2	

DEPARTMENT OF PETROLEUM ENGINEERING

S.No	Course code	Course Name	L-T-P	Cr	Pre-Req.	Mapping with SO										
						a	b	c	d	e	f	g	h	i	j	k
23	15 PE 2207	Chemical Engineering Thermodynamics	3-2-0	4					2						2	
PROFESSIONAL CORE COURSES																
24	15 PE 2103	Geology for Petroleum Engineers	3-0-2	4	1	3										
25	15 PE 2104	Drilling Engineering & Well Completion	2-2-2	4		2			3							
26	15 CE 2105	Surveying	3-0-2	4	1										2	
27	15 PE 2205	Petroleum Exploration Methods	2-2-2	4	2	3										
28	15 PE 2206	Reservoir Engineering	2-2-2	4		2			3							
29	15 PE 2208	Process Heat Transfer	2-2-2	4		3			2							
30	15 PE 3109	Chemical Reaction Engineering	2-2-2	4		2			2							
31	15 PE 3110	Natural Gas Engineering & Processing	2-2-2	4					2						2	
32	15 PE 3111	Petroleum Formation Evaluation	2-2-2	4					2						3	
33	15 PE 3112	Pipeline Engineering & Transportation of Oil & Gas	2-2-2	4			2								3	
34	15 PE 3113	Mass Transfer	2-2-2	4		3			2							
35	15 PE 3214	Environmental Hazardous and Safety Management	2-2-2	4		2						3				
36	15 PE 3215	Petroleum Production Engineering	2-2-2	4					3						3	
37	15 PE 3216	Oil and Gas Well Testing	2-2-2	4					3						3	
38	15 IE 3250	Term Paper	0-0-4	2		2		3	3		3		2			
39	15 IE 4049	Minor Project	0-0-4	2	3						3					
40	15 IE 4050	Major Project	0-0-16	8	3		3				3	3	3	3		
41	Industrial Training ---2 CR (Summer Break in II/IV year) Professional Electives (3 CR X 5) - 15 CR Open Electives (3 CR X 2) - 6 CR Foreign Language --- 3CR Management Elective --- 3 CR Students can opt for Practice School in place of Major Project.			**29**												
	TOTAL CREDITS			**168**												

SYLLABUS 2015- 16

HUMANITIES & SOCIAL SCIENCES

RUDIMENTS OF COMMUNICATION SKILLS

Course code: 15 EN 1101 **L-T-P:** 0-0-4

Pre Requisite: NIL **Credits:** 2

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Remember speech sounds and apply stress and intonation rules to enhance pronunciation skills.	g	1
CO 2	Understand writing strategies and apply those by using the basic and advanced concepts of grammar.	g	1
CO 3	Understand the types of texts and tone of the author.	g	1
CO 4	Understand the importance of interpersonal skills	g	1

Syllabus:

Speaking & listening skills - Vowels in English, Diphthongs, Consonants, Word stress, Intonation, Words in Groups - English Conversation Practice, Difference between British English and American English, Received Pronunciation and Dialects, American Spelling and American Grammar , American Pronunciation, Listen and respond, Speak and Listen, Listen and Speak.

Speaking and listening exercises from Effective Speech Richard W Clark- Speaking to persuade, listening to understand.

General writing skills - Paragraph Writing: Seven `C's of writing , Identifying & writing Topic sentences, Linkers, Coordinates, Sequencing, Letter Writing: Formal & Informal formats- Full block, Semi block, Modified block- Types & tone of letters, content & brevity, Note Making & Note Taking.

Reading skills - Reading comprehension Practice exercises (TOEFL Level) - Reading for information, Reading for specifics - Theme, Attitude, Identifying tone.

Soft skills - Introduction to soft skills, Body Language, Postures, Gestures, Eye contact, Personality styles, Grooming, Dress code, Group discussion - Format, Do s and Don'ts, scoring method

Text book:

1. Material produced by the Dept.

References Book:

1. Mark Hancock and Sylvie Donna, "English pronunciation in use: Intermediate", 2nd edition,Cambridge publication.
2. Krishna Mohan & N P Singh, "Speaking English Effective (English) 2nd Edition", Laxmi Publications-New Delhi, (2005).
3. Mr. Gopalaswamy Ramesh et al, "The Ace of Soft Skills", Pearson publishers, (2010).
4. Richard W.Clark, "Effective speech", Glencoe Pub. Co., (1988).

INTERPERSONAL COMMUNICATION SKILLS

Course code: 15 EN 1202 **L-T-P:** 0-0-4

Pre Requisite: NIL **Credits:** 2

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the method of identifying the meaning of words from the context and form sentences using words.	g	1
CO 2	Understand and analyze seven types of reading techniques and improve reading speed.	g	2
CO 3	Understand and apply writing strategies for office/ formal communication.	g	2
CO 4	Understand and analyze different cultures and the importance of empathy in cross-cultural communication.	d	1

Syllabus:

Speaking skills - Interactive Skills: Group Activities taken from keep Talking by Mary Spratt; at the chalk face Oxford word skills (Units 21-50)

Vocabulary Skills -Basic Word List (900 words), Identifying meaning from context, Antonyms and Synonyms (Level 1)

Writing skills - Inter Office Communication and Intra Office Communication - Memo Writing, Circulars, Emails -

Netiquette, Formal and Informal Formats, Clear, concise expression, Dos and Don'ts of Email writing.

Reading skills - Types of Reading - Vertical Reading, Identifying the central idea, Speed Reading, and Seven techniques to improve reading speed.

Soft skills-II (Case Studies, Vodcasts and Role Play - ICT enabled) - Cultural sensitivity, Empathy and understanding, Diversity and Acculturation

Text Books:

1. Aruna Koneru, "Professional Communication", Tata Mc Graw- Hill Publishing Company, New Delhi, (2008)t.
2. Asha Kaul, "Effective Business Communication", PHI Learning Private Limited, New Delhi, (2011).
3. Sharon J. Gerson, Steven M Gerson, "Technical Writing Process and Product" (third edition), Pearson Education, Asia.
4. Frangoise Grelle, "Developing Reading Skills: A Practical Guide to Reading Comprehension Exercises", Cambridge University Press, (1981)
5. Eric H. Glendinning, Beverly Holmström, "Study Reading: A Course in Reading Skills for Academic Purposes", Cambridge University Press, (2004)
6. Content Area Reading: Teaching and Learning in an Age of Multiple Literacies, Video-Enhanced Pearson eText, Maureen, Pearson Education (US), (2014)

PROFESSIONAL COMMUNICATION SKILLS

Course code : 15 EN 2103 **L-T-P :** 0-0-4

Pre Requisite : NIL **Credits :** 2

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the concept of Group Discussion and listen and speak effectively during the discussion.	g	1
CO 2	Understand and improve learners' competency in competitive English and apply the principles of grammar in real life contexts.	g	2
CO 3	Understand skimming & scanning, and apply the types of reasoning in comprehending the information.	g	3
CO 4	Understand the mechanics and application of presentation skills.	f	1

Syllabus:

Speaking skills - Group Discussions (Level 1) - Format of GD as used in national level recruitment boards, Rules, ambience and normal practices, Do s and Don't s in Group Discussions, Helping to build confidence, improve on content and clarity, Practicing skills like Initiating, developing and concluding discussions

Structures and written expression (exercises) - Sentence Completion (Single blank TOEFL level), Analogies, One word substitutes, Mechanics of Grammar - Correction of Sentences, Errors in grammar and usage, Jumbled Sentences / Paragraph scramble, Rephrasing.

Reading skills level 2 (gre gmat cat level) - Skimming and scanning, Word Perception tests, Reading speed development (7 skill exercises), Searching for key words, Reasoning Skills - Analytical Reasoning, Critical Reasoning, Language Specific Reasoning

Soft skills III - Seminars, Presentations, Case Studies: Role Plays and Simulated Presentation.

Text Books:

1. Edgar Thorpe and Showick Thorpe, "Objective English"3rd Ed,Pearson Publishers, (2010).
2. R. S. Aggarwal, "Objective General English", S Chand Publishers, New Delhi.
3. Mortimer J. Adler, Charles Van Doren, Simon and Schuster, "How to Read a Book: The Classic Guide to Intelligent Reading" , (2014).
4. Bob Underwood, Jesse Zuck, "Philosophy Skills Book: Exercises in Philosophical Thinking, Reading, and... Chris Case", A&C Black, (2012)
5. Joanne Carlisle, "Reasoning and Reading Level 1", School Specialty Intervention, (1999)
6. Patsy Mc Carthy & Caroline Hatcher, "Presentation skills. The essential guide for students", Sage publications, (2002).

EMPLOYABILITY SKILLS

Course code : 15 EN 2204 **L-T-P :** 0-0-4

Pre Requisite : NIL **Credits :** 2

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Analyze one's own strength as a speaker/ Communicator and use discretion while listening.	g	2
CO 2	Apply and analyze various concepts of writing strategies in professional communication skills like, reports, resume and minutes of the meeting.	g	3
CO 3	Understand the organization of the passage and also analyze the tone, attitude and style of the author.	g	2
CO 4	Acquire knowledge of and apply people skills in various social organizational and corporate ambiences.	f	2

Syllabus:

Speaking skills - Group Discussions Level 2 Speaking and listening exercises From Effective Speech by Richard W Clark.

Know yourself as a Communicator, Communicating with others, Group Discussion, Interactive Listening.

Writing skills- Writing Proposals, Product and process description, Agenda, Minutes and Scheduling meetings, Technical Writing Skills - Report Writing, Types of reports, Formats, How to write good reports, Résumé and Job Application.

Reading skills - Reading Comprehension (GRE, GMAT Pattern) - Identifying the author's purpose, Main Idea/ Theme, Suitable Title, Specific information, not mentioned/ Negative factual information, Tone, Attitude and Style, Structure / Organization. Vocabulary in context - Signpost words, Pejorative Signals and Complimentary Signals, Continuation Signals, Contrast signals, Sentence Completion, Text completion, Sentence Equivalence (Single blank, double blank, three blank, two answer Questions)

People skills - Initiating and ending conversations, Expressing and creating interest, practicing therapeutic listening, Breaking good/bad news.

Text Books:

1. Raymond V.Leisikar et al. , "Business Communication: Connecting in a Digital World", Tata Mc Graw Hill Education, 13th Ed., (2015)
2. Mallika Nawal, "Business Communication", Cengage Learning Pvt Limited, Delhi, (2014)
3. Lisa Zimmer Hatch, Scott Hatch, "GMAT for Dummies", John Wiley & Sons, (2012)
4. Eric H. Glendinning, Beverly Holmström, "Study Reading: A Course in Reading Skills for Academic Purposes", Cambridge University Press, (2004).
5. Sunitha Mithra, "Personality Development and soft skills", OUP (2012).

VERBAL AND QUANTITATIVE REASONING

Course code : 15 EN 3105 **L-T-P :** 0-0-4

Pre Requisite : NIL **Credits :** 2

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the method of identifying synonyms and antonyms and analyze the meaning of a word from the context.	i	1
CO 2	Analyze issues and arguments in the process of critical reasoning and apply grammar rules to correct sentences.	i	1
CO 3	Apply the Concepts of basic Algebra and their importance while solving the problems	i	1
CO 4	Apply the short-cut methods on the concepts of different models in Calendars, Clocks, Blood relations and various types of arrangements.	i	1

Syllabus:

Verbal ability (GRE, GMAT, CAT PATTERN): Synonyms, Antonyms and One word substitutes.

Critical reasoning: Analyzing issues, Analyzing arguments and Sentence correction.

Quantitative reasoning (GRE, GMAT, CAT pattern):Arithmetic – Decimals, Exponents and Roots, Fractions, Integers, Percent, Ratio, Real Numbers. Algebra - Applications, Coordinate Geometry, Functions, Graphs of Functions, Operations with Algebraic Expressions, Rules of Exponents, Solving Linear Equations, Solving Linear Inequalities, Solving Quadratic Equations.

Reasoning - Clocks, Calendars, Binary logic, seating arrangement, Blood relations, Logical sequence, Assumption, Premise Conclusion, Linear and matrix arrangement.

Text Books:

1. Hari Mohan Prasad, "Objective English for Competitive Examinations (English)" 4th Ed. Tata McGraw - Hill Education, 2009.
2. RS Agarwal, "Objective General English", S Chand Publishers, New Delhi
3. P Bhardwaj , "Analytical & Logical Reasoning For CAT & Other Management Entrance Tests", Arihant Publications(I) Pvt.Ltd – Meerut, 2012 print.
4. R. S. Aggarwal, "Quantitative Aptitude for Competitive Examinations", S.Chand, (2013).

CORPORATE COMMUNICATION SKILLS

Course code : 15 EN 3206 **L-T-P :** 0-0-4

Pre Requisite : NIL **Credits :** 2

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand and analyze the depth of a topic and use the advanced levels in creative speaking and debating.	g	1
CO 2	Understand and analyze various strategies involved in writing an essay and apply various styles in writing.	g	2
CO 3	Understand and analyze the given text critically and answer questions on critical reasoning based on the given information.	g	3
CO 4	Acquire knowledge on various employability skills & analyze a situation and develop adaptability.	f,g	3
CO5	Apply the Concepts of basic geometry and their importance while solving the problems.	g	2

Syllabus:

Speaking skills - Speaking and listening exercises, From Effective Speech Richard W Clark, Storytelling and interpretation - Speaking to Explain, Speaking Activities - JAM, Information Gap / Creating stories, Picture Description, Debate

Writing skills - Five Types of Essays (TOEFL IBT pattern) - Agree or disagree, which you prefer and why, If / imaginary, Description / Explanation, Comparison and Contrast, Styles in Writing: Modes of Discourse - Narration, Description, Exposition, Argumentation/ Persuasion

Reading skills - Reading Comprehension - Critical Reading, Searching for implied meanings, Answering questions on theme, tone, point of view, title etc.

Soft skills - Interview Skills, Mock Interviews, Writing personal profile & Company profile, Answering unconventional HR questions, Dress Code, Dining etiquette, Interpersonal skills.

Quantitative reasoning -2: Geometry - Circles, Lines and Angles, Polygons, Quadrilaterals, Three-Dimensional Figures, Triangles – Data Analysis- Counting Methods, Data Interpretation Examples, Distributions of Data, Random Variables, and Probability Distributions, Graphical Methods for Describing Data, Numerical Methods for Describing Data, Probability.

Text Books:

1. Sanjay Kumar & Pushp Lata, "Communication Skills", Oxford University Press, (2014)
2. Akanksha Makwana, Heeral Bhatt, "IELTS Essay Booster (One Stop Destination for the Writing Module) (English)", MK Book Distributors- Ahmedabad.
3. GRE Analytical Writing: Solutions to the Real Essay Topics (English), Create space Independent Pub.
4. Critical Reading: English for Academic Purposes 1st Edition, Pearson Education ESL; 1 edition, (2015)
5. Eric H. Glendinning, Beverly Holmström, "Study Reading: A Course in Reading Skills for Academic Purposes", Cambridge University Press, (2004).
6. M S Rao, "Soft Skills Enhancing Employability – Connecting campus with corporate", International Publishing Pvt Ltd, (2002).
7. R. S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", S Chand Publishers, (2010).

ECOLOGY AND ENVIRONMENT

Course code: 15 GN 1001 **L-T-P:** 2-0-0

Pre Requisite: NIL **Credits:** 2

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the importance of Environmental education and conservation of natural resources.	h	1
CO 2	Understand the importance of ecosystems and biodiversity.	i	1
CO 3	Apply the environmental science knowledge on solid waste management, disaster management and EIA process.	h	2

Syllabus:

The Multidisciplinary nature of Environmental Studies - Introduction to Environment, Definit ion,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 - Benifits,Deforestation,causes, effects and impacts, Afforestation programmes, Socio-forestry, Agro-forestry, Vanasamrakshana programmes,. Mining its impact on environment - mining, dams and their effects on forests and tribal people. Water resources- Distribution of surface and ground water, 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. Land resources-. 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, Energy flow in the ecosystem ,Ecological succession, Food chains, food webs and ecological pyramids. Types of ecosystem. Biodiversity and its Conservation- Introduction, Definition, Levels, Values of biodiversity, India as a mega diversity nation. Hotspots of biodiversity. Threats to biodiversity- Endangered and endemic species of India. Conservation of biodiversity- Assessment of Biodiversity and its impact on Environment. Environnemental Pollution- Définition, Causes, effects, control measures of Air pollution, Water pollution, oïl pollution, Marine pollution, Noise pollution, Thermal pollution,Nuclear hazards. Soil waste management. Electronic waste management, Biomedical waste management - Role of an individual in prevention of pollution. Disaster management–.Climate change, global warming, acid rain, ozone layer depletion. Environmental Legislation and objectives of Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife protection Act, Forest conservation Act, Biodiversity Act, Public awareness. Environmental Impact Assessment Process.

Text Book:

1. Anubha Kaushik, C.P.Kaushik, "Environmental Studies" , New Age International, (2007).
2. Benny Joseph, "Environmental Studies", Tata McGraw-Hill companies, New Delhi, (2009).

HUMAN VALUES

Course code: 15 GN 1002 **L-T-P:** 2-0-0

Pre Requisite: NIL **Credits:** 2

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand and identify the basic aspiration of human beings	f	1
CO2	Envisage the roadmap to fulfill the basic aspiration of human beings.	f	2
CO3	Analyze the profession and his role in this existence.	f	2

Syllabus:

Introduction to Value Education: Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity - The Basic Human Aspirations, Right Understanding, Relationship and Physical Facilities, Happiness and Prosperity – Current Scenario, Method to fulfill the Basic Human Aspirations.

Harmony in the Human Being: Understanding the Human Being as Co-existence 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, Program to Ensure Sanyam and Svasthya.

Harmony in the Family and Society: Harmony in the Family - the Basic Unit of Human Interaction, Values in Human-to-Human Relationships, 'Trust' – the Foundational Value in Relationships, 'Respect' – as the Right Evaluation, Understand Harmony in the Society, 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 Co-existence' at All Levels, The Holistic Perception of Harmony in Existence.

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 Value-based Life and Profession.

Text Book:

1. R R Gaur, R Sangal and G P Bagaria, " A Foundation Course in Human Values and Professional Ethics", 1st Ed, Excel Books.

BASIC SCIENCES

SINGLE VARIABLE CALCULUS AND MATRIX ALGEBRA

Course Code : 15MT1001 **L-T-P :** 2-2-2

Pre-requisite : Nil **Credits :** 4

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Formulate physical laws and relations mathematically in the form of first order differential equations and identify a method for solving and interpreting the results.	e	1
CO-2	Formulate physical laws and relations mathematically in the form of second/higher order differential equations and identify a method for solving and interpreting the results.	e	1
CO-3	Provide solutions for Fourier series of periodic/ non-periodic phenomenon in models involving differential equations.	e	1
CO-4	Apply numeric solution methods for a system of linear algebraic equations and application oriented matrix eigenvalue problems.	e	1
CO-5	Verify the solution of problems through MATLAB.	k	1

Syllabus:

Differential Equations: Definitions and terminology and mathematical models used in a differential equations. First-order and higher-order differential equations, along with the methods of solutions and their applications. Modeling with first and higher-order also systems of linear first-order differential equations. Solutions of first order ordinary differential equations by Numerical methods.Fourier series: Definitions and Fourier series for a periodic signal. Fourier series for simple functions. Fourier series of the summation of sinusoids directly from the definition by using Euler's formula. Solving particular solution to differential equation by Fourier series.Matrix algebra: Solving linear System of equations by Gauss-elimination, L U decomposition and Jacobi, Gauss seidal iteration methods, orthogonal, symmetric, skew-symmetric, Hermitian, Skew-Hermitian and unitary matrices, Eigen values, Eigen vectors and their properties, Cayley -Hamilton theorem (without proof) and its applications, and quadratic forms.

Text Books:

1. Erwin Kreyszig ,"Advanced engineering mathematics". JOHN WILEY Publishers, 10th edition.
2. Green Berg ,"Advanced engineering mathematics", PHI publishers, 2 nd edition.

Reference Books:

1. Differential equations for engineers, WEI-CHAU XIE, Cambridge University Press, New York.
2. Dr. B.S. Grewal ,"Higher Engineering Mathematics', Publisher: Khanna,New Delhi.
3. S.C. Chapra ,"Advanced Numerical methods with Matlab" , Tata Mc-Graw Hill.

MULTI VARIATE CALCULUS

Course code: 15 MT 1203 **L-T-P:** 2-2-2

Pre Requisite: NIL **Credits:** 4

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Determine the maximum and minimum values for the function involving two variables	e	2
CO 2	Calculate the length of the arc, area, volume of the surface of a solid revolution	e	2
CO 3	Model the given phenomena as a partial differential equations of first and second orders	k	2
CO 4	Solve the partial differential equations by analytical and finite difference methods	e	2
CO 5	Verify the solution of problems through MATLAB.	k	2

Syllabus:

Differential Calculus: Partial derivatives, Jacobian, total differentiation and their applications, chain rule, Taylor's series for function of two variables, maxima and minima of functions of two variables, Lagrange's multipliers method.

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

Vector Calculus: Scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of a vector point function. Line, surface and volume integrals, Green's, Gauss divergence and Stoke's theorems and their applications

Modeling with partial differential equations: Formation of partial differential equations, solutions of first order linear and nonlinear PDEs by Lagrange and Charpit's methods, solution of second order PDEs by method of separation of variables i.e., one dimensional wave and heat equations, Laplace equation in two dimensions. Solving Laplace equation by Finite difference method.

Text Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, , John Wiley &Sons, Inc, Newyork .(2015)
2. Nakhle H Asmar, "Partial differential equations with Fourier series and boundary value problems", Second edition Pearson Pub.

Reference Books:

1. Michael Greenberg, Advanced Engineering Mathematics. 2nd Ed, Prentice Hall, USA.
2. Zafar Ahsan, Differential equations and their applications, 2nd Ed., PHI

PROBABILITY AND OPTIMIZATION TECHNIQUES

Course code : 15 MT 2104 **L T P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Co. No.	Course outcome's	Mapped SO	BTL
1	To apply the basic rules of theorems of probability theory to determine the probabilities that help to solve the problems of engineering problems and to determine the expectation and variance of a random variable from its distributions.	a,e	2
2	To appropriately choose, define and / or to derive probability distributions such as the Binomial, Poisson and normal etc. to model and solve engineering problems	a,e	2
3	To understand how regression analysis can be used to develop an equation that estimate how two variables are related and how the analysis of variance procedure can be used to determine it means of two papulation are equal	a,e	2
4	To have through knowledge on linear and non linear programming	a,e	2

Syllabus:

Probability and Random variables: Definitions of probability, Sample space, Axioms of probability, Conditional probability, Addition, Multiplication and Bayes' theorem. Random variables, Joint and marginal probabilities, Mathematical expectation.

Standard discrete and continuous distributions: Definitions and simple properties of Binomial, Poisson, Geometric, Hyper-Geometric, Uniform, Exponential, Weibull and Normal distributions, Applications of the above distributions.

Correlation and Regression: Correlation coefficient for grouped and ungrouped data, Rank correlation. Linear and Non-Linear Regression.

Linear programming: Formulation of LPPs, Graphical solution of LPP, Simplex method, Big-M method, duality in LPP and dual simplex method.

Nonlinear programming: Convex sets and convex functions, Kuhn-Tucker conditions.

Convex quadratic programming: Wolfe's and Pivot complementary algorithms. Separable programming.

Text Books:

1. Ronald E. Walpole, Sharon L. Myers and Keying Ye, "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson.
2. H A Taha, Operations Research: An Introduction, Prentice Hall Pub.

Reference Books

1. Richard A Johnson , Miller & Freund's Probability and Statistics for Engineers, 11th Edition PHI, New Delhi .
2. Jay L. Devore, Probability and Statistics for Engineers, CENAGE learning.
3. S C Gupta and V K Kapoor, Fundamentals of Mathematical Statistics, 11th Edition, S Chand & Sons, New Delhi.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, Wiley Pub.
5. S D Sharma, Operations Research, Kedar Nath Ram Nath & Co

PROBABILITY AND STOCHASTIC MODELS

Course Code : 15MT2005 **L-T-P :** 2-2-2

Pre-requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
1	Construct the probability distribution of a random variable, based on a real-world situation, and use it to compute expectation and variance	e	2
2	Predict the relationship between two variables and construct the linear and non-linear regression lines for the given data	e	2
3	Model the Single and multi server markovian queuing models with finite and infinite capacity.	k	2
4	Verify and validate the simulation models.	k	2
5	Verify the solution of problems through MATLAB/MINITAB.	k	2

Syllabus:

Probability and Random variables: Definitions of probability, Sample space, Axioms of probability, Conditional probability, Addition, Multiplication and Bayes' theorem. Random variables, Joint and marginal probabilities, Mathematical expectation.

Standard discrete and continuous distributions: Definitions and simple properties of Binomial, Poisson, Geometric, Hyper-Geometric, Uniform, Exponential, Weibull and Normal distributions, Applications of the above distributions.

Correlation and Regression: Correlation coefficient for grouped and ungrouped data, Rank correlation. Linear and Non-Linear Regression.

Stochastic Processes: Discrete-Time Markov Chains, Continuous- Time Markov Chains.

Queueing models: Single and multi server markovian queuing models with finite and infinite capacity. Networks of queues.

Simulation: Introduction to simulation, simulation examples, general principles, statistical models in simulation. Verification and validation of simulation models.

Text Books

1. Ronald E. Walpole, Sharon L. Myers and Keying Ye, "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson.
2. Kishore S Trivedi, "Probability & Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, Wiley India, 2009.

Reference Books

1. Richard A Johnson, Miller & Freund's Probability and Statistics for Engineers, 11th Edition PHI, New Delhi.
2. Jerry Banks, John S Carson, Barry L Nelson, David M Nicol, Discrete- Event System Simulation, 4th Edition, Pearson
3. Jay L. Devore, Probability and Statistics for Engineers, CENAGE learning.
4. S C Gupta and V K Kapoor , Fundamentals of Mathematical Statistics, 11th Edition, S Chand & Sons, New Delhi.

MECHANICS

Course code : 15 ME 1001 **L-T-P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Apply the concept of forces, governing static equations and analyze planer system of forces. Apply different analytical methods on spatial system of forces and analyzing them	a	2
CO 2	Understanding the concepts of planar and non-planar system of parallel forces and analyzing them. estimate moment of inertia of lamina and material bodies	a	2
CO 3	Analyzing the rigid bodies under translation and rotation with and without considering forces.	e	1
CO 4	Understanding the engineering mechanics physical systems prepare and demonstrate the models with the help of mechanics concepts to solve the engineering problems	e	1
CO5	Apply the concepts of mechanics and carryout different experiments and analyze the results	b	2

Syllabus:

Vectors, Units, Dimensions and conversions

Two Dimensional Force Systems: Basic concepts, Laws of motion, Principle of Transmissibility of forces, Transfer of a force to parallel position , Resultant of a force system, Simplest Resultant of Two dimensional concurrent and Non-concurrent Force systems, Free body diagrams, Equilibrium and Equations of Equilibrium, Applications, Forces in space, Truss- Method of joints and sections.

Properties of areas and volumes: Centroids, centre of gravity, Moment of inertia- Area and Mass

Friction: Introduction, Laws of Coulomb Friction, Equilibrium of Bodies involving Dry-friction, Application.

Kinematics of Rigid Body: Introduction, Plane Motion of Rigid Body, Velocity and Acceleration under Translation and Rotational Motion.

Kinetics of Rigid Body: Introduction, Force, Mass and Acceleration, Work and Energy, Impulse and Momentum, D'Alembert's Principles and Dynamic Equilibrium.

Text Books:

1. Stephen Timoshenko, D. Young, J Rao, "Engineering Mechanics" Revised Fourth Edition (in SI Units) (special Indian Edition) , Tata McGraw Hill.

Reference Books:

1. Irving H. Shames "Engineering Mechanics", Prentice-Hall.
2. F. P. Beer and E.R. Johnston "Vector Mechanics for Engineers (in SI units) Statics & Dynamics" – Mc Graw Hill Publications.

ENGINEERING MATERIALS

Course code : 15 PH 1001 **L-T-P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the concepts of crystallography and crystalline imperfections in order to determine crystal structures and to identify defects in crystals	c	1
CO 2	Understand electrical and optical properties of materials and apply them to know various mechanisms involved in electrical, electronic, optical, optoelectronic devices.	c	1
CO 3	Understand mechanical and thermal properties of materials and apprehend their importance in identification of materials for specific engineering applications	c	1
CO 4	Understand magnetic properties of materials and apply them to know various mechanisms involved in magnetic memory devices and transformers.	c	1
CO 5	Understand various properties of materials and apply the knowledge to execute the related experiments to get hands on experience and also to develop some inter disciplinary projects.	c	1

Syllabus:

Crystallography: Bonding in materials, Space lattice, basis, unit cell, Seven Crystal systems, Bravais lattice system, Reciprocal lattice, Crystal directions, Miller Indices, problems, Diffraction of Crystals, Bragg's Law, XRD, Laue, Rotating Crystal and powder XRD Techniques, Problems.

Crystal Imperfections: Point Defects, Line Defects, Surface Defects, Volume Defects, Effects of Defects on Crystalline Properties.

Electrical Properties: Free Electron Model (Postulates of Classical and Quantum models and their Failures), Bloch theorem (qualitative analysis only), Kronig- Penny model (qualitative analysis only), Brillouin Zones, Energy band theory, Band structures in Conductors, Semi conductors and Insulators, Electrical properties of conductors- Ohms, Mathiessen rule, conductivity, Mobility, Electrical properties of Semi conductors, Factors effecting the carrier concentration , Conductivity and Mobility of charge carriers. Electric properties of Insulator-Dielectrics- Types of Dielectrics, Dielectric Constant, Polarization, Types of Polarizations, Frequency Dependence of Polarization, Ferro, Piezo Electrics.

Optical properties: Optical reflectance, Optical Absorption, Exciton Binding Energy, Raman Effects in Crystals, Energy Loss of Fast Particles in Solids.

Thermal properties: Crystal vibrations with Mono atomic basis, Phonon Momentum, Heat capacity , Thermal Expansion and Thermal Conductivity in Metals, Ceramics and Polymers, Heat treatment of Materials, Hardening, Tempering, Quenching and Nitriding.

Mechanical Properties: Stress, Strain, Hooke's Law, Elasticity, Plasticity, Creep, Ductility, Brittle, Hardness, Strength, Modulus of Elasticity, Fracture, Fatigue, Stress- Strain Behavior of Ductile and Brittle Materials, Hardness Tests- Vickers, Rockwell and Brinell.

Magnetic properties: Origin of Magnetic Moment, Dia, Para, Ferro, Antiferro and Ferri Magnetism, Domain theory and Hysteresis Effect of Ferro and Ferri Magnetism, Soft and Hard Magnetic Materials.

Text Books:

1. William D. Callister,Jr. "Materials Science and Engineering: An Introduction" 6th edition, Wiley India Pvt.Ltd, (2007)
2. Charles Kittel, "Introduction to Solid State Physics" 8th edition, Wiley India Pvt.Ltd,(2012).

Reference Books:

1. Adrianus J. Dekker, "Solid State Physics" 1st Edition, Macmillan India Ltd, (2002).

ENGINEERING CHEMISTRY

Course Code: 15CY1001 **L-T-P:** 2-2-2

Pre-requisite: NIL **Credits:** 4

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Predict potential complications from combining various chemicals or metals in an engineering setting.	c	1
CO-2	Discuss fundamental aspects of electrochemistry and materials science relevant to corrosion phenomena.	c	1
CO-3	Examine water quality and select appropriate purification technique for intended problem.	c	1
CO-4	Apply phase rule, polymers, conducting polymers and nano chemistry to engineering processes.	b	1
CO-5	An ability to analyze & generate experimental skills.	b	1

Syllabus:

ENERGY SOURCES: Chemical Energy: Basic concepts of electrochemistry – electrode potential, origin of single electrode potential, Galvanic cells, Reference electrodes- Determination of pH using glass electrode. Chemistry, construction and engineering aspects of Primary (zinc-carbon cell) and secondary (lead-Acid cell, Ni-Cd cell, Lithium cells) and fuel cells– Hydrogen–Oxygen fuel cell, advantages of fuel cell. Nuclear Energy: Fission and fusion– power rectors– Atomic pile applications. Solar Energy: Methods of utilization– thermal conversion– Liquid Flat– Plate collector, photovoltaic conversion- solar cell and Applications. Thermal Energy: Fuels, classification– Solid fuels – coal – Liquid fuels – primary – petroleum – cracking, knocking, synthetic petrol, gaseous fuels– natural gas, calorific value of fuel– HCV, LCV. CORROSION AND ITS CORROSION CONTROL: Introduction, causes and different types of corrosion and effects of corrosion. Theories of corrosion– Chemical, Electrochemical corrosion and corrosion reactions; 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. Control Methods – Cathodic protection, sacrificial anode, impressed current cathode. Surface coatings: methods of application on metals- hot dipping, galvanizing, tinning, cladding, electroplating; Organic surface coatings– paints constituents and functions. WATER TREATMENT: 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, corrosion, priming & foaming. Softening of water: Internal and external treatments -Lime soda, Ion exchange process and Numerical problems. Desalination-reverse osmosis and electro dialysis - domestic water treatment POLYMERS AND PLASTICS: Definition – Types of polymerization – Mechanisms of polymerization. Effect of polymer structure on properties. Plastics – Thermoplastic resins and Thermosetting resins - Compounding of plastics – Fabrication of plastics. Preparation, properties and engineering applications of: polyethylene, PVC, Teflon, Bakelite, Urea Formaldehyde . Conducting Polymers: Poly acetylene, polyaniline, conduction, doping, applications. Liquid Crystal polymers: Characteristics and uses. Nano-Chemistry: Introduction, types of Nano materials, General methods of preparation of Nano materials, Applications. PHASE RULE: Definitions – phase, component, degree of freedom, phase rule equation. Phase diagrams – one component system: water system. Two component system lead - silver system, heat treatment based on iron-carbon phase diagram, hardening, annealing.

Text Book:

1. J C Kuriacose & J Rajaram ,"Chemistry in Engineering and Technology", Volume 2, , TMH, New Delhi.

2. Shashi Chawla, " text book of Engineering Chemistry," Dhanpat Rai , New Delhi.

Reference Books:

1. O G Palanna, ,"Engineering Chemistry", TMH, New Delhi.

2. B. Sivasankar," Engineering Chemistry", TMH, New Delhi.

3. Jain & Jain ,"Engineering Chemistry," , Dhanpat Rai Publishing Company. New Delhi.

4. C Parameswara Murthy, C V Agarwal and Andra Naidu ,"Engineering Chemistry", , B S Publications.

BIOLOGY FOR ENGINEERS

Course Code: 15BT1001 **L-T-P:** 2-0-0

Pre-requisite: Nil **Credits:** 2

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Acquire the Knowledge of basic biology	h,j	1,2
CO-2	Acquire the Knowledge of Human Biological Systems	h,j	1,2
CO-3	Acquire Knowledge on Microorganisms and Biosensors	h,j	1,2

Syllabus:

Basic Biology : Introduction, Living organisms, Cell structure and Organelles, Organogenesis, Human Anatomy,

Systems of Life: Digestion, Respiration, Circulation, Excretion, Reproduction, Thinking and coordination and Defense,

Diet and Nutrition: Macro (Carbohydrates, proteins, lipids) - and Micronutrients (vitamins), Essential minerals and their role; deficiency symptoms; and their role; deficiency symptoms. Micro organisms: Classification of Microorganisms, beneficial and harmful effects of Bacteria, Fungi and Viruses.

Biosensors, biomechanics and Medical Imaging technology, Applications of Biosensor in Food and Agriculture.

Text Books:

1. Dr RC Dubey ,"Advanced Biotechnology", S Chand Publications.
2. P K Gupta ,"Elements of Biotechnology", RASTOGI Publications.

FIELDS & NETWORKS

Course code : 15 EE 1201 **L – T – P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
Co 1	Understand the circuit elements, kirchhoff's law and theorems to solve the networks	a,k	1
Co 2	Apply the procedure to determine form factor and peak factor to different symmetrical & unsymmetrical waves.	a	2
Co 3	Apply vector algebra to field fundamentals to analyze electric and magnetic field distributions	a	2
Co 4	Apply Maxwell's equations for static and time varying fields	a	2
Co 5	Test and Analyze the concepts learned in fields and networks by conducting experiments or by any simulation softwares	a	2

Syllabus:

Circuit Concept, R, L, C parameters, voltage and current sources, specifications of Active and Passive elements, voltage – current relationship for passive elements Kirchoff's Laws, Mesh and Nodal methods of analysis of networks.

Network theorems- (without proof): Superposition, Reciprocity, Thevenin's, Norton's, Maximum power transfer. Star/delta transformation, source transformation,.

AC Circuits- RMS and average values and form factor of different periodic wave forms (Sinusoidal, rectangular, triangle and saw-tooth), steady state analysis of R, L and C (in series, parallel and series parallel combinations) with sinusoidal excitation, concept of reactance, impedance, susceptance and Admittance, Phase and Phase difference, concept of power factor, Real and Reactive powers, j-notation, complex and polar forms of representations, complex power. Vector Algebra: Co-ordinate systems, Del operator, Gradient of a scalar, Divergence of a vector, Curl of a vector. Electrostatics: Coulomb's Law, Electric Field Intensity – Fields due to Different Charge Distributions, Electric Flux Density, Gauss Law and Applications, Electric Potential, Relations Between E and V. Poisson's and Laplace's Equations; Capacitance calculations, related Problems. Magneto Statics: Biot-Savart Law and its applications, Ampere's Circuit Law and Applications, Inconsistency of Ampere's Law, Magnetic Flux Density, Magnetic Scalar and Vector Potentials, Lorentz Force Equation, Inductances calculations, related Problems. Time Varying Fields: Faraday's Law, Maxwell's Equations in Different Final Forms and Word Statements. Conditions at a Boundary Surface: Dielectric-Dielectric and Dielectric-Conductor Interfaces.

Text Books:

1. W.H.Hayt and J.E.Kimmerly "Engineering circuit analysis", McGraw Hill, 5th Edition, 1993.

2. Mathew NO Sadiku, Elements of Electromagnetics, Oxford University Press,2011.

ENGINEERING GEOLOGY

Course code : 15 CE 2103 **L T P :** 3-0-2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
Co 1	Understand various geological processes operate on the surface of the earth, impact of the processes on the construction materials.	a,b,e	1
Co 2	Understand the formation of different types of rocks and their identification and properties and use in sourcing suitable geological materials for construction	a,e	1
Co 3	Equip with factors leading to various geological hazards and able to identify areas vulnerable to sliding, come out measures to stabilize slopes and seismic vulnerability.	a,c,e	2
Co 4	Equip with basic knowledge required for identification of suitable site for the proposed construction project, Equip with basic knowledge of hydro geological properties of rocks, identification of potential pockets for tapping groundwater and geological settings that are un favorable / unsafe for construction of dams and driving the tunnels.	a,c,e	2
Co 5	Able to study various geological features	a,e	2

Syllabus:

Introduction: Importance of geology from Civil engineering point of view,

Physical Geology: Introduction; Weathering Process, types of weathering and its importance in civil engineering; Soil formation, Soil profile, soil conservation measures; Geological action of Rivers, stages in a river system, features of river erosion and deposition.

Mineralogy: Definition of mineral; physical properties of minerals. Study of common rock forming minerals - Quartz, Feldspar, Muscovite, Asbestos calcite, Talc, Kaolin

Petrology: Introduction; Rock Cycle, major rock types, formation of Igneous rocks; Structures of Igneous rocks. Formation of Sedimentary rocks; Structures of Sedimentary Rocks. agents of metamorphism, Structures of Metamorphic rocks, distinguisition of major rock types,

Engineering properties of rocks: Different Engineering property of rocks. Description of some important Rocks Granite - Basalt Dolerite Sand Stone Lime Stone Shale Laterite - Granite gneiss schist Marble K hondalite Charnockite.

Structural geology: Introduction; Strike and Dip; Outcrop. Parts and classification of Folds; Faults; Joints; and their importance in Civil Engineering constructions.

Earthquakes and seismic hazards: Terminology; Classification, Causes and effects of

earthquakes; seismic waves, measuring instruments, seismic zones of India, Seismic belts, seismic hazards in India ; Civil Engineering considerations in seismic areas. A step towards urban earthquake vulnerability reduction

Land slides: Classification; Causes and effects of Landslides; Preventive measures of Landslides.

Site investigation techniques for civil engineering projects: Introduction, Different stages of site investigation, toposheets/topographic maps; Geological maps and their interpretation in site investigation; Geophysics in civil engineering, electrical resistivity investigations, seismic survey, remote sensing, Geographical information systems and their application

Ground water: sources of ground water, factors controlling ground water, water bearing properties of rocks and soils, types of aquifers, exploration of ground water

Dams: Dams terminology; Types of dams and suitable foundations; guidelines for major dam and reservoir investigations;

Tunnels: Purpose of tunneling; types of tunnels, tunnels and underground excavations methods of site selection, tunnel excavation in various rock types, geological problems, Geology of some tunnel sites;

Text Books:

1. D.Venkat Reddy; .Engineering Geology Vikas Publishing House Pvt.Ltd., Noida
2. Parbin Singh; Engineering and General Geology S. K. Kataria & Sons, New Delhi.

Reference Books:

1. Krynine and Judd, .Engineering Geology and Geo techniques Mc Graw Hill Book Company.
2. Subinoy Gangopadhyay: Engineering geology Oxford University Press
3. K.M. Bangar, Principles of Engineering Geology Standard Publications, Distributors, 1705-B, Nai sarak, New Delhi.
4. A text Book of Engineering Geology by N. Chennakesavulu; Macmillan India Ltd., Delhi.
5. Rock Mechanics for Engineers by Dr. B.P.Varma, Khana Publishers, Delhi-6.
6. Principles of Engineering Geology by KVGK Gokhale, B.S. Publications, Hyderabad.

PROBABILITY AND STATISTICS

Course Code: 15 MT 2103 **L– T–P:** 3-0-0

Pre Requisite: NIL **Credits:** 3

Mapping of course outcome with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Construct the probability distribution of a random variable, based on a real-world situation, and use it to compute expectation and variance	a, e	2
CO-2	Predict the relationship between two variables and construct the linear and non-linear regression lines for the given data	a,e	2
CO-3	Apply statistical tests for large and small samples to test the hypothesis.	a,e	2
CO-4	Testing the hypothesis to analyze the variance by applying suitable design.	a,e	2

Syllabus:

Probability and Random variables: Definitions of probability, Sample space, Axioms of probability, Conditional probability, Addition, Multiplication and Bayes' theorem. Random variables, Joint and marginal probabilities, Mathematical expectation. Standard discrete and continuous distributions: Definitions and simple properties of Binomial, Poisson, Geometric, Hyper-Geometric, Uniform, Exponential, Weibull and Normal distributions, Applications of the above distributions. Correlation and Regression: Correlation coefficient for grouped and ungrouped data, Rank correlation. Linear and Non-Linear Regression. Tests of Hypothesis: Sampling distributions- Point and interval estimation. Confidence limits for interval of mean and standard deviation. Small sample tests - Test for mean, variance using t, chi-square and F distributions. Chi-square test for independence of attributes and goodness of fit. Large sample tests-Test for mean with known and unknown standard deviation and test for standard deviation.

Analysis of Variance: General principles, Completely randomized design, Randomized block designs and Latin square design.

Text Books:

1. Richard A Johnson, "Miller & Freund's Probability and Statistics for Engineers", PHI, New Delhi, 11th Edition (2011).

Reference Books:

1. Ronald E. Walpole, Sharon L. Myers, Keying Ye, "Probability and Statistics for Engineers and Scientists", 8th Edition Pearson Pub.
2. S C Gupta and V K Kapoor, "Fundamentals of Mathematical Statistics", 11th Edition, S Chand & Sons, New Delhi.

BASIC MATHEMATICS

Course Code : 15MT1102 **L-T-P:** 2-2-2

Pre-requisite : Nil **Credits:** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Apply knowledge of mathematics, fundamentals in biological science problems	a	1
CO-2	Identify the formulas, for solving complex engineering problems in sciences by using derivatives and Integrals.	e	1
CO-3	Understand Vector products and their interpretations	a	1
CO-4	Understand and Interpret conic sections	a	1
CO-5	Verify the problem models using MAT lab	k	1

Syllabus:

Ordinary Differential Equations and its Applications : Practical approach to differential equations, First order differential equations, Variable separable method, linear equations, Bernoulli's equation. Models for the real world problems: Newton's Law of Cooling, Law of natural growth and decay. System of first order differential equations (Prey-Predator models). Applications on Chemical reactions. Numerical solutions of first order ODE : Taylor's series method, Euler's method, Runge- Kutta method of fourth order.Second and High order differential Equations :Linear differential equations of higher order with constant coefficients, complimentary function, particular integral, method of variation of parameters, Laplace Transforms and its applications: Motivation, Definition, Linearity property, Laplace transforms of elementary functions, Shifting theorem, Laplace transforms of periodic,. Inverse Laplace transforms of derivatives and integrals, Convolution theorem, Application of Laplace Transforms in solving ordinary differential equations.Partial Differential Equations: Formation of Partial differential equations, direct integration method, models of first order partial differential equations.

Text Books:

1. Differential equations and their applications, ZAFAR AHSAN, PHI, Second edition.
2. Advanced Engineering Mathematics (Tenth Edition), Erwin Kreyszig,John-Wiley publications

Reference Books:

1. Higher Engineering Mathematics, By Dr. B.S. Grewal. Publisher: Khanna, New Delhi.
2. Elementry Differential Equations, By W.E.Boyce and R. Diprima.
3. Applied numerical methods with MATLAB for engineers and scientists, Steven C.

   Chapra, third edition, Tata McGraw-hill edition, New Delhi.
4. Differential equations and Mathematical Biology by D.S.Johns, Michael plank, B.D.Sleeman: C.R.C press

ENGINEERING SCIENCES

INTRODUCTION TO ENGINEERING

Course Code: 15GN1004 **L-T-P :** 2-0-2

Pre-requisite: Nil **Credits:** 3

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand the basic principles of engineering design	h	1
CO-2	Understand the aspects of critical thinking and problem solving in engineering	h	2
CO-3	Apply to knowledge of critical thinking to frame real-world problems and provide basic solution approach to such problems from engineering perspective	h	2
CO-4	Understand and analyze the possible career options in Engineering and develop strategic plan, career targets and mechanism to achieve the same.	f	3

Syllabus:

History of Engineering, What is Engineering, Fields of Specialization in Engineering, Engineering Design Process, Types of Engineering Design, Societal considerations in Engineering Design, The Engineer as a Professional: Characteristics And Responsibilities - Ideals And Obligations Of Professional Engineers - Engineering Ethics - Codes Of Engineering Ethics - Case Studies In Ethics, Career Paths for Engineers - Initial Career Profiles, Engineering Communication and Presentations: Brief Overview

LAB COMPONENT: MS Office- MS WORD, MS PPT, MS XCEL

Text Book:

1. George E Dieter and Linda C Schimidt ,"Engineering Design" , Mc Graw Hill Publications

C PROGRAMMING & DATA STRUCTURES

Course Code : 15CS1001 **L-T-P :** 2-4-2

Pre-requisite : Nil **Credits :** 5

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Illustrate how problems are solved using computers and programming.	a	2
CO-2	Interpret & Illustrate user defined C functions and different operations on list of data.	a	2
CO-3	Implement Linear Data Structures and compare them.	e	2
CO-4	Implement Binary Trees.	e	2
CO-5	Apply the knowledge obtained by the course to solve real world problems.	k	2

Syllabus:

Introduction to C language, Control structures, Functions, recursive functions. storage classes and scope of variables. Arrays- passing arrays as parameters to functions. Searching- linear search, binary search, Sorting- Bubble sort, quick sort. Strings, operations on strings and Multidimensional arrays. Pointers, call by value Vs call by reference. Structures and Unions. Dynamic memory allocation. Stack and Queue- implementation of Stack, Queue, circular Queue. Infix, post-fix and prefix notations, Stack Applications - Evaluation of infix expression, conversion of infix to post-fix expressions using stacks. Linked List- Linked List vs Arrays, Creation, insertion, deletion of Singly linked list, Doubly linked list and Circular linked list . Linked list representation of Stack and Queues. Trees- Tree, Binary trees, Binary search tree:- Creation, Insertion, Deletion and Tree traversals.

Text Books:

1. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language: ANSI C Version", 2/e, Prentice-Hall/Pearson Education-2005.
2. E. Balagurusamy , "Programming in ANSI C" 4th ed., Tata McGraw-Hill Education, 2008.
3. R. F. Gilberg, B. A. Forouzan, "Data Structures", 2nd Edition, Thomson India Edition-2005.

Reference Books:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2008, Third Edition, Pearson Education.
2. Horowitz, Sahni, Anderson Freed, "Fundamentals of Datastructures in C", 2nd Edition-2007.
3. Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, "Data structures and Program Design in C", 4th Edition-2007.
4. C for Engineers and Scientists – An Interpretive Approach by Harry H. Cheng, Mc Graw Hill International Edition-2010.
5. Jeri R. Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", 7/e, Pearson Education-2004.
6. Jean Paul Trembly Paul G.Sorenson, "An Introduction To Data Structures with applications", 2nd Edition.

ENGINEERING GRAPHICS

Course Code: 15ME1002 **L-T-P :** 0-0-6

Pre-requisites : Nil **Credits :** 3

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Draft orthographic Projections, Isometric views, projection of planes, Manually and prepare Models in workshop by using drawings.	k	2
CO-2	Draftorhtographic projections ,isometric views, projection of planes using Autocad. Draft projection of solids Manually and by using AutoCAD and prepare Models in workshop by using different workshop trades	k	2
CO-3	Draft Development of surfaces of solid and sections of solid Manually	k	2
CO-4	Practicing house wiring through Auto Cad	k	2
CO-5	Develop 2D & 3D components using Auto Cad Software	b	2

Syllabus:

Introduction To Computer Aided Drafting: Commands, Tool Bars, Layout of Drawing sheet, Dimensions, Point Style and Text.

Projections Of Points: Theory of Projection, Elements of projection, Planes of projection, Quadrants, Projection of points in four (4) Quadrants and Conclusions.

Projections Of Planes: Different Planes, Projections of planes in various positions w.r.t planes of projection (Use First Angle Projection).

Projections Of Solids: Types of Solids, Names and Nomenclature of Solids, Projection of solids in simple position, Projections of solids with axis inclined to one reference plane and parallel to the other reference plane (Use First Angle Projection).

Orthographic Views: Projection, Orthographic projection, Importance of Front view, Position of Top view and side views w.r.t Front view, Difference between First Angle Projection and Third Angle Projection, Symbol indicating the Angle of Projection.

Sectional Views: Purpose of Sectioning, Types of sections, Importance of Hatching.

Development Of Surfaces: Principle of Development of Surfaces, Methods of Development of Surfaces, Practical Applications of Development of Surfaces.

Isometric Views: Principle of Isometric Projection, Isometric Axes, Isometric lines, Non-Isometric lines, Isometric Planes, Non-Isometric Planes, Isometric scale, Difference between Isometric drawing and Isometric Projection.

Perspective Views: Principle of perspective projection, Definitions of Perspective elements, Methods of Drawing Perspective view(s).

MEASUREMENTS

Course Code: 15GN1003 **L-T-P :** 0-0-4

Pre-requisite: Nil **Credits :** 2

Mapping of Course outcomes with Student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand and apply the fundamentals of a measurement system, characteristics, and metrology using simulation and experimentation tools.	a,b	2
CO-2	Understand various electrical & computer parameters, and apply different measuring techniques on various electrical parameters using simulation and experimentation tools.	a,b	2
CO-3	Understand electronic & electro-physiological parameters, and apply measuring techniques on electronic parameters using simulation and experimentation tools.	a,b	2
CO-4	Understand and apply different measuring techniques on civil and mechanical parameters using simulation and experimentation tools.	a,b	2
CO-5	Apply the theoretical concepts to measure different parameters	b	2

Syllabus:

Fundamentals of Measurements: Introduction, significance, types, GMS, Static & Dynamic characteristics, Error – types, sources and remedies, Statistical & Regression analysis of data, Transducers – classification.Metrology: Definition, types, linear metrology, angular metrology. Straightness, flatness, squareness, parallelism, roundness and cylindricity measurements. Applications and advanced measurement techniques.Measurement of Electrical & Computer parameters: Definition, Representation and analogy of Current, Voltage, Power, Energy, Power factor and R – L – C components. Analog meters: Types, connections, Selection & Extension of range, applications. Electrical Bridge circuits for R, L, and C. Computer terms: Units of digital information, memory measurement, measurement of RAM, Processor speed, internet transfer speed, network connection speed, baud rate. Measurement of Electronic & Electrophysiological parameters: DSO – front panel controls, connectivity, measurement of Amplitude and Time period, Phase and Frequency using lissajuous patterns. Applications and advanced measurement techniques. Metric system, Electrophysiological measurements (EEG, ECG, EMG, ERG), tilt measurement, acceleration in human body (jumps), Arm flexion and rotation angle, stability of hand muscles and breathing muscles contraction, pulse rate, blood pressure, oxygen content in exhaled air, registration of algal rest and action bio potentials. Biomedical applications and advanced measurement techniques.Measurement of Civil & Mechanical parameters: Definition and representation of Displacement (Linear/Angular), Speed, Force, Torque, Stress/Strain, Flow, Temperature, Humidity, Viscosity. Measurement of angles and distances (height, area, distance between two elevations), Water and waste water analysis (Spectrophotometry/ Chromatography), Liquid Level using Direct and Indirect methods, Hardness of a given material sample using Brinell/Rockwell hardness testing machine, Modulus of Elasticity of a specimen using tension test, measurement analysis of air pollution. Industrial applications and advanced measurement techniques.NI MyDAQ/ LabVIEW:

Introduction, Hardware/Software overview, Getting started with MyDAQ (Signal connections), applying the MyDAQ as DMM, DVM, DAM, Oscilloscope, Function Generator, Real-time signal capturing, interfacing of sensors (Thermistor/LM35/Thermocouple/Opto-coupler).

Text books & References:

1. JP Holman ,"Experimental methods for engineers",McGraw Hill Ltd.
2. Thomas G Beckwith ,"Mechanical measurements", 6/E, Pearson
3. Martin U Reissland ,"Electrical measurements"New Age Int.
4. A course in Electrical, Electronic Measurement and Instrumentation- AK Sawhney- Dhanpat Rai & Co.
5. Bewoor ,"Metrology & Measuremen",McGraw Hill Ltd.
6. NI MyDAQ User Manual

OBJECT ORIENTED PROGRAMMING

Course code: 15 CS 2002 **L–T–P :** 2-2-2

Pre Requisite : NIL **Credits:** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand Basic Concepts of OOP, introduction to classes and objects through Java Language and apply.	e	2
CO2	Understand the concepts of constructors, Overloading, parameter passing, access control, Inheritance and apply.	e	2
CO3	Understand Packages, Interfaces, and Exception Handling and apply.	e	2
CO4	Understand I/O Streams & apply and understand Basic Concepts of Multi -Threading	k	3
CO5	Apply OOP concepts for developing an application	k	3

Syllabus:

Introduction: Object-Oriented Programming, OOP Principles, Encapsulation, Inheritance and Polymorphism Java as a OOPs & Internet Enabled language, The Byte code, Data types, Variables, Dynamic initialization, scope and life time of variables, Arrays, Operators, Control statements, Type Conversion and Casting, Compiling and running of simple Java program. Classes and Objects: Concepts of classes and objects, Declaring objects, Assigning Object Reference Variables, Methods, Constructors, Access Control, Garbage Collection, Usage of static with data and methods, usage of final with data, Overloading methods and constructors, parameter passing - call by value, recursion, Nested classes. Inheritance: Inheritance Basics, member access rules, Usage of super key word, forms of inheritance, Method Overriding, Abstract classes, Dynamic method dispatch, Using final with inheritance, The Object class. Packages and Interfaces: Packages, Classpath, Importing packages, differences between classes and interfaces, Implementing & Applying interface. I/O Streams- file, byte streams, character streams, Exception Handling: Exception Handling fundamentals, Types of Exceptions, Usage of try and catch, throw, throws and finally keywords, Multithreading.

Text Books:

1. Herbert Schildt, "The Complete Reference Java2", 7th edition TMH,(2002).
2. Timothy A. Budd, "An Introduction to Object-Oriented Programming", 3/E, Pearson, (2008).

Reference Books:

1. Jim Keogh, "The Complete Reference J2EE", TMH, (2006).
2. Deitel & Deitel, "`JAVA – How to program", 6th edition, PHI,(2007).
3. Cay.S.Horstmann and Gary Cornell "Core Java 2, Vol 1, Fundamentals", Seventh Edition, Pearson Education.

SIGNAL ANALYSIS

Course Code : 15 EC 2002 **L–T–P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Demonstrate signals and their Spectra	a	2
CO 2	Analyze discrete time systems	a	2
CO 3	Design filters to cater signal analysis needs	k	2
CO 4	Analyze non stationary signals in time	k	2
CO 5	Analyze non stationary signals in frequency domains	k	2

Syllabus:

Introduction to signal and system, Elementary signals, Signal properties and operations, Orthogonal signal space, Signal approximation using orthogonal functions, Orthogonal Properties of Sinusoidal functions

Exponential and trigonometric Fourier series, Complex Fourier spectrum, Fourier Transform, Properties of Fourier Transform, Fourier transform of Periodic Signals, Case studies

Sampling of continuous time signals, sampling theorem, DTFT, DFT, FFT, Z-Transform, Properties of Z-Transform, Case studies.

DT Systems, Classification of DT systems, System Function, Impulse Response, Response for an arbitrary input, Causality and stability of LTI systems ,case studies

Realization of discrete time systems, Design of Butterworth IIR low pass filter, FIR low pass filter using windows, Case studies

Time frequency analysis: STFT, Wavelet transform and applications, Case studies

Text books:

1. Simon Haykin and Barry Van Veen, "Signals and systems", Wiley, (2003).
2. J G Proakis and D G Manolakis, "Digital Signal Processing", Pearson Education, (2007).
3. V. Oppenheim, R. W. Schafer and J R Buck, "Digital Signal Processing", Pearson Education, (2007).
4. M. Vetterli and J. Kovacevic, "Wavelets and Sub band Coding", Prentice Hall, (1995).

Reference Books:

1. Alan. V. Oppenheim, Alan.V.Willsky, "Signals and systems", Prentice-Hall signal processing series.
2. Raghuveerrao and AjitS.Bopardikar, "Wavelet transforms: Introduction, Theory and applications", Pearson Education Asia, (2000).
3. Stark, "Wavelets and signal processing: An application based introduction", Springer, (2005).
4. Dimitris G. Manalakis and Vinay Ingle, "Applied Digital Signal Processing, theory, and practice", Cambridge University Press, New York, (2011).
5. S. Mallat, "A Wavelet Tour of Signal Processing", 2nd edition, Academic Press, (1999).

Simulation Books:

1. Vinay, Ingle, John G Proakis, "Digital Signal Processing Using Matlab", Pearson Education.
2. Nasser Kehtarnavaz, Namjin Kim, "Digital Signal Processing System Level Design using LabVIEW", Elsevier.
3. E. S. Gopi, "Mathematical Summary for Digital Signal Processing Applications with Matlab", Springer.

DISCRETE MATHEMATICS

Course code : 15 CS 2003 **L–T–P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand sets, relations, functions and discrete structures , Count discrete event occurrences	a	2
CO2	Apply Propositional logic and First order logic to solve problems	a	2
CO3	Formulate and solve recurrence relations, apply algebraic structures and lattices.	k	2
CO4	To identify the basic properties of graphs and trees and model simple applications	k	2
CO5	Relate practical examples to the appropriate set, function or relation model and interpret the associated operations and terminology in context	k	2

Syllabus:

The Foundations: Logic and Proofs: Propositional Logic, Applications of Propositional, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Introduction to Proofs, Proof Methods and Strategy . Basic Structures: Sets, Functions, Sequences, Sums, and Matrices: Sets , Set Operations , Functions, Sequences and Summations, Cardinality of Sets, Matrices. Induction and Recursion Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions and Structural Induction, Recursive Algorithms, Program Correctness. Counting: The Basics of Counting, The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients and Identities, Generalized, Permutations and Combinations, Generating Permutations and Combinations. Advanced Counting Techniques: Applications of Recurrence Relations, Solving Linear Recurrence Relations, Divide-and-Conquer Algorithms and Recurrence Relations, Generating Functions, Inclusion–Exclusion , Applications of Inclusion–Exclusion. Relations: Relations and Their Properties, n-ary Relations and Their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orderings,Lattices. Graphs: Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Representing Graphs and Graph Isomorphism, Connectivity, Euler and Hamilton Paths, Shortest-Path Problems, Planar Graphs, Graph Coloring. Trees: Introduction to Trees, Applications of Trees, Tree Traversal, Spanning Trees, Minimum Spanning Trees. Algebraic Structures: Algebraic Systems-Semi Groups, Monoids-Groups-Subgroups and Homomorphisms- Cosets and Lagrange's Theorem- Ring and Fields (Definitions and Examples).

Text Books:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", Special Indian Edition, 7th Edition, Tata Mcgraw-Hill Publisher, New Delhi.
2. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics: An Applied Introduction", 4th Edition, Pearson Education Asia, Delhi, (2002).

Reference Books:

1. Joe L. Mott, Abraham Kandel, Theodare P. Baker ,"Discrete mathematics for computer scientists and mathematicians" Second Edition, PHI.
2. Tremplay J P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill Publishing Company Limited, New Delhi, (2007).
3. Thomas Koshy., "Discrete Mathematics with Applications", Elsevier Publications, (2006).

ADVANCED DATA STRUCTURES

Course code : 15 CS 2104 **L–T–P :** 2-2-2

Pre Requisite : 15 CS 1001 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Develop and analyze algorithms for sorting techniques	e	2
CO2	Develop algorithms for balanced trees, graphs and heaps	k	3
CO3	Implement symbol table using hashing techniques, understand Union find structures	k	3
CO4	Identify data structures suitable to solve problems	e	2
CO5	Choose the appropriate data structure for modeling and solving real-world problems	e	2

Syllabus:

Sorting Techniques, The List ADT, Skip Lists, AVL Trees, Splay Trees, Top-Down Splay Trees, Red-Black Trees, B-Trees, Trees, Suffix Arrays and Suffix Trees, k-d Trees, Hashing: Separate Chaining, Hash Tables Without Linked Lists, Universal Hashing, Extendible Hashing, Binary Heap, d-Heaps, Leftist Heaps, Skew Heaps, Fibonacci Heaps, Pairing Heaps, Binomial Queues, Amortized Analysis, The Graph ADT, Data Structures for Graphs, Graph Traversals, Transitive Closure, Topological Ordering, Shortest Paths, Minimum Spanning Trees, Disjoint Partitions and Union-Find Structures

Text Books:

1. Peter Brass, "Advanced Data Structures", Cambridge University Press, (2008)
2. Mark Allen Weiss, "Data structures and algorithm analysis in C" 2nd Edition, Pearson, (2012)

Reference Books:

1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in C++", John Wiley, (2014)
2. Adam Drozdek, "Data Structures and Algorithms in C++", Second Edition, Cengage,(2010)
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, PHI, (2011).

THERMODYNAMICS

Course code : 15 ME 1003 **L – T – P :** 2- 2- 2

Pre Requisite : Nil **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand the fundamentals of thermodynamic systems and processes	a	2
CO-2	Apply laws of the thermodynamics and principle of entropy to engineering devices.	a	2
CO-3	Analyze various air standard cycles and their performance.	a	2
CO-4	Evaluate the performance of fuels and combustion to various engines.	k	1
CO 5	Apply the theoretical concepts to conduct various experiments of thermodynamics practically and analyze the data.	b	2

Syllabus:

FUNDAMENTAL CONCEPTS AND DEFINITIONS: Thermodynamic system and control volume, Macroscopic and Microscopic points of view. Thermodynamic properties, Thermodynamic equilibrium, Quasi-static process, Reversible and Irreversible processes, Zeroth law, concept of temperature, work, work done at the moving boundary of system, work done in various non-flow processes, heat, comparison of heat and work.

LAWS OF THERMODYNAMICS: First law of thermodynamics for flow and non-flow processes, energy-a property of system, internal energy and enthalpy, specific heat at constant volume and constant pressure, PMM1, steady flow energy equation and applications. Second law of thermodynamics, thermal reservoirs, Kelvin-Plank and Clausius statements, Equivalence of Kelvin-Plank and Clausius statements, Carnot cycle, Reversed heat engine, Carnot's theorem and corollaries, Absolute thermodynamic temperature scale.

ENTROPY: Clausius theorem, temperature-entropy plot, inequality of Clausius, entropy change in reversible and irreversible process, principle of increase of entropy, applications, entropy change of an ideal gas, availability and irreversibility.

AIR STANDARD CYCLES: Otto, Diesel, Dual and Brayton cycles, performance evaluation and calculation of mean effective pressure, reversed Carnot cycle and Bell Coleman cycle.

FUELS AND COMBUSTION: Types of fuels, exothermic and endothermic combustion equation, stoichiometry combustion analysis by mass and volume, conversion of gravimetric to volumetric analysis and vice versa, exhaust gas analysis, excess air, combustion problem by mole method.

TEXT BOOKS:

1. Younus A Cengel & Michael Boles, "Thermodynamics, An Engineering Approach" - (6E) Tata McGraw Hill, New Delhi.
2. P.K.Nag, "Engineering Thermodynamics" - (4E) Tata McGraw Hill, New Delhi.

REFERENCE BOOKS:

1. G.J. Van Wylen., Sonntag (6E) "Fundamentals of Thermodynamics ", Wiley India publications.
2. Coheand Rogers "Engineering Thermodynamics" (5 E)-Pearson education India limited.
3. Zemansky "Heat and Thermodynamics"-, Mc Graw Hill (5E),

BIOCHEMICAL THERMODYNAMICS

Course code : 15 BT 2218 **L-T-P :** 3-2-0

Prerequisite : Nil **Credits:** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Acquire the knowledge of terminology of thermodynamics	a	1
CO-2	State the zeroth, first, second laws of thermo- -dynamics and determine the entropy changes.	a	1
CO-3	Determine P-V-T behavior of pure fluids and apply the laws of thermodynamics.	k	3
CO-4	Compute thermodynamic properties for homogeneous pure substances and solutions.	b	3
CO-5	Design thermodynamic models for microbial growth.	b	3

SYLLABUS:

BASIC CONCEPTS: Systems and surroundings, Types of systems, Processes-types, Properties of system- types, functions-types, Pressure, Temperature, Volume, work, heat, equilibrium state and phase rule, heat reservoirs & heat engines.

LAWS OF THERMODYNAMICS: zeroth law of thermodynamics, Temperature and Zeroth law of thermodynamics; internal energy, enthalpy, First law of thermodynamics- General statements, applications for cyclic, flow and non-flow processes, limitations of first law of thermodynamics; Second law of thermodynamics- General statement of second Law of thermodynamics, entropy & Heat, entropy &Temperature, the carnot principle, calculation of entropy changes, process involving ideal gases, adiabatic mixing process.

P-V-T BEHAVIOR OF PURE FLUIDS: equation of state, Joule Thomson coefficient. Processes involving ideal gasses: constant Volume process, adiabatic process, polytropic process. Equation of state for real gases: Van der equation, redlich-kwong equation, redlich kwong-soave equation, virial equation.

APPLICATIONS OF THE LAW OF THERMODYNAMICS: Flow processes- continuity equation, energy equation, Bernoulli's equation, steam ejector, joule-Thomson expansion, refrigeration, coefficient of performance, carnot cycle and limitations, liquefaction process, Linde process for gas liquefaction.

THERMODYNAMIC PROPERTIES OF FLUIDS: Classification, work function, Gibbs free energy, fundamental property relations, Maxwell's equations, clasius-clapeyron equation, entropy-heat capacity relationships, Fugacity, standard state of Fugacity, fugacity coefficient, effect of temperature & pressure on fugacity, Activity, effect of temp and pressure on activity.

PROPERTIES OF SOLUTIONS: Partial molar properties and properties of solution, chemical potential, effect of temp & pressure on chemical potential fugacity in solutions, Lewis randall rule, Henry's law and dilute solutions, activity in solutions, activity coefficient, effect of pressure and temperature on activity coefficient.

BIOCHEMICAL THERMODYNAMICS: Stoichiometry and energetic analysis of Cell Growth and Product Formation. Elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield Coefficients of biomass and Product formation, Maximum possible yield, Chemical Equilibria for biochemical reactions, Thermodynamics of microbial growth.

Text books:

1. A text book of chemical engineering thermodynamics-K.V.Narayanan, Phi learning (2009)
2. Introduction to chemical engineering thermodynamics-J.M.Smith, H.C.Vanness&Abbott, Mcgraw Hill Higher Education (2001-05-01)

References:

1. Methods In Enzymology, Volume 308 - Enzyme Kinetics And Mechanisms, Part E, Energetics Of Enzyme Catalysis, (Hardcover), by Vern Schramm, Publisher: Elsevier (1999) .

BASIC ELECTRICAL & ELECTRONICS ENGINEERING

Course code : 15 EE2202 **L–T–P :** 2 - 2 - 2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand various basic circuit elements, Kirchoff's law and three phase systems	a	1
CO2	Understand working principle of DC Machines and conduction of semiconductors.	a,b	2
CO3	To understand conduction of semi conductors	a	1
CO4	Understand conduction of semiconductors.	c	1
CO5	Analyze number systems and their conversions	b,e	1

Syllabus:

Circuit elements and ac fundamentals: Basic Circuit elements, series and parallel circuits, Voltage and Current dividers, Kirchoff's laws, Mesh analysis, sinusoidal voltage and current, peak, average and RMS Values of alternating signals, Three phase systems (Y and Δ Systems)

D.c.machines: Constructional features and principle of operation of DC Generator, EMF Equation(No derivation), Types of Excitation systems, Torque development in Motors, Torque Equation(No derivation), Applications of DC Generators and Motors.

Transformers: Principle and operation of transformers, EMF equation (No derivation)

Induction Motor: Principle operation and construction of three phase induction motor, single phase induction motor and applications.

Conduction in semiconductors: Conductivity of a semiconductor, carrier concentration in an intrinsic semiconductor, Fermi – level in an intrinsic semiconductor, law of mass action, Donor and acceptor impurities, charge densities in a semiconductors, Fermi level in a semiconductor having impurities, diffusion.

Semiconductor diode: Quantitative theory of P – N JUNCTION DIODE, V-I Characteristics and its temperature dependence, transition and diffusion capacitances of P – N Junction diode.

Number systems & binary codes number systems: Decimal, Binary, Octal, Hexadecimal Number systems and their conversions, signed binary numbers, Binary Arithmetic additions, subtraction using the method of complements, Binary Codes: BCD, Excess-3, Grey codes and their conversions.

Text books:

1. Ashfaq Husain, "Electric Machines",2nd Edition,Dhanpat Rai& Co.
2. Jacob Millman, Christor. C Halkias, "Electronic Devices and Circuits" TMH 2002.

Reference books:

1. W. H. Hayt, J.E. Kimmerly, "Engineering circuit analysis", 6th Edition, Tata Mc-Graw Hill.
2. Morris Mano, "Digital Logic and computer Design" PHI, 2003.
3. Jagan and C. LAkshmi Narayana, "Network Theory", B. S. Publications.
4. Robert L Boylested, Louis Nashelsky, "Electronic Devices and circuit Theory", 8th Edition, Pearson Education, 2002.

FLUID MECHANICS

Course code : 15 ME 2104 **L– T–P :** 2 - 2- 2

Pre Requisite : Nil **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand various properties of fluid, Apply various laws for measuring the total pressure and centre of pressure on surfaces of various geometries using various manometers	c	2
CO-2	Apply continuity equation, velocity potential and stream function for fluid flow, Apply Euler's and Bernoulli's equations for various fluid flow applications	c	2
CO-3	Estimate various major and minor losses in pipes and concept of boundary layer theory on fluid flow	e	2
CO-4	Estimate the forces exerted by jet on plates of various geometries and performance of various Turbines and centrifugal pumps.	c	2
CO 5	Apply the theoretical concepts to conduct various experiments of fluid flow practically and analyze the data.	b	2

Syllabus:

Fluid properties: Properties, classification, surface tension and capillarity, vapour pressure.

FLUID STATICS: Pressure, Pascal's law, hydrostatic law, measurement of pressure, Total pressure and centre of pressure.

Fluid kinematics: Types of fluid flow, Discharge, Continuity equation, velocity potential function and stream function, Newtonian Fluid: Navier-Stokes Equations.

Fluid dynamics: Euler's equation, Bernoulli's equation and applications, Dimensional analysis and model similitude.

Flow through pipes: Major and minor losses, friction coefficient, Hagen-Poiseuille law, Hydraulic gradient and total energy line, pipes, water hammer.

Boundary layer theory: Laminar, turbulent boundary layer, separation of boundary layer, methods of preventing separation.

Text books:

1. John F Douglas "Fluid Mechanics",Tata McGraw-Hill publications.
2. SK Som G Biswas "Fluid mechanics" ,Tata McGraw-Hill publications.
3. S.M. Yahya "Turbine,Compressors and Fans",TMH

Reference books:

1. Frank M White "Fluid Mechanics"
2. KR Arora "Fluid Mechanics & Hydraulics" Standard Book house, New Delhi
3. Modi & sath "Fluid Mechanics & Hydraulics", Standard Book House, New Delhi

MOMENTUM TRANSFER

Course code : 15 ME 2104 **L– T–P :** 2 - 2- 2

Course code : 15 PE 2101 **L-T-P :** 2-2-2

Pre Requisite: NIL **Credits:** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Learn the fluid statics and momentum balances and recognize the application of basic mathematics and sciences in those concepts.	e	1
CO 2	Have the ability to analyze fluid flow problems with the application of the momentum and energy equations	e	2
CO 3	Learn the design concepts of Flow of Incompressible Fluids Through Ducts , Flow past immersed bodies	e	2
CO 4	Learn the design concepts of Transportation and Metering.	e	2
CO 5	Apply the theoretical concepts to conduct various experiments of fluid flow practically and analyze th e data.	b	2

Syllabus:

Introduction and Fluid statics: Properties of fluids and concept of pressure: Introduction - Nature of fluids - physical properties of fluids - types of fluids.

Fluid statics: Pressure - density - height relationships, Pressure measurement. Units and Dimensions - Dimensional analysis; Similarity - forces arising out of physical similarity - dimensionless numbers.

Momentum Balance and applications: Kinematics of fluid flow: Stream line - stream tube - velocity potential. Newtonian and non-Newtonian fluids - Time dependent fluids - Reynolds number - experiment and significance - Momentum balance - Forces acting on stream tubes - Potential flow - Bernoulli's equation - Correction for fluid friction - Correction for pump work.

Flow of Incompressible Fluids Through Ducts: Flow of incompressible fluids in pipes - laminar and turbulent flow through closed conduits - velocity profile & friction factor for smooth and rough pipes - Head loss due to friction in pipes, fitting etc.

Introduction to compressible flow: Isentropic flow through convergent and divergent nozzles and sonic velocity.

Flow past immersed bodies: Form drag - skin drag - Drag co-efficient. Flow around solids and packed beds. Friction factor for packed beds - Ergun's Equation - Motion of particles through fluids - Motion under gravitational and centrifugal fields - Terminal settling velocity; Fluidization - Mechanism, types, general properties - applications.

Transportation and Metering: Measurement of fluid flow: Orifice meter - Venturi meter, Pitot tube – Rotameter - Weirs and Notches - wet gas meter and dry gas meter - Hot wire and hot film anemometers.

Transportation of fluids: Fluid moving machinery performance. Selection and specification- Air lift and diaphragm pump. Positive displacement pumps: Rotary and Reciprocating pumps - Centrifugal pumps and characteristics.

Text Books:

1. W. L. McCabe, J. C. Smith & Peter Harriot, "Unit Operations of Chemical Engineering", 6th ed., McGraw-Hill, (2001).
2. P. Chattopadhyay, "Unit Operations of Chemical Engineering", Vol -1, Khanna Publishers, (2003).
3. J.M. Coulson, J.F. Richardson, "Chemical Engineering", Vol-I, Oxford, Pergamon Press, (1968).

Reference Books:

1. Christie J Geankoplis, "Transport Processes and Unit Operations", 3rd ed., PHI Pvt Ltd, (1993).
2. Foust, Alan S., "Principles of Unit Operations", 2nd ed., John Wiley and Sons, (1980).
3. Neol de Nevers, "Fluid Mechanics for Chemical Engineers." II Edition, Mc.Graw Hill (1991).
4. James O. Wilkes and Stacy G. Bikes, "Fluid Mechanics for Chemical Engineers" Prentice Hall PTR (International Series in Chemical Engineering) – (1999).

FLUID MECHANICS AND HEAT TRANFER

Course code : 15 BT 2104 **L – T – P :** 3-2-0

Pre Requisite : Nil **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	summarize the various types of fluid flow and illustrate the continuity equation and velocity potential for fluid flow	b	2
CO-2	Construct various laws for measuring the total pressure and centre of pressure on surface of various geometries using transportation and metering of fluids	e	2
CO-3	Employ the basic principles of law of conservation of energy to systems which involve mode of heat transfer operations	e	2
CO-4	identify, formulate and solve engineering problems involving conduction, convection and radiation heat transfer and heat exchangers by transforming the physical system into a mathematical model, selecting an appropriate solution techniques and evaluating significance results and develop the heat transfer unit operations for various Biological materials	e	2
CO-5	identify, formulate and solve engineering problems involving Evaporation of biological materials and drying of biological fluids and evaluating significance results and develop the heat transfer unit operations for various Biological materials	e	2

Syllabus:

Basic concepts in fluid flow- Introduction, basic laws, nature of fluid, viscosity, shear stress, coefficient of viscosity, Newtonian and Non Newtonian fluids, Flow field, Reynolds experiment, Laminar and Turbulent; flow, fluid head, total energy balance for steady flow, Bernoulli's theorem, flow of a fluid past a solid surface. Friction losses in laminar flow through a circular tube (Hagen-Poiseulle equation) Friction losses in turbulent flow (Fanning equation).Transportation and metering of fluids-Manometers: Simple, differential and inclined manometers. Hydrodynamic methods: Pitot tube, orifice and Venturimeter, weirs, Rotameters. Centrifugal pump Principles of steady state heat transfer-Fourier's law of heat conduction, Thermal conductivity, convective HTC, conduction through a flat slab as wall, conduction through hollow cylinder, conduction through solids in series, plane walls in series, Log mean temperature difference and varying temperature drop. Introduction and basic equations for radiation. Heat exchange equipment and basic concepts in evaporation: Heat exchangers- Types of exchanger's double-pipe heat exchanger shell & tube. Evaporation: Introduction, processing factors types of evaporation equipment and evaporation methods-general types of evaporators, methods of operation, overall heat transfer coefficients in evaporators. Heat and material balances for single-effect evaporator. Evaporation of Biological materials – Introduction and properties of Biological materials, Fruit juices, sugar solutions, paper-pulp waste liquors. Drying of process materials-Equilibrium moisture content, Bound and unbound moisture, free moisture, rate of drying curves, drying rate curve for constant drying conditions, drying in the constant rate and falling rate periods, calculation methods for constant rate drying and falling rate drying periods.

Texts books:

1. S. K. Ghosal, S. K. Sanyal & S. Dutta. Introduction to Chemical Engineering
2. W. L. Badger and J. T. Banchero. Introduction to Chemical Engineering

Reference books:

1. Christie . J. Geankoplis. Transport processes and Unit operations
2. W. L. Mc Cabe & J. C. Smith. Unit Operations in Chemical Engineering.

PROCESS ENGINEERING PRINCIPLES

Course Code : 15 BT 1102 **L-T-P :** 3-2-0

Prerequisite : Nil **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Describe the engineering calculations in Bioprocess Technology principles.	a	2
CO 2	Employ the basic principles of ideal gas law for measuring no. of moles of various solutions.	e	2
CO 3	Employ the basic principles of material balance of a various reaction systems and Estimate the chemical and microbial kinetic parameters for better biomass and product formation	e	2
CO 4	Employ the basic principles of Energy balance of a various reaction systems and Estimate the chemical and microbial kinetic parameters for better biomass and product formation	e	2
CO 5	Measurement and prediction of thermo physical and biological properties of binary and ternary liquid mixtures.	e	2

Syllabus:

Introduction to Engineering Calculations Physical variables; dimensions and Units; Measurement conventions: Density, specific gravity; specific volume, mole, chemical composition, vapor pressures, concentration, composition of mixtures and solutions: molarity, molality, normality, weight fractions, mole fractions,volumetric composition laws of chemical combination **Ideal gases** Ideal gas law, differences between ideal and real gases, application of ideal gas law, Daltons law of additive pressures, amagat's law of additive volumes, volume changes with change in composition, pure component volume method, partial pressure method, gases in chemical reactions. **Material balances** Stiochiometry, Introduction to system and process; difference between steady state and equilibrium, Law of conservation of mass: Types of material balances, Procedure for material balance calculations with and without chemical reactions, yield, conversion, limiting and excess reactants. **Energy balances** Basic Energy concepts: law of conservation of energy, standard heat of formation, standard heat of reaction. latent heat of vaporization and condensation, specific heat, sensible heat of formation ,heat of reaction, heat of combustion Hess's law, effect of temperature and pressure on heat of reaction, Kirchhoff's law; **Material and energy balances in cell culture** Material balance for continuous filtration, batch mixing, material balances with recycle, by pass and purge streams. Energy balance worked examples without reaction: cooling in downstream processing, continuous water heater, and fermentation energy balance; Biological and thermo physical properties of binary and ternary liquid mixtures.

Text Books :

1) Bioprocess Engineering Principles, Pauline M. Doran, ELSEVIER publications.

2) Introduction to Biochemical Engineering, D G Rao, Mc Graw Hill publications.

Reference Books

3) Bioprocess Engineering, basic concepts, Michael L.Shuler Fikret Kargi

MECHANICS OF FLUIDS

Course code : 15 CE 2102 **L T P :** 2-2-2

Pre Requisite : 15 ME 1001 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To understand concept of flow phenomenon and determination of fluid properties.	a,b,e,h,k	1
CO 2	To understand the mechanics pressure and its measurement.	a,b,e,h,k	1
CO 3	To get the concepts of kinematic principles and solutions for simple mathematical equations, To understand the energy principle, continuity equation of fluid in 3-dimensions	a,b,e,h,k	2
CO 4	To know various hydraulic principles of pipe flow and losses in pipe systems.To Understand the Dimensional analysis concept and deriving the relevant equations.	a,b,e,h,k	2
CO 5	Able to identify the fluid properties	a,k	2

Syllabus:

Fluid properties: Definition of fluid, properties of fluid-density, specific weight, specific gravity, viscosity, classification of fluids, surface tension and capillarity, vapour pressure and cavitation.

Fluid statics: pressure, Pascal's law, hydrostatic law, measurement of pressure-simple and differential manometers, Total pressure and centre of pressure on vertical, horizontal and Inclined surfaces.

Fluid statics-buoyancy and floatation: Buoyancy, centre of buoyancy, Meta-centre, Meta-centric height.

Fluid kinematics: types of fluid flow, Discharge, Continuity equation, Continuity equation in three dimensional flow, velocity potential function and stream function. Fluid dynamics: Euler's equation of motion, computational approaches for solving Euler's equation Finite Volume Method, Bernoulli's equation and applications, Venturimeter, Orificemeter, Pitot-tube, coefficient of discharge, orifices and mouth pieces.

Momentum equation: Impulse-momentum equation, Force exerted by flowing fluid on pipe-bend.

Flow through pipes: Introduction, major and minor energy losses, hagen- poiseuille law, Hydraulic gradient and total energy line, pipes in series and parallel and Water hammer.

Turbulance: Introduction to Turbulance, Navier Strokes Equations,

Dimensional analysis & model similitude: Buckingham's PI theorem, Model analysis, Types of similarities, Dimensionless numbers, Classification of models, Model laws-Reynolds and Froude model law

Text Books:

1. Fluid Mechanics by John F. Douglas, Tata McGraw Hill publications
2. Fluid Mechanics by S.K.Som, G Biswas, Tata McGraw Hill publications

Reference Books:

1. Fluid Mechanics by Frank M white, Tata McGraw Hill publications
2. Fluid Mechanics by A. Cengel and John M. Cimbala, Tata McGraw Hill publications
3. Fluid Mechanics by G. S Sawhney, IK International Publishing house (P) Ltd. New Delhi
4. Fluid Mechanics by Edward J. Shaughnessy, Oxford University Press, USA

SOLID MECHANICS

Course code : 15 CE 1201 **L- T- P :** 3-0-2

Pre Requisite : 15 ME 1001 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Associate with the stress-strain diagrams and the relationship between the elastic constants, estimate temperature stresses in compound bars and find the stresses in thin walled pressure vessels	a,e	1
CO2	Draw Shear force and Bending moment diagrams for statistically determinate beams	a,e	2
CO3	Calculate the Bending and shear stresses and draw the distribution diagrams for various cross sections.	a,e	2
CO 4	Estimate the transformation of stress in a plane and draw Mohr's circle, Estimate stresses due to torsion for circular shafts and find buckling load for centric and eccentric columns	a,e	2
CO 5	Able to asses the material properties	a,e	2

Syllabus:

Simple stresses and strains: Elasticity and plasticity; Types of stresses and strains; Hooke's law; stress strain diagram for mild steel and HYSD-bars Working stress; Factor of safety ; Lateral strain, Poisson's ratio and volumetric strain ; Elastic constants and the relationship between them ; Bars of varying section ; composite bars ; Temperature stresses. Resilience Gradual, sudden, impact and shock loadings simple applications.

Shear Force and Bending Moment: Diagrammatic conventions for supports; Diagrammatic conventions for loading; Classification of beams; Concept of shear force and bending moment; relationship between load, shear force and bending moment, Shear force and bending moment diagrams for statically determinate beams and frames.

Pure Bending and Shearing Stresses of Beams: The flexure formula; Computation of the moment of inertia; Remarks on the flexure formula. The shearing stress formula for beams; Shear stress distribution for various sections; Shear centre.

Analysis of Plane Stress: Equations for the transformation of plane stress; Principal Stresses; Principal planes; Maximum shearing stresses; Mohr's circle of stress; Construction of Mohr's circle of stress.

Torsion: torsional deformations of a circular bar, circular bar of elastic materials, stresses and strain in pure shear, relationship between E and G.

Columns: Stability of equilibrium; The Euler's formula for columns with different end restraints; Limitations of the Euler's formulas; Generalized Euler buckling - load formulas; The Secant formula; Rankine's empirical formula.

Thin pressure vessels: Concepts of hoop and longitudinal stresses, Analysis of cylinders and shells.

Text Books:

1. J.M. Gere, Thomsom brooks/Cole India edition, Mechanics of materials Sixth edition, 2006.

2. Andrew Pytel & F. L. Singer, Strength of Materials Harper Collin Publisher's Pvt. Ltd. New Delhi, Fourth edition.

Reference Books:

1. S P Timoshenko. Strength of Materials Part I & II CBS Publishers and distributors, New Delhi, 3rd Edition.

2. Riley, Strurges and Morris, Mechanics of Materials John Wiley and Sons Inc. fifth Edition.

CONSTRUCTION MATERIALS AND CONCRETE TECHNOLOGY

Course code : 15 CE 2206 **L T P :** 3-0-2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Compare the properties of most common and advanced building materials	a,e	2
CO2	Understand the typical and potential applications of these materials such as concrete and its mix proportioning	a,e	2
CO3	Understand the relationship between material properties and structural form	a,e	2
CO 4	Understand the importance of experimental verification of material properties.	a,e	2
CO 5	Able to identify the concrete properties	a,e	2

Syllabus:

Stones bricks concrete blocks: Stone as building material; Criteria for selection;Tests on stones; Deterioration and Preservation of stone work; Bricks; Classification Manufacturing of clay bricks Tests on bricks Compressive Strength Water Absorption Efflorescence Bricks for special use Refractory bricks Cement, Concrete blocks Light weight concrete blocks.

Lime cement aggregates mortar: Lime Preparation of lime mortar Cement Ingredients Manufacturing process Types and Grades Properties of cement and Cement mortar Hydration Compressive strength Tensile strength FinenessSoundness and consistency Setting time Industrial byproducts Fly ash Aggregates Natural stone aggregates Crushing strength Impact strength Flakiness Index Elongation Index Abrasion Resistance Grading Sand Bulking.

Concrete: Concrete Ingredients Manufacturing Process Batching plants RMC Properties of fresh concrete Slump Flow and compaction Factor Properties of hardened concrete Compressive, Tensile and shear strength Modulus of rupture Tests Mix specification Mix proportioning BIS method High Strength Concrete and HPC Self compacting Concrete Other types of Concrete Durability of Concrete.

Timber and other materials: Timber Market forms Industrial timberPlywood Veneer Thermacole Panels of laminates Steel Aluminum and Other Metallic Materials Composition Aluminium composite panel Uses Market forms Mechanical treatment Paints Varnishes Distempers Bitumens.

Modern materials: Glass Ceramics Sealants for joints Fibre glass reinforced plastic Clay products Refractories Composite materials Types Applications of laminar composites Fibre textiles Geomembranes andGeotextiles for earth reinforcement.

Text Books:

1. Varghese. P. C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2012.
2. Shetty. M. S., "Concrete Technology (Theory and Practice)", S. Chand and Company Ltd., 2008.

Reference Books:

1. Jagadish.K.S, "Alternative Building Materials Technology", New Age International, 2007.
2. IS456 2000: Indian Standard specification for plain and reinforced concrete, 2011
3. IS4926–2003: Indian Standard specification for ready–mixed concrete, 2012
4. IS383–1970: Indian Standard specification for coarse and fine aggregate from natural Sources for concrete, 2011
5. IS1542–1992: Indian standard specification for sand for plaster, 2009
6. Duggal. S. K., "Building Materials", 4th Edition, New Age International , 2008.
7. Gambhir. M.L., & Neha Jamwal., "Building Materials, products, properties and systems", Tata McGraw Hill Educations Pvt. Ltd, New Delhi, 2012.
8. Gambhir. M. L., "Concrete Technology", 3rd Edition, Tata McGraw Hill Education, 2004

MATERIAL & ENERGY FLOW COMPUTATION

Course code : 15 PE 2102 **L-T-P :** 3-2-0

Pre Requisite : NIL **Credits :** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the fundamental laws of conservation and apply the material balance equation for single unit non-reactive systems.	a, c	1
CO 2	Apply the material balance equation for multi-unit reactive as well as non-reactive systems.	c	2
CO 3	Apply the energy balance equation for processes involving temperature effects and analyze various processes in which combined material and energy flow computations are applicable.	c	2
CO 4	Apply the Combined material and Energy balance of the industrial problems	c	2

Syllabus:

Stoichiometry: Units and Dimensions, Conversion of Units, expressions and equations, dimensional groups and constants, Ideal and real gas laws, Behavior of ideal gases and mixtures, calculations of pressure, volume and temperature using ideal gas law, Gas mixtures, Use of partial pressure and pure component volume in gas calculations, Raoult's law - vapor pressure, Clausius-Clapeyron equation, Cox Chart, Duhring's Plot.

Material Balance – non-reactive systems: Material balance problems on single and multi-unit systems without involving chemical reactions - Degrees of freedom - Recycle - Bypass and Purge calculations.

Material Balance – reactive systems: Processes involving chemical reactions for single and multiple unit systems

Energy Balance: Energy balances with and without chemical reactions: Enthalpy - Heat capacity - Thermo-chemistry; Hess's law of heat summation - Heats of formation - reaction and combustion - Theoretical flame Temperature.

Combustion of coal - fuel gases and sulfur - Degree of conversion - Excess reactant - Limiting reactant.

Humidity and saturation: Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity – Dew point – Use of humidity in condensation and drying – Wet and dry bulb temperatures, Humidity chart, solving problems using humidity chart.

Combined material and Energy balance: Integrated material and energy balance equation – solving processes involving both material and energy balance equations.

Text Books:

1. Richard M. Felder and Ronald W. Rousseau, "Elementary Principles of Chemical Processes", 3rd Ed, John Wiley & Sons, INC. (2000).
2. B. I. Bhatt and S. M. Vora, "Stoichiometry", 4th Ed., Tata McGraw Hill Publishers Ltd., New Delhi, (2004).

Reference Books:

1. O. A. Hougen, K. M. Watson and R. A. Ragatz, "Chemical Process Principles", Vol- I, CBS Publishers and Distributors, New Delhi, (1995).
2. David M. Himmelblau, "Basic Principles and Calculations in Chemical Engineering", 8th Ed., Prentice Hall of India Private Limited, (2012).
3. Ernest J. Henley and Edward M. Rosen, "Material and Energy Balance Computations", John Wiley & Sons, (1969).

CHEMICAL ENGINEERING THERMODYNAMICS

Course code: 15 PE 2207 **L-T-P :** 3-2-0

Pre Requisite: 15 ME 1003 **Credits :** 4

Mapping of the course outcomes with student's outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Apply fundamental concepts of thermodynamics to engineering applications	a	2
CO 2	Estimate thermodynamic properties of substances in gas and liquid states	a, k	2
CO 3	Learn Phase Equilibria and VLE calculations	a	2
CO 4	Apply equilibrium criteria to systems and be able to interpret equilibria calculations and case studies	a, k	3

Syllabus:

Heat effects: Sensible heat effects - Internal energy of ideal gases: Microscopic view, Latent heats of pure substances, heat effects of industrial reactions, heat effects of mixing processes. Standard heat of reaction, Standard heat of formation, Standard heat of combustion, temperature dependence of heat of reaction

P-V-T relations: PVT relationships for gases and liquids - equations of state - Z charts - gas mixtures. Compression - expansion.

Thermodynamic Relations: Thermodynamic relations - Maxwell's relations - Jacobian algebra - estimation of thermodynamic properties.

Solution thermodynamics: Theory: Fundamental property relations - chemical potential as a criterion for phase equilibrium - partial properties - ideal gas mixtures - fugacity and fugacity coefficient for pure species - fugacity and fugacity coefficient for species in solutions, generalized correlations for fugacity coefficient Gibbs free energy- ideal solutions - excess properties.

Phase Equilibria and VLE calculations: liquid phase properties from VLE data, models for the excess Gibbs energy and property changes of mixing. VLE from equations of state – various correlations and theorems - Dew point and bubble point calculations, flash calculations. Concepts of liquid-liquid equilibrium (LLE), vapor- liquid–liquid equilibrium (VLLE), solid-liquid equilibrium (SLE), solid vapor equilibrium (SVE), equilibrium absorption of gases on solids

Chemical reaction equilibria: The reaction coordinate, application equilibrium criterion to chemical reactions, the standard Gibb's energy change and the equilibrium constant, effect of temperature on equilibrium constants, relation of equilibrium constants to composition, equilibrium conversion for single reactions, Phase rule and Duhem's theorem for reacting systems..

Text Books:

1. J. M. Smith, H.C. Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics, 7th Ed., McGraw Hill, (2005).
2. Y. V. C. Rao, "Chemical Engineering Thermodynamics", 1st Ed., University Publication, (1997).

Reference Books:

1. K. V. Narayanan, "A textbook of chemical engineering thermodynamics", Prentice Hall Of India, New Delhi
2. P. K. Nag, "Engineering Thermodynamics" 4th Ed. Tata McGraw Hill, New Delhi.
3. G. J. Van Wylen., Sonntag, "Fundamentals of Thermodynamics" - 6th Ed, Wiley India publications.

DEPARTMENT OF BT

CELL BIOLOGY

Course Code: 15 BT 1203 **L-T-P :** 3-2-0

Pre-requisite: Nil **Credits:** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of cell and Nuclear Organization	a	2
CO 2	Compare Cell division and cell cycle .	a	2
CO 3	Acquire the knowledge of tissues and Receptors	a	2
CO 4	Understand membrane Structure	a	2
CO 5	transport mechanisms	a	2

SYLLABUS:

Introductory cell- What are microorganisms? Differences between Eukaryotic and prokaryotic organisms. Structure and function of Prokaryotic and Eukaryotic cell – bacterial cell, plant cell, animal cell, Cyanobacterial cell. Cell organelles – plasma membrane, mitochondria,Golgi complex, E.R, Lysosomes, Ribosomes. Nuclear Organization- Nuclear ingredients – Nuclear membrane, Nature of the genetic material, Nucleoproteins. Packaging of genetic material, Nucleosome model,Organization of Chromatin, Chromosome. Cytoskeleton – Microtubules, microfilaments. Cell division and cell cycle- Cell Division: Mitosis and Meiosis. Steps in cell cycle, Go-G1 transition, cell cycle check points, Chromosome movements, regulation of cell division. Cell differentiation: cortical Differentiation, nuclear differentiation and cell death. Tissues & Receptors- Meristems, Simple, complex and special tissues. Growth patterns, Cell growth and mechanisms. Embryonicdevelopment, Organogenesis, metamorphosis, Cell signaling–Membrane receptors, Cell – Cell interactions. Membrane Structure and Transport- The structural and functional organization of cell membrane, the extra cellular matrix of eukaryote's cell wall. Transport across cell membrane - passive and active transport, Na-K pump, Ca^{2+} ATPase pumps, Lysosomal and Vacuolar membrane ATP dependent proton pumps, Co-transport into prokaryotic cells, endocytosis, exocytosis, pinocytosis and phagocytosis.

Text Books:

1. P.S. Verma and V.K. Agarwal,"Cell biology, Genetic, Molecular Biology, Evolution and Ecology" edition, S. Chand and Company Ltd.
2. George H fried, "Biology scham series", edition, Mc Graw Hill.

Reference Books:

1. EDP Roberties & EMF Roberties ,"Cell Biology & Molecular Biology" Sauder College.
2. G P Talwar and L.M. Srivatsava ,"Textbook of Biochemistry and Human biology ",Eastern Economy Edition.

MICROBIOLOGY

Course Code: 15 BT 1205 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge about chronological development, classification, cell structure, characteristics and diseases of microorganisms	b	2
CO 2	Acquire the knowledge characteristics and diseases of microorganisms	b	2
CO 3	Construction of growth curve, identification of various factors affecting growth and outline about microbial growth estimation methods	k	3
CO 4	Compare various media, isolation, identification and sterilization methods of microorganisms	e	2
CO 5	Demonstrate various methods of microbiology such as sterilization, isolation, identification and characterization.	b	2

SYLLABUS:

History and classification of microorganisms-Discovery of microorganisms; Theory of spontaneous generation, Germ theory of disease; Microbial taxonomy and diversity: Bacteria and their broad classification-Major characteristics used in taxonomy. Major contributors in field of Microbiology-Antony van leeuwenhoeks; Louis Pasteur; Robert Koch; Edward Jenner; Joseph Lister; Winogradsky; Beijerinck. Microscope- Simple, Compound and Fluorescence. Morphology & Cell structure of microorganisms-Ultra structure of bacteria, cell wall, flagella, pili, capsule, endospore and cell inclusions. Viruses – Chemistry & Morphology (size, shape and symmetry), replication of viruses, lytic and lysogenic cycles. Yeasts & Molds – Morphology, life cycle, economic importance of fungi (Eg. Aspergillus). Identification based on shape, staining reactions (Differential stain, Acid fast, capsule staining, Endospore staining).Growth kinetics of microorganisms, Bacterial nutrition-Nutritional classification of bacteria, Essential Macronutrients, Micronutrients and Growth factors. Microbial growth–Growth curve and factors affecting the growth– solutes, water activity, pH, Temperature, Oxygen concentration, Osmotic pressure, Radiation. Bacterial growth; synchronous growth and methods of growth estimation. One step growth curve, Physiology of Archaebacteria–thermophiles, psychrophiles, halophiles and methanogens. Growth media and control of microorganisms- culture media-synthetic and complex media, solidifying agents, types of media. Isolation of pure cultures - spread, pour and streak plate methods; Maintenance and Preservation of microorganisms. Control of microorganisms – Sterilization and disinfection, effects of physical (moist and dry heat, radiation and filtration) and chemical agents. Antibiotics – classification, mode of action and resistance. Medical microbiology-Disease reservoirs; Respiratory infections caused by bacteria and viruses, (tuberculosis); Disease transmitted by animals (rabies) and insects (malaria); Food and water-borne diseases (cholera); pathogenic fungi, Viriods& Prions.

Texts books:

1. Pelczar MJ, Chan ECS & Krieg NR, "Microbiology" edition, Tata McGraw Hill, (Year)
2. Prescott & Dunn, "General Microbiology", edition, McGraw Hill publishers, (Year)

References Books:

1. C.B.Power. General Microbiology Vol I & II
2. Brock, Biology of microorganisms Prentice Hall Int.Inc.

BIOCHEMISTRY

Course Code: 15 BT 2106 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the functions and properties of biomolecules (carbohydrates, nucleic acids, proteins, lipids) in biological systems.	c	2
CO 2	Understand the organization and biochemical reactions of biomolecules.	c	2
CO 3	Understand the importance of various metabolic pathways	c	2
CO 4	Understand the importance of various biosignaling in biological systems.	c	2
CO 5	Perform techniques used in biochemistry to address biochemical problems.	k	2

SYLLABUS:

Carbohydrates-Introduction to biomolecules; types of linkages/bonds; importance of biomolecules; Classification, structure and functions of Monosaccharides (Ribose, Glucose, And Fructose), Disaccharides (Maltose, Lactose and Sucrose) Polysaccharides (Starch, Cellulose and Glycogen) and Heteropolysaccharides. Amino acids and proteins-amino acid structure, classification, biological properties of amino acids; physicochemical properties, Physical Synthesis of Peptides (solid phase peptide synthesis); Primary, secondary, tertiary and quaternary structure and proteins. Lipids- Classification; Structure; physico-chemical properties of different classes of lipids. Nucleic acid- Structure; properties and biological functions of nucleic acids. Different types of DNA and RNA. Metabolism-Introduction, IUBN Classification of enzymes, basic metabolic pathways; glycolysis, Krebs cycle, Electron Transport Chain, Beta oxidation of fatty; Concepts of biosignaling Importance of biosignaling in living systems; introduction to gated ion channels; Type study functions of Na+/K+ channels; receptor enzymes – insulin.

Text Books:

1. A L Lehninger& Nelson & Cox ,"Principles of Biochemistry", CBS publications.

2. U. Satyanaray,"Biochemistry" ana, Allied and Books Pvt. Ltd. Kolkata.

Reference Books:

1. Harpers," Biochemistry", 25th edition, Mc Graw Hill(2000).

BIOANALYTICAL TECHINIQUES

Course Code: 15 BT 2207 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand the basic principles of different bio analytical methods	c	3
CO-2	Knowledge about techniques related to electrophoresis & spectroscopy	c	3
CO-3	Knowledge about techniques related to spectroscopy	c	3
CO-4	An understanding of use of Radioisotopes in biological sciences and its ethical issues	c	3
CO-5	An ability to perform centrifugation, chromatography, electrophoresis & spectroscopy techniques	k	3

SYLLABUS:

Centrifugation – Basic principles (sedimentation, Sedimentation coefficient, Svedberg units) and types of rotors in centrifuges - Fixed angle rotor, Vertical rotor, Swing out rotor, Zonal rotors. Types of centrifuges – Ultra and Analytical centrifuges, Preparative and Density gradient centrifugations, Density gradients preparations – Sucrose, Cesium chloride. Determination of molecular weight and purity of macromolecules by centrifuges. Chromatography-Basic principle of chromatography - Partition chromatography, Counter Current distribution. Modes & Types of chromatography – Paper, TLC. Column Chromatography – Gel permeation, Ion exchange, Affinity chromatography, GLC, HPLC. Electrophoresis- Principle of electrophoresis, Types of electrophoresis: Free Electrophoresis – Microelectrophoresis, Moving boundary; Zonal Electrophoresis – Paper, Cellulose Acetate, Starch gels, Agarose gels, SDS-PAGE. IEF (Isoelectric focusing), Pusle field gel electrophoresis (PFGE), 2-D gel electrophoresis, Capillary electrophoresis.
Spectroscopy Basic concepts of spectroscopy, Beer- Lamberts law, Colorimetry, Visible & UV Spectroscopy, Fluorescence spectroscopy, Flame photometry, Atomic absorption spectrophotometer, Infrared, FT-IR, NMR & Mass spectroscopy. Isotopic and electro chemicaltechniques-Auto- radiography – Principles and Applications of radioisotopes in biological sciences Non- isotopic tracer techniques. Principles and range of electrochemical techniques – pH electrodes. Ion-selective, gas sensing electrodes and Oxygen electrodes, Immuno-histochemistry.

Text books:

1. KeithWilson & John Walker, "Principles & Techniques of Biochemistry and Molecular biology. Practical Biochemistry. Principles and Techniques". 5th ed. Cambridge University press(1994).

2. Uppadyay, Uppadyay & Nath ,"Biophysical Chemistry. Principles and Techniques". 11th ed. Himalaya publishing house.

Reference Books:

1. Freifelder ," Biophysical Chemistry". Freeman & Co.

MOLECULAR BIOLOGY

Course Code: 15 BT 2208 **L-T-P :** 3-2-0

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the genome organization & replication	a	2
CO 2	Compare DNA transcription and translation mechanisms	b	2
CO 3	Analyze gene regulation mechanisms	b	2
CO 4	Acquire the knowledge of Translation in prokaryotic and Eukaryotes	a	2
CO 5	Analyze Regulation of gene expression in Bacteria	b	2

SYLLABUS:

Genome organization & dna structure-Nucleic acid as genetic material, transformation in pneumococcus, Hershey-Chase experiment, RNA as genetic material in viruses. Genome of prokaryotes & eukaryotes, C-Value Paradox, structural genes, regulatory genes, overlapping genes, pseudogenes, split genes. Structure of DNA-Watson & Crick's model; Types of DNA: A, B and Z-DNA; Denaturation, renaturation of DNA. DNA replication and repair-semi conservative replication apparatus, bi-directional & rolling circle replication. dna damage-Mutations, Types of Mutations, Effect of UV, Deamination, Alkylation. Repair Mechanisms-Direct Repair, Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair. Mechanism of transcription and translation Prokaryotic & Eukaryotic Transcription – Initiation, Elongation and Termination; Structure of Promoters; RNA Polymerases of Prokaryotic and Eukaryotic Organisms; gene splicing and Ribozyme. Post Transcriptional Processes of Eukaryotic RNA–Processing of t-RNA, r-RNA, m-RNA. Translation in prokaryotic and Eukaryotes-Genetic code, Aminoacylation of tRNA – initiation, elongation and termination of translation, Post-translational modifications. Regulation of gene expression Regulation of Gene expression in Bacteria–Operon concept, inducible and repressible operons, positive and negative regulations, Inducer molecules, repressor molecules, co repressor molecules; Induction and catabolic repression of lac Operon in E.Coli; Repression and attenuation of trp operon in E.Coli; Absolute control by Antisense RNA's. Regulation in eukaryotes – Control by promoter, enhancer and silencers. Cis-trans elements.

Text Books:

1. David Freifelder ,"Molecular Biology ", Narosa publications house.
2. P. K. Gupta ,"Genetics", Rastogi publications.

Reference Books:

1.Weaver ,"Molecular Biology ";Academic International Publication.

2. Benjamin Lewin ,"Gene IX ", Pearson Publishing.

BIOCHEMICAL REACTION ENGINEERING

Course Code: 15 BT 2209 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of reaction engineering basics	b	2
CO 2	Interpret batch reactor kinetic data	e	3
CO 3	Develop design equations of different bioreactor systems to analyze microbial growth and product formation.	e	3
CO 4	Design and construct various multiphase bioreactors	k	2
CO 5	Demonstrate biochemical processes to analyze various biochemical parameters on microbial growth.	b	2

SYLLABUS:

Over View of Biochemical Reaction Engineering- Over view of biochemical reaction Engineering; Classification of reactions; Reaction rate; Kinetics of homogenous reactions; Single and multiple reactions; Elementary and Non elementary reactions; Molecularity and order of reactions; rate constant; Kinetic models of non elementary reactions; Temperature dependency of rate equation. Interpretation of Batch Reactor Data-Constant volume batch reactor; Analysis of total pressure data; The conversion; Integral method of analysis of data; Irreversible uni-molecular, bimolecular reactions; Zero order reactions. Half life of a reaction; Varying volume batch reactor; differential method of analysis; Integral method of analysis; Zero order; First order & second order reactions; Temperature & reaction rate.: Bioreactor Systems- Definitions; Differences and similarities between chemical and bioreactors; Classification of bioreactors; Reactor configurations;Description of a conventional bioreactor with all aspects; Design and construction criteria of a bioreactor; Concept of ideal and nonideal reactors; Residence time distribution; stimulus response techinique; Models of non ideal reactors; Imperfect mixing. Designing Of Bioreactors-Design equations for enzyme reactors; batch growth of microorganism; Design equation of a plug flow reactor; Design of CSTR with wash out concept; Stirred tank reactors with recycle of biomass; Continuous stirred tank fermentors in series with out and with recycle of biomass; Estimation of kinetic parameters. Multiphase Bioreactors-Different types of reactors: Cell lift reactor; Multipurpose tower reactor; Liquid impelled loop reactor; Pumped tower loop reactor; Fluidized-bed reactor; Packed bed reactor; bubble column reactors, Airlift reactors Gas inducing reactors. Animal & plant cell reactor technology-Environmental requirements for animal cell cultivation; Reactors for large scale production using animal cells, plant cell cultivation

Text Books:

1. Octave Levenspiel, "Chemical Reaction Engineering," Third edition, Wiley India pvt. Ltd (October,2006)
2. D.G.Rao," Biochemical Engineering", McGraw Hill)(2008).

Reference Books:

1. Bailey&Ollis, Fundamentals of Biochemical Engineering, Mcgraw Hill HiEducation (31121988).
2. Atkinson & Mavituna, Biotechnology and Biochemical Engineering Springer (Mar1973).

IMMUNOLOGY

Course Code : 13 BT 3110 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the various defense mechanism of body system	a	1
CO 2	Compare different types of Ag-Ab reactions	k	2
CO 3	Differentiate the role of B and T cells	a	1
CO 4	Development of ELISA method for Ag-Ab reactions	b	2
CO 5	Demonstrate various immunologfical techniques	k	2

SYLLABUS:

Basics of immunology-Types of immunity – Innate, acquired, Humoral & cell mediated; Organs of the immune system: Primary lymphoid organs – Bursa of fabraceous, Bone marrow, thymus; Secondary lymphoid organs – Spleen, lymph node. Cells of immunity–Lymphoid & Myeloid lineage. Antigens–Types, Chemical nature, characteristics of Antigen, Hapten and adjuvant. Cytokines–Types, receptors and functions. Immunological techniques- Antigen-Antibody Reactions– Mechanism and types. Agglutination–blood grouping, Widal&VDRL. Precipitation–double immunodiffusion, Radial Immuno Diffusion; Immunoelectrophoresis, Rocket lavor electrophoresis, Complement fixation test. ELISA, Western blotting, FACS, IHC and RIA. B Cell ontogeny-B-Cell biology, BCR, Immune response – primary, secondary and tertiary response's; Theories of immune response. Immunoglobulins– Structure, types, subtypes and functions. Antibody genes and generation of diversity, Production of monoclonal antibodies. Complement System – Classical, alternative and MB Lectin pathway& regulation T Cell ontogeny-T-Cell biology, TCR; Types of T cells – TH, TC and TS cells. Structure of MHC – I & II, Professional Antigen Presenting Cells, Mechanism of Antigen processing and Antigen presentation. Tcell effector mechanism. Clinical immunology-Hypersensitivity: IgE mediated, antibody dependant cell cytotoxicity, immune complex mediated reactions and delayed type of hypersensitivity; Auto immunity–systemic & organ specific. Transplantation immunity– MLR and MCA; Tolerance-Natural&Adaptive. Tumor immunity – Tumor antigens, Vaccinations – basic concept, types.

Text books:

1. Richard A. Goldsby, Thomas J. Kindt & Barbara A. Osborne, Kuby, "Immunology", John Wiley publishers 6th ed.,(2007).
2. Ivan M. Roitt, Peter J. Delves, "Essential Immunology", Blackwell publishers. 10th addition.

References Books:

1. Ian R. Tizard," Immunology – An Introduction", Thomson publishers.

GENETIC ENGINEERING

Course Code : 13 BT 3111 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand the methods of recombinant DNA technology	b	3
CO-2	Compare different vectors and assess recombinant DNA molecules	b	3
CO-3	Analyze PCR and sequencing methods	b	3
CO-4	Construct an recombinant DNA molecule	e	3
CO-5	Demonstrate various genetic engineering techniques	e	3

SYLLABUS:

Basics of Genetic Engineering-Basic steps of gene cloning. Isolation & Purification of DNA & RNA. Enzymes used in cloning – Nucleases, Polymerases, Ligases, Transferases, Dnases, Rnases, Kinase, Phosphatase. Restriction Enzymes – Nomenclature, classification, uses, restriction sites, applications. Special DNA molecules – Linker, Adaptor, Polytailing. Cloning Vehicles-Plasmids Vectors – Classification, Properties, pUC 18/19, pBR 322, Blue script vectors. Cosmid Vectors – essential features, strategies to generate genomic library. BACs & YACs Their uses in construction of genomic library. Phagemids – M13 derived vectors. Expression vectors – pRT and pET vectors. Vectors for construction of cDNA libraries. Polymerase Chain Reaction-PCR– History, Principle, Mechanism, Methodology, Applications, Primers, Designing of mutagenic primers. Identification of PCR products, Cloning of PCR products, Multiplex PCR, Anchored PCR, Asymmetric PCR, Nested PCR, Inverse PCR, fusion PCR , RAPD-PCR, RT-PCR, Hot Start PCR, Touch Down PCR and Real Time PCR. Genes to Clones-Gene Transfer Techniques – Microinjection, Electroporation, Transformation, Particle bombardment, Macroinjection, Chemical methods. Screening of clones – Complementation method, genetic methods, Immunological methods, Hybridization methods. Gene Technology-Sequencing of DNA by Maxam-Gilbert method and Sanger's method. RNA silencing, RAPD, RFLP, AFLP. Restriction Mapping. Invitro mutagenesis. Site directed mutagenesis. Blotting Techniques – Southern, Northern & Western. Probe preparation, labeling and detection techniques (Phosphoimaging and Radioactive labeling). Applications of gene cloning in medicine and agriculture.

Textbooks:

1. Old R.W and Primrose S.B, "Principles of gene manipulation-An introduction to genetic engineering". 5th edition. Blackwell scientific publications. London(1995).
2. Winnaker E.C,"From genes to clones. Introduction to gene technology. VCH Publications"(1987).

Reference Books:

1. J.D.Watson ,"Recombinant DNA (A short Course)". W.H.Freeman (1983).
2. T.A Brown," gene cloning and DNA analysis", Wiley Blackwell(Apr- 2010).

BIOINFORMATICS

Course Code : 15 BT 3112 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Acquire the theoretical basis of bioinformatics	b	2
CO2	understand the access and retrieval of biological information from data bases	b	2
CO3	Manipulate the DNA/Protein sequences using stand alone PC programs and with the help of World Wide Web	b	2
CO4	Develop Multiple Sequence Alignment tools to find homologous, analyze sequences, construct and interpret the evolutionary trees	k	3
CO5	Demonstrate the protein structures using retrieved sequences	k	3

SYLLABUS:

Introduction to bioinformatics & databases- Need of Computers in Biotechnology Research- Biological Information on the web. Introduction to Biological databases – their Organization and management - Database search – Algorithms issues in database search - Information retrieval from Databases - Concepts of Data mining, data warehousing and Data integration. Sequence comparisions and alignments-String similarity-Local, Global alignment; pair wise alignments – Dot plots, Dynamic Programming Methods, Heuristic methods – FASTA, BLAST; Amino acid substitution matrices- PAM and BLOSUM. Multiple sequence Methods-for Multiple sequence alignments- local and global multiple sequence alignment; Significance and applications of MSA- sequence comparisons- Profile analysis, Block analysis, pattern searching. Phylogenetic analysis-Origins of Molecular Phylogenetics; Methods of Phylogenetic analysis- Maximum Parsimony Maximum Likelihood and Distance based methods, Tree Evaluation, Problems in Phylogenetic Analysis, Automated Tools for Phylogenetic Analysis; Programing using perl-Introduction to PERL. Programming basics, scalar, arrays and hashes. Control statements, I/O, Regular expressions, data formats, file handles, file tests. File and directory manipulations.

Texts:

1. P. Baldi, S. Brunak ,"Bioinformatics: A Machine learning approach ", MIT press(1988).
2. SC Rastogi, N Mendiratta & P Rastogi ,"Bioinformatics: Methods and Applications".

Reference books:

1. Joao Carlos Setubal, Joao Meidanis, Jooao Carlos Setuba, "Introduction to Computational Molecular Biology".

FERMENTATION TECHNOLOGY

Course Code : 15 BT 3113 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of fermentation process basics	e	3
CO 2	Acquire the knowledge of medium optimization	e	3
CO 3	Develop bio catalytic processes to convert biomass to value added products and analyze mass transfer effects on the growth of bacteria, yeast and other microorganisms to assess the change in microbial growth rate.	k	2
CO 4	Design and construct bioreactor systems to scale up and scale down fermentation process for better yield of biomass and product formation	e	3
CO 5	Demonstrate fermentation processes to produce value added proteins and other biological substances for human, animal therapeutic use, food production processing and bio fuels.	e	3

SYLLABUS:

Introduction to Fermentation Process- Different range of fermentation processes; Chronological development of fermentation industry; General requirements of fermentation processes; an overview of aerobic and anaerobic fermentation process, Design of reactor with respect to aspect ratios; Ancillary fittings for reactors (sampling port); Aseptic transfer of spore suspension. Medium Requirements and Optimization- Medium requirements for fermentation processes, Carbon, Nitrogen, Minerals, Vitamins and Other Complex nutrients, Oxygen requirement. Introduction to medium optimization; Methods of media optimization (One factor method and Plackett- Burman design). Fermentation Process & Sterilization Techniques-Classification of fermentation system (Batch, fed-batch, Continuous); Dual and multiple fermentations; Concept of Chemostat; Turbidstat; Monitoring and control of fermentation process. Kinds of sterilization techniques; Thermal death kinetics of microorganisms, Batch and Continuous sterilization of liquid media, Filter sterilization, Design of sterilization equipment. Aeration and Agitation In Fermentor-Types of mixing mechanisms (bubble aeration & mechanical); mixing equipment; Types of spargers and impellers in fermentors; Significance of oxygen transfer in fermentations; Factors affecting oxygen transfer rates; importance of Kla in fermentors; Estimation methods of Kla (Sodium sulphite oxidation technique; Dynamic gassing out method; static method; oxygen balance method).Scale Up And Rheology In Fermentations-Scale up of fermentation process; Principles; Theoretical considerations and techniques used; Scale down methods; The Rheology of fermentation broths; Rheological models; Measurement of rheological parameters

Text Books:

1. Peter F Stanbury," Principles of Fermentation Technology", Elsevier, (2009).

2. Bailey & Ollis, "Biochemical Engineering fundamentals", Mcgraw Hill Higher Education (31-12-1988).

Reference Books:

1. F.C. Weeb ,"Biochemical Engineering," Amazon Publishers/bspublications, (1997)
2. Harvey W Blanch, "Biochemical Engineering". Taylor & Francis /b S Publication (Feb 1997).

MASS TRANSFER OPERATIONS

Course Code : 15 BT 3114 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Describe the basic principles of mass transfer operations, Apply fick's law of diffusion for measuring diffusivity coefficient on reaction systems.	b	2
CO 2	Describe the equilibrium relations and Apply the distillation for separation of value added products	k	3
CO 3	Understand the basic principles of extraction and leaching mass transfer unit operations	b	2
CO 4	Understand the basic principles of adsorption, Apply ion exchange principles to estimate affinity for separation of bioproducts. To Understand the importance of crystallization and Determine crystal growth-individual and overall growth coefficients	k	3
CO5	Demonstrate various mass transfer operations	k	3

SYLLABUS:

Mass Transfer between phases-Analogy between the momentum, heat and mass transfer, Ficks Law of Molecular diffusion, Diffusion in gases, liquids and solids-Convective mass transfer and mass transfer coefficients,: Concentration profiles in inter phase Mass Transfer, Film mass transfer coefficients. Equilibrium relations between phases; Gas-liquid equilibrium, Absorption, single stage equilibrium contact for Gas-liquid system, counter current multiple contact stages. Absorption in plate and packed towers: Equipment for absorption and Distillation, Design of plate Absorption Towers, vapor-liquid equilibrium relations, Vapor-liquid equilibrium-Simple, steam and flash Distillation-Distillation with reflux- McCabe Thiete method and enthalpy-concentration method.: Liq-Liq equilibrium staged and Continuous extraction-solid-liquid extraction-equilibrium relation and staged leaching. Adsorption-equilibrium-Batch and fixed bed Adsorption-Ion exchange process. Types of adsorption, Nature of adsorbents Adsorption equilibria, adsorption isotherms, the freundrich equation, adsorption operations-single stage, multistage cross current and counter current, application of Freundlich equation. Crystallization-Importance of crystal size, crystal geometry. Invariant crystal, crystal size and shape factors. Nucleation, origins of crystals in crystallizers, primary nucleation, Homogeneous nucleation, ketin equation, and rate of nucleation, crystal growth- individual and overall growth coefficients –allow of crystal growth.Crystallization equipment-vacuum crystallizers, continuous crystallizer, draft tube crystallizer, MS MFR crystallizer.

Text Books:

1. Christie J.Geankoplis ,"Transport processes and Unit Operations".

2. Robert E. Treybal ,"Mass transfer operations".

Reference Books

1. W. L. McCabe , J. C. Smith & Peter Harriot ,"Unit operations in chemical Engg".

BIOPROCESS DYNAMICS AND CONTROL

Course Code : 15 BT 3215 **L-T-P :** 3-2-0

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of bioprocess Dynamics and Control basics.	e	3
CO 2	Use various control strategies to monitor and control bio process variables for better yield of biomass and product formation	k	2
CO 3	Design Bioreactor control systems.	k	2
CO 4	Design and construct various advanced control strategies	k	2
CO 5	Design and construct various control algorithms	k	2

SYLLABUS:

Linear Open Loop Systems: Response of first order systems: mercury thermometer, transient response, step, impulse, sinusoidal response . Examples of first order systems, liquid level process with constant flow outlet, mixing process, second order response and transportation lag,Linear closed loop systems: Components of control systems, block diagram, negative and positive feedback, measuring element, final control elements :mechanisms: control valve, proportional control, proportional integral controller, proportional derivative controller, proportional integral derivative controller, on-off controller. Bioreactor control systems: Description of system, reactor transfer functions, control valve, measuring element, transportation lag, block diagram for bioprocess Transient response of simple control systems: Servo problem, regulator problem. Advanced control strategies: Cascade control, analysis of cascade control, feed forward control, analysis of feed forward control, ratio control, dead time compensation, control valves: control valve sizing, valve construction, valve positioner control of steam jacketed kettle. Computers in process control: Digital computer simulation of control systems: Runge kutta integration, tasks of microprocessor: implementation of control algorithms, displays, alarms, mathematical functions, data acquisition and storage, special features of microprocessor, distributed controller.

Textbooks:

1. Biochemical Engineering Fundamentals – Bailey,& Ollis Mc Graw Hill, 1986.
2. Process systems analysis and control-Couganowr, second edition, Mgh International (2003)

Reference books:

1. Peter Stanbury, Principles of Fermentation technology. Elsevier(2009).
2. Donald P.Eckman, Industrial Instrumentation –CBS (2004-12-01) .

PLANT AND ANIMAL BIOTECHNOLOGY

Course Code : 15 BT 3216 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Describe the plant tissue culture and genetic engineering of plants	f	2
CO 2	Describe Homozygous plants & Protoplast technology	f	2
CO 3	Apply the Animal cells and Tissue culture	f	2
CO 4	Apply the cells lines, cloning and gene transfer in animals	h	3
CO 5	Produce In vitro culture plants and cells	h	3

SYLLABUS:

Fundamentals of Tissue culture-Introduction to cell and tissue culture, Nutritional components of culture media and different plant tissue culture medias. Regulation of cell differentiation, regeneration of plants through organogenesis and somatic embryogenesis. Concept of synthetic seeds. Homozygous plants & Protoplast technology-Production of homozygous plants through anther and ovule culture. Protoplast technology – Isolation, protoplast fusion, identification and characterization of somatic hybrids, culture and plant regeneration. Concept of cybrids. Genetic engineering of plants-Methods for production of transgenic plant – vector mediated (Agrobacterium) and Vector less methods. Development of transgenic plants with resistance to stress, disease, herbicides, drought and insects. Secondary metabolites production by tissue culture technology. Animal Cells and Tissue Culture- History of animal cell culture; Basic requirements for animal cell culture; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; substrate on which cells grow; Micro-carrier cultures, cell synchronization, Tissue Engineering and biomaterials. Cell lines, Cloning and Gene transfer-Disaggregation of Tissue and Primary culture, Maintenance of cultures – cell lines, Somatic cell fusion. Transfection methods, Gene transfer using engineered and cultured stem cells, cloning of cell lines, Large-scale cell culture in Biotechnology. Transgenic animals – Mice, sheep, pig, goat, cow & fish. Bioreactor for animal cell culture. Applications of animal cell culture.

Recommended Text Books:

1. Robert smith," Plant tissue culture: Technique & Experiments "2nd ed; Academic press(2000).
2. MK Razdan. "An Introduction to Plant Tissue Culture". 2nd Ed.2003. Oxford and IBH.

References Books:

1. C. Chawla. "Plant Biotechnology. 2004. Oxford and IBH &Animal cell culture – Practical approach "– Ed. John R.W. Masters, Oxford.
2. Eds.M. Butler & M. Dowson," Cell culture Lab Fax", bios Scientific Publications Ltd; Oxford. Cell growth & Division; A practical approach. Ed. R. Basega. IRC press.

DOWN STREAM PROCESSING

Course Code : 15 BT 3217 **L-T-P :** 3-0-2

Prerequisite : Nil **Credits :** 4

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of unit operations and understand the principle behind the unit operations, their advantages and disadvantages involved in DSP.	b	3
CO 2	Design, develop and optimize processes for purification of products.	k	2
CO 3	Application of appropriate technique/unit operation for the process and evolve processes for purification of products with high market value.	e	2
CO 4	Design and develop new economical processes in terms of time and energy for quality product development.	b	3
CO 5	Demonstrate various down stream process techniques	k	2

SYLLABUS:

Down Stream Processing In Biotechnology-Overview of Bioseparations, Characterization of Biomolecules, characterization of Bioprocess, characterization of fermentation broth: Morphology of cells, structure of the cell wall, product concentrations, Biomass density, Rheological Behavior of fermentation broth. Primary Separation And Recovery ProcessesRecovery of intracellular products- Cell disruption methods-physical methods (osmotic shock, grinding with abrasives, solid shear, liquid shear) – chemical methods (alkali, detergents)- enzymatic methods. Removal of suspended solids-Foam separation, filtration.Filtration equipment, centrifugation, tubular bowl centrifuge, disk. Bowl centrifuge, basket centrifuge, scale up of centrifuges. Product Enrichment Operations; Membrane based separations –Classification & characteristics of membrane separation, merits of the process. Micro filtration, ultra filtration, Reverse osmosis, dialysis & electro dialysis. Selection of membrane, operational requirements of membrane. Retention coefficient, concentration factor, permeates yield & solid yield in membrane separation processes. Membrane modules: Plate & Frame, hollow fiber, spiral wound, shell & tube, cross flow micro filtration. Aqueous two-phase extraction process-Applications of aqueous two-phase extraction, reversed micelles extraction principle, micelle structures, critical micelle concentration. Protein solubilization, limitation of reversed micelles. Precipitations of proteins with salts and organic solvents, kinetics of protein aggregation. Product Purification Chromatographic Separations-Classification of chromatographic techniques, column chromatography, elusion frontal displacement techniques, partition coefficient, retention time and volume, capacity factor, column efficiency, design and scale up of chromatography.Principles & practices of Gel Filtration, Ion Exchange and Affinity chromatography. Alternative Separation Methods and Product Polishing- Super critical extraction: principles of SCE, Flow scheme of a simple SCE system. Formulationstrategies-Importance of formulation, formulation of beakers yeast, Enzymes, formulation of pharmaceutical products. Polishing-Crystallization, Principles of crystallization and equipment. Principles of drying and lyophilization, Freeze dryer.

Textbooks:

1. Butterworth and Heinmann. "Product recovery in bioprocess Technology" Elsevier India (2004).
2. B. Siva Sankar ,"Bioseperations", Phi Learning (2009).

References Books:

1. Harvey Blanch. Biochemical Engineering, Taylor & Francis /b S Publication (Feb1997)
2. Christie J.Geankoplis., Transport processes and Unit operations, Phi Learning (2009).

MOLECULAR GENETICS AND DNA FORENSICS

Course Code : 15 BT 3251 **L-T-P :** 3-0-0

Prerequisite : 15 BT 2208 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Genome Organization	a	1
CO 2	Acquire the knowledge of types of Sequences and Recombination	e	2
CO 3	Describe about Gene Expression Regulation	k	3
CO 4	Compare X chromosome , Y Chromosome & Mt DNA analysis in Forensics	k	3

SYLLABUS:

Genome Organization &Types of Sequences-Nomenclature of chromosome, C-value paradox, dosage compensation. Chromosome structure, Genome organization, Chromatin, Euchromatin, Hetero- chromatin, Organization and evolution of nuclear and organelle genomes, Split genes, Essential & Non-essential genes, VNTR, SNP, SINES, LINES, SSR, STR, Mini and Micro Satellites. Recombination-Types of recombination: homologous, reciprocal and nonreciprocal, site-specific and illegitimate. Different models of homologous recombination. Molecular mechanisms of recombination: Base pairing, Nick initiation, Homologous recombination, Cross strand exchange, Site specific recombination, Transpositional recombination. Gene Expression Regulation-An Overview of Gene Control, DNA-binding Motifs in Gene, Regulatory Proteins, Genetic Switches, Chromatin Structure and the Control of Gene Expression. The Molecular Genetic Mechanisms that create specialized Cell Types, Posttranscriptional Controls.X chromosome in Forensics-History of forensic utilization of the X chromosome, X-chromosomal STR's and markers in trace analysis and kinship analysis. Mapping and haplotype analysis, Population haplotype distribution, Ethical considerations in X Chromosomal marker testing.Y Chromosome & Mt DNA analysis in ForensicsY-Chromosomal Markers in Forensic: Introduction, Identification of the male sex and lineage, Identification of a male's paternity and geographical origin. Mitochondrial DNA (mtDNA) biology, Identification of individuals (mtDNA typing).

Text Books:

1. Alberts ,"Molecular Biology of the Cell" , 5th Ed, Garland Science / Taylor & Francis Group (2008).
2. Ralph Rapley ,"Molecular Forensics " John Wiley & Sons, Ltd(2007).

Reference Books:

1. R.M Twyman ,"Advanced Molecular Biology", Springer-verlag (1998).
2. Eberhard Passarge ,"Genetics ", (27/sep/2006).

TRANSGENIC TECHNOLOGY

Course Code : 15 BT 4155 **L-T-P :** 3-0-0

Prerequisite : 15 BT 2208 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Vehicles for Transgenic Technology and Transgenic Plants	a	1
CO 2	Describe transgenic animals and silencing Technology	e	2
CO 3	Develop Gene Therapy strategies	k	3
CO 4	Develop Knock outs strategies	k	3

SYLLABUS :

Vehicles for Transgenic Technology- Plasmids, Phagemids, Cosmids, viruses, artificial chromosomes and shuttle vectors. Gene constructs. Principle and applications. Basic strategies of construction and screening of genomic and cDNA libraries. Transgenic Plants-Gene transfer methods in plants, Transgenic plants with beneficial traits, Transgenic plant as bioreactor, Diagnostics in agriculture, Molecular breeding, Molecular markers, Edible vaccines, Bioethics. Case studies on Bt-Cotton and Bt-brinjal.Transgenic Animals-Gene transfer methods in animals, Embryonic Stem Cell Method, Pronucleus Method, Random vs. Targeted Gene Insertion, Super ovulation, Transgenic animals, Case studies on Dolly.Silencing Technology-RNA silencing, SiRNAs and anti-sense RNAs – their design and applications, ShRNA, micro RNAs, and siRNA libraries. Epigenetic gene silencing, RNA silencing in plants, Case studies on Drosphilla, Mammalian Oocytes and Yeast cells.Gene Therapy & Knock outs-Cationic liposomes, Lentiviral vectors, Retroviral vectors, HSV vectors, SCID therapy, Gene Therapy for Cystic Fibrosis: Gene Therapy Approaches, Gene Therapy Approaches to Duchenne Muscular Dystrophy. Knockout Mice, Tissue-Specific Knockout Mice, Knock-in Mice. Ethics of Gene therapy.

Textbooks:

1. Old and Primrose ,"Principles of Gene Manipulation" , Wiley-blackwell (1994-09-27).
2. Patrick J. Paddison ,"RNAi ", Springer-verlag (Feb 2008).

References:

1.Anthony Meager ,"Gene therapy Technologies" by, John Wiley & Sons (December 1999)

GENOMICS AND PROTEOMICS

Course Code : 15 BT 4156 **L-T-P :** 3-0-0

Prerequisite : 15 BT 2208 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Genomes and Genome analysis	a	1
CO 2	Compare Comparitive and Functional genomics	e	2
CO 3	Acquire the knowledge Microarrays and Proteomics-	a	1
CO 4	Develop protein networks and mapping strategies	k	3

SYLLABUS :

Genomes and Genome analysis-Organization and structure of genomes, Genome Mapping: Construction of genomic libraries, mapping strategies and techniques. Human Genome Project, Genomes of other organisms. Principles of gene expression; Global analysis of gene expression, Peptide nucleic acid technology. Comparitive and Functional genomics-Comparative genomics: protein evolution from exon shuffling, Protein structural genomics, Gene function by sequence comparison. Functional Genomics, Pharmacogenomics, Genomics in relation to molecular Diagnosis, Role of genomics in Drug discovery and development.Microarrays-Whole genome analysis of mRNA and protein expression, microarray analysis, types of micro arrays and applications in cancer diagnosis. Protein Biochips, Protein arrays.Proteomics-Principles of separation of Bio-molecules, 2D-Gel Electrophoresis, MALDI-TOF, Protein-protein interaction networks:Topology, Network motifs, Protein Expression profiling and applications.Protein Networks and mapping-Yeast two hybrid, Co-Precipitation, Phage Display, Phylogenetic Profile, Domain fusion, Gene Neighborhood, Gene Cluster, Mirror Tree, Analysis of genome wide Protein-Protein Interactions in yeast, Genome wide yeast two hybrid analysis of other organisms, Protein fragment complementation assays.

Texts Books:

1. S. Sahai, "Genomics and Proteomics, Functional and Computational Aspects ", Pienum Publications(1999).
2. Moody P C E and A J Wilkinson,"Protein Engineering". IRL Press.

Reference Books:

1. Creighton T E, "Proteins", Freeman W H. Second edition (1993).

MOLECULAR EXPRESSION TECHNOLOGY

Course Code : 15 BT 4157 **L-T-P :** 3-0-0

Prerequisite : 15 BT 2208 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of gene expression and Prokaryotic system-	a	1
CO 2	Compare Prokaryotic and Eukaryotic system	a	1
CO 3	Describe mammalian system	e	2
CO 4	Develop various strategies of Protein purification system	k	3

SYLLABUS:

Gene Expression-Transient VS stable expression, RT-PCR and the Standardized Expression Measurement, Monitoring Eukaryotic Gene Expression, Suppression Subtractive Hybridization, Gene Expression Informatics. Prokaryotic system-Expression in E.coli: lac promoter, T7 expression system, pET, pMAL vectors. Induction methods, Case study on Insulin production.Eukaryotic system-Saccharomyces cerevisiae: GAL system, CUP1 system, Pichia pastoris: AOX system, Expression in insect cells, Baculovirus expression, Polyhedrin promoter, Expression in higher-Eukaryotic cells, Tet-on/Tet-off system. Advantages and disadvantages of yeast and insect expression systems. Case study of Interferons & Interleukins production in Pichia and SF9 cells. Mammalian system-CHO cell expression system, Vectors and markers for screening, Roller bottles, Fermentors used, Secretory proteins and Non-secretory proteins, Secretory pathway and signal peptides, Post translation modifications – Glycosylation. Case study of Erythropoietin production in CHO cells.Protein purification system-Purification of expressed proteins from E.coli, purification of soluble recombinant proteins, Purification of inclusion bodies, Invitro refolding of proteins, verifying protein integrity. Techniques for measuring protein stability. His-tag, GST-tag, MBP-tag. Factor X, Enterokinase signal cleavage.

Text Books:

1. Shimkets , "Gene Expression Profiling and Methods", Humana Press (Feb 2004).
2. Reece , "Analysis of genes and genomes ", John Wiley & Sons (January 2004).

Reference Books:

1. Simon Roe ,"Protein purification applications", Oxford University Press (2001).
2. David R ,"Pichia Protocols", Higgins Humana Press (1998-06-15).

BIOSAFETY AND BIOETHICS

Course Code : 15 BT 4155 **L-T-P :** 3-0-0

Course Code : 15 BT 4158 **L-T-P :** 3-0-0

Prerequisite : 15 BT 2208 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Bio safety Concepts and Issues	a	1
CO 2	Asses Biosafety principles in the Laboratory	e	2
CO 3	Develop strategies for Biosafety Regulations, Food Safety and Assessment	k	3
CO 4	Develop strategies for social responsibility and biotechnological ethics	k	3

SYLLABUS:

Biosafety Concepts and IssuesIntroduction to Biosafety, International dimensions in Biosafety, Cartagena protocol on biosafety, Rational Vs Subjective perceptions of risks and benefits, Relationship between risk, hazard, exposure and safeguards, Bioterrorism and conventions on biological weapons.

Biosafety In The Laboratory Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory institution.

Biosafety Regulations, Food Safety and Assessment

Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, Biosafety assessment procedures in India and abroad. The GM-food and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance (e.g.-cotton).Biosafety assessment of biotech pharmaceuticals products such as drugs/vaccines etc.

Biotechnology and Society

Introduction to science, technology and society, biotechnology and social responsibility, public acceptance issues in biotechnology, issues of access, ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs private funding, biotechnology in international relations, globalization and development divide.

Biotechnology and Bioethics

Ethics from biomedical practices to biotechnology, ethical conflicts in biotechnology-interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs business ethics, ethical dimensions of IPR, technology and other global biotech issues.

Recommended Textbooks:

1. Biotechnology & Safety Assessment (3 rd Ed)- Thomas J.A, Fuch R.L(2002) –Academic Press.

2. Biotechnology Safety Principles & Practices (3 rd Ed)-FlemingD.A, Hunt D.L(2000) – Academic Press.

Reference books:

1. Encyclopedia of Bioethics.-S.K.Ghosh-Global Publishing House.

PROFESSIONAL ELECTIVES

(INDUSTRIAL AND FOOD BIOTECHNOLOGY)

FOOD TECHNOLOGY

Course Code : 15 BT 3252 **L-T-P :** 3-0-0

Prerequisite : 15 BT 2105 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of food associated microbes	a	1
CO 2	Describe food processing	e	2
CO 3	Develop various strategies involved in preservation and storage	k	3
CO 4	Conclude various principles involved in food microbiology	k	3

SYLLABUS:

Food associated Microbes- History of microorganisms in food, historical developments. Biotechnology in relation to the food industry, nutritive value of food, types of microorganism's associated with food, its sources, types and behavior in foods. Role and significance of microorganisms in food. Intrinsic and extrinsic parameters of foods that affect microbial growth. Food processing-Bioprocessing of meat, fisheries, vegetables, diary product, enzymes and chemicals used in food processing, biochemical engineering for flavor and food productions. Emerging processing and preservation technologies for milk and dairy products. Food preservation-Food preservation using irradiation, Characteristics of Radiations of interest in food preservation. Principles underlying the destruction of Microorganisms by irradiation, processing of foods for irradiation. Application of radiation, Radappertization, Radicidation, and Radurization of foods. Legal status of food irradiation. Effect of irradiation of food constituents.: Storage of foods-Stability of food preservation with low temperatures, high temperatures, drying. Indicator and food borne pathogens. Food borne illness, quality control, HFCS (High Fructose Corn Syrup) and mycoproteins. Air sampling, metabolically injured organisms, enumeration and detection of food-borne organisms. Food microbiology-Utilization of microorganisms in food industries, genetic manipulations. Thermophiles and Radiation-resistant microorganisms, characteristics and growth of thermophilic microorganisms, Nature of Radiation resistance in microorganisms. Rheology of food production.

Text Books:

1. Lidsay, "Willis Biotechnology, Challenges for the lavor and food industries", Elsevier Applied Science(1988).

2. F.F.G. Lopez & G.V. B. Canovas ,"Food Science and Food Biotechnology", CRC Press, Florida, USA(2003).

Reference Books:

1. George J.B,"Basic Food Microbiology", CBS Publishers & Distributors(1987).
2. Roger, A.,Gordan B, and John T. "Food Biotechnology"(1989).

MICROBIAL TECHNOLOGY

Course Code : 15 BT 4159 **L-T-P :** 3-0-0

Prerequisite : 15 BT 2105 **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of microbial technology	a	1
CO 2	Screen out medium and strain development	e	2
CO 3	Develop various strategies to produce Primary and secondary metabolites	k	3
CO 4	Design various strategies to produce Enzymes, recombinant Proteins, and other special bio products	k	3

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 (e.g., 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's), 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

Text books:

1. Stanbury PF, A Whitaker ,"Principles of Fermentation Technology" GH Hall
2. A.H.Patel ,"Industrial Microbiology".

Reference Books:

1. Glazer AN, Nikaido H ,"Microbial Biotechnology", WH Freeman and Company, (1995).
2. JE Baily & DF Ollis ,"Biochemical Engineering Fundamentals"(2nd ed), , McGraw Hill Book Co. New York.(1986).

METABOLIC ENGINEERING

Course Code : 15 BT 4160 **L-T-P :** 3-0-0

Prerequisite : 15 BT 2105 **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Introduction of Metabolic Engineering	a	1
CO 2	Acquire the knowledge of Genetic improvement of strains	a	1
CO 3	Analyze metabolic pathways	e	2
CO 4	Develop experimental determination strategies of of Flux	k	3

SYLLABUS:

Introduction of Metabolic Engineering, Identification of metabolic regulation is a key point in metabolic engineering. Synthesis of Primary Metabolites, Metabolic Engineering for Bioproduction , Metaboliic Pathway(MP)Modeling and Obserbability of MP, Metabolic Flux Analysis(Cell Capability Analysis), Metabolic Flux Analysis(Genome Scale Flux Analysis), Metabolic Control Analysis Molecular Metabolic Engineering, Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Co metabolism, Product inhibition, mixed or sequential bioconversions, Conversion of insoluble substances. Regulation of Enzyme Production, Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway, manipulations to improve fermentation, Feedback repression, Catabolite, Repression, optimization and control of metabolic activities. The modification of existing - or the introduction of entirely new - metabolic pathways. Experimental Determintion Method of Flux Distribution with Isotope Labeling, Metabolic Engineering with Bioinformatics. Application in pharmaceuticals, chemical bioprocess, food technology, agriculture, environmental bioremediation and biomass conversion.

Text Books:

1. Wang.D.I.C Cooney C.L., Demain A.L., Dunnil.P. Humphrey A.E. Lilly M.D., Fermentation and Enzyme Technology, John Wiley and sons 1980.
2. Stanbury P.F., and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.

BIOPROCESS ECONOMICS AND PLANT DESIGN

Course Code : 15 BT 4161 **L-T-P :** 3-0-0

Prerequisite : 15 BT 2105 **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand basics of economic evaluation	b	2
CO 2	Acquire the knowledge of Bioprocess Economics	b	2
CO 3	Develop various strategies of process design	c	2
CO 4	Design various strategies of Basic considerations in equipment design and Basic Design Problems	e	2

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. Bioprocess Economics Introduction, elements of total production cost, outline of the total capital investment, equipment sizing, capital cost estimates large-scale equipment and utilities. Manufacturing cost estimates – Operating costs-Raw materials, utilities, fixed costs and overhead costs, case studies of antibiotics, recombinant products, single cell protein. Introduction to process design 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. Basic considerations in equipment design General design procedure, 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. Design conventions. 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/Fermentor construction. Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries. Design exercise on trickle flow fermenter. Problems associated with design equations.

Recommended Text Books:

1. Peters & Timmerhaus, Plant design and Economics for Chemical Engineers McGraw Hill Higher Education (2004).
2. M V Joshi & V . V. Mahajani, Process equipment design, 3rd Ed. Macmillan India Limited (2000).

Reference books:

1. Harvey W Blanch, Biochemical Engineering,2nd Ed,Taylor &Francis/bS Publication (Feb 1997).

PHARMACEUTICAL BIOTECHNOLOGY

Course Code : 15 BT 4162 **L-T-P :** 3-0-0

Prerequisite : Nil **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Fundamentals of pharmaceutical practice	c	3
CO 2	Asses the drug metabolism and pharmacokinetics and formulate pharmaceutical dosage & blood, plasma products	d	2
CO 3	Compare various Pharmaceutical products	d	2
CO 4	Develop various strategies of manufacturing processes	k	3

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; Drug metabolism(Biotransformation of drugs);Excretion of drugs; Pharmacokinetics; Basic considerations; Controlled Release Medication; Design of Controlled drug delivery 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 Blood products; Transfusion products. Pharmaceutical products-Fundamentals of Therapeutic categories such as Analgesics, Anesthetics, Antipyretic; Anti-inflammatory drugs; Antacids; Alkaloids; Glycosides; Hormone & Hormone antagonists; Antineoplastics and Immuno active drugs; Biologicals (Immunizing agents and allergenic extracts).Drug manufacturing processes-Good manufacturing practices; Manufacturing facilities; Sources of Biopharmaceuticals; Production & analysis of Biopharmaceuticals.

Texts Books:

1. Leon Lachman ,"The Theory and Practice of Industrial Pharmacy", Cbs Publishers & Distributor Pvt. Ltd. (pur) (2009).
2. Remington ,"The Science and Practice of Pharmacy" (Vol.1&11), Lww (2007)

Reference Books:

1. SS Purohit,H N Kakarani &AK Saluja ,"Pharmaceutical Biotechnology", Student Edition (2010).

MOLECULAR MODELING AND DRUG DESIGN

Course Code : 15 BT 3253 **L-T-P :** 3-0-0

Prerequisite : 15 BT 3111 **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Introduction to Molecular Modeling	c	3
CO 2	Describe the Basic concepts of Protein Modeling and Protein structure Determination	b	2
CO 3	Develop Molecular Dynamics and Simulations	k	3
CO 4	Design and construct Molecular modeling strategies in Drug designing	k	3

SYLLABUS:

Introduction to Molecular Modeling- History of molecular modeling, physical and computer models, different representations of computer models, Generation of 3D coordinates– using x-ray crystallographic databases, compilation of fragment libraries with standard geometrics, drawing of 2D structures using sketch. Basic concepts of Protein Modeling -Concepts of Force Fields, Quantum and Molecular mechanical force fields, Generation of potential energy surfaces, Geometry Optimization, Energy-Minimizing Procedure, and Use of Charges. Salvation Effects, Methods, Ab initio Methods, Semi-empirical Molecular Orbital Methods, Conformational Analysis. Protein structure Determination- Comparative Modeling of Proteins, Ab initio modeling and fold recognition Transmembrane Protein Models Based on High-Throughput Molecular Dynamics Simulations with Experimental Constraints, Nuclear Magnetic Resonance-Based Modeling and Refinement of Protein Three-Dimensional Structures and Their Complexes.

Molecular Dynamics and Simulations- Molecular Dynamics Simulations, Monte Carlo Simulations, Hybrid Quantum and Classical Methods for Computing, Kinetic Isotope Effects of Chemical Reactions in Solutions and in Enzymes, Normal Modes and Essential Dynamics.

Molecular modeling applications in Drug designing- Identifying Putative Drug Targets and Potential Drug Leads: Starting Points for Virtual Screening and Docking Receptor Flexibility for Large-Scale In Silico Ligand Screens: Chances and Challenges, Molecular Docking

Textbooks:

1. Hans-Dieter Holtje and Gerd Folkers ,"Molecular modeling basic principles and applications", Wiley (2003).
2. Andreas Kukol, "Molecular modeling of Proteins-edited ", Humana Press. (Apr 2008).

Reference books:

1. AR Leach," Molecular Modeling Principles and Applications", Longman (1996).

BIOPERL AND PERL PROGRAMMING

Course Code : 15 BT 4163 **L-T-P :** 3-0-0

Prerequisite : 15 BT3111 **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of an Introduction to Perl & Variables and Data Types	d	3
CO 2	Acquire the knowledge of Arrays and Hashes	c	2
CO 3	Describe Control Structures & String Manipulation and Input and Output- Program Parameters	d	3
CO 4	Develop various strategies involved in Bioperl	k	3

SYLLABUS:

An Introduction to Perl & Variables and Data Types-The Perl Interpreter - Perl Variables -Scalar Values-Variable Definition -Special Variables Arrays and Hashes- Arrays-Array Manipulation -Push and Pop, Shift and Unshift –Splice-Other Useful Array Functions-List and Scalar Context -Hashes -Maintaining a Hash Control Structures & String Manipulation-Comparisons Choices-If - Boolean Operators- Else-Loops-For Loops -For each Loops 52. Indeterminate Loops -While -Repeat Until -Loop Exits -Last - Next and Continue -Array-Based Character Manipulation -Regular Expressions –Match-Substitute – Translate. Input and Output- Program Parameters -File I/O -File handles- Working with Files -Built-in File Handles -File Safety - The Input Operator –Binary- Interprocess Communications – Processes- Process Pipes-Creating Processes -Monitoring Processes. Bioperl- Sequences -SeqFeature – Annotation-Sequence - Example Bioperl Programs

Text books:

1. James Tisdall ,"Beginning Perl for Bioinformatics", Reilly Publishers
2. Jamison D."Perl Programming for Biologists", Wiley publishers

Reference books:

1. Peter Norton,"Introduction to computers", Tata Mc Graw Hill publishers.

BIOMEDICAL INFORMATICS

Course Code : 15 BT 4164 **L-T-P :** 3-0-0

Prerequisite : 15 BT3111 **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of web programming with Javascript	b	3
CO 2	Acquire the knowledge of Outline of genomics	b	3
CO 3	Analyze biochemical pathways	e	2
CO 4	Develop virtual Physiological Human; geometric models of proteins	k	3

SYLLABUS:

web programming with Javascript Why JavaScript? Environment setup: Chrome, Git, GitHub. Control flow, functions, closures; objects, built-in objects; prototype, inheritance; coding style guide, the Javascript ecosystem, Coffeescript. Biomolecules and life Outline of genomics: DNA and genetic code, RNA, mapping of genes and proteins. Outline of proteomics: primary, secondary, tertiary and quaternary structures. Biochemical pathways. Nervous system, neurons, neuro-muscular interface. Biomedical records, data and images Electronic Medical Record (EMR) environments. Laboratory data, anatomic data, biomedical imaging, PACS systems, DICOM images. PDB (Protein Data Bank), European Bioinformatics Institute (EBI) services. Symbolic biomedical knowledge Web 3.0. Ontologies as formal and explicit specification of objects, properties and relations in organizing biomedical data. The University of Washington FMA anatomic model (Digital Anatomist-Foundational Model of Anatomy); Biomedical modeling and simulation Physiological models. Virtual Physiological Human; geometric models of proteins, cells, tissues and systems. Geometric models of neurons, axons and dendrites. Models of the neuro-muscular interface

Text Books:

I. J. Kalet, Principles of Biomedical Informatics, Elsevier, 2009.

SYSTEMS BIOLOGY

Course Code : 15 BT 4165 **L –T – P :** 3-0-0

Prerequisite : 15 BT 3111 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Structural biology of Nucleic acids	c	3
CO 2	Describe the Protein dynamics	c	3
CO 3	Compare various techniques for structural biology	d	2
CO 4	Conclude the principles involved in Structure predictions and Structural elucidation	k	3

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, t-RNA tertiary structure. Protein dynamics-Protein Purification &Crystallization methods, Principles of X-ray 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, PSI-PRED, 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.

Recommended Textbooks:

1. Arthur M. Lesk, "Introduction to Protein Science" Oxford University Press(2004).
2. Arthur M. Lesk, "Introduction to Protein Architecture" ,Oxford University Press(2001).

Reference textbooks:

1. McPherson, "Introduction to Macromolecular Crystallography", John Wiley Publication (2003)
2. Philip E. Bourne, Helge Weissig, "Structural Bioinformatics".

MEDICAL BIOTECHNOLOGY

CANCER BIOLOGY

Course Code : 15 BT 3254 **L-T-P :** 3-0-0

Prerequisite : 15 BT 1203 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of cancer	b	3
CO 2	Acquire the knowledge of Carcinogenesis	b	3
CO 3	Describe molecular biology of cancer	e	2
CO 4	Conclude the principles involved in Cancer metastasis and Cancer immunology.	f	3

SYLLABUS:

Basics of cancer-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.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), p53. Mechanism leading to tumour suppressor function loss. Oncogenes - Detection of oncogenes, proto-oncogenes, Proto-oncogene activity. Growth 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. Cancer immunology-B & T cell biology, Tumour antigens, Monoclonal antibodies, Cytokines in cancer, Complement proteins in cancer, Antigen processing & presentation, Factors influencing the incidence of cancer, Mechanism of immune response to cancer, Immunotherapy.

Text Books:

1. Roger.G.B ,"Cancer Biology ". Prentice Hall (May 2006).
2. Margaret A Knowles and Peter. J. Shelly, "Introduction to Molecular and Cellular Biology of Cancer". 4th Edition. Elsevier publications.

References Books:

1. Dimmock N. J, "Introduction to modern virology", Blackwell scientific Publications. Oxford.

STEM CELL TECHNOLOGY

Course Code : 15 BT 4167 **L-T-P :** 3-0-0

Prerequisite : 15 BT 1203 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of stem cell technology	b	3
CO 2	Describe stem cell characterization and tissue engineering	h	2
CO 3	Develop various strategies involved in biopharming and regulation thics.	k	3
CO 4	Conclude various principles involved in biopharming and regulation thics.	k	3

SYLLABUS:

Introduction-What are stem cells,types, origin and nature of stem cells? Characteristic features, pluripotent stem cells and its types, Molecular basis of pluripotency. Cell surface markers of stem cells. Embryonic stem cells, factors requirements for maintain stem cells. Differences between human and mouse stem cells. Development of epithelial stem cell concept. Stem cell niches.Stem cell characterization-Cell cycle regulation in stem cell. Mechanism of stem cell renewal, Changes of phenotypic characters, Characterization of human embryonic stem cells, Isolation and maintenance of Stem cell. Genetic manipulation of Embryonic Stem cell, homologous recombination of stem cells. Surface antigenic markers, lineage marking, Genomic reprogramming. Microarray analysis of stem cells & differentiation. Zebra fish and Stem cell research. Tissue engineering-Neural stem cells and applications in neurodegenerative diseases, Treatment of heart diseases, diabetes, burns & skin ulcers, muscular dystrophy, regeneration of epidermis, orthopedic applications. Embryonic applications in tissue engineering. Novel sources of multipotent stem cells. Adult stem cells, Stem cell gene therapy.Biopharming-What is biopharming? Applications of stem cell technology in animal biotechnology. Production of artificial organs using stem cell technology. Artificial pancreas, kidney, heart, liver etc. Regulations and Ethics-Ethics of human cell research-immortal cells and moral selves, Ethical considerations, stem cell based therapies. FDA products and preclinical regulatory considerations. Patent advocacy, Science policies, ethics in stem cell research, primordial germ cells and germ cell development epigenetics and reprogramming in stem cell biology, norms in clean room.

Text books:

1. Rober Lanza, "Essentials of Stem cell biology", Elsevier academic press (2009).
2. Joseph D, "Bronzino Tissue engineering and artificial organs, Biomedical engineering hand book'. volume -2, 3rd edition, CRC press, Taylor & Francis publications(2006).

Reference book:

1. Daniel R. Marshak, "Stem Cell Biology, Johns Hopkins University and Cambrex Corp.; Richard L. Gardner, University of Oxford; David Gottlieb, Washington University, St. Louis(2001).

NANO BIOTECHNOLOGY

Course Code : 15 BT 4168 **L-T-P :** 3-0-0

Prerequisite : 15 BT 1203 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowiedge of nanotechnology	b	2
CO 2	Compare biopolymer and Lipo polymer strategies	f	2
CO 3	Develop various strategies of Nucleic acid based nanomaterials	h	3
CO 4	Conclude various principles involved in Biocompatible nanometerials	h	3

SYLLABUS:

Introduction to Nanotechnology – definition and scope, nanobiotechnology- recent development and applications, Biocompatability and cytotoxicity studies of Nanomaterials, carbon nanotubes, Bioconjugation mediated drug delivery. General medicine is changing into personalized nanomedicine. Biopolymer- polymer nanofibers - electrospinning method and their biomedical applications, polymer nanocomposite- bone and dental restorations, polymer controlled drug delivery for the treatment of cancer and other diseases. Biodegradable polymer derived from amino acid. Liposphere in drug target and delivery Liposome - liposomes in sensor technology, polymeric Micelles – Production of Lipospheres for Bioactive compound delivery – Melt dispersion technique, Solvent evaporation technique and InVitro drug release - Polymeric biodegradable liposphere for vaccine delivery. Nucleic acid based nanomaterials: ` 12 Nucleic acid engineered nanomateials and their applications. Protein patterning for applications in biomaterials. DNA lipoplexes

– Lipofection efficiency In Vitro and In Vivo, Polymer controlled delivery of therapeutic nucleic acid. Biocompatible nanometerials: PLA and PLGA Based nanoparticulate delivery system. Metal Microbes interaction, Biological metal nanoparticle synthesis and biomedical application – Dendrimers, quantum dots, Biodegradable optical nanoparticles for tumor diagnosis and treatment.

Text books:

1. Challa S.S.R. Kumar (Ed). Biological and pharmaceutical nonmaterial's. Wiley-VCH Verlag Gmbh & Co., KgaA(2006.).
2. K.K. Jain ," Nanobiotechnology in Molecular Diagnostics: Current Techniques and Application Horizon Biosciences"(2006)..

Reference books:

1. Niemeyer, C.M. Mirking C.A., (Eds.). "Nano biotechnology concepts"(2004).
2. Applications and Perspectives, 2004 Wiley- VCH, Weinheim 5. Claudio Nastruzzi – (Ed) Liposphere in drug targets and delivery, CRC press(2005).

TISSUE ENGINEERING

Course Code : 15 BT 4169 **L-T-P :** 3-0-0

Prerequisite : 15 BT 1203 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Tissue Engineering and Cell-Based Therapies	c	3
CO 2	Acquire the knowledge of issue culture basics	c	3
CO 3	Analyze 3D organization and angiogenesis	f	2
CO 4	Develop Stem Cell Therapies with case studies.	h	3

SYLLABUS:

Introduction: Tissue Engineering and Cell-Based Therapies, Biomaterials. metals, ceramics, polymers (synthetic and natural). Biodegradable materials, native matrix, Tissue culture basics: primary cells vs. cell lines, sterile techniques, plastics, enzymes, reactors and cryopreservation. Principals of self assembly. cell migration, 3D organization and angiogenesis. Tissue Morphogenesis, Stem Cells and Lineages, Cell Isolation and Culture, Cell-Cell Communication, ECM and Natural Scaffold Materials, Synthetic Biomaterial Scaffolds, Scaffold Fabrication & Tailoring, Graft Rejection/Material Biocompatibility, Cell Migration, Engineered Disease Models, Stem Cell Therapies with case studies. Liver tissue engineering. bioartificial liver (BAL) assist device, shear forces , oxygen transport, plasma effects. Cardiovascular tissue engineering. introduction, blood vessels structure, vascular grafts. Skin tissue engineering. introduction, scar vs. regeneration, split skin graft, apligraft.

Text Books:

1.Principles of Tissue Engineering, 4th Edition 4th Edition by Robert Lanza, Academic Press

2.Cells and Biomaterials in Regenerative Medicine by Daniel Eberli, Springer

NEURO BIOLOGY

Course Code : 15 BT 4170 **L-T-P :** 3-0-0

Prerequisite : 15 BT 1203 **Credits :** 3

Mapping of Course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of Neuroscience	a	2
CO 2	Acquire the knowledge of Neurotransmitters and Receptors	a	2
CO 3	Describe the Vestibular system	e	3
CO 4	Develop various strategies of nervous system and its Neuronal modulation	h	3

SYLLABUS:

Neuroscience Overview, Resting Potential and Active Conductance, Excitable membranes – Action potentials, Channels and Transporters, Synaptic Transmission, Neurotransmitters and Receptors, Synaptic Plasticity, Survey of Human Neuroanatomy, Construction of Neural Circuits

Modification of Brain Circuits, The Somatic Sensory system, The Somatic Sensory System Auditory System, The Vestibular system, Chemical senses, The Eye, Sleep, Association Cortex and Cognition, Pain, Neuroscience in the News: Chronic Pain, Sex, Sexuality, and the Brain, Gender traits and pathways, Central nervous system, Peripheral nervous system, Sensory organs and their functions, Development of the nervous system, Neuronal modulation, Learning and memory, Repair and Regeneration in the Nervous System, Stroke, Epilepsy & Neurodegenerative diseases, Neurobiology of diseases.

Text Books:

1. Gordon M. Shepherd, Neurobiology, Oxford University Press, 1979.
2. Fundamentals of Neuroscience by Dana Park, Elsevier publishers.

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

PROFESSIONAL CORE COURSES

DATABASE SYSTEMS

Course code : 15 CS 2007 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 1001 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand functional components of the DBMS.	b	3
CO2	Design database schema,ER Model, Evaluate and optimize queries.	b	3
CO3	Understand transaction processing, concurrency control and recovery techniques.	b,k	3,2
CO4	Understand indexing and query processing	b	3
CO5	Develop queries using Relational Algebra, Relational Calculus,SQL ,DBMS Internals	k	2

SYLLABUS:

Database Fundamentals: DBMS Characteristics & Advantages, Database Environment, Database Users, Database Architecture, Data Independence, Languages, Tools and Interface in DBMS, DBMS types

SQL: Data Definition and other languages in SQL, Creating tables and Data types, Constraints, DML statements, Functions and writing SQL statements using nested sub queries, complex queries, joining relations, Security: access control via database views.

Data Modelling: ER Model, Notation used in ER Diagram, Constraint, Types, Relationships in ER Model and other considerations in designing ER diagram. Enhanced ER data Model, EER Diagram, Specialization and Generalization, Lattice, Union, Disjoint Properties, Constraints and relationships, Other issues in designing EER diagrams, Relational Model, Relational Algebra, Operators in relational algebra, Algorithms for ER to relational mapping.

Database Design: Guidelines for good database design, Normalization- Normal Forms, First, Second, Third Normal Forms, BCNF, Multi value and join dependencies, 4th and 5th normal forms. Decomposition algorithms for normalization. File and storage structures: File storage, Index structures, Indexing and hashing. Query Processing: Issues in query processing, simple algorithms for insert, project, join and other operators.

Transaction Processing: Transaction processing issues, Transaction states, problems during multiple transactions processing, ACID properties, system log and concurrency control techniques: binary locks, exclusive locks, Lock based techniques, and Timestamp based techniques, versioning in locks, Multi-version locking techniques.

Text Books:

1. Elmasri and Navathe, 'Fundamentals of Database Systems', 4th edition, Pearson Education, (2008).

2. A. Silberschatz, Henry F Korth, S. Sudarshan, "Database System Concepts:,Fifth Edition, Tata McGraw-Hill,(2003).

Reference Books:

1. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", second Edition, Tata McGraw Hill, (2004).

SOFTWARE ENGINEERING

Course code : 15 CS 2105 **L – T – P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Comprehend software development life cycle and prepare SRS document	e	2
CO2	Apply software design and development techniques, understand software process improvement	e	2
CO3	Identify verification and validation methods in a software engineering project	k	2
CO4	Analyze and Apply Human Computer techniques for a case study	e	2
CO5	Apply UML Specification and anaylsis techniques to software designs and programs	k	2

SYLLABUS:

Software and Software Engineering: Nature of software, software application domains, unique nature of web applications, software engineering, 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, Modeling techniques for Class & Object Diagrams.

Behavioral Modeling: Interaction diagrams. Activity Diagrams.

Software testing: A strategic approach to software testing, strategic issues, test strategies for conventional software, Black-Box and White-Box testing, validation testing, system testing. The Human and The Computer, Thinking, Reasoning and problem solving, Psychology and Design of Interactive Systems, Golden Rules, HCI Patterns.

User interface design: The golden rules, user interface analysis and design, interface analysis, interface design steps. Software Process Improvement, SPI, The SPI process, The CMMI.

Text Books:

1. Roger S. Pressman, "Software Enginering – A Practitioner's Approach 7th Edition, Mc Graw Hill, (2010).
2. Ian Sommerville, 'Software Engineering', Sixth Edition,Pearson Education,(2001).
3. Jim Arlow, Ila Neustadt, "UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design", 2nd Edition, Pearson, (2005).

Reference Books:

1. Craig Larman, "Applying UML and Patterns: An introduction to OOAD and design and interface deployment", Pearson, (2002).
2. Alan Dix, Janet Finlay, Gregory d Abowd, Russel Bealel,"Human Computer Interaction", 3rd edition, Pearson education, (2008).
3. Stephen R.Schach, "Software Engineering", Tata McGraw-Hill Publishing Company Limited, (2007).

OPERATING SYSTEMS

Course Code : 15 CS 2206 **L – T – P :** 2-2-2

Pre Requisite : 15EM2001 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Develop algorithms for subsystem components	b	2
CO2	Understand process and memory virtualization	b	2
CO3	understand persistence concepts	b	2
CO4	Design and solve synchronization problems , and multi threading libraries	k	3
CO5	Develop application programs using UNIX system calls	k	3

SYLLABUS:

Basics: Operating System Functionalities, Types of Operating Systems, Computer Architecture support to Operating Systems

Process Virtualization: Processes, Process API code, Direct Execution, CPU Scheduling, Multi-level Feedback, Lottery Scheduling code, Multiprocessor Scheduling

Concurrency: Concurrency and Threads code, Thread API, Common concurrency problems ,Locks, Locked Data Structures, Condition Variables, Semaphores, Event-based Concurrency

Memory Virtualization: Address Spaces, Memory API, Address Translation, Segmentation, Free Space Management, Introduction to Paging, Translation Look aside Buffers, Advanced Page Tables,

Swapping: Mechanisms, Swapping: Policies.

Persistence: I/O Devices, Hard Disk Drives, Redundant Disk Arrays (RAID), Files and Directories, File System Implementation, Distributed systems, Data Integrity and Protection

Text Books:

1. Operating Systems: Three Easy Pieces, Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, Arpaci-Dusseau Books, May, (2014).
2. Operating System Concepts - Operating System Concepts, Sixth Edition, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, John Wiley & Sons Inc, (2013).
3. The Design of The Unix Operating System by Maurice J. Bach, PHI Publishing,(2013).

Reference Books:

1. Uresh Vahalia ,"Unix Internals-The new Frontiers",Pearson edition,(2006).
2. Andrew S Tanenbaum ,"Modern Operating Systems-", Prentice Hall.
3. William Stallings ,"Operating Systems - Operating System: Internals and Design Principles" 4^{th} edition,(2013).

COMPUTER NETWORKS

Course code : 15 CS 2208 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 1001 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand OSI and TCP/IP models	k	2
CO2	Analyze MAC layer protocols and LAN technologies	e	2
CO3	Implement routing and congestion control algorithms	e,k	2
CO4	Understand application layer concepts	e	2
CO5	Design applications using internet protocols	k	2

SYLLABUS:

Introduction: Overview of networking using the Internet as an example, history and development of computer networks, networks topologies, LANs and WANs, OSI reference model, Internet TCP/IP Protocol Stack. Client/server paradigm, End-to-end communication: packet switching and circuit switching. (5 lectures)

Link layer: Link layer services, error detection and correction, Sliding Window, Stop and Wait protocols.

MAC Layer: Aloha, CSMA, CSMA/CD, CSMA/CA protocols. Examples: Ethernet, including Gigabit Ethernet and WiFi (802.11). Token Ring and to Bluetooth, WiMax. (10 lectures)

Network layer: Network layer services, IP packet switching, IP addresses- Subnetting, Classless addressing, Network Address Translation, Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, RIP, OSPF, BGP, multicast, Inter-domain routing congestion control algorithms(10 Lectures)

Transport layer: Ports, UDP, principles of reliable data transfer, TCP(handshake, windowing, congestion control) Connection establishment and termination, TCP variants, Use of TCP/IP protocol suite as running example, securing TCP (SSL) (10 Lectures)

Application layer: Service requirements, WWW, HTTP, electronic mail, DomainName System, P2P, socket programming. (8 Lectures)

Introduction to symmetric and public key cryptography

Text Books :

1. Peterson, LL and Davie BS "Computer Networks -- A Systems Approach", Morgan Kaufmann, Elsevier,-5th edition-(2012)
2. Kurose, J and Ross, K Computer Networking: A Top-Down Approach Addison-Wesley- 6th edition-(2012).
3. Comer, DE (2004) Computer Networks and Internets with Internet Applications, 4th edition, Prentice Hall (Most recent edition is 5th edition, (2009).

Reference Books:

1. Comer, DE (1995) Internetworking with TCP/IP vol I (3rd edition) Prentice Hall ,Most recent edition is 5th edition, (2006).
2. Behrouz A. Forouzan , "Data Communication and Networking", TMH, 5th Edition ,(2012).
3. Andrew S. Tanenbaum, David J. Wetheral "Computer Networks" Pearson, 5th –Edition-(2011).
4. W. Richard Stevens and G. Gabrani, TCP/IP Illustrated, Volume 1: The Protocols and Unix Network Programming, Volume 1: The Sockets Networking API ,3rd Edition, (2001).
5. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", Mc Graw Hill Publisher, (2011).

THEORY OF COMPUTATION

Course code : 15 CS 3109 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 2003 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand formal machines, languages and computations	a	2
CO2	Design finite state machines for acceptance of strings and context free grammars for formal languages	a	2
CO3	Develop pushdown automata accepting strings	e	2
CO4	Distinguish between decidability and undecidability	e	2
CO5	Design Turing machine	e	2

SYLLABUS:

Automata – The Methods & Madness: Finite Automata, an Informal Picture of Finite Automata, Deterministic Finite Automata, Nondeterministic Finite Automata, Finite Automata with Epsilon Transitions.

Regular Expressions and Languages: Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions.

Properties of Regular Languages: Proving Languages not to be Regular, Closure Properties of Regular Languages, Decision Properties of Regular Languages, Equivalence and Minimization of Automata.

Context-Free Grammars and Languages: Context-Free Grammars, Parse Trees, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages.

Pushdown Automata: Definition of the Pushdown Automaton, The Language of a PDA, Equivalence of PDA's and CFG's, Deterministic Pushdown Automata.

Properties of Context-Free Languages: Normal Forms for Context-Free Grammars, the Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages, Decision Properties of CFL's.

Turing Machines: Introduction to Turing Machines, Problems that Computer Cannot solves, The Turing Machines, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Restricted Turing Machines.

Undecidability: A Language that is not Recursively Enumerable, An Undecidable Problem that is RE, Undecidability problems about Turing Machines

Text Books :

1. John. E. Hopcroft, R. Motwani, & Jeffery. D Ullman, "Introduction to Automata Theory, Languages and Computations", Third Edition, Pearson Education,(2008).

2. Harry R. Lewis, Christos H Papadimitriou: "Elements of the theory of computation", 2nd Edition, PHI/Pearson Education, (1997).

Reference Books:

1. Michel Sipser, "Theory of Computation", 1st Edition, Cengage Publications, (2008)

2. Elaine Rich, "Automata Computability and Complexity: Theory and Applications", 1st Edition, Pearson Publications, (2012)

3. Peter Linz, "An Introduction to Formal Languages and Automata", 3rd Edition, Narosa Publishers, (1998).

ALGORITHM DESIGN AND ANALYSIS

Course code : 15 CS 3110 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 2104 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Analyze time and space complexity	e	2
CO2	Identify algorithm design methodology to solve problems.	e	2
CO3	Design algorithms for network flows and string processing	e	2
CO4	Distinguish between P and NP classes of problems and solve complex problems	k	3
CO5	Apply algorithm design techniques to solve any real world problems	k	3

SYLLABUS:

Introduction: Definition of an Algorithm- Algorithm Specification - Performance Analysis. Divide and Conquer: Merge Sort-Quick Sort-Strassen's Matrix Multiplication- Convex Hull. Greedy Method: The General Method- Job Sequencing with Deadlines- Knapsack Problem- Minimum Cost Spanning Trees- Huffman Codes - Single Source Shortest Path Method. Dynamic Programming: Optimal Binary Search Tree- 0/1 Knapsack- Traveling Sales Person Problem.Ford Fulkerson

Backtracking: The Eight Queens Problem - Sum of Subset Problem - Graph Coloring - Knapsack Problem.

Branch and Bound: Knapsack Problem- Traveling Sales Person Problem. NP Hard and NP Complete Problems: Basic Concepts- Cook's Theorem, NP Hard Graph Problems-CDP, NCDP, AOG.

PRAM Algorithms: Merging-Sorting. String Algorithms

Text Books :

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", 2nd Edition, University Press,(2008).
2. Cormen, Leizerson & Rivest, "Introduction to algorithms", 3rd Edition, Prentice-Hall, (2010).
3. Jon Kleinberg and Eva Tardos, "Algorithm Design", Pearson Education, (2006).

Reference Books:

1. Robert Sedgewick and Kevin wayne ,"Algorithms", 4th edition,Addison – Wesley Professional, (2011).
2. Anny Levitin, "Introduction to Design and Analysis of Algorithms", 2rd Edition, Person Education Press. (2007).
3. Michael T.Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, Second Edition, Wiley-India, (200)6.
4. Steven S. Skiena, "The Algorithm Design Manual", Second Edition, Springer, (2008)

ARTIFICIAL INTELLIGENCE

Course code : 15 CS 3111 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 2104 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Select and implement an appropriate informed search algorithm for a problem by designing the necessary heuristic evaluation function.	c	2
CO2	Compare and contrast basic search issues with game playing issues.	c	2
CO3	Formulate a problem specified in natural language (e.g., English) as a constraint satisfaction problem and implement it using a chronological backtracking algorithm or stochastic local search.	c	2
CO4	Understand knowledge representation using logic and rules	c	2
CO5	Representing Knowledge Using Rules and develop intelligent application	c,e	2

SYLLABUS:

Introduction to AI, Problems, Problem Spaces and Search: Defining the Problem as a State space Search, Production Systems, Problem Characteristics, Production system characteristics, Issues in the Design of Search Programs.

Heuristic Search Techniques: Generate-and-test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis.

Knowledge Representation Using Predicate Logic: Representing Simple Facts in logic, Representing Instance and Isa Relationships, Computable Functions and Predicates, Resolution. Representing Knowledge Using Rules: Procedural versus Declarative Knowledge, Logic Programming, Forward versus Backward Reasoning, Matching, Control Knowledge. Weak slot-and-filler structures: Semantic Nets, Frames,

Strong slot-and-filler structures: Conceptual dependency, Scripts. Connectionist models: Hopfield Networks, Perceptions, Back Propagation Networks, Applications of Neural networks. Game Playing: Min Max search Procedure, adding alpha beta cutoffs, additional refinements, iterative deepening, references on specific games,

Natural Language Processing: syntactic processing,semantic analysis,discourse and programmatic processing, statistical natural language processing, spell checking, Expert Systems

Text Books:

1. Elaine Rich & Kevin Knight, 'Artificial Intelligence', 3rd Edition, Tata McGraw Hill Edition,Reprint(2008)
2. Russel and Norvig, 'Artificial Intelligence', Pearson Education, PHI, (2003)

Reference Books:

1. Patrick Henry Winston, 'Artificial Intelligence', Pearson Education (2003)
2. G. Luger, W. A. Stubblefield, "Artificial Intelligence", Third Edition, Addison-Wesley, (2007)

INFORMATION ASSURANCE & SECURITY

Course code : 15 CS 3112 **L – T – P:** 2-2-2

Pre Requisite : 15 CS 2208 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Perform packet sniffing and analyze packets for vulnerabilities	a	2
CO2	Identify system vulnerabilities of communication protocols	a	2
CO3	Design firewalls , Authentication Protocols	e	2
CO4	Analyze encryption algorithms	e	2
CO5	Developing an application using public key encryption techniques which supports digital signing concepts	e	2

SYLLABUS:

A Model for Network Security, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography, Block Ciphers and DES: Block Cipher Principles, DES, DES Example, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles. AES: The Origins AES, AES Structure, AES Example, AES Implementation. Block Cipher Operation: Multiple Encryption and Triple DES, ECB Mode, CBC Mode, CFB Mode, OFB Mode, Counter Mode, XTS Mode for Block-Oriented Storage Devices, Pseudorandom Number Generation and Stream Ciphers: Principles and Pseudorandom Number Generation, Pseudorandom Number, Generators, Pseudorandom Number Generation using a Block Cipher, Stream, Ciphers, RC4 Public-key Cryptography and RSA: Principles of Public-Key Cryptosystems, the RSA algorithm. Other Public-key Cryptosystems: Diffie-Hellman Key Exchange, ElGamal Cryptosystem, Elliptic Curve Arithmetic Elliptic Curve Cryptography. Crypographic Hash Functions: Applications of Cryptographic Hash functions, Two Simple Hash Functions, Requirements and Security, Hash Functions based on Cipher Clock Chaining, SHA, SHA-3. MAC: Message Authentication Requirements, Message Authentication Functions, Message Authentication Codes, Security of MACs, MACs based on Hash Functions: HMAC, MACs based on Block Ciphers: DAA and CMAC, Authenticated Encryption: CCM and GCM. Digital Signatures: Digital Signatures, ElGamal Digital Signature Scheme, Schnorr Digital Signature Scheme, Digital Signature Standard (DSS). KMD: Symmetric Key Distribution using Symmetric Encryption, Symmetric Key Distribution using Asymmetric Key Distribution, Distribution of Public Keys, X.509 Certificates, Public Key Infrastructure, User Authentication Protocols, Remote User Authentication Principles, Remote User Authentication using Symmetric Encryption, Kerberos, Remote User Authentication using Asymmetric Encryption, Federated Identity Management

†Text Books:

1. William Stallings, "Cryptography and Network Security," 5th Edition, Pearson Education, (2010).
2. Wenbo Mao, "Modern Cryptography: Theory and Practice", 1st Edition, Pearson, (2003).

Reference Books:

1. William Stallings, "Network Security and Essentials: Applications and Standards," 3rd Edition, Pearson Education.
2. Neal Koblitz, "A Course on Number Theory & Cryptography," 2nd Edition, Springer, (1994).
3. Forouzon B, "Cryptography and Network Security," Indian Edition, TMH,(2010).
4. Bruice Schneier, "Applied Cryptography", 2nd Edition, Wiley,(2007).

PLATFORM BASED DEVELOPMENT

Course code : 15 CS 3113 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 2002 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand current and evolving Web languages for integrating media and user interaction in both front end and back end elements of a Web site	e	2
CO2	Understand Java-Script functions and CSS	e	2
CO3	Understand game and industrial platforms	e	2
CO4	Understand, analyze and build dynamic and interactive web sites,Design and implementation of modern SOA and SOA-specific methodologies, technologies and standards	k	3
CO5	Install and manage server software and Mobile programming tools.	k	3

SYLLABUS:

Overview of various platforms. Web Programming: HTML5, Fundamentals of HTML, Working with Images, Colors, and Canvas • Working with Forms, JavaScript Functions, Events, Image Maps, and Animations• JavaScript Objects, Validation, Errors, Exception Handling, and Security. CSS3: Colors, fonts, text styles positioning, working with jQuery. Integrating PHP with Ajax. Mobile Programming: HTML5 for mobiles, JS productivity tips, jQuery Mobile, Sencha Touch. Industrial Platforms: Geometric configurations, operations, programming and controls of robots, actuators, sensing for robots, Performance specifications, Applications. Game Platforms: Fundamentals of Software Engineering for Games, 3D Math for Games. Xbox. Creating games with canvas. Web services: XML web services, SOAP, SOA.

Text Books:

1. Adrian Kosmaczewski "Mobile JavaScript Application Development_ Bringing Web Programming to Mobile Devices",O'Reilly Media (2012)

2. HTML5 Black Book: Covers CSS3, Javascript, XML, XHTML, Ajax, PHP and Jquery, dreamtech publishers, (2011)
3. D. J. Todd,"Fundamentals of Robot Technology_ An Introduction to Industrial Robots, Teleoperators and Robot Vehicles"-Springer

Reference Books:

1. Jason ,"Gregory-Game Engine Architecture", Second Edition-CRC Press (2014)
2. James L. Williams,"Learning HTML5 game programming a hands-on guide to building online games using Canvas", SVG, and WebGL -Addison–Wesley ,(2012)
3. Mark D Hansen, "SOA Using Java web services", Pearson, (2007).
4. Deitel, Deitel and Nieto, "Internet and Worldwide Web - How to Program", 5th Edition, PHI, (2011).
5. Bai and Ekedhi, "The Web Warrior Guide to Web Programming", 3rd Edition, Thomson, (2008).

LANGUAGES AND COMPILERS

Course code : 15 CS 3214 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 3109 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Analyzing the design issues involved in various constructs of programming languages, Design top-down and bottom-up parsers	e	2
CO2	Develop syntax directed translation schemes, Design and Implement LR parser	e	2
CO3	Use formal grammars to specify the syntax of languages	e	2
CO4	Analyzing the methods and tools to define syntax and semantics of a languages	k	2
CO5	Develop algorithms to generate code for a target machine ,Apply Lex and Yacc tools	k	2

SYLLABUS:

Introduction to languages and overview of compilation: The Art of Language Design, Programming Language Spectrum, Why Study Programming Languages? Compilation and Interpretation, Programming Environments, Overview of Compilation

Programming Language Syntax: Specifying Syntax: Regular Expressions and Context-Free Grammars, Scanning, Parsing, Theoretical Foundations, Phases of Compilation, Lexical Analysis, Regular Grammar and regular expression for common programming language features, pass and Phases of translation, interpretation, bootstrapping, data structures in compilation, LEX lexical analyzer generator.

Names, Scopes, and Bindings: The Notion of Binding Time, Object Lifetime and Storage Management, Scope Rules, Implementing Scope, The Meaning of Names within a Scope, The Binding of Referencing Environments, Macro Expansion, Separate Compilation.

Syntax and Semantic Analysis: The Role of the Semantic Analyzer, Attribute Grammars, Evaluating Attributes, Action Routines, Space Management for Attributes, Context free grammars, Top down parsing, Backtracking, LL (1), recursive descent parsing, Predictive parsing, Preprocessing steps required for predictive parsing.

Bottom up parsing: - Shift Reduce parsing, LR and LALR parsing, handling ambiguous grammar, YACC, automatic parser generator. Intermediate forms of source Programs, abstract syntax tree, Attributed grammars, Syntax directed translation, Conversion of popular Programming languages language Constructs into Intermediate code forms, Type Checker.

Control Flow: Expression Evaluation, Structured and Unstructured Flow, Sequencing, Selection, Iteration, Recursion, Non Determinacy

Data Types and storage in compilers: Type Systems, Type Checking, Records (Structures) and Variants (Unions), Arrays, Strings, Sets, Pointers and Recursive Types, Lists, Files and Input/ Output, Equality Testing and Assignment Symbol table format, organization for block structured languages, hashing, tree structures representation of scope information. Block structures and non block structure storage allocation: static, Runtime stack and heap storage allocation, storage allocation for arrays, strings and records.

Subroutines, Control Abstraction and global optimization in compilers, Review of Stack Layout, Calling Sequences, Parameter Passing, Generic Subroutines and Modules, Exception Handling, Coroutines, Events Concurrency: Concurrent Programming Fundamentals, Implementing Synchronization, Language-Level Mechanisms, Message Passing

Run-time Program Management: Late Binding of Machine Code, Data flow analysis: Dataflow Analysis, Intermediate representation for flow analysis , Various dataflow analyses , Transformations using dataflow analysis, Speeding up dataflow analysis ,

Data Abstraction, Object Orientation and code and loop optimization: Object-Oriented Programming, Encapsulation and Inheritance, Initialization and Finalization, Dynamic Method Binding, Multiple Inheritance. Consideration for Optimization, Machine dependent and machine independent code optimization, Scope of Optimization, local optimization, loop optimization, frequency reduction, folding, Dominators, Loop-invariant computations, Induction variables, Array bounds checks, Loop unrolling, peephole optimization.

Functional Languages and code generation in compilers: Functional Programming Concepts, A Review/Overview of Scheme, Evaluation Order Revisited, Higher- Order Functions, DAG representation. Processing the intermediate Code- Interpretation, Code generation, Simple code generation, code generation for basic blocks

Text Books:

1. Michael Scott, Elsevier, Morgan Kaufmann ,"Programming Language Pragmatics", 3/e, (2009).
2. Sebesta ,"Concepts of Programming languages", 8/e, PEA
3. A.V. Aho . J.D.Ullman ,"Principles of compiler design ", Pearson Education
4. Dick Grune, Henry E. Bal, Cariel T. H. Jacobs," Modern Compiler Design", Wiley dreamtech.

Reference Books:

1. Zelkowitz,"Programming Languages Design and Implementation" , 4/e Pratt , PHI
2. A.V.Aho,Ravi Sethi& J.D. Ullman; ,"Compilers principles ,techniques and tools Pearson ed."
3. John R. Levine, Tony Mason, Doug Brown, ",lex &yacc,",O'reilly
4. Andrew N.Appel, ,"Modern compiler implementation in java"Cambridge,(2002).
5. Steven S. Muchnick, "Advanced Compiler Design & Implementation", Morgan Kaufmann, Elsevier Science,(2003)

PARALLEL AND DISTRIBUTED COMPUTING

Course code : 15 CS 3215 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 2208 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Analyze algorithms for coordination, communication, security and synchronization in distributed systems	c	2
CO2	Design distributed algorithms for handling deadlocks, Understand distributed shared memory models	c	2
CO3	Design algorithms suited for Multicore processor systems using OpenCL, OpenMP, Threading techniques.	e	2
CO4	Characterize features of a workload that allow or prevent it from being naturally parallelized	c	2
CO5	Design and analyze the parallel algorithms for real world problems and implement them on available parallel computer systems	e	2

SYLLABUS:

Parallel Architecture: Superscalar, Out-of-order execution, Vector Processing/SIMD, Multithreading: pThreads, Uniprocessor memory systems, A parallel zoo of architectures, Multicore chips

Principles of Parallel Algorithm Design, Parallel Decomposition: Independence and partitioning, Data and task decomposition, Synchronization, Characteristics of parallel efficiency

Communication and Coordination: Shared Memory, Threads, Message Passing, Consistency, Modeling and Analysis of Parallel Computations,

Parallel Programming with MPI, OpenMP, Parallel Algorithms for Solving Time Consuming Problems (Matrix calculation, System of linear equations, Sorting, Graph algorithms, Solving PDE, Optimization, Monte Carlo Methods), Load balancing, CUDA Programming Model,

Distributed service design, Logical Time and Global States in Distributed Systems, Core distributed algorithms: Election, discovery, Consensus, Self Stabilization, Snapshot, check pointing, Distributed Resource Allocation, Termination detection, Distributed Shared Memory.

Text Books:

1.Quinn, M. J. “Parallel Programming in C with MPI and OpenMP”, McGraw-Hill, (2004).

2.A Grama, A Gupra, G Karypis, V Kumar. Introduction to Parallel Computing (2nd ed.). Addison Wesley, (2003).

3.Michel Raynal, Distributed Algorithms for Message-Passing Systems-Springer, (2013).

Reference Books:

Ajay D. Kshemkalyani, Mukesh Singhal, “Distributed Computing: Principles, Algorithms, and Systems”, Cambridge University Press, (2008).

GRAPHICS & VISUALIZATION

Course code : 15 CS 3216 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 2104 **Credits :** 4

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome’s	Mapped SO	BTL
CO1	Analyze and select visualization techniques for specific problems	k	2
CO2	Obtain 2-dimensional and 3-dimensional points by applying transformations	c	2
CO3	Implement a simple real-time renderer using a rasterization API (e.g., OpenGL) using vertex buffers and shaders	k	2
CO4	Analyze the effectiveness of a given visualization for a particular task	c	2
CO5	Use standard APIs and tools to create visual displays of data, including animations,graphs, charts, tables, and histograms.	k	2

SYLLABUS:

Introduction, Mathematics for Computer Graphics,, Raster Images, Ray Tracing, Transformations, Viewing, Graphics Pipeline, Signal Processing for Images, Surface Shading, Texture Mapping, Data Structures for Graphics, Curves, Computer Animation, Using Graphics Hardware. Building Interactive Graphics Applications, Visualization, Conceptualization of Interaction., User Centric Interaction., Interfaces and Interaction, Interaction Design, Evaluation Framework, Usability Testing.

Text Books:

1. Fundamentals of Computer Graphics, Third Edition, Peter Shirley Steve Marschner, A K Peters, Natick, Massachusetts.,(2009)

2. Hugues,,Angel, "Interactive Computer Graphics: A Top-Down Approach Using OpenGL" (2002)

3. Y Rogers, J. Preece, H. Sharp ,"Interaction Design", 2nd Edition Wiley and Sons , (2007)

Reference Books:

1. Alan Dix, janet finlay, Gregory d abowd, russel beale ` Human computer interaction, 3rd edition,,pearson education,(2008)

2. Donald Hearn and M. Pauline Baker, Warren Carithers,"Computer Graphics With Open GL",4th Edition, Pearson Education, (2010).

NETWORKING & SECURITY

TCP/IP PROTOCOL SUITE

Course code : 15 CS 325 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2208 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Design and analyze the existing routing protocols using NS	a	2
CO2	Identify solution for each functionality at each layer	a	2
CO3	Understand the working of TCP	a	2
CO4	Case Study: Simulation Of Network Protocols Using NS.	k	2

SYLLABUS:

The Internet Address Architecture, Link Layer, ARP: Address Resolution Protocol, The Internet Protocol (IP), System Configuration: DHCP and Autoconfiguration, Firewalls and Network Address Translation (NAT), ICMPv4 and ICMPv6: Internet Control Message Protocol, Broadcasting and Local Multicasting (IGMP and MLD), User Datagram Protocol (UDP) and IP Fragmentation, Name Resolution and the Domain Name System (DNS), TCP: The Transmission Control Protocol, TCP Connection Management, TCP Timeout and Retransmission, TCP Data Flow and Window Management, TCP Congestion Control, TCP Keepalive, Security: EAP, IPsec, TLS, DNSSEC, and DKIM, Case Study: Simulation Of Network Protocols Using NS.

Text Books :

1. Richard Stevens W, "TCP/IP Illustrated Volume 1", 2nd Edition, Prentice Hall of India/ Pearson Education, New Delhi, (2014).

2. Douglas E Comer, "Internetworking with TCP/IP- Volume I", Prentice Hall of India/ Pearson Education, New Delhi, Fourth Edition,(2002).

Reference Books:

1. Washburn K and Evans J, "TCP/IP", Addison Wesley, USA, Second Edition, (2003).

2. Behrouz A Forouzan, "Local Area Networks", Tata McGraw Hill Publishing Company, New Delhi, (2002).

3. Behrouz A Forouzan, "TCP/IP- Protocol Suite", Tata McGraw Hill Publishing Company, New Delhi, (2002).
4. BehrouzA.Forouzan, "TCP/IP Protocol Suite", 3rd Edition, McGraw-Hill,(2005).
5. Pete Loshin, "TCP/IP Clearly Explained", 4th Edition, Morgan Kaufmann,(2003).
6. Buck Graham "TCP/IP Addressing", 2nd Edition, Morgan Kaufmann, (2001).

NETWORK ARCHITECTURE AND DESIGN

Course code : 15 CS 4159 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2208 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Discuss methodologies for analyzing networks of different fields.	a	2
CO2	Demonstrate knowledge of recent research in the area and exhibit technical writing and presentation skills.	e	2
CO3	Explain the key concepts and algorithms in complex network analysis.	a	2
CO4	Apply a range of techniques for characterizing network structure.	e	2

SYLLABUS:

Introduction: Overview of Analysis, Architecture and Design Process, Systems Methodology, System Description, Service Characteristics, Performance Characteristics, Network Supportability

Network Architecture: Introduction, Component Architecture, Reference Architecture, Architectural Models, Systems and Network Architecture

Addressing and Routing Architecture: Addressing Mechanisms, Routing Mechanisms, Addressing Strategies, Routing Strategies, Architectural Considerations

Network Management Architecture & Security Architecture: Defining Network Management, Network Management Mechanisms, Architectural Considerations, Security and Privacy Administration, Security Architectural Considerations

Network Design: Design Concepts, Design Process, Vendor, Equipment and Service-Provider Evaluations, Network Layout, Design Traceability, Design Metrics, Testing Network Design, Optimizing Network Design, Documenting Network Design

Text Books:

1. McCabe James, "Network Analysis, Architecture, and Design", Morgan Kaufmann Publishers.
2. Priscilla Oppenheimer, "Top-Down Network Design", Pearson Education India

Reference Books:

1. Mani Subramanian, "Network Management – Principles & Practice" – 2nd Edition Prentice Hall, (2012).
2. J.Radz,"Fundamentals of Computer Network Analysis and Engineering: Basic Approaches for Solving Problems in the Networked Computing Environment", Universe,(2005).

NETWORK SECURITY

Course code : 15 CS 4160 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2208 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Analysis and design of algorithms to implement secure protocols.	b	2
CO2	Discuss security properties and limitations of wired networks	e	2
CO3	Describe the architecture for public and private key cryptography and how public key infrastructure (PKI) supports network security	b	2
CO4	Describe common types of vulnerabilities and attacks in web applications, and defenses against them	e	2

SYLLABUS:

Network Security Foundations, Designing Secure Networks, Network Management, Network Protocol Security, TLS: Web Security Issues, Secure Sockets Layer (SSL), Transport Layer Security (TLS), HTTPS, Secure Shell (SSH), Wireless Network Security: IEEE 802.11 Authentication, WEP, WEP Encryption, Email Security: Pretty Good Privacy (PGP), S/MIME, Domain Keys Identified Mail (DKIM) IP Security: IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange, Cryptographic Suites. System and Platform Security: Intruders, Intrusion Detection, Password Management, Viruses and Related Threats, Virus Countermeasures, DDOS Attacks, Operating System Security, File & Disk Protection, Firewalls: Firewall Design Principles, Trusted Systems. Web Application Insecurity, Core Defense Mechanisms, Web Application Technologies, Mapping the Application, Bypassing Client-Side Controls, Attacking Authentication, Attacking Session Management, Attacking Access Controls, Injecting Code, Exploiting Path Traversal, Attacking Application Logic, Attacking Other Users, Attacking Complied Applications, Attacking Application Architecture, Attacking the Web Server, Finding Vulnerabilities in Source Code.

Text Books:

1. William Stallings, "Cryptography and Network Security," 5th Edition, Pearson Education, (2010).
2. Dafydd Stuttard, "The Web Application Hacker's Handbook: Discovering and Exploiting Security Falws," Wiley, 1st Edition, (2007).

Reference Books:

1. William Stallings, "Network Security and Essentials: Applications and Standards," 3rd Edition, Pearson Education.
2. Forouzon B, "Cryptography and Network Security," Indian Edition, TMH, (2010).
3. Sean Convery, "Network Security Architectures (Networking Technology)", Kindle Edition, CISCO Press, (2004).
4. Bruice Schneier, "Applied Cryptography", 2nd Edition, Wiley, (2007).

WIRELESS COMMUNICATIONS AND NETWORKS

Course code : 15 CS 4161 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2208 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand algorithm/protocols, environments and communication systems in mobile computing.	a	2
CO2	Evaluate the efficiency of modulation schemes and multiple access technquies.	k	2
CO3	Analyze the performance of MAC,TCP protocols used for wired network and wireless networks.	k	2
CO4	Design and analyze the existing routing protocols for multi-hop wireless networks.	a	2

SYLLABUS:

An Overview of Wireless Systems, Teletraffic Engineering, Radio Propagation and Propagation Path-Loss Models, An Overview of Digital Communication and Transmission, Fundamentals of Cellular Communications, Multiple Access Techniques, Architecture of a Wireless Wide-Area Network (WWAN), Speech Coding and Channel Coding, Modulation Schemes, Antennas, Diversity, and Link Analysis, Spread Spectrum (SS) and CDMA Systems, Mobility Management in Wireless Networks, Security in Wireless Systems

Text Books :

1. Vijay K. Garg,"Wireless communications and networking", Morgan Kaufmann Publishers (2007).
2. Anurag Kumar, D. Manjunath and Joy Kuri,"Wireless networking", Morgan Kaufmann Publishers

Reference Books:

1. Andreas F. Molisch, ,"Wireless Communications", John Wiley India, (2006).
2. William Stallings,,"Wireless Communications and Networks",Pearson/ Prentice Hall of India, 2nd Edition, (2007).
3. Andrea Goldsmith ,"Wireless Communication", Cambridge University Press,(2007).

COMPUTER FORENSICS

Course code : 15 CS 4162 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2208 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Discuss the security issues network layer and transport layer	a	2
CO2	Apply security principles in the application layer	c	2
CO3	Apply their theoretical and practical knowledge in forensic computing, into the future and emerging technology	c	2
CO4	Use forensics tools , Analyze and validate forensics data	a	2

SYLLABUS:

Digital forensics: Introduction – Evidential potential of digital devices: closed vs. open systems, evaluating digital evidence potential- Device handling: seizure issues, device identification, networked devices and contamination, Digital forensics examination principles: Previewing, imaging, continuity, hashing and evidence locations. Seven element security model- developmental model of digital systems- audit and logs- Evidence interpretation: Data content and contex, Introduction: Real-World Incidents, Introduction to the Incident Response Process, Preparing for Incident Response, After Detection of an Incident, Data Collection: Live Data Collection from Windows Systems, Live Data Collection from Unix Systems, Forensic Duplication, Collecting Network-based Evidence, Evidence Handling, Data Analysis: Computer System Storage Fundamentals, Data Analysis Techniques, Investigating Windows Systems, Investigating Unix Systems, Analyzing Network Traffic, Investigating Hacker Tools, Investigating Routers, Writing Computer Forensic Reports

Text Books:

1. Kevin Mandia, Chris Prosise, Matt Pepe, "Incident Response and Computer Forensics," 3rd Edition, McGraw-Hill, (2014)
2. Richard Bejelich, "The Practice of Network Security Monitoring – Understanding Incident Detection and Response", First Edition,(2013).

Reference Books:

1. Gregory Kipper, "Wireless Crime and Forensic Investigation", Auerbach Publications, (2007).
2. Iosif I. Androulidakis, "Mobile phone security and forensics: A practical approach", Springer publications, (2012).
3. Leighton Johnson, Computer Incident Response and Forensics Team Management: Conducting A Successful Incident Response, Syngress, Elsevier, (2014)
4. Suzanne Widup, "Computer Forensics & Digital Investigation (With Encase Forensics V7)", First Edition, McGraw Hill, (2014).

5. Man Young Rhee, "Internet Security: Cryptographic Principles", "Algorithms and Protocols" Wiley Publications, (2003).
6. Nelson, Phillips, Enfinger, Steuart, "Computer Forensics and Investigations", Cengage Learning, India Edition, (2008).

SOFTWARE METRICS AND MEASUREMENTS

Course code : 15 CS 3252 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 1001 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Determine the software measurement attributes and process metrics	e	2
CO2	Plan and evaluate metrics for object oreiented software projects	a	2
CO3	Understand project monitoring and control techniques	e	2
CO4	Describe several process metrics for assessing and controlling a project. Assess the quality of a proposed metric.	a	2

SYLLABUS:

Evolution of software metrics: Evolution of the software industry and evolution of software measurements, The cost of counting function point metrics, The paradox of reversed productivity for high, Level languages, The Varieties of functional metrics. Measuring software quality: Five steps to software quality control, Measuring software defect removal, Measuring the costs of defect removal, Evaluating defect prevention methods, Measuring customer reported defects, Measuring invalid defects, Duplicate defects. Process Metrics: In-Process Metrics for Software Testing-Complexity Metrics and Models, Lines of Code, Halstead's Software Science, Syntactic Constructs - Structure Metrics, Metrics for Object-Oriented Projects, Concepts and Constructs, Design and Complexity Metrics, CK OO Metrics Suite , Productivity Metrics. Mechanics of measurement: Software Assessments, Software Baselines, Software Benchmarks, What a Baseline analysis covers, Developing or Acquiring a baseline data collection Instrument, Administering the data collection questionnaire, Analysis and aggregation of the Baseline data. Measuring and Analyzing Customer Satisfaction, Surveys, Data Collection, Sampling Methods, Analyzing Satisfaction Data. Conducting In-Process Quality Assessments, Preparation, Evaluation, Quantitative Data , Qualitative Data , Evaluation Criteria, Overall Assessment.

Text Books:

1. Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Addison Wesley, (2011).
2. Caper Jones, "Applied Software Measurement: Global Analysis of Productivity and Quality", Third Edition, McGraw Hill Companies, (2008).

References Books:

1. Mark Lorenz, Jeff Kidd, "Object-Oriented Software Metrics", Prentice Hall, (2000).
2. Naresh Chauhan, "Software Testing Principles and Practices", Oxford University Press, (2010).
3. Ravindranath Pandian C., "Software Metrics A Guide to planning, Analysis, and Application", Auerbach, First Indian Reprint, (2011).
4. Norman E. Fenton, Shari Lawrence Pfleeger, "Software Metrics - A Rigorous and Practical Approach", 2nd Edition, PWS Pub, (1996).

SOFTWARE VERIFICATION AND VALIDATION

Course code : 15 CS 4163 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2101 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Design test cases suitable for a software development for different domains.	a	2
CO2	Identify suitable tests to be carried out. Conduct an inspection or review of software source code for a small or medium sized software project.	c	2
CO3	Prepare test planning based on the document using automatic testing tools.	a	2
CO4	Document test plans and test cases designed	c	2

SYLLABUS:

Software Testing Fundamentals –Testing objectives, Testing lifecycles, Test cases, human error, testing and debugging, general principles of testing, test metrics, Agile methodology and Its Impact on Testing, Verification and Validation. Failure, Error, Fault, and Defect. Testing Approaches - Static testing, structured group examination static analysis, Control flow and data flow Testing, Determining Metrics, Dynamic Testing, Black Box testing, equivalence Class Portioning, Boundary Value Analysis, state transition test, cause effect graphing and decision table technique and used case testing and Advanced black box and white box techniques Gray box testing, intuitive and Experience based. verification and validation planning, Top down versus bottom up Testing Functional Vs Structured Testing, mutation testing, Test planning and Management, Testing process, Maturity Models. Types of Testing-Concept of Unit Testing, Domain testing, Concept of Integration Testing. System testing acceptance testing, Alpha &Beta testing, Installation Testing, Usability Testing, Regression testing, System Tests- Performance testing, Load testing, Stress testing, Security testing, Gorilla testing, Syntax Based Testing , Functionality Tests ,Robustness Tests, Interoperability Tests, Scalability Tests, Documentation Tests.

Text Books:

1. Ammann & Offutt , "Introduction To Software Testing" , Cambridge Univ Press
2. Naik,"Software Testing and Quality Assurance", Wiley India pub.

Reference Books:

1. Limaye ," Software Testing ", TMH Pub
2. Steven R. Rakitin , "Software Verification and Validation for Practitioners and Managers", Second Edition
3. Aditya P. Mathur, "Foundations of Software Testing _ Fundamental Algorithms and Techniques", Pearson Education, (2008).

SOFTWARE ARCHITECTURE AND DESIGN PATTERNS

Course code : 15 CS 4164 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2101 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Analyze and combine design patterns to work together in software design	e	2
CO2	Refactor an existing software implementation to improve some aspect of its design	c	2
CO3	Discuss and select appropriate software architecture for a simple system suitable for a given scenario	e	2
CO4	Implement the design patterns in an object oriented language.	c	2

SYLLABUS:

Software Architecture and Agile Approaches Software Architecture, Agile Software Development and Architecture, Making Architectural and Agile Approaches Work Taking Object Orientation and Architectural World The Vision, Form and Function in Architectural history, What is Object Orientation, Shortcoming of the methods, DCI a new paradigm, DCI and Architecture Refactoring Software Architectures Dealing with design flaws, Evolution and Style of Refactoring – Code Refactoring, Evolution and Style of Refactoring – Refactoring to Patterns, The Motivation for Software Architecture Refactoring, Architectural Smells, A Real world Example, Quality Improvement, The process of Continues Architecture Improvement, Additional examples of Architecture Refactoring Patterns, Know Obstacles of Architecture Refactoring, Comparing Refactoring Reengineering and Rewriting Driving Architectural Design and Preservation from a Persona Perspective in Agile Projects Personas in the Design space, Discovering ASRs, Personas for Driving Architectural Design, Personas and Architectural Preservation, ASPs in Other Project Domains Architecture Decisions Introduction, Research Methodology, The Agile Architecture Axes Framework, Industrial Cases, Analysis, Reflection, Supporting Variability Through Agility to Achieve Adaptable Architectures Background, Challenges When Combining Variability and Agility, Arguments for Combining Variability and Agility Continuous Software Architecture Analysis Software Architecture Analysis, Approaches to Software Architecture Analysis, Continuous Software Architecture Analysis , CSAA in Exiting Approaches, CSAA and Analysis Goals, Experience with an Approach to CSAA, Findings and Research Challenges Light weight

Architecture Knowledge Management for Agile Software Development Challenges to Agile Architecture Documentation, Supporting Techniques for AKM in Agile Software Development, Architecture Practices in Agile Projects, Architectural Information Flow in Industry, AKM in Scrum, Bridging User Stories and Software Architecture Agile Architecting, Agile Architecting Mechanisms, A Tailored Scrum for Agile Architecting, Agile Architecting in Practice.

Text Books:

1. Mohammad All Babar , AlanW.Brown, Kai Koskimies, Ivan Mistrik "Agile Software Architecture – Alligning Agile Processec and Software Architectures MK(Morgan Kaufmann) Publishers (2014).
2. Richard N. Taylor, Nenad Medvidovic, Eric Dashofy, "Software Architecture: Foundations, Theory, and Practice", Wiley, (2009).

Reference Books:

1. Frank Buschmann, Regine, "Pattern-Oriented Software Architecture, A System of Patterns -Volume1", Wiley, (2008).
2. Ian Gorton, "Essential Software Architecture" Springer International Edition –(2006)
3. Len Bass, Paul Clements, Rick Kazman: "Software Architecture in Practice", 2/e, Pearson Education, (2003).
4. Mary Shaw and David Garlan," Software Architecture- Perspectives on an Emerging Discipline", Prentice-Hall of India, (2004).

SOFTWARE PROJECT MANAGEMENT

Course code : 15 CS 4165 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2101 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand Requirements Specification & Management, Scope Management, Project Initiation Management	a	2
CO2	Apply Software Project Effort and Cost Estimation	e	2
CO3	Apply the basic principles of risk management, Time Management, and Configuration Management in a variety of simple scenarios including a security situation.	e	2
CO4	Use a project management tool to assist in the assignment and tracking of tasks in a software development project.	a	2

SYLLABUS:

Introduction to Software Project Management: Introduction to Project Management, Importance of Software Projects, Problems in Project Management, Processes in Software Projects, Project Processes, People, and Technology, Successful Software Project Manager, Project Management Processes: Software Project Initiation, Software Project Planning, Software Project Monitoring and Control, Software Project Closure, Configuration and Version Control Management, Management Metrics, Requirements Specification & Management, Scope Management, Project Initiation Management: Introduction, Define Project Charter, Define Project Scope , Define Project Objectives, Practical Considerations, Estimate Initial Project Size, Estimate Initial Project Effort and Costs, Estimate Initial Project Schedule, Create Initial Project Plan, Project Initiation in Iterative Model, Stakeholder Influence, Quality Planning, Feasibility Study, Project Division, Artifacts of Project Initiation, Software Project Effort and Cost Estimation: Introduction, Effort Estimation Techniques, Cost Estimation: Cost Factor Analysis, Activity-Based Cost Estimation, Cost Estimation for Iterations-Based Planning, Schedule Estimation, Resource Estimation, Artifacts of Effort and Cost Estimates, Practical Considerations in Effort and Cost Estimates, Effort and Cost in Product Development, Risk Management: Introduction, Causes of Risks, Risk Categories, Risk Analysis, Balancing Act, Project Risk Management in Agile Models, Artifacts of Project Risk Management, Practical Considerations for Risk Management, Time Management, Configuration Management: Introduction, Configuration Management, Configuration Management Techniques, Artifacts of Configuration Management, Configuration Management.

Text Books:

1. Ashfaque Ahmed , "Software Project Management – A Process-Driven Approach" - December, (2011).
2. Robert K. Wysocki, "Effective Software Project Management", John Wiley, (2006).

Reference Books:

1. Bob Hughes and mike Cottrell "Software Project Management" , McGraw-Hill Education, (2006).
2. Schwalbe, K.," Information Technology Project Management", 7th edition, Thomson Learning. (2012)

FAULT TOLERANT COMPUTING

Course code : 15 CS 4166 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2101 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Discuss the process by which a fault eventually causes a system failure. Understand the link between fault model and the corresponding dependability mechanisms.	a	2
CO2	Calculate reliability of a system. Use of tools for reliability modeling. Design of dependable HW.	e	2
CO3	Understand critical functions such as clock synchronisation, consensus, FDIR protocols, etc. Understand Byzantine failures and its impact on system complexity. Introduction to asynchronous message-passing distributed systems.	a	2
CO4	SW: Understand the various methods for SW fault tolerance. NVP, recovery blocks, run-time checks, problem of predicate detection.	e	2

SYLLABUS:

Introduction: Computer and Computation Distribution, System models and Fault models. Test generation for combinational circuits, sequential circuits and Fault simulation. Fault Tolerance Concepts- Recovery in time, Fault detection techniques, Modeling Fault tolerant systems - Rollback modular redundancy and Exception Handling. Fault Tolerant in Real time Systems - Architecture of Fault - tolerant computers general purpose commercial systems - High availability systems - Critical computations Fault Tolerant multiprocessor - Communication Architectures, Shared memory Interconnections, loop architectures, Tree Networks, Graph Network and in Binary cube interconnection. Fault Tolerant Software - Design of fault Tolerant software - Reliability Models, Construction of acceptance tests, validation of Fault tolerant software.

Text Books:

1. Israel & Krishnan, "Fault Tolerant Systems" Elsevier Publications, (2007).
2. Pradhan, D.K. (ed.), Fault-Tolerant Computer System Design, Prentice-Hall, (1996).

Reference Books:

1. L. L. Pullum, "Software Fault Tolerance Techniques and Implementation", Artech House Computer Security Series, (2001).
2. M. L. Shooman," Reliability of Computer Systems and Networks Fault Tolerance Analysis and Design", Wiley, (2002)
3. D. K. Pradhan, "Fault Tolerant computing - Theory and Techniques "Prentice Hall.Inc. (1986)

DISTRIBUTION AND CLOUD COMPUTING

ENTERPRISE STORAGE SYSTEMS

Course code : 15 CS 3253 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2003 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand storage systems	a	2
CO2	Understand Networking Technologies	a	2
CO3	Understand object based and unfied storage	a	2
CO4	Apply security and management	e	2

SYLLABUS:

Storage Systems: Data Classification, Storage Evolution and Data Center infrastructure. Host components, Connectivity, Storage, and Protocols. Components of a disk drive, physical disk and factors affecting disk drive performance. RAID level performance and availability considerations. Components and benefits of an intelligent storage system.

Storage Networking Technologies: Direct-Attached Storage (DAS)architecture, Storage Area Network (SAN) attributes, components, topologies, connectivity options and zoning. FC protocol stack, addressing, flow control, and classes of service. Networked Attached Storage (NAS)components, protocols, IP Storage Area Network (IP SAN) iSCSI, FCIP and FCoE architecture.

Object-Based and Unified Storage, Object-Based Storage Devices, Content-Addressed Storage, CAS Use Cases, Unified Storage.

Continuity: Business Continuity measurement, terminologies, and planning. Backup designs, architecture, topologies, and technologies in SAN and NAS environments. Local and Remote replication using host and array-based replication technologies such as Synchronous and Asynchronous methods.

Storage Security and Management: Storage security framework and various security domains. Security implementation in SAN, NAS, and IP-SAN networking. Monitoring and Storage management activities and challenges

Text Books:

1. Somasundaram Gnanasundaram, Alok Shrivastava ,"Information Storage and Management", Wiley Publishing Inc, 2nd Edition, (2012)
2. Richard Barker, Paul Massiglia ," Storage area network essentials", Wiley New York , (2002)

Reference Books:

1. Ulf Troppens, Rainer Erkens, Wolfgang Mueller-Friedt, Rainer Wolafka, Nils Haustein, "Storage Networks Explained", July (2009).
2. W. Curtis Preston, "Using SANs and NAS, O'Reilly & Associates Sebastopol, Calif",(2002)
3. Himanshu Dwivedi ,"Securing storage", Addison-Wesley Upper Saddle River, NJ,(2006).

PARALLEL ALGORITHMS

Course code : 15 CS 4167 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3211 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand Algorithms and sorting networks	a	2
CO2	Ability to design and analyze parallel algorithms	e	2
CO3	Apply graph and search algorithms on sorting networks	e	2
CO4	Understand arithmetic and randomized compuations	a	2

SYLLABUS:

Principles of parallel algorithm design, PRAM Model: Performance evaluation of PRAM Algorithms, Comparison of PRAM models, Sorting Networks: Odd-Even Merge sort, sorting on One-Dimensional Network, Networking: Interconnection Networks, Communication models, Peer-to-Peer Computing, Algorithms on a Ring of Processors. Algorithms on Grids of Processors: Matrix multiplication on a Grid of Processors, Load Balancing on Heterogeneous

Platforms, Scheduling, Advanced Scheduling: Divisible load Scheduling, Steady-State scheduling, workflow scheduling, Hyperplane Scheduling, Lists and Trees: Euler-Tour Technique, tree contraction, lowest common ancestors, Searching Merging and Sorting: Sorting Networks. Graphs: Connected components, minimum spanning tree, biconnected components, Ear Decomposition, Graph and Search Algorithms, Planar Geometry: The convex-Hull problem, intersection of convex sets, Plane Sweeping, Visibility Problems, Strings. Arithmetic Computations: Linear Recurrences, Triangular Linear Systems, Discrete Fourier Transform, Polynomial multiplication and Convolution, Toeplitz matrices, Polynomial Division, Randomized Algorithms, Limitations of PRAMS.

Text Books:

1. Henri Casanova, Arnaud Legrand, Yves Robert, "Parallel Algorithms", CRC Press.
2. Joseph Jaja, "Introduction to Parallel Algorithms", Addison-Wesley.

Reference Books:

1. Ananth Grama, Vipin Kumar,"Introduction to Parallel Computing", 2nd Edition, Addison Wesley
2. Russ Miller, Laurence Boxer, "Algorithms Sequential & Parallel: A Unified Approach", Cengage Learning, 3rd Edition.
3. Fayez Gebali, "Algorithms and Parallel Computing", Wiley.
4. Chryssis Georgiou, Alexander A. Shvartsman,"Cooperative Task-Oriented Computing: Algorithms and Complexity", Morgan Claypool Publishers.
5. Karl Heinz Hoffmann, Arnd Meyer, "Parallel Algorithms and Cluster Computing: Implementations, Algorithms and Applications", Springer.
6. Sanguthevar Rajasekaran, John Reif,"Handbook of Parallel Computing: Models, Algorithms and Applications", Chapman & Hall/CRC.

CLOUD NETWORKING

Course code : 15 CS 4168 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2208 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand data center networking standards	a	2
CO2	Understand server virtualization , Switch Fabric Technology	e	2
CO3	Cloud Data Center Networking Topologies	a	2
CO4	Understand software defined networking	e	2

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. S

erver 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.

Text Book:

1. Gary Lee, "Cloud Networking - Understanding Cloud-based Data Center Networks", Elsevier, (2014).

Reference Books:

1. Andrew Tanenbaum ,"Computer networks", 5/e, PHI,.
2. Larry L. Peterson, Bruce S. Davie ."Computer Networks a system approach", 2/e,Harcourt Asia PTE LTD., (2007)

CLOUD COMPUTING

Course code : 15 CS 4169 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3211 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Identify the appropriate cloud services for a given application	e	2
CO2	Analyze Cloud infrastructure including Google Cloud and Amazon Cloud.	c	2
CO3	Analyze authentication, confidentiality and privacy issues in Cloud computing environment.	c	2
CO4	Determine financial and technological implications for selecting cloud computing platforms	e	2

SYLLABUS:

Cloud Computing Basics-Overview, Applications, Intranets and the Cloud. Your

Organization and Cloud Computing- Benefits, Limitations, Security Concerns. Hardware and Infrastructure- Clients, Security, Network, Services. Software as a Service (Saas)-Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA. Platform as a Service (PaaS)-IT Evolution Leading to the Cloud, Benefits of Paas Solutions, Disadvantages of Paas Solutions. Infrastructure as a Service (Iaas)-Understanding IaaS, Improving Performance through Load Balancing, System and Storage Redundancy, Utilizing Cloud-Based NAS Devices, Advantages, Server Types. Virtualization-Understanding Virtualization, History, Leveraging Blade Servers, Server Virtualization, Data Storage Virtualization. Securing the Cloud- General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. Application Scalability-Load-Balancing Process, Designing for Scalability, Capacity Planning Versus Scalability, Scalability and Diminishing Returns and Performance Tuning.

Text Books:

1. Anthony T. Velte Toby J. Velte, Robert Elsenpeter ,"Cloud Computing : A Practical Approach", McGraw-Hill, (2010).
2. Dr. Kris Jamsa ,"Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more".

Reference Books:

1. Frank H. P. Fitzek, Marcos D. Katz, "Mobile Clouds: Exploiting Distributed Resources in Wireless, Mobile and Social Networks", Wiley Publications, ISBN: 978-0-470-97389-9, (2014).
2. Jason Venner, "Pro Hadoop- Build Scalable, Distributed Applications in the Cloud", A Press, (2009).
3. Tom White, "Hadoop The Definitive Guide", First Edition. O'Reilly, 2009.
4. Judith Hurwitz, Robin Bloor, Marcia Kaufman, and Dr. Fern Halper, "Cloud Computing for Dummies" Wiley Publishing, (2010).
5. Dinakar Sitaram ,"Moving to The Cloud", Elsevier, (2014).

HIGH PERFORMANCE COMPUTING

Course code : 15 CS 4170 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3211 **Credits:** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Analyze the performance of GPU memory hierarchy and MPI programming	a	2
CO2	Develop parallel programs using OpenCL library and understand FPGA-Based Supercomputer	e	2
CO3	Develop mixed mode programs for Multicore, GPU and cluster oprtimization systems	e	2
CO4	Generate parallel programs for matrix, graph and sorting problems using Cuda, OpenMP library	a	2

SYLLABUS:

Modern processors, Basic optimization techniques for serial code, Data access optimization, Parallel computers, Basics of parallelization,Shared-memory parallel programming with OpenMP, Efficient OpenMP programming, Locality optimizations on ccNUMA architectures, Distributed-memory parallel programming with MPI, Efficient MPI programming, Hybrid parallelization with MPI and OpenMP, A Topology and affinity in multicore environments, History of GPU Computing, Introduction to CUDA, CUDA Threads and Memories, Performance and floating point considerations, Parallel Programming and Computational Thinking, OpenCL. Hybrid-Core Architecture, Low Cost High Performance Reconfigurable Computing, FPGA-Based Supercomputer for Statistical Physics, Weird Case of Janus, High-Speed Torus Interconnect Using FPGAs, Re-architecting Memory Resources for Clusters, High-Speed Dynamic Reconfiguration. Parameterization, Models, Core optimization, Node and Cluster optimization, Grid-level Brokering to save energy.

Text Books:

1. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Engineers and Scientists", CRC Press.
2. David B Krik, Wen-mei W Hwu, "Programming Massively Parallel Processors", Morgan Kaufmann.

Reference Books:

1. Christian de Schryver, Norbert Wehn, "High-Performance Computing Using FPGAs", Springer, (2013).
2. Ralf Gruberc, Vincent Keller, "HPC @ Green IT, Green High Performance Computing Methods", Springer,(2010).
3. John Levesque, Gene Wagenbreth ,"High Performance Computing: Programming and Applications", CRC Press.
4. Ananth Grama, Anshul Gupta and Vipin Kumar, "Introduction to Parallel Computing", 2nd Edition, Pearson Edition (2009).
5. Jason Sanders, Edward Kandrot, "CUDA by Example - An Introduction to General-Purpose GPU Programming", Addison Wesley, (2011).
6. Benedict R Gaster, Lee Howes, David R Kaeli Perhaad Mistry Dana Schaa, "Heterogeneous Computing with OpenCL", MGH, (2011)

COMPUTATIONAL INTELLIGENCE

SOFT COMPUTING

Course code : 15 CS 3254 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3107 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the working of neural networks to store and process information	a	2
CO2	Build optimal classifiers using genetic algorithms	e	2
CO3	Apply ANN, RNN models and various soft computing frame works.	e	2
CO4	Understand Fuzzy Logic Systems and develop Fuzzy logic controllers	a	2

SYLLABUS:

Introduction to Intelligent systems and soft computing: Intelligence systems, Knowledge -based systems, knowledge representation and processing, soft computing. Fundamentals of Fuzzy Logic Systems: Fuzzy sets, Fuzzy logic operations, generalized operations, Fuzziness and fuzzy resolution, fuzzy relations, composition and interface, considerations of fuzzy decision- making. Fuzzy logic control: Basic of fuzzy control, Fuzzy control architecture, Properties of fuzzy control, robustness and stability. Fundamentals of Artificial neural networks: Learning and acquisition of knowledge, features of artificial neural networks, fundamentals of connectionist modeling. Major classes of neural networks: The multi-layer perceptrons, radial basis function networks, Kohonen's self-organizing network, The Hopfield network, industrial and commercial application of ANN. Dynamic neural networks and their applications to control and chaos prediction: Training algorithms, fields of applications of RNN, dynamic neural networks for chaos time series prediction, artificial neural networks for chaos predictions. Neuro Fuzzy Systems: Architecture of neuro fuzzy systems, construction of neuro fuzzy systems. Evolutionary computing: Over view of Evolutionary computing, Genetic algorithms and optimization, the schema theorem: the fundamental algorithm of Genetic algorithms, Genetic algorithms - operations, integration of Genetic algorithms with neural networks, integration of Genetic algorithms with fuzzy logic.

Text Books:

1. Fakhreddine O. Karry, Clarence De Silva, "Soft Computing and Intelligent systems Design Theory, Tools and Applications", Pearson, (2009).
2. J.S.R.Jang, C.T. Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI / Pearson Education,(2004).

Reference Books:

1. Laurene Fausett, "Fundamentals of Neural Networks", Pearson, (2004).
2. Timothy J Ross "Fuzzy Logic with Engineering Applications", 3rd Edition, Wiley, (2010).
3. Bart Kosko, "Neural Networks and Fuzzy Systems", PHI, (2004).
4. S N Sivanandam, S N Deepa, "Principles of Soft Computing", Wiley India,(2008).

MACHINE LEARNING

Course code : 15 CS 4171 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3107 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Explain the differences among the styles of learning: supervised, reinforcement, unsupervised, inductive and deductive	a	2
CO2	Comprehend probabilistic methods for learning	e	2
CO3	Understand Multivariate regression and Classification	a	2
CO4	Understand rule based knowledge and Analyze clustering	a	2

SYLLABUS:

Supervised Learning: Learning a Class from Examples, Vapnik Chervonenkis (VC) Dimension, Probably Approximately Correct (PAC) Learning, Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, Dimensions of a Supervised Machine Learning Algorithm Bayesian Decision Theory: Classification, Losses and Risks, Discriminant Functions, Utility Theory, Association Rules Parametric Methods: Maximum Likelihood Estimation, Evaluating an Estimator: Bias and Variance, The Bayes' Estimator, Parametric Classification, Regression, Tuning Model Complexity: Bias/Variance Dilemma, Model Selection Procedures Multivariate Methods: Multivariate Data, Parameter Estimation, Estimation of Missing Values, Multivariate Normal Distribution, Multivariate Classification, Tuning Complexity, Discrete Features, Multivariate Regression Dimensionality Reduction: Subset Selection, Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis Clustering: Mixture Densities, k-Means Clustering, Expectation-Maximization Algorithm, Mixtures of Latent Variable Models, Supervised Learning after Clustering, Hierarchical Clustering, Choosing the Number of Clusters Nonparametric Methods: Nonparametric Density Estimation, Generalization to Multivariate Data, Nonparametric Classification, Condensed Nearest Neighbor, Nonparametric Regression: Smoothing Models, Choosing the Smoothing Parameter Decision Trees: Univariate Trees, Pruning, Rule Extraction from Trees, Learning Rules from Data, Multivariate Trees Local Models: Competitive Learning, Radial Basis Functions, Incorporating Rule-Based Knowledge, Normalized Basis Functions, Competitive Basis Functions, Learning Vector Quantization, Bayesian Estimation: Estimating the Parameter of a Distribution, Bayesian Estimation of the Parameters of a Function, Gaussian Processes Hidden Markov Models: Discrete Markov Processes, Hidden Markov Models, Three Basic Problems of HMMs, Evaluation Problem, Finding the State Sequence, Learning Model Parameters, Continuous Observations, The HMM with Input, Model Selection in HMM.

Text Book:

1. Ethem Alpaydin, "Introduction to Machine Learning", The MIT Press, (2010)

Reference Books:

1. Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Press, (2009).
2. Richard O Duda, Peter E Hart, David G Stork, " Pattern Classification", Second Edition, Wiley

ATURAL LANGUAGE PROCESSING

Course code : 15 CS 4172 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3107 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Analyze the natural language text.	a	2
CO2	Identify the challenges of representing meaning and Generate natural language.	e	2
CO3	Identify techniques for information retrieval, language translation, and text classification	a	2
CO4	Simulate, apply, or implement classic and stochastic algorithms for parsing natural language.	e	2

SYLLABUS:

Mathematical Foundations, Linguistic Essentials, Corpus-Based Work.

Words: Collocations, Statistical Inference: n-gram Models over Sparse Data, Word Sense Disambiguation, Lexical Acquisition.

Grammar: Markov Models, Part-of-Speech Tagging, Probabilistic Context Free Grammars, Probabilistic Parsing.

Applications and Techniques: Statistical Alignment and Machine Translation, Clustering, Topics in Information Retrieval, Text Categorization.

Text Book:

1. Christopher D Manning, Hinrich Schutze, "Foundations of Statistical Natural Language Processing", MIT Press,(2003).

References Books:

1. Lucja M Iwanska, Stuart C Shapiro, "Natural Language Processing And Knowledge Representation: Language For Knowledge And Knowledge For Language", AAAI Press,(2000).
2. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press,(2008).
3. Anne Kao, Stephen R Poteet, "Natural Language Processing and Text Mining", Springer, (2010).
4. Daniel Jurafsky, James H Martin, "Speech and Language Processing", Pearson, (2000).

PERCEPTION AND COMPUTER VISION

Course code : 15 CS 4173 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3107 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand Image representation and modeling	a	2
CO2	Apply Image transformation methods	c	2
CO3	Implement image processing algorithms	a	2
CO4	Design of face detection and recognition algorithms	c	2

SYLLABUS:

Cameras: Sensing, Sources, Shadows, and Shading: Qualitative Radiometry, Sources and their effects, Local shading models, Application: photometric stereo, Inter-reflections: global shading models Color: The physics of color, Human color Perception, Representing color, A Model for image color, Surface color from image color Linear Filters: Linear filters and convolution, Shift Invariant linear systems, Spatial Frequency and Fourier Transforms, Sampling and Aliasing, Filters as Templates, Technique: Scale and Image Pyramids, Edge Detection: Noise, Estimating Derivatives, Detecting Edges Texture: Representing Texture, Analysis Using Oriented Pyramids, Application: Synthesizing Textures for Rendering, Shape from Texture The Geometry of Multiple Views: Two Views, Three Views Stereopsis: Reconstruction, Human Stereopsis, Binocular Fusion, Using More Cameras Segmentation by Clustering: Human Vision: Grouping and Gestalt, Applications: shot boundary detection and background subtraction, Image segmentation by clustering pixels, Segmentation by Graph-Theoretic Clustering Segmentation by Fitting a Model: The Hough Transform, Fitting Lines, Fitting Curves, Robustness, Example: Using RANSAC to fit Fundamental matrices Segmentation and Fitting Using Probabilistic Methods: Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in practice, Model selection: best Fit, Model-Based Vision: Initial Assumptions, Obtaining Hypotheses by Pose Consistency, Obtaining Hypotheses Using Invariants, Verification, Application: Registrations in Medical Imaging Systems, Curved Surfaces and Alignment Finding Templates Using Classifiers: Classifiers, Building Classifiers from Class Histograms, Feature selection, Neural Networks, The Support Vector Machine Recognition by Relations between Templates: Finding objects by voting on relations between templates, Relational Reasoning Using Probabilistic Models and Search, Using Classifiers to Prune Search, Technique: Hidden Markov Models, Applications: Hidden Markov Models and Sign Language Understanding Geometric Templates from Spatial Relations: Simple Relations between object and image, Primitives, Templates, and Geometric Inference, Object Recognition.

Text Book:

1. Forsyth David A and Ponce J, "Computer Vision – A Modern Approach", Pearson Publication, (2003).

Reference books:

1. R. Szeliski ,"Computer Vision: Algorithms and Applications", Springer Verlag, (2011)
2. Milan Soanka, Vaclav Hlavac and Roger Boyle, "Digital Image Processing and Computer Vision", Cengage Learning.
3. R.C. Gonzalez and R.E. Woods," Digital Image Processing", Pearson Education.

MULTI AGENT SYSTEMS

Course code : 15 CS 4174 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3107 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Characterize and contrast the standard agent architectures.	a	2
CO2	Create logical agents to do inference using first order logic.	c	2
CO3	Demonstrate using appropriate examples how multi-agent systems support agent interaction	a	2
CO4	Describe the primary paradigms used by learning agents.	c	2

SYLLABUS:

Intelligent Agents: Environments, Intelligent Agents, Agents and Objects, Agents and Expert Systems, Agents as Intentional Systems, Abstract Architectures for Intelligent Agents. Deductive Reasoning Agents: Agents as Theorem Provers, Agent-Oriented Programming, Concurrent MetateM.

Practical Reasoning Agents: Practical Reasoning Equals Deliberation Plus Means-Ends Reasoning, Means-Ends Reasoning, Implementing a Practical Reasoning Agent, The Procedural Reasoning System.

Reactive and Hybrid Agents: Reactive Agents, Hybrid Agents.

Understanding each other: Ontology fundamentals, Ontology Languages, RDF, Constructing an Ontology, Software Tools for Ontologies

Communication: Speech Acts, Agent Communication Languages.

Working Together: Cooperative Distributed Problem Solving, Task Sharing and Result Sharing, Result Sharing, Combining Task and Result Sharing, Handling Inconsistency, Coordination, Multiagent Planning and Synchronization

Methodologies: Appropriate Agent-Based Solution, Agent-Oriented Analysis and Design Techniques, Pitfalls of Agent Development, Mobile Agents.

Applications: Agents for Distributed Sensing, Agents for Information Retrieval and Management, Agents for Electronic Commerce, Agents for Human-Computer Interfaces, Agents for Virtual Environments, Agents for Social Simulation

Text Book:

1. Michael Wooldridge, "An Introduction to MultiAgent Systems", 2/e, John-Wiley & sons, (2009).

Reference Books:

1. Adelinde M. Uhrmacher, Danny Weyns, Multi-Agent Systems: Simulation and Applications, CRC Press, (2009).
2. Shoham, Kevin Leyton-Brown, "MultiAgent Systems - Algorithmic, Game-Theoretic, and Logical Foundations", Cambridge University Press, (2009).

3. Stuart Russell, Peter Norvig, "Artificial Intelligence -A Modern Approach", 2/e, Pearson, (2003).

4. Nils J Nilsson, "Artificial Intelligence: A New Synthesis", Morgan Kaufmann Publications, (2000).

GRAPHICS & VISUALIZATION

2D/3D GRAPHICS

Course code : 15 CS 3255 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2104 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Contrast forward and backward rendering	a	2
CO2	Construct CSG models from simple primitives, such as cubes and quadric surfaces.	a	2
CO3	Analyze affine and vector geometry	a	2
CO4	Understand Bezier and B-Spline Curves	a	2

SYLLABUS:

Two-Dimensional Computer Graphics: From Common Curves to Intricate Fractals Turtle Graphics , Fractals from Recursive Turtle Programs , Some Strange Properties of Fractal Curves, Affine Transformations , Affine Geometry: A Connect-the-Dots Approach to Two-Dimensional Computer Graphics , Fractals from Iterated Function Systems , Fixed-Point Theorem and Its Consequences, Recursive Turtle Programs and Conformal Iterated Function Systems, Mathematical Methods for Three-Dimensional Computer Graphics, Vector Geometry: A Coordinate-Free Approach Coordinate Algebra , Some Applications of Vector Geometry, Coordinate-Free Formulas for Affine and Projective Transformations, Matrix Representations for Affine and Projective Transformations, Projective Space versus the Universal Space of Mass-Points , Quaternions: Multiplication in the Space of Mass-Points, Three-Dimensional Computer Graphics: Realistic Rendering Color and Intensity, Recursive Ray Tracing , Surfaces I: The General Theory, Surfaces II: Simple Surfaces, Solid Modeling, Shading, Hidden Surface Algorithms , Geometric Modeling: Freedom Curves and Surfaces, Bezier Curves and Surfaces , Bezier Subdivision, Blossoming , B-Spline Curves and Surfaces , Knot Insertion Algorithms for B-Spline Curves and Surfaces, Subdivision Matrices and Iterated Function Systems , Subdivision Surfaces.

Text Book:

1. Ronald Goldman, Rice University, Houston, "An Integrated Introduction to Computer Graphics and Geometric Modeling"CRC Series, (2009).

Reference Books:

1. C. M. Hoffmann, "Geometric and Solid Modeling: An Introduction",(1989).

2. M. E. Mortenson, "Geometric Modeling. New York", Wiley, (1985).

MULTIMEDIA TECHNOLOGIES

Course code : 15 CS 4175 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3109 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Describe the media communications and supporting devices commonly associated with multimedia information and systems	a	2
CO2	Demonstrate the use of content-based information analysis in a multimedia information system.	a	2
CO3	Critique multimedia presentations in terms of their appropriate use of audio, video, graphics, color, and other information presentation concepts with Quality of Service In Network Multimedia Systems	a	2
CO4	Implement a multimedia application using an authoring system and Middleware for Multimedia	j	2

SYLLABUS:

Multimedia Communications: Human Communication model, evolution and Convergence, Technology Framework, standardization Framework, Frameworks For Multimedia standardization: standardization Activities, Standards to build a new global information infrastructure, standardization process on multimedia Communications, ITU-T Mediacom 2004 frame work for Multimedia Communications, ISO/IEC MPEGF-21 Multimedia Framework, IETF multimedia internet standard, industrial for a and consortia, Application layer: ITU Applications, MPEG Applications, Digital Broad Casting, Mobile Services and Applications, Universal Multimedia Access. Middleware Layer: Middleware for Multimedia, Media Coding, Media Streaming, Infrastructure for Multimedia content distribution. Middleware Technologies for multimedia networks. Network Layer: Network Aspects Of Standardization Projects, Network Functions, Network Traffic Analysis, Quality of Service In Network Multimedia Systems, Generic Networks, Access Broadband Networks, Core Broadband Networks, and Content Delivery Networks.

Text Books:

1. Kamisetty rao, Zoran Bojkovic, Dragorad Milovanovic, "Introduction To Multimedia Communications: applications, middleware networking", Wiley publisher, (2005).
2. Suzanne Weixel, Jennifer Fulton, Karl barksdale, "Multimedia BASICS, Course Technology",1st edition, (2003).

Reference Books:

1. Li, Z.-N. & drew, M.S, ,"Fundamentals Of Multimedia",prentice hall, (2004).
2. Berkeley,"The Non-Designer's Design Book", nd edition, CA: peachpit press, (2004).
3. Tanenbaum, R. S, W. H. Freeman ,"Theoretical Foundations Of Multimedia",

GAME GRAPHICS PROGRAMMING

Course code : 15 CS 4176 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3212 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Discuss the concepts of Game design and development.	c	2
CO2	Design the processes, and use mechanics for game development, Create interactive Games.	c	2
CO3	Explain the Core architectures of Game Programming.	a	2
CO4	Use Game programming platforms, frame works and engines	a	2

SYLLABUS:

Introduction to Game Development: History of Computer Games, Input Devices and User Interfaces, Commercial Game Systems, Software Tools and Technology, Modeling, Simulation, Graphics , Game Main Loop, Programming and Common APIs, Games and Society, Future of Games.Game Engines: 2D/3D Game engines and the underlying technologies, Development of game using game engines, Typical functionality provided by a game engine, Hardware abstraction and Middleware, Console programming. Mathematics & Geometry: Vectors, Matrices, Transformations, Homogeneous Coordinates, Triangle Mathematics, Intersection Issues, Fixed-point Real Numbers, Parametric Curves. Computer Graphics: Basic Graphics systems, 3D Viewing, Synthetic Camera, RGB Color Model, Basics of rendering, Rendering Transformations, Rendering Pipeline. Game Physics: Rigid body motion, Collision Detection and Resolution, Deformable bodies. Character Motion: Inverse Kinematics, Character Animation, Key framing, Principles of Traditional Animation Motion Capture, Motion Blending, Motion Retargeting.Terrain Modeling & Scene Management: Ground / Building / Static models / Dynamic models, Polygon mesh, Grids-2D, Quadtree, Height map, Procedural height map, Terrain Formats, Triangular mesh, Procedurally generated, Created by artists, Culling, Level of detail, Draw order, Off-screen rendering, Paging. Game Control System & AI: Search, Path Finding, Finite State Machines, Steering Behavior, Blind search, Heuristic search, A* search, Adversary search, Minmax search. Network Gaming: Multiplayer Games, Networking Models & Topologies, Topology: Client-Server vs. P2P, Computing Model: Distributed Object vs. Message Passing, Protocol: TCP vs. UDP, Socket-Level programming, Bandwidth / Latency tradeoffs. Current Issues: Consistency, Cheating in Games, Cheat Proofing, Massive Multiplayer Online Games (MMOGs).

Text Books:

1. Alan Watt and Fabio Policarpo ,"3D Games: Volume 1: Real-Time Rendering and Software Technology", Addison-Wesley.
2. Alan Watt and Fabio Policarpo ,"3D Games, Volume 2: Animation and Advanced Real-time Rendering", Addison-Wesley.
3. Alan Watt and Fabio Policarpo, A K Peters ,"Advanced Game Development with Programmable Graphics Hardware".
4. Mark DeLoura, "Game Programming Gems 1-6", Charles River Media.
5. Steve Rabin ,"AI Game Programming Wisdom 1-3", Charles River Media.

Reference Books:

1. Mike Mc Shaffrfy and David Graham, "Game Coding Complete", 4th Edition, Cengage Learning, PTR, (2012).
2. Jason Gregory, "Game Engine Architecture", CRC Press / A K Peters,(2009).

ANIMATION & VISUALIZATION

Course code : 15 CS 4177 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3212 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand interpolation & Describe several approaches to using a computer as a means for interacting with and processing data	a	2
CO2	Explain kinematic linkages and motion capture	a	2
CO3	Understand modeling and animating human figures	a	2
CO4	Apply facial animation, behavioral animation	j	2

SYLLABUS:

Introduction, technical background, interpolating values, interpolation- based animation, kinematic linkages, motion capture, physically based animation, fluids: liquids & gases, modeling and animating human figures, facial animation, behavioral animation and special models for animation. Data Foundations, Human Perception and Information Processing, Visualization Foundations, Visualization Techniques for Spatial Data, Visualization Techniques for Geospatial Data, Visualization Techniques for Multivariate Data, Visualization Techniques for Trees, Graphs, and Networks, Text and Document Visualization

Text Books:

1. R Parent, Morgan Kaufmann ,"Computer animation algorithms and techniques", 3rd edition, (2012).
2. Matthew O. Ward; Georges Grinstein; Daniel Keim ,"Interactive data visualization: foundations, techniques, applications"2nd edition, A K Peters/CRC Press, (2015).

Reference Books:

1. M. O'Rourke, W. W. Norton ,"Principles of three dimensional computer animation", 3rd edition, (2003)
2. Bill Ferster, "Interactive Visualization: Insight through Inquiry", MIT Press, (2013).
3. Zhigang Xiang, Roy A. Plostok, "Schaum's outline of computer graphics", 2nd edition, McGraw-Hill.

CROSS PLATFORM MOBILE DEVELOPMENT

Course code : 15 CS 4178 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 3109 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Design and implement a mobile application using OPENGL ES2.0,Phonegap HTML 5 and JS	a	2
CO2	Design and develop mobile apps, using Android as development platform, with key focus on user experience design, native data handling and background tasks and notifications.	c	2
CO3	Discuss the constraints that mobile platforms put on developers.	a	2
CO4	Discuss the performance vs. power tradeoff	c	2

SYLLABUS:

HTML5 and JS for iOS: HTML5, CSS3 and iOS Styling, JavaScript and APIs, Mobile Frameworks, Usability, Navigation, and Touch, GPS and Google Maps, Animation and Effects, Canvas, Audio and Video, Integrating with Native Services, Offline Apps and Storage, Mobile Testing.

Creating apps with android: Android User Interface, Designing Your User Interface Using Views, Displaying Pictures and Menus with Views, Data Persistence, Content Providers, Messaging and Networking, Location-Based Services, Developing Android Services, Publishing Android Applications.

OpenGL ES 2.0: Benefits of the API, Implementation Prerequisites, ES 2.0 Fundamentals, 3D Modeling, Texturing and Shading, Phonegap. MOBILE HCI- Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games-Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Text Books:

1. Scott Preston-,"Learn HTML5 and JavaScript for iOS_Web Standards-based Apps for iPhone, iPad, and iPod touch"-Apress (2012)
2. Wei-Meng Lee, "Beginning Android Application Development Wrox", Mar.(2011).

Reference Books:

1. Prateek Mehta,"Learn OpenGL ES_ For Mobile Game and Graphics Development"-Apress (2013)
2. Brian Fling, "Mobile Design and Development", First Edition , O'Reilly Media Inc., (2009)
3. Adrian Kosmaczewski-,"Mobile JavaScript Application Development_ Bringing Web Programming to Mobile Devices-"O'Reilly Media (2012).
4. Maximiliano Firtman-"Programming the Mobile Web",-O'Reilly Media (2013).

COMPUTATIONAL SCIENCE

MODELING AND SIMULATION FOR SCIENCES

Course code : 15 CS 3256 **L – T – P :** 3-0-0

Pre Requisite : 15 MT 2005 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand System dynamics models with interactions: competition, predator-prey models, spread of disease models	a	2
CO2	Apply Cellular automaton diffusion simulations: spreading of fire, formation of biofilms	e	2
CO3	Understand Monte Carlo simulations	a	2
CO4	Determine system dynamics projects throughout, such as modeling falling and skydiving, enzyme kinetics, the carbon cycle, economics and fishing	e	2

SYLLABUS:

Overview of Computational Science, The Modeling Process, System Dynamics Problems with Rate Proportional to Amount, Force and Motion, System Dynamics Models with Interactions, Simulation Techniques, Data-Driven Models, Simulating with Randomness, Cellular Automaton Diffusion Simulations, Agent-Based Models, Matrix Models, Monte Carlo Simulation

Text Books:

1. Angela B. Shiflet and George W. Shiflet," Introduction to Computational Science: Modeling and Simulation for The Sciences", 2nd Edition, Princetion University Press, (2014).

Reference Books:

1. John A. Sokolowski, Catherine M. Banks, "Modeling and simulation fundamentals: Theoretical Underpinnings and Practical Domains", Wiley, (2010).
2. Hans-Joachim Bungartz, Stefan Zimmer, Martin Buchholz, Dirk Pflüger, "Modeling and Simulation, An Application-Oriented Introduction", Springer, (2014).

SCIENTIFIC COMPUTING AND VISUALIZATION

Course code : 15 CS 4179 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 1001 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Determine the convergence region for a finite difference method and Solve PDE.	a	2
CO2	Solve nonlinear differential equations by numerical methods.	e	2
CO3	To use iterative methods to solve systems of non-linear equations	a	2
CO4	Understand volume Visualization, Optimization and Minimum Principles	a	2

SYLLABUS:

Computational Basics, Coordinate Systems, Background: Numerical Linear Algebra, Solving Linear Systems, Eigen-Problems, Background: Numerical Calculus, Data Fitting, Computing Dynamic Processes, Finding Roots, Computing with Multivariate Functions, Optimization and Minimum Principles, Visualizing Empirical Data, Facets, Visualizing Scalar Values over 2D Data, Volume Visualization, Background: Computer Graphics

Text Books:

1. Gerald Farin, Dianne Hansford, "Mathematical Principles for Scientific Computing and Visualization", A K Peters, Ltd., Wellesley
2. Gilbert Strang, "Computational science and Engineering", Cambridge Press, (2007).

Reference Books:

1. Owen Jones, Robert Maillardet, and Andrew Robinson, "IntroductIon to Scientific Programming and Simulation using r", Taylor & Francis Group, (2009).
2. G.D. Smith, "Numerical Solution of Partial Differential Equations", Oxford Univ. Press, (2004).

PARALLEL COMPUTING

Course code : 15 CS 4180 **L – T – P :** 3-0-0

Pre Requisite : 15 EM 2001 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Describe the levels of parallelism including task, data, and event parallelism	a	2
CO2	Understand Distributed Shared Memory Systems And Programming	a	2
CO3	Apply standard numerical algorithms to solve ODEs and PDEs. Use computing systems to solve systems of equations	e	2
CO4	Understand Mutex-Free Synchronization and The Transactional Memory Approach	a	2

SYLLABUS:

Parallel Computers, Message-Passing Computing, Embarrassingly Parallel Computations, Partitioning And Divide-And-Conquer Strategies, Pipelined Computations, Synchronous Computations, Load Balancing And Termination Detection, Programming With Shared Memory, Distributed Shared Memory Systems And Programming, Sorting Algorithms, Numerical Algorithms, Image Processing, Searching And Optimization, Lock-Based Synchronization, On the Foundations Side: The Atomicity Concept, Mutex-Free Synchronization, The Transactional Memory Approach, On the Foundations Side: From Safe Bits to Atomic Registers, On the Foundations Side: The Computability Power of Concurrent Objects (Consensus),

Text Books:

1. Barry Wilkinson," parallel programming", Pearson, (2004).
2. Michel Raynal, "Concurrent Programming: Algorithms, Principles, and Foundations", Springer, (2013).

Reference Books:

1. Fayez Gebali, "Algorithms and Parallel Computing", Wiley.
2. Sanguthevar Rajasekaran, John Reif,"Handbook of Parallel Computing: Models, Algorithms and Applications", Chapman & Hall/CRC.
3. Ananth Grama, Vipin Kumar,"Introduction to Parallel Computing", 2nd Edition, Addison Wesley

OPTIMIZATION AND GAME THEORY

Course code : 15 CS 4181 **L – T – P :** 3-0-0

Pre Requisite : 15 MT 2005 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Determine the optimum solution to constrained and unconstrained.	a	2
CO2	Determine average queue length and waiting times of queuing models.	a	2
CO3	Determine optimum solution to transportation problem Using PERT/CPM	a	2
CO4	Determine the integer solutions to Linear Programming Problems.	j	2

SYLLABUS:

Overview of the Operations Research Modeling Approach, Introduction to Linear Programming, The Simplex Method, Other Algorithms for Linear Programming, The Transportation and Assignment Problems, Network Optimization Models, Project Management with PERT/CPM, Dynamic Programming, Integer Programming, Nonlinear Programming, Game Theory, Decision Analysis, Markov Chains, Queueing Theory, The Application of Queueing Theory, Forecasting, Markov Decision Processes, Simulation.

Text Books:

1. Frederick S. Hillier, Gerald J. Lieberman, "Introduction to Operations Research", 9th Edition, Mc Graw Hill, (2014).
2. Hamdy A. Taha," Operations Research An Introduction", 8th Edition, Pearson (2007)

Reference Books:

1. Kanti Swarup, Man Mohan and P.K.Gupta, "Introduction to Operations Research", S.Chand & Co., (2006)
2. Wayne L. Winston, "Operations Research: Applications and Algorithms", 4th Edition, Cengage,(2004) H.A. Eiselt ,Carl-Louis Sandblom," Operations Research: A Model-Based Approach", 2nd Edition, Springer, (2012)

DISCRETE EVENT SIMULATION

Course code : 15 CS 4182 **L – T – P :** 3-0-0

Pre Requisite : 15 MT 2005 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Discrete-Event Simulation Framework for modeling and simulation to a range of problem areas	a	2
CO2	Understand Activity-Based Modeling and Simulation	a	2
CO3	Explain and give examples of the benefits of simulation and modeling in a range of important application areas	a	2
CO4	Understand event graph modeling for simulation	k	2

SYLLABUS:

Basics of Discrete-Event System Modeling and Simulation, Input Modeling for Simulation, Introduction to Event-Based Modeling and Simulation, Parameterized Event Graph Modeling and Simulation, Introduction to Activity-Based Modeling and Simulation, Simulation of ACD Models Using Arena, Output Analysis and Optimization, State-Based Modeling and Simulation, Advanced Topics in Activity-Based Modeling and Simulation, Advanced Event Graph Modeling for Integrated Fab Simulation, Concepts and Applications of Parallel Simulation, Honeypot Communities: A Case Study with the Discrete-Event Simulation Framework, Network Modeling, Designing and Implementing CASiNO: A Network Simulation Framework, Modeling Network Traffic

Text Books:

1. Byoung Kyu Choi, Donghun Kang, "Modeling and simulation of discrete-event systems", Wiley, (2013).
2. Mohsen Guizani¸ Ammar Rayes, Bilal Khan, Ala Al-Fuqaha, "Network modeling and simulation, a practical perspective", Wiley, (2010).

Reference Books:

1. George Fishman, "Discrete-Event Simulation: Modeling, Programming", and Analysis", springer
2. Lawrence M. Leemis, Stephen Keith Park,"Discrete-event Simulation: A First Course" , Pearson Prentice Hall,(2006).

DATA ANALYTICS

DATAWAREHOUSING AND MINING

Course code : 15 CS 3257 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2003 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand stages in building a Data Warehouse	a	2
CO2	Apply preprocessing techniques for data cleansing and Analyze multi-dimensional modeling techniques.	k	2
CO3	Analyze and evaluate performance of algorithms for Association Rules.	k	2
CO4	Analyze Classification, Outlier detection and Clustering algorithms	a,k	2

SYLLABUS:

Data Mining Functionalities-What Kinds of Patterns Can Be Mined, Getting to Know Your Data, Preprocessing, Data Warehousing and On-Line Analytical Processing, Data Cube Technology, Mining Frequent Patterns, Associations and Correlations: Concepts and Methods, Advanced Frequent Pattern Mining, Classification: Basic Concepts, Classification: Advanced Methods, Cluster Analysis: Basic Concepts and Methods, Advanced Cluster Analysis, Outlier Analysis, Trends and Research Frontiers in Data Mining

Text Books:

1. Jiawei Han and M Kamber, "Data Mining Concepts and techniques", Third Edition, Elsevier Publications, (2011).
2. P. N. Tan, M. Steinbach, V. Kumar ,"Introduction to Data Mining", Addison- Wesley (2005).

Reference Books:

1. Ian H.witten , Eibe frank , Mark.A.Hall , "Data Mining: Practical machine learning tools and techniques", 3rd edition, elsevier,(2011).
2. Daniel T .Larose ," Data mining methods and models", Wiley, (2006).

BIG DATA & OPTIMIZATION

Course code : 15 CS 4183 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2003 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand issues related to R Representation	a	2
CO2	Understand issues related to blind search.	e	2
CO3	Apply population based search and develop query processing strategies.	e	2
CO4	Understand applications like Travelling Salesman Problem	a	2

SYLLABUS:

Introduction: Motivation, Why R, Representation of a Solution , Evaluation Function , Constraints , Optimization Methods , Demonstrative Problems ,

R Basics: Introduction , Basic Objects and Functions , Controlling Execution and Writing Functions, Importing and Exporting Data, Additional Features ,

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

Text Books:

1. Paulo Cortez, "Modern Optimization with R " , Springer, (2014).
2. Nicholas J. Horton & Ken Klein man, " Using R and R Studio for Data Management, Statistical Analysis, and Graphics", Second Edition , CRC Press, (2015).

Reference Books:

1. Carlo Zaniolo, "Advanced database systems", Morgan Kaufmann, Elsevier, (1997).
2. Jan L. Harrington, "Relational Database Design", Morgan Kaufmann, Elsevier, (2009).

ADVANCED DATABASES

Course code : 15 CS 4184 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2003 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand issues related to object relational , multimedia database design	a	2
CO2	Understand issues related to Distributed database Design.	a	2
CO3	Apply Partitioning techniques to databases, Design and develop query processing strategies.	k	2
CO4	Understand transaction processing and concurrency control in distributed databases.	a	2

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, Query Processing and optimization in distributed database design ,Overview of Transaction Management in distributed database, Overview Of Concurrency Control and Recovery in distributed database design. Object Oriented database systems: Object DBMSs, Weakness of RDBMSs,Object Oriented Concepts, Storing Objects in a Relational Database, Advantages and disadvantages of OODBMSs.Object Oriented DBMSs-Standards and Systems: Object Management Group, Object Data Standard ODMG 3.0,Object Store. Object Relational DBMSs:, Query Processing and Optimization, New Index Types, Object Oriented Extension in Oracle, Comparision of ORDBMS and OODBMS. Multimedia Databases: Multimedia databases, Multimedia Data, SQL and Multimedia-Manipulating Large objects, Querying Multimedia-Introduction, Manipulating Multimedia data. Multimedia modeling data Multimedia Database Architecture and performance. Dealing with Multimedia text, image, video.

Text Books:

1. Ramez Elmasri, Shamkanth B.Navathe, "Fundamentals of Database Systems", 5th Edition Pearson, (2007).
2. Thomas Connolly, Carolyn Begg "Database Systems", 4th Edition, Pearson, (2012).
3. Dunckley Lynne, "Multimedia Databases: An Object Relational Approach", 1st Edition, Pearson Education, (2009).

Reference Books:

1. M.Tamer Ozsu,Patrick Ualduriel, "Principles of Distributed Database Systems", 3rd Edition, Pearson Education ,(2009).

2. David Taniar, Clement H. C. Leung, Wenny Rahayu, Sushant Goel,,"High Performance Parallel Database Processing and Grid Databases", Wiley Edition

3. Carlo Zaniolo, "Advanced database systems", Morgan Kaufmann, Elsevier, (1997).

4. Jan L. Harrington, "Relational Database Design", Morgan Kaufmann, Elsevier, (2009).

INFORMATION VISUALIZATION & GRAPH ANALYTICS

Course code : 15 CS 4185 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2003 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand Geographic Visualization	a	2
CO2	Apply Extracting Salient Structures for data cleansing	e	2
CO3	Analyze and evaluate Stats and Layout	a	2
CO4	Analyze Point-and-Click: Graph Tools like NodeXL, Gephi, Cytoscape	e	2

SYLLABUS:

Introduction: A Road Map for Information Visualization, Geographic Visualization, Abstract Information Visualization, Optimal Information Foraging, Exploring Cyberspaces, Social Interaction in Online Communities, Information Visualization Resources

Extracting Salient Structures: Proximity and Connectivity ,Clustering and Classification ,Virtual Structures ,Complex Network Theory ,Structural Analysis and Modelling ,Generalized Similarity Analysis ,

Why Graphs?: Visualization in Business, Graphs in Business, Finding Anomalies, Managing Networks and Supply Chains, Identifying Risk Patterns, Optimizing Asset Mix, Mapping Social Hierarchies, Detecting Communities, Graphs Today

A Graph for Every Problem: Relationships, Hierarchies, communities, Flows, Spatial Networks

Stats and Layout: Basic Graph Statistics, Lay Outs,

Visual Attributes: Essential Visual Attributes, Key Node Attributes, Key Edge Attributes, Combining Basic Attributes, Bundles, Shapes, Images and More.

Explore & Explain: Explore, Explain and Export, Essential Exploratory Interactions, Explain, Point-and-Click: Graph Tools: Excel, NodeXL, Gephi, Cytoscape, yEd,

Visual Analysis of Graphs: Relationships, Hierarchies, Communities.

Text Books:

1. Robert Spence, "Information Visualization: An Introduction", Third Edition, Springer, (2014).

2. Richard Brath & David Jonker, "Graph Analysis & Visualization: Discovering Business Opportunities in Linked Data ", John Wiley & Sons, Inc, (2015).

Reference Books:

1. Chaomei Chen "Information Visualization: Beyond the Horizon", Second Edition, Springer, (2006).

DATA SCIENCE & BIG DATA ANALYTICS

Course code : 15 CS 4186 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2003 **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand big data challenges in different domains including social media, transportation, finance and medicine	a	2
CO2	Analyze scalability and performance of relational model, SQL and emergent systems. Apply the statistical analysis methods.	k	2
CO3	Comprehend machine learning and algorithms for data analytics.	a	2
CO4	Analyze Map-Reduce programming model for better optimization	k	2

SYLLABUS:

Introduction to Big Data Analytics

Big Data Overview, State of the Practice of Analytics, Big Data Analytics in Industry Verticals. It also covers Overview of Data Analytics Lifecycle, Discovery ,Data Preparation, Model Planning, Model Building, Communicating Results and Findings, Operationalizing.

Using R for Initial Analysis of the Data-Introduction to Using R Initial Exploration and Analysis of the Data Using R Basic Data Visualization Using R. Use the R package as a tool to perform basic data analytics, reporting, and apply basic data visualization techniques to your data. Apply basic analytics methods such as distributions, statistical tests and summary operations, and differentiate between results that are statistically sound vs. statistically significant. Identify a model for your data and define the null and alternative hypothesis

Advanced Analytics and Statistical Modeling for Big Data – Theory and Methods-analytic needs and select an appropriate technique based on business objectives; initial hypotheses; and the data's structure and volume. Apply some of the more commonly used methods in Analytics solutions Explain the algorithms and the technical foundations for the commonly used methods. Explain the environment (use case) in which each technique can provide the most value. Use appropriate diagnostic methods to validate the models created Use R and in-database analytical functions to fit, score and evaluate models Advanced Analytics and Statistical Modeling for Big Data – Technology & Tools -tools to Perform Analytics on Unstructured data using MapReduce Programming paradigm. Use Hadoop, HDFS, HIVE,PIG and other products in the Hadoop ecosystem for unstructured data analytics Effectively use advanced SQL functions and Greenplum extensions for in-database analytics. Use MADlib to solve analytics problems in-database Operationalizing an Analytics Project- Articulate three tasks needed to operationalize an analytics project. Explain how the four common deliverables of an analytics lifecycle project meet the needs of key stakeholders. Use a framework for creating final presentations for sponsors and analysts. Evaluate a data visualization and identify ways to improve it

Text Books:

1. Datawarehousing in the age of BIG Data by Krishnan, Morgan Kaufmann
2. A.Ohri ,"R for Business Analytics",springer,(2012).

Reference Books:

1. Nicholas J. Horton & Ken Kleinman, "Using R and RStudio for Data Management, Statistical Analysis, and Graphics", CRC Press, (2015)
2. Bill Franks, "Taming The Big Data Tidal Wave", 1st Edition, Wiley, (2012).
3. Frank J. Ohlhorst," Big Data Analytics",1st Edition, Wiley, (2012).
4. Donald Miner ,"MapReduce Design Patterns"O'Reilly, (2012).

DEPARTMENT OF CIVIL ENGINEERING

STRUCTURAL ANALYSIS

Course code : 15 CE 2104 **L T P :** 3-2-0

Pre Requisite : 15 CE 1201 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Find the deformation using energy theorems i.e. castigliano's theorems, Betti's theorem and maxwell's reciprocal theorem.	e	2
CO2	Students will be able to estimate the deflection of beams by various methods such as deflection curves, moment area method, conjugate beam method and unit load method	k	2
CO3	Able to analysis proper cantilevers and fixed beams for any type of landing using consistent deformation method and also can analysis conjugate beam by Clapereyon's theorem of Three moments	k	2
CO 4	Student will be able to analyze beams and frams for any type of loading using slope deflection method and moment deflection methods	k	2

SYLLABUS:

Energy Theorems: Principle of superposition, Maxwell's reciprocal theorem, Betti's theorem, Principles of virtual work, Application of virtual work, Castigliano's theorems, Applications of castigliano's theorem.

Deflection: Relation between curvature, slope and deflection, Deflection curves, Deflection by moment area method, Deflection by conjugate beam method, unit load method.

Propped Cantilevers and Fixed Beams: Analysis of propped cantilevers with point load, partially loaded u.d.l and uniformly varying load, fixed beam with point load, udl, Unsymmetrical concentrated load and varying load,

Analysis of Continuous beams: Clapereyon's theorem of Three moments, analysis of beam with constant EI for all span, varying EI for different span, sinking of supports.

Analysis of Structure by Slope Deflection Method: Difference between force method and displacement method. Advantage of displacement method. Analysis of indeterminate beams, Beams with uneven support settlement, rigid frames by slope deflection method.

Analysis of Structure by Moment Distribution Method: Advantage of moment distribution method, stiffness, carry over and distribution factor, analysis of indeterminate beams and rigid frames, uneven settlement of support for beam and rigid frame by moment distribution method.

Text Books:

1. C. K. Wang, Intermediate Structural Analysis McGraw Hill Book Company, 2010

Reference Books:

1. C S Reddy, Basic Structural Analysis Tata McGraw Hill publishing Company ltd. Delhi. 2nd edition 2010.
2. T.S Thandavamoorthy, Structural Analysis Oxford University Press, New Delhi, First edition, 2011.
3. M L Gambhir, Fundamentals of Structural Mechanics and Analysis PHI learning private limited, New Delhi, 2011.

SURVEYING

Course code : 15 CE 2105 | **L T P :** 3-0-2

Pre Requisite : NIL | **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand basic concepts of surveying	a	1
CO 2	Understand how to operate instruments required for surveying	k	2
CO 3	Applying the surveying equipments required based on the functionality and nature of work	k	2
CO 4	Apply field data to prepare a plan required for a given civil engineering project	k	2
CO 5	Able to perform field experiments and analyse the data making use of equipments	b	2

SYLLABUS:

Surveying Introduction - Overview of plane surveying (chain, compass and plane table), Objectives, Principles and classifications.

Distances and Direction - Distance measurement conventions and methods; use of chain and tape, Electronic distance measurements, Meridians, Azimuths and Bearings, declination, computation of angle.

Leveling and Contouring - Concept and Terminology, Temporary and permanent adjustments- method of leveling. Characteristics and Uses of contours- methods of conducting contour surveys and their plotting.

Computation of Areas and Volumes - Area from field notes, computation of areas along irregular boundaries and area consisting of regular boundaries. Embankments and cutting for a level section and two level sections with and without transverse slopes, determination of the capacity of reservoir, volume of barrow pits.

Theodolite - Theodolite, description, uses and adjustments - temporary and permanent, measurement of horizontal and vertical angles. Principles of Electronic Theodolite, Trigonometrical leveling,Traversing.

Tachometric Surveying - Stadia and tangential methods of Tacheometry. Distance and Elevation formulae for Staff vertical position.

Curves - Types of curves, design and setting out simple curves. Introduction to geodetic surveying

Total Station: Introduction Accessories with description - Features of total station Onboard software electronic data reading - Summary of total stations characteristics - Field procedure of total stations in topographic survey, Global positioning system, Introduction to Geographic information system (GIS).

Text Books:

1. R.Subramanian, Surveying and Levelling Oxford University Press, 2nd edition, 2012
2. Dr. B.C . Punmia Surveying Vol - I, II, III Laxmi publications, Delhi-6

Reference Books:

1. Kanetkar.T.P. & S.V.Kulkarni, Puna vidyarthi girha, Prakashan Surveying and levelling part I & II, 23rd edition,1993.
2. Arora K. R, "Surveying Vol-I", Rajsons Publications Pvt. Ltd, 10th Edition, 20

BUILDING PLANNING AND CONSTRUCTION

Course code : 15 CE 2207 **L T P :** 3-0-2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the concept of building planning and the building bye laws and the regulations	c	2
CO2	Understand the stages involved in building planning	k	2
CO3	Understand different techniques Of construction viz., Brick Masonry and stone Masonry	k	2
CO 4	Understand the different types of floors, roofs, doors, stairs and its use, know about the supporting structures and building amenities.	k	2
CO5	Able to draw Plan, section & elevation for given line plan of buildings using Auto cad	b	2

SYLLABUS:

Building Planning: Introduction to Buildings, Classification of Buildings, National Building Code Building Planning: Selection of Site, Orientation, Ventilation, Furniture requirements, Roominess, Sanitation, Lighting, Space for equipment for air–conditioning, Space for machinery etc.; Aspect and prospect, Privacy, Elegance and economy; Climatic considerations; Materials selection, Wall thickness and Scales.

Building Bye–Laws & Regulations: Objectives of Building Bye–Laws, Building regulations; Calculation of Plinth Area (PA), floor area and carpet area; Floor Area Ratio (FAR), Floor Space Index (FSI), Height of Buildings as per local code book.

Masonry: Masonry, Stone Masonry, Rubble and Ashlar Masonry, Brick Masonry, Bond, Types of bonds, English and Flemish bond, Composite masonry, Stone masonry, Concrete Masonry, Reinforced masonry, Types of walls, Types of Partition walls.

Floors and roofs: Floors, Types of floor, Details of concrete and Terrazzo floors, Roofs, Types of Roofs, Flat roofs, Sloping roofs, Shell Roofs, Roof coverings, AC sheets, GI sheets, Lintels, Classification of lintels, Arches, Classification of arches, Types of weathering courses, Damp proofing, Methods of damp proofing.

Stairs and supporting structure: Staircase, Types of staircase, Types of doors and windows, Wooden and metallic door frames, Ventilators, Fixtures and fastening for doors and windows, Shoring, Types, Underpinning, Types, Scaffolding, Components, Types, Form work, From work for columns, beam, stairs, walls.

Building amenities: Thermal insulation, Heat transference, Insulating material, Method of application, Ventilation, Requirements, Types of ventilation, Air conditioning, Fire proof Construction methods, Fire alarms, Principles of acoustical design of building, Sound insulation-materials and methods.

Text Books:

1. Dr. N. Kumara Swamy, A. Kameswara Rao, Building planning and drawing Charotar Publishing House, 7th Edition,2013.
2. P C Varghese, Building construction Prentice hall of India (P) Ltd, New Delhi, 2007.

Reference Books:

1. MG Shah, Building Drawing Tata McGraw-Hill, New Delhi,2006.
2. B. C Punmia, Building construction Laxmi Publications, New Delhi.

ENVIRONMENTAL ENGINEERING

Course code : 15 CE 2208 **L T P :** 3-0-2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand various aspects related to water supply process and water quality	b	2
CO 2	Design and analyze water treatment system	k	2
CO 3	Assess Sewage quantity and design of sewerage system	k	2
CO 4	Design and analyze of sewage treatment process, Learn the impacts of air pollution its control techniques and disposal of solid wastes	k	2
CO 5	Able to perform and estimate water quality parameters	b	2

SYLLABUS:

Introduction to water supply: Necessity of protected water supply. Role of Civil Engineer. Water demand, per capita consumption and factors affecting. Effect of variations of water demand on design of different components of water supply schemes. Design period population forecasting. Sources of water - quality parameters and their significance. Drinking water quality standards in India. Intake structures.

Water treatment: Types and origin of impurities, Need for water treatment. Purpose, principles of operation and design considerations of plain sedimentation, sedimentation with coagulation, slow, rapid sand and pressure filters. Chlorination, Ozonization, and UV radiation. Special treatment processes for color, odor, taste and hardness removal from water.

Introduction to sewerage system: Sewerage systems, Quantity estimation, Velocity in sewers, Storm water sewers- Strom water estimation by rational method. Sewerage system design, Sewage conveyance- Sewer types and appurtenances. Objectives and extent of wastewater treatment, Quality parameters physical, chemical and microbial. Standards of discharge of effluents on surface waters, sewers and for agricultural use.

Sewage treatment: Purpose, principle and design considerations of Preliminary treatment. Screens, grit chambers; Primary treatment- Sedimentation rectangular and circular tanks; Secondary treatment- Activated sludge process, Trickling filter and Secondary clarifiers. Septic tanks - design parameters and working principles. Sludge digestion and sludge dewatering beds.

Air pollution & solid waste management: Air Pollution-Types, Impacts on environment, and Principles of control techniques. Solid Wastes-Types, sources and composition of solid wastes, Methods of collection, Transportation and disposal methods; Landfills, composting, incineration, pyrolysis, gasification

Text Books:

1. Met Calf & Eddy, Wastewater Engineering Treatment, Disposal & Reuse Tata McGraw Hill publishing Co. Ltd., New Delhi.
2. S. K. Garg, Environmental Engineering (Vol I), Water Supply Engineering, Khanna

Publishers, New Delhi, Twelfth Revised Edition, 2010

Reference Books:

1. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering Mc Graw-Hill International Editions, New York
2. Mark. J Hammer and Mark. J Hammer, Water and Waste water Technology, Eastern Economy Edition, PHI-Learning, New Delhi (2008)
3. Davis Cornvel, Environmental Engineering McGraw Hill Book Co., New York. (2000)
4. G.M. Fair, J.C. Geyer, and Okun, Water and waste water Engineering John Wiley & Sons, New York (1998)
5. M.N Rao and A.K Dutta, Waste water Engineering Oxford & IBH Publishing Co. Ltd. (2000)
6. S. K. Garg, Environmental Engineering (Vol II), Sewage Disposal and Air Pollution Engineering Khanna Publishers, New Delhi, Twenty-second Revised Edition, 2010

HYDRAULICS AND HYDRAULIC MACHINES

Course code : 15 CE 2209 **L T P :** 3-0-2

Pre Requisite : 15 CE 2102 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To understand open channel flow through Chezy's, Kutter's and Manning's formula, design economical channel sections, Rapidly Varied Flow and applications.	b	2
CO2	To understand the mechanics of impact of jet on various types of vanes.	k	2
CO3	To understand the components, function and uses of Pelton turbine , Francis turbine and Kaplan turbine.	k	2
CO 4	To performance of hydraulic design of turbines and pumps(C.P and R.P), To know various hydraulic aspects of components function and uses of Centrifugal Pumps and Reciprocating Pumps.	k	2
CO5	Able to perform and caluculate efficiencies of hydraulic machines	b	2

SYLLABUS:

Open Channel Flow: Definition, classification, and Comparison between open channel flow and pipe flow, Types of channels, Chezy's and Manning's equation ,Flow through rectangular, Trapezoidal and Circular channels Most efficient channel section -Rectangular, Trapezoidal. Specific energy, Specific energy diagram, Critical flow, critical flow in rectangular channel,criticalslope, Froude's number Channel transitions.

Gradually Varied Flow (GVF): Gradually varied flow in rectangular channels-equation, Water surface slope w.r.t. channel bed and horizontal, Classification of channel slopes, classification of surface profiles, Backwater and draw down curves.

Rapidly Varied Flow (RVF): Hydraulic jump, elements and characteristics of hydraulic jump, Types of hydraulic jump, Location and applications of hydraulic jump, Energy loss in a hydraulic jump.

Impact of Jets: Force exerted by the jet on a stationary plate vertical, inclined and curved, Force exerted by a jet on a hinged plate on moving plates, force exerted by jet on flat plates and series of vanes.

Turbines: Introduction, classification of turbines, pelton wheel, velocity triangles and work done on Pelton wheel, Design of Pelton wheel.

Reaction Turbines Radial flow reaction turbine, Velocity triangles and work done by water on runner, Francis turbine, Design of Francis turbine, Axial flow reaction turbine Kaplan turbine, head and efficiency, Draft tube types, draft tube theory, efficiency of draft tube, Specific speed, Unit quantities, Selection of turbines, Cavitation.

Centrifugal Pumps: Manometric head; losses and efficiencies; work done, working principle; priming; velocity triangles; performance and characteristics curves; multistage and double suction pumps, Cavitation effects.

Reciprocating Pumps: Classification of reciprocating pump, working principle, Discharge through reciprocating pump, Negative slip Discharge, work done and power required to drive double acting pump.

Text Books:

1. P. N. Modi & S. N. Seth; Hydraulics & Fluid Mechanics Standard Book house, New Delhi
2. A. K. Jain; Fluid Mechanics Khanna Publishers, Delhi

Reference Books:

1. V. T. Chow, Open Channel flow Mc.Graw Hill book company
2. Subramanya K,"Flow in Open channels", Tata McGraw-Hill Publishing Company,1994.
3. Robert W.Fox and Alan T. Mc Donald, "Introduction to Fluid Mechanics" 4th Edition, John Willey & sons, New York, 1995
4. Jagadhishlal; Hydraulic Machines Metropoliton Company, Delhi

SOIL MECHANICS

Course code : 15 CE 2210 **L T P :** 3-0-2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand origin, index & engineering properties of soil	b	3
CO2	Classify the soil according to I.S. guidelines and to know the stresses in soil	e	2
CO3	Analyze stresses developed at various points below the ground surface using various methods and Analyze important engineering property of soil such as permeability	k	2
CO 4	Analyze important engineering properties of soil such as compaction, compressibility and consolidation of soil, Analyze important engineering property of soil such as shear strength of soil	k	2
CO5	Able to perform and estimate the soil quality parameters	b	2

SYLLABUS:

Origin of Soils: Soil Origin, rock cycle. Phase Relations: Weight Relationships, Volume Relationships, Density and Unit Weight Relationships, Inter-relationships. Soil Classification: coarse grained soils, fine grained soils. IS soil classification

Compaction: variables in compaction, laboratory tests, field compaction, specification and control. Effective Stress: Effective stress Principle, effective stress, pore water pressure, and total stress variation with depth, vertical normal stress due to overburden, capillary effects in soils.

Permeability: Bernoulli's Equation, Darcy's law, Laboratory and field measurement of permeability, factors affecting permeability. Stress in soils due to flow, Seepage Force, Downward Flow, Upward Flow, Quick Condition.Vertical stresses beneath the loaded areas: stresses due to point load, stresses due to line load, stresses under the corner of rectangular load, 2:1 distribution method.

Compressibility: Compressibility as a function of effective stress, soil type, stress history; normally consolidated and over consolidated clay.Consolidation: Terzaghi's One-Dimensional Consolidation theory, consolidation test, Consolidation Settlement, Determining Coefficients of compressibility and consolidation, limitations in predicting consolidation behavior, amount of consolidation, time for consolidation, secondary compression.

Shear Strength: Mohr's Circle, Mohr Coulomb failure criterion, Mohr circles and failure envelopes interms of effective and total stresses. Drained and undrained loading tests, direct shear test, traixial test, skempton pore water pressure parameters. Field vane shear test

Text Books:

1. N Sivakugan And Braga M Das, Geotechnical Engineering: A practical problem solving approach Eureka series, J. Ross publishing, 2009.

Reference Books:

1. Gopal Ranjan and ASR Rao, Basic and Applied Soil Mechanics New Age International Publishers, Second Edition, 2007.
2. V. N. S. Murthy, Soil Mechanics and Foundation Engineering CBS Publishers & Distributors, New Delhi.
3. Donald P. Coduto, Man-Chu Ronald Yeung and William A.Kitch, Geotechnical Engineering Principles and Practices PHI Learning Pvt. Ltd., Second Edition.

FOUNDATION ENGINEERING

Course code : 15 CE 3111 **L T P :** 3-2-0

Pre Requisite : 15 CE 2210 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Carry out geotechnical field investigation and can prepare field reports and Thoroughly understand different geotechnical investigation methodologies and can handle individually	b	3
CO2	Can compute stress distribution using different techniques and can carry settlement analysis in different soil types	e	2
CO3	Compute bearing capacity of shallow and deep foundations in laboratory and field using different methods	k	2
CO 4	Can analyze stability of slopes for finite and infinite in different soil conditions and methods, Carry earth pressure analysis and can design retaining walls	e	2

SYLLABUS:

Site Investigations: Various geotechnical field investigations, geotechnical field report.

Bearing Capacity Of Shallow Foundations: Introduction, Basic definitions, Principal modes of soil failures, Terzaghi's bearing capacity theory/ equation and its modifications for square, rectangular and circular foundation, Skempton's bearing capacity analysis for clays, Meyerhof's analysis, Hansen's bearing capacity theory, Vesic's bearing capacity theory, IS code recommendations for bearing capacity, Bearing capacity of granular soils based on SPT value and Static cone resistance, Bearing capacity of footings on layered soils, Factors influencing bearing capacity, Allowable bearing pressure. General requirements of foundations, Factors affecting location and depth of foundation, Choice of type of foundations, Steps involved in the proportioning of footings.

Pile Foundations: Use of piles, Types of piles, Construction, Selection of pile type, Types of foundations to suit subsoil conditions, Pile load capacity, Static formulae, Dynamic formulae, Load tests, on piles, Group action of piles, Load carrying capacity of pile groups, Negative skin friction, Piles subjected to uplift loads.

Well Foundations: Types of wells and caissons, components of well foundation, shapes of wells, depth of a well foundation, forces acting on a well foundation, lateral stability of well foundation, construction and sinking of a well.

Settlement Analysis: Consolidation settlement, Immediate settlement, Corrections to settlement due to consolidation, Settlement in different soil types/Settlement from field tests, Allowable settlement, Settlement of pile group.

Stability of Slopes: Infinite slopes and translational slides, Definitions of factor of safety, Finite slopes-Forms of slip surface, Limiting equilibrium method and Critical stages in stability, Total stress and effective stress methods of analysis, $\phi u = 0$ Analysis (total analysis), c ϕ analysis - method of slices, Location of the most critical circle, Friction circle method, Taylor's stability number.

Earth Pressure and Retaining Walls: Effect of wall movement on earth pressure, Earth pressure at rest, Rankine's theory of earth pressure, Coulomb's theory of earth pressure, Coulomb's equation for c = 0 back fills, Cullman's graphical method, Passive earth pressures-Friction circle method, Design considerations retaining walls.

Text Books:

by Gopal Ranjan and ASR Rao, Basic and Applied Soil Mechanics New Age International Publishers, Second Edition, 2007.

Reference Books:

1. J.E. Bowles, Foundation Analysis and Design MacGraw Hill, 1996.
2. V. N. S. Murthy, Soil Mechanics and Foundation Engineering CBS Publishers & Distributors, New Delhi.
3. Donald P. Coduto, Man-Chu Ronald Yeung and William A.Kitch, Geotechnical Engineering Principles and Practices PHI Learning Pvt. Ltd., Second Edition.
4. W. C. Teng, Foundation Design Prentice hall.

DESIGN OF REINFORCED CONCRETE STRUCTURES

Course code : 15 CE 3112 **L T P :** 3-0-2

Pre Requisite : 15CE2206, 15CE2104 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Design RC beams subjected to bending using Working Stress Method.	c	3
CO2	Explain the concept of Limit State Design and apply it to beams	k	2
CO3	Apply Limit state design for flanged sections subjected to shear, torsion and concept of bond	k	2
CO 4	Design one-way, two-way and continuous slabs, Design columns and isolated footings subjected to axial load, uni-axial and bi-axial bending	c	3
CO5	Able to show the reinforcement details of RCC elements using the required software	b	2

SYLLABUS:

Introduction to working stress method: Introduction, Design for bending, Analysis and design of singly reinforced and doubly reinforced beams.

Introduction to limit state design: Concepts of limit state design, Characteristic loads, Characteristic strength, Partial loads and Material Safety factors, Representative stress, Strain curves, Assumptions in limit state design, Stress block parameters, Limiting moment of resistance.

Singly and doubly reinforced beams: Limit state analysis and design of singly reinforced, doubly reinforced beams. Flanged sections: Limit state design of T and L beam sections.

Shear, torsion and bond: Limit state analysis and design of sections for shear and torsion, Concept of bond, anchorage and development length, I.S Code provisions. Design examples in simply supported beams.

Slabs: Design of one way slabs, Two way slabs, Continuous slabs using IS coefficients. Columns: Short and long columns Uni axial loads Uni - axial bending and bi-axial bending I.S code provisions.

Footings: Different types of footings–Design of isolated, square, rectangular and circular footings.

Text Books:

1. Pillai & Devdas Menon, "Reinforced concrete design", 3rd Edition, Tata McGraw Hill, New Delhi, 2009.
2. A.K.Jain, "Reinforced Concrete Design", 5th edition, Charotor Publications, 2010.
3. M. L. Gambhir, "Design of Reinforced Concrete Structures" 6th Edition, PHI, Delhi, 2013.

Reference Books:

1. N.C. Sinha and S.K Roy, "Fundamentals of Reinforced Concrete", 4th Edition, S. Chand publishers, 2002
2. N. Krishna Raju and R.N. Pranesh, "Reinforced Concrete Design", 8th Edition, New age International Publishers, New Delhi, 2004.

DESIGN OF STEEL STRUCTURES

Course code : 15 CE 3113 **L T P :** 3-2-0

Pre Requisite : 15CE2206, 15CE2209 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Analyse and design bolted and welded connections	c	2
CO 2	Design single and compound beams as per IS code	k	3
CO 3	Design simple and built-up columns as per IS code	k	3
CO 4	Design column base systems as per IS code, Calculate wind forces and design roof trusses	k	3

SYLLABUS:

Welded and bolted connections: Introduction, Advantages and disadvantages of welding-Strength of welds-Butt and Fillet welds: Permissible stresses IS Code requirements. Design of

Butt weld and fillet weld subjected to moment acting in the plane and at right angles to the plane of the joints.

Beams: Introduction to plastic analysis, Design requirements as per IS CodeDesign of simple and compound beams-Curtailment of flange plates, check for deflection, shear, buckling and bearing, for laterally supported and unsupported beams.

Tension members: General design of members subjected to direct tension.

Compression members: Effective length of columns, Slenderness ratio permissible stresses, Design of compression members, Struts etc. BUILT UP COLUMNS: Design of built up compression members Design of lacings and battens. Design Principles of eccentrically loaded columns and splicing of columns.

Design of column bases: Design of slab base and gusset base. Column bases subjected to moment.

Roof trusses: Different types of trusses Design loads Load combinations, IS Code 800-2007 recommendations, structural details Design of simple roof trusses involving the design of purlins

IS Codes:

1. IS -800 2007, "Codes of Practice for General Construction in Steel", BIS, 2007
2. IS 875 Part III, "Codes of Practice for Design Loads" (other than Earthquake, for Buildings and Structures), 1987.
3. Steel Tables.

Text Books:

1. Bhavikatti, "Design of Steel Structures", 6th Edition, University Press. Hyderabad, 2010.
2. S.K. Duggal, "Limit state design of steel structures", 1st Edition, TMH publication, 2011
3. N.Subramaniyan, "Design of Steel structures", 1st Edition, Oxford university press, 2008.

Reference Books:

1. B.C. Punmia, "Comprehensive Design of Steel structures", 10th Edition, Ashok Kumar Jain and Arun Kumar Jain, Laxmi Publications, New Delhi, 2007.
2. P. Dayaratnam, "Design of Steel Structures", 2nd Edition, S. Chand Publishers, 2009.
3. Prof. Dr. V.L. Shah, Prof. Veena Gore, "Limit State Design of Steel Structures", 1st Edition, Structures Publications, 2009.

ADVANCED STRUCTURAL ANALYSIS

Course code : 15CE3114 **L T P :** 3-0-2

Pre Requisite : 15CE2104 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Students will be able to draw influence line diagrams for determinate structure and able to estimate maximum bending moment and absolute maximum bending moment.	e	2
CO2	Students will be able to analysis cable structure and three hinged arches.	k	2
CO3	Students will be able to carry plastic analysis of structures	k	2
CO 4	Analyze beams and frames using matrix methods of analyze such as force method and displacement method	k	2
CO5	Able to perform the analysis of structures using the required softwares	b	2

SYLLABUS:

I.L.D for Determinate Structures: Influence line for reactions, simply supported, over hang, I L D for shear force in cantilever, simply supported, I L D for B. M cantilever, over hang and simply supported beams, position and magnitude of maximum shear force and B.M for concentrated load and udl, series of concentrated loads, absolute maximum S.F and B.M.

Analysis of Structure by Flexibility Matrix Method: Concept of flexibility coefficients, analysis of truss, indeterminate beams and rigid frames by this method (up to 2 DOF)

Analysis of Structure by Stiffness Matrix Method Concept of degrees of freedom, degree of indeterminacy and stiffness coefficients, analysis of truss, indeterminate beams and rigid frames by this method (up to 2 DOF)

Analysis of Cable and Three Hinged Structures: Solution method for cable structure, analysis of three hinged arch,

Plastic Analysis 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

Text Books:

1.C S Reddy, Basic Structural Analysis Tata McGraw Hill publishing Company ltd. Delhi. 2nd edition 2010

Reference Books:

1. C. K. Wang, Intermediate Structural Analysis McGraw Hill Book Company, 2010
2. Pandit & Gupta, Structural analysis, A Matrix Approach Tata McGraw Hill publishing Company ltd. New Delhi.2008
3. T.S Thandavamoorthy, Structural Analysis Oxford University Press, New Delhi, First edition, 2011.
4. M L Gambhir, Fundamentals of Structural Mechanics and Analysis PHI learning private limited, New Delhi, 2011.

TRANSPORTATION ENGINEERING

Course code : 15 CE 3115 **L T P :** 3-0-2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Know Versatile with history - current trends of transportation and Carry engineering surveys and can decide the alignment	b	2
CO2	Analyze and design highway geometric elements	h	2
CO3	Analyze and design of flexible, rigid pavements, Pavement Drainage	h	2
CO4	Handle pavement construction activities and also conduct quality control at site and Evaluate pavement condition and can identify and suggest remedial measures, Understand traffic Rules, Analyze and design of traffic infrastructure	h	2
CO5	Able to perform the experiments on highway materials and analyse the data	b	2

SYLLABUS:

Transportation Development and Planning: Importance of Transportation Engineering, Classification of Transportation Studies Modal, Elemental & Functional Classification. Historical Development of Road Construction, Highway Development in India.

Highway Alignment -Factors governing alignment; Engineering surveys.

Highway Geometric DesignIntroduction, Highway cross-section elements; Sight distance SSD, ISD, OSD; Design of horizontal alignment; Design of vertical alignment summit curves and valley curves.

Pavement Design Engineering and Drainage

Pavement types, components of flexible & rigid pavements, Pavement Design Factors, Flexible Pavement Design - Design strategies, CBR Method, IRC 37-2012 Guidelines, Rigid Pavement Design - General Design Considerations, Stresses in concrete pavements, Joints, Design of Rigid Pavements as per IRC:58-2011 Guidelines. Pavement Drainage - Necessity, Analysis and Design of Surface and sub surface drainage system.

Highway Construction & Highway Maintenance

Highway Construction: Equipment, Stages of Pavement Construction, Earthwork, Stabilization of Soil, Bituminous Pavement Construction and Cement Concrete Pavement Construction. Highway Maintenance: Pavement Distress causes and remedial measures.

Traffic Infrastructure Design:

Properties of Traffic Engineering Elements Introduction, Vehicle Characteristics, Human Factors and Driver Characteristics, Road Characteristics, Control Mechanisms and Terminal Facilities. Traffic Studies, Traffic Operations –Traffic Regulations, Traffic Control Devices - Traffic Signs, Traffic signals, Road Markings and Islands. Traffic Stream Parameters and their

Relations; Design of Traffic Signals, Design of Intersections Intersection at Grade and grade separated Intersections.

CODES:

1. IRC 37 2012: Guidelines for the design of flexible pavements, Indian Road Congress Publications, New Delhi.
2. IRC 58 2001: Guidelines for the design of plain jointed rigid pavements for highways, Indian Road Congress Publications, New Delhi.
3. MORTH - Specifications for Road and Bridge works, Indian Road Congress Publication, New Delhi, Latest Edition
4. IRC 67 2012: Code of Practice for Road Signs, Indian Road Congress Publication, New Delhi
5. IRC 35 1997: Code of Practice for Road Markings, Indian Road Congress Publication, New Delhi

Text Books:

1. Partha Chakroborty and Animesh Das Principles of Transportation Engineering. Prentice Hall of India, New Delhi
2. S.K.Khanna & C.J.Justo, Highway Engineering Nemchand & Bros., Latest Edition.

Reference Books:

1. Yoder & wit zorac Principles of pavement design Jhonwilley & Sons
2. Dr. L. R. Kadiyali & Dr. N. B. Lal Principles and practices of highway Engineering Khanna publishers, Latest Edition .
3. C. Jotin Khisty, B.Kent Lall, Traffic Engineering and Transportation Planning by L.R.Kadiyali, Khanna Publishers
4. Transportation Engineering Prentice Hall of India, New Delhi

QUANTITY SURVEYING AND ESTIMATION

Course code : 15 CE 3216 **L T P :** 3-0-2

Pre Requisite : 15 CE 2207 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To understand the fundamentals of estimation and specification	e	2
CO2	To provide exposure to rate analysis	k	2
CO3	To provide hands on experience on estimation	k	2
CO 4	To study the fundamentals of evaluation, To carry out valuation by different methods	k	2
CO5	Able to estimate the civil engineering works using the required software	b	2

SYLLABUS:

INTRODUCTION TO ESTIMATES AND SPECIFICATIONS: General introduction to Quantity surveying - purpose of estimates.Types of estimates, various items to be included in estimates. Principles in selecting units of measurement for items, various units and modes of measurement for different trades, I.S. 1200 - Specifications purpose and basic principles of general and detailed specifications; detailed specifications for various items of work.

RATE ANALYSIS: Taking out quantity, Measurement and abstract sheets and recording. Centre line method. Analysis of rates, factors affecting the cost of materials, labour. Task work, schedule as basis of labour costs. Plants and equipment - hour costs based on total costs and outputs. Transports, Overhead charges, rates for various items of construction of civil engineering works. Standard schedule of rate, price escalation

ESTIMATION OF CIVIL ENGINEERING WORKS: Reading and interpretation of architectural and structural drawings - Detailed estimate of masonry buildings, R.C.C works, Preparation of schedule for steel as reinforcement. Industrial sheds- steel trusses, columns, beams, Culverts, earthwork for canals. Roads - road materials for flexible and rigid pavements. Preparation of bills of quantities Approximate estimates, purpose, various methods used for buildings and other civil engineering works such as bridge, water supply, drainage - road railway projects, school buildings

FUNDAMENTALS OF VALUATION: Principles of valuation,definition of value, price and cost. Attributes of value, Different types of values- Book value, salvage value, scrap value, replacement value, reproduction value, earning value, Market value, Potential value, Distress value, Speculation value, Sentimental value. Accommodation value. Essential characteristics of market value . Valuer and his duties, purpose of valuation and its function. Factors affecting the valuation of properties-tangible and intangible properties, Landed properties-free hold and leasehold properties, different types of lease

METHODS OF VALUATION: Rental method of valuation. Form of rent, different types of rent, standard rent. Value of land, belting method of valuation, Valuation based on land and building- item wise, carpet area basis, unit basis, cubic content basis. Valuation from yield and from life, gross yield and net yield, outgoing, capitalized value, Year's purchases- Single rate and dual rate, reversion value of land, annuity - perpetual, whole life, deferred. Sinking fund. Depreciation, different methods of calculating depreciation straight line method, declining balance method, sinking fund method, quantity survey method. Depreciated cost

Text Books:

1. Chakraborti .M, "Estimating Costing", Specification and Valuation in Civil Engineering, 2001.
2. Dutta .B .N, "Estimating and Costing in Civil Engineering Theory and Practice," 2000.
3. Birdie .G. S, "A Text Book on Estimating and Costing", Dhanpat Rai and Sons, New Delhi, 2000.

Reference Books:

1. Jogleka.P.T, "Practical Information for Quantity Surveyors" , Mrs. Mandakini Joglekar, Pune,1990.
2. Rangwala.S.C. "Elements of Estimating and Costing", Charotar Publishing House, Anand, 1987.
3. Rangwala .S.C, "Valuation of Real Properties", Charotar Publishing House, Anand, 1984.
4. Jagannathan. G, "Getting More at Less Cost",-The Value Engineering Way,Tata McGraw Hill, New Delhi, 1992.

ADVANCED DESIGN OF REINFORCED CONCRETE STRUCTURES

Course codeb: 15 CE 3217 **L T P :** 3-0-2

Pre Requisite : 15 CE 3112 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Design different types of stair cases.	b	2
CO2	Select appropriate foundation system.	e	2
CO3	Apply the design principles of retaining walls.	k	3
CO 4	Differentiate types of rectangular water tanks and analyse as per IS code methods, Select types of circular water tanks and analyse as per IS code methods	e	2
CO5	Able to show the reinforcement details of RCC elements using the required software	b	2

SYLLABUS:

COMBINED FOOTINGS: Introduction, Design of combined rectangular footings, combined rectangular footings with central beam, MAT foundation, Reinforcement detailing and bar bending schedule.

STRUCTURAL DESIGN OF PILE FOUNDATIONS: Types of piles, Load carrying capacity of piles, Group action in piles, Structural design of RC piles, Design of pile cap for 2 or 3 piles, Reinforcement detailing and bar bending schedule.

RETAINING WALLS: Introduction Types of retaining walls –Active and passive earth pressure-Design principles of cantilever retaining walls with horizontal back fill –With sloping back fill. Design principles of Counter fort retaining walls with horizontal back fill. Reinforcement detailing and bar bending schedule.

RECTANGULAR WATER TANKS: Introduction General design requirements according to Indian standard code of practice Design of on ground and underground water tanks-Design of over head water tanks- Reinforcement detailing and bar bending schedule.

CIRCULAR WATER TANKS: Introduction General design requirements according to Indian standard code of practice Joints in water tanks Circular tank with flexible joint between floor and wall Circular tank with rigid joint between floor and wall Design of Over head tanks - IS code method for design of circular tanks- Reinforcement detailing and bar bending schedule need to be prepared.

INTRODUTION TO PRESTRESSED CONCRETE: Historic development General principles of Pre-stressing Pretensioning and Post tensioning Advantages and Limitations of Prestressed concrete Materials High Strength Concrete and High Tensile Steel and their characteristics. Methods and Systems of Pre-stressing; Pretensioning and Post tensioning methods Different systems of Pre-stressing like Hoyer system, Magnel Blaton System, Freyssinet's system and Gifford Udall System. Analysis of sections for flexure; Elastic analysis of concrete beams pre-stressed with straight, Concentric, Eccentric, Bent and Parabolic Tendons.

Text Books:

1. Punmia B.C., Ashok kumar Jain & Aurn Kumar Jain,"Reinforced concrete structures",

volume 5th Edition,Laxmi publications Pvt. Ltd., New Delhi, 2008.

2. Varghese P.C., "Limit State Design of Reinforced Concrete Structures", 3rd Edition, Prentice hall of India, New Delhi,2005.

Reference Books:

1. Varghese P.C., "Advanced Reinforced Concrete Structures",4th edition, Prentice hall of India, 2005.
2. Pillai S.V. and Menon D, "Reinforced Concrete Design",2nd edition, Tata Mc Graw Hill, 2006.
3. Krishna Raju N, "Advanced Reinforced Concrete Design",4th edition, University Press, 2007.

Codes: Relevant IS codes

WATER RESOURCES ENGINEERING

Course code : 15 CE 3218 **L T P :** 3-0-0

Pre Requisite : 15 CE 2208 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand stream flow and its measurements	b	2
CO2	Understand the classification of the rivers and design of cross drainage works	k	2
CO3	Understand the reservoir planning and classification of dams	b	2
CO 4	Able to design gravity and earth dams	k	2

SYLLABUS:

Stream Gauging: Necessity; Selection of gauging sites; Methods of discharge measurement; Area-Velocity method; Venturi flume; Chemical method; weir method; Measurement of velocity; Floats Surface float, Sub–surface float or Double float, Twin float, Velocity rod or Rod float; Pitot tube; Current meter; Working of current meter; rating of current meter; Measurement of area of flow; Measurement of width - Pivot point method; Measurement of depth Sounding rod, Echo- sounder.

River Engineering: Classification of rivers; Meandering; Causes of meandering; Basic factors controlling process of meandering; general features of meandering; Classification of river training works; groynes or spur.

Cross Drainage Works: Introduction; Types of cross - drainage works; Selection of suitable type & design principles of cross - drainage works; Classification of Aqueducts and Syphon Aqueducts; Selection of a suitable type.

Reservoir Planning: Introduction; Investigations for reservoir planning; Selection of site for a reservoir; Zones of storage in a reservoir; Storage capacity and yield; Mass inflow curve and demand curve; Calculation of reservoir capacity for a specified yield from the mass inflow curve; Determination of safe yield from a reservoir of a given capacity; Sediment flow in streams; Life of reservoir; Reservoir sediment control; flood routing. Various types of Spillways.

Dams: Introduction; Classification; Physical factors governing selection of type of dam and selection of site for a dam.

Gravity Dams: Introduction; Forces acting on a gravity dam; Combination of loading for design; Modes of failure and criteria for stability requirements; Stability analysis; Elementary profile of a gravity dam; Practical profile of a gravity dam; Limiting height of a gravity dam; High and low gravity dams; Design of gravity dams–single step method.

Earth Dams: Introduction; Types of earth dams; Causes of failure of earth dams; Criteria for safe design of earth dams; Section of an earth dam; Design to suit available materials; Seepage Slope protection.

Text Books:

1. K.Subramanyam, Engineering hydrology Tata McGraw Hill ,New Delhi.
2. S. K. Garg; Irrigation Engineering and Hydraulic Structure Khanna Publishers, Delhi.

Reference Books:

1. Dr. P. N. Modi, Irrigation Water Resources and Water Power Engineering Standard book house, New Delhi.
2. V. P. Singh Elementary Hydrology, PHI Publishers, New Delhi.
3. Ven Te Chow, Applied Hydrology McGraw-Hill Book Company.

LIST OF PROFESSIONAL ELECTIVES

ADVANCED DESIGN OF STEEL STRUCTURES

Course code : 15 CE 3251 **L T P :** 3-0-0

Pre Requisite : 15 CE 3113 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Analyse and design a beam-column	a	1
CO2	Explain the need of plate girder and its design as per IS code	c	3
CO3	Calculate the loads on gantry girder and its design	a	1
CO 4	Design a simple truss for wind loads and design of gable frame, Explain the concepts of pre-engineered buildings and their design	a	1

SYLLABUS:

DESIGN OF BEAMS-COLUMNS: Introduction General behavior of beams-columns Codal provision for local capacity check and overall buckling check Design of beams-columns.

DESIGN OF PLATE GIRDER: Introduction to plate girder Elements of plate girderIS 800-2007 codal provisions, preliminary design considerations - Concept of tension field action, design of end panels. Design of plate girder using IS 800-2007- Design of vertical stiffeners Design of longitudinal stiffeners Design of torsional stiffeners Introduction to steel plate shear wall. .

DESIGN OF GANTRY GIRDER: Introduction - Loading consideration & maximum load effect –Selection of Gantry girder Design of gantry girders for primary loads only.

DESIGN OF INDUSTRIAL STRUCTURES: Introduction Analysis and design of knee braced roof truss members Design of gable portal frame Analysis and design of Gantry girder columns.

PRE-ENGINEERED BUILDINGS: Introduction Connection details Design of typical portal frame of Industrial SHED USING IS: 800-2007.

Text Books:

1. N. Subramanyam, "Design of Steel Structures", 1st Edition, Oxford University Press, 2008. Units: I to IV
2. M.R. Sheyekar "Limit state design in Structural Steel", 1st Edition, PHI Publications, 2010. Unit-V.

Reference Books:

1. Edmin H. Gaylord, J. Charles. N. Gaylord & James E. Stallmeyer, "Design of steel structures", 3rd Edition, Mc Graw Hill International 1992.

BRIDGE ENGINEERING

Course code : 15 CE 4156 **L T P :** 3-0-0

Pre Requisite : 15 CE 3112 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To design slab culverlt as per IRC Code	a	1
CO2	To design simple supported T-beam girder beam	e	2
CO3	To design pier and abutments	e	2
CO 4	To design various bridge bearing, To design bridge foundation like well foundation	e	2

SYLLABUS:

Concrete Bridge: Various types of bridges; I.R.C. specifications for road bridges. Culverts: Design of R.C. slab culvert. T-Beam Bridge: Pigeaud's method for computation of slab moments; courbon's method for computation of moments in girders; Design of simply supported T-beam bridge.

Sub Structure for Bridges: Pier and abutment caps; Materials for piers and abutments' Design of pier; Design of abutment; Backfill behind abutment; approach slab.

Bearings for Bridges: Importance of bearings; bearings for slab bridge; bearings for girder bridges; Expansion bearings; Fixed bearings; Design of elastomeric pad bearing.

Foundations for Bridges: scour at abutments and piers; Grip length; Types of foundations; Design of well foundation.

Cable Supported Bridge: Different types of cable supported bridge, difference between suspension bridge and cable stayed bridge. Different components and factors considered for design of a) suspension bridge, b) cable stayed bridge.

Text Books (Max. 2 books):

1. Dr. Johnson Victor; Essentials of Bridge Engineering Oxford & IBH publishing Co. Pvt. Ltd.
2. N J Gimsing. Cable supported bridges, concepts and design John Willey and Sons

Reference Books:

T. R Jagadeesh, M.A Jayaram, Design of Bridge Structures Prentice Hall of India Pvt. Ltd.

EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

Course code : 15 CE 4157 **L T P :** 3-0-0

Pre Requisite : 15 CE 3112 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To understand the principles of vibration with regard to single degree of freedom system and multy degree of freedom system	b	2
CO2	To understand the seismo resistant building Architecture.	b	2
CO3	To determine the design lateral forces by means of codal provisions.	e	2
CO 4	To introduce the concept of ductility and corresponding detailing, To expose the students to earthquake resistant design of masonry buildings	b	2

SYLLABUS:

Dynamics of Structures and Seismic Response: Equation of motion, single degree of free system, dynamic response of single storey structure (SDOF), , seismic response of SDOF structure, concept of response spectrum, dynamic response of spectrum representation for elastic systems.

Systems with multi degree of freedom (MDOF): periods and mode of vibration, elatic response, restoring force, damping, damping values for buildings.

Earthquake and ground Motion: Causes of earthquake, nature and occurrences, seismic waves, effects, consequences, measurements, strong ground motion, seismic zones.

Seismo-resistant building architecture: Lateral load resisting systems- moment resisting frame, Building with shear wall or bearing wall system, building with dual system; Building configuration Problems and solutions; Building characteristics Mode shape and fundamental period, building frequency and ground period, damping, ductility, seismic weight, hyperstaticity/redundancy, non-structural elements, foundation soil/ liquefaction. Foundations; Quality of construction and materials quality of concrete, construction joints, general detailing requirements.

Design forces for buildings: Equivalent static method, Determination of lateral forces as per IS 1893(Part 1), Modal analysis using response spectrum.

Ductility considerations in earthquake resistant design of RCC buildings: Impact of ductility; Requirements for ductility; Assessment of ductility Member/element ductility, Structural ductility; Factor affecting ductility; Ductility factors; Ductility considerations as per IS13920.

Earthquake resistant design of a long two-storey, two-bay RCC building: Determination of lateral forces on an intermediate plane frame using Equivalent static method and Modal analysis using response spectrum; various load combinations as per IS1893(Part 1); Identification of design forces and moments in the members; Design and detailing of typical flexural member ,typical column, footing and detailing of a exterior joint as per IS13920.

Masonry building: categories, plain and reinforced masonry walls, box action and bands, infill walls, improving seismic behavior of masonry building, load combinations and permissible stress, seismic design of masonry building.

Text Books:

1. Pankaj Agarwal and Manish Shrikhande, Earthquake resistant design of structures Prentice-Hall of India, 2006.

Reference Books:

1. T. Paulay and M.J.N. Priestley, Seismic design of reinforced concrete and masonry buildings John Wiley & Sons, 1991.
2. The seismic design handbook, Edited by F. Naeim, Kluwer Academic publishers, 2001.

PRESTRESSED CONCRETE

Course code : 15 CE 4158 **L T P :** 3-0-0

Pre Requisite : 15 CE 3112 **Credits:** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To introduce prestressing methods, principles and concepts	a	1
CO2	To determine losses in prestress	a	1
CO3	To Analyse PSC Sections both at transfer of prestress and Service load conditions	c	3
CO 4	To design prestressed concrete beams as per IS Code, To design end block of PSC beams.	c	3

SYLLABUS:

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: pretensioning; Post tensioning ; Thermoelectric prestressing; chemical prestressing.

Analysis of Prestress and Bending Stresses: Resultant stresses; Pressure (Thrust) line and internal resisting couple; Concept of Load balancing; Stresses in tendons; Cracking moment. 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 un-cracked members; Effect of tendon profile on deflections. Ultimate flexural strength of simple sections using simplified IS code Recommendations.

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 provision for the design of end block reinforcement.

Text Books:

1. N. Krishna Raju; Prestressed Concrete Tata Mc.Graw - Hill Publishing Company Limited, New Delhi.
2. P. Dayarathnam: Pre-stressed Concrete- Oxford and IBH Publishing Co.
3. Indian standard code of practice for prestressed concrete (IS -1343-1980): Bureau of Indian stanadards New Delhi

Reference Books:

1. N. Rajagopalan; Prestressed concrete Narosa Publishing House.
2. T.Y. Lin and Ned H. Burns Design of pre-stressed concrete structures - John Wiley & Sons, New York.
3. N.C. Sinha & S.K. Roy Fundamental of pre-stressed concrete-

PREFABRICATED STRUCTURES

Course code : 15 CE 4159 **L T P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To Analyze Structural Components in Prefabricated Components	c	2
CO 2	To Analyze Joints for different Structural connections	i	2
CO 3	Able to design abnormal loads using code provisions	c	3
CO 4	Able to analyze abnormal effects using code provisions	c	2

SYLLABUS:

INTRODUCTION: Need for prefabrication –Principles –Materials –Modular coordination –Standarization –Systems –Production –Transportation –Erection.

PREFABRICATED COMPONENTS: Behaviour of structural components –Large panel constructions –Construction of roof and floor slabs –Wall panels –Columns –Shear walls l

DESIGN PRINCIPLES: Disuniting of structures-Design of cross section based on efficiency of material used –Problems in design because of joint flexibility –Allowance for joint deformation.

JOINT IN STRUCTURAL MEMBERS: Joints for different structural connections –Dimensions and detailing –Design of expansion joints

DESIGN FOR ABNORMAL LOADS:Progressive collapse –Code provisions –Equivalent design loads for considering abnormal effects such as earthquakes, cyclones, etc., -Importance of avoidance of progressive collapse.

Text books:

1. CBRI, Building materials and components, India, 1990
2. Gerostiza C.Z., Hendrikson C. and Rehat D.R., "Knowledge based process planning for construction and manufacturing", Academic Press Inc., 1994

References Books:

1. Koncz T., "Manual of precast concrete construction", Vol. I, II and III, Bauverlag, GMBH, 1976.
2. "Structural design manual", Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 2009

GROUND IMPROVEMENT TECHNIQUES

Course code : 15 CE 3252 **L T P :** 3-0-0

Pre Requisite : 15 CE 2210 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Knowledge about the different techniques of ground improvement and their suitability.	c	2
CO2	Understanding and design of stone columns for enhancing soil bearing capacity.	i	2
CO3	Knowledge of the grouts, their types, properties and application.	c	2
CO 4	Introduction to geo synthetics, their types, function and application, Ability to design and analyse the earth-reinforcements with their connections	i	2

SYLLABUS:

Necessity of ground improvement- objectives, Introduction to different methods Mechanical stabilization- Types of rollers, effect on engineering properties- Chemical stabilization-cement stabilization- factors affecting soil cement mixing-admixtures- lime stabilization-effect of lime on soil properties-construction of lime stabilized bases-bituminous stabilization.

Dewatering-well-point system-electro osmosis-pre-loading- sand drains- methods of installation - PVD's, Types, Design, construction -stone columns in clays - vibro-flotation in sands and clays, Designs as per BIS and case histories.

Grouting-Introduction to grouts and grouting- basic functions groutability ratio –classification of grouts, properties of grouts - grouting applications- Impermeability grouting seepage control in soil under dams and for cut off walls- seepage control in rock under dams-stabilization grouting for under pinning.

Geo-synthetics Types, functions, typical Applications of filtration and drainage, use in road /airport pavements and strengthening existing pavements.

Earth Reinforcement- mechanism and concept - laboratory behavior of reinforced soil-Reinforced Soil retaining Structures Types of Reinforcements, fascia and connections - design concepts and stability analysis Use in India

Text Books :

1. IRC (1995). Ground Improvement Techniques
2. Stabilization of clays, Indian Raods congress, New Delhi , Spl Publication No. Venkatappa Rao, Gand Ramana, G.V. (2000)
3. Relevant I.S.Codes

Reference Books:

1. Bowles, J.F. Foundation Design
2. Das, B.M, Geotechnical Engineering
3. Jones, C.J.F.P.Earth Reinforcement and Soil structures
4. Koerner, R.M. (2005) Designing with Geotextiles

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ADVANCED FOUNDATION ENGINEERING

Course code : 15 CE 4160 **L T P :** 3-0-0

Pre Requisite : 15 CE 3111 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Knowledge about the different techniques for laying foundations in expansive soils.	b	3
CO2	Understanding and design of different types of footings.	e	2
CO3	Various factors to be considered in foundation design.	e	2
CO 4	Understanding the design criteria of Machine foundations, Understanding the design criteria of Mat and For designing and construction of foundations for reciprocating machines as per IS.	e	2

SYLLABUS:

Foundation on collapsible and expansive soils: Collapse potential and settlement, Computation of collapse settlement, Foundation design, Treatment methods for collapsible soils, Distribution of expansive soils, General characteristics of swelling soils, Clay mineralogy and mechanism of swelling, Definition of some parameters, Evaluation of the swelling potential of expansive soils by single Index Method, Classification of swelling soils by Indirect Measurement, Swelling pressure by direct measurement, Effect of initial moisture content and initial dry density on swelling pressure, Estimating the magnitude of swelling, Design of foundation in swelling soils, drilled pier foundations, Elimination of swelling

Factors to consider in foundation design: Footing Depth and spacing, Displaced soil effects, Net versus gross soil pressure design soil pressures, erosion problems for structures adjacent to flowing water, Corrosion protection, Water table fluctuation, Foundations in Sand deposits, Foundations on Loess and other collapsible soils, Foundations on sanitary landfill sites, Frost depth and foundations on permafrost, Environmental considerations problems.

Spread footing and beams on elastic foundations: Rectangular combined footings, design of trapezoid shaped footings, design of strap (or cantilever) footings, footings for industrial equipment, Modulus of sub grade reaction, Classical solution of Beam on Elastic foundation, Finite Element solution of beam on elastic foundation, General Comments on the finite element procedure problems.

Mat foundations: Types of Mat foundations, Bearing capacity of Mat foundations, Mat settlements, Modulus of subgrade reaction for mats, Design of Mat foundation, Finite difference Method for Mats, Finite element method for Mat foundations, The finite grid method, Mat superstructure interaction, Circular mats or plates.

Machine foundations: 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.

Text Books :

1. J.E.Bowles, Foundation analysis and design published by Mc Graw-Hill International Editions
2. Gopal Ranjan and A.S.Rao, Basic and applied soil mechanics Wiley Eastern Limited

Reference Books:

1. VNS Murthy, Soil Mechanics and Foundation Engineering CBS publishers&distributors
2. N.N.Som &S.C.Das, Theory and Analysis of Foundations Prentice Hall India Ltd.
3. CV Vaidyanathan and Srinivasulu P. Hand Book of Machine Foundations Tata Mcgraw Hill Publishing Co. Ltd.

GEOTECHNICAL EARTHQUAKE ENGINEERING

Course code : 15 CE 4161 **L T P :** 3-0-0

Pre Requisite : 15 CE 2210 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Knowledge of the seismic phenomenon, its occurrence, tectonic theories, seismic waves and their motion in different media and measurement of ground motions.	b	3
CO 2	Analysis skills of 1-D ground responses using linear and non-linear approaches.	e	2
CO 3	Ability to analyze the seismic hazard through deterministic and probabilistic approaches.	e	2
CO 4	Ability of modifying the actual ground motion records and their time and frequency domain generation. Knowledge of dynamic soil properties and their measurements using field and laboratory tests, Knowledge of the liquefaction phenomenon and its effects and the remedial measures to be taken for soil improvement.	b	3

SYLLABUS:

Seismology and Earthquakes: Seismic Hazards, seismic waves, internal structure of earth, Continental drift and plate tectonics, faults, elastics rebound theory, geometric notations, location of earthquakes, size of earthquakes.

Strong Ground Motion: Strong ground motion measurement, ground motion parameters, estimation of ground motion parameters.

Seismic Hazard Analysis: Identification and Evaluation of Earthquake Sources, deterministic seismic hazard analysis, probabilistic seismic hazard analysis.

Wave Propagation Waves in unbounded media, waves in a semi infinite body, waves in a layered media, attenuation of stress waves.

Artificial Ground Motion Generation: Modification of actual ground motion records, time domain generation, frequency domain generation.

Dynamic Soil Properties Representation of stress conditions by Mohr circle, measurement of dynamic soil properties using field and laboratory tests, stress strain behavior of cyclically loaded soils, strength of cyclically loaded soils.

Ground Response Analysis: OneDimensional Ground response Analysis Linear and Non-Linear Approaches.

Local Site Effects: Effect of local site conditions on ground motion, design parameters, development of design parameters. Liquefaction Flow liquefaction, cyclic mobility, evaluation of liquefaction hazards, liquefaction susceptibility, initiation of liquefaction, effects of liquefaction.

Soil Improvement for Remediation of Seismic Hazards: Densification techniques, Reinforcement Techniques, Grouting and Mixing techniques, Drainage techniques.

Text Books:

1. Geotechnical Earthquake Engineering by Steven L. Kramer, prentice Hall

Reference Books:

1. Geotechnical Earthquake Engineering Handbook by Robert W. Day, McGraw-Hill

DESIGN OF EARTH RETAINING STRUCTURES

Course code : 15 CE 4162 **L T P :** 3-0-0

Pre Requisite : 15 CE 3111 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Knowledge about the different techniques of earth retaining structures and their suitability.	b	3
CO2	Understanding and design of retaining walls, braced cuts and sheet piles.	e	2
CO3	Knowledge of the grouts, their types, properties and application.	b	3
CO 4	Introduction to reinforced earth and geo synthetics, their types, function and application, Ability to design and analyse the earth-reinforcements and coffer dams with their functions.	e	2

SYLLABUS:

Retaining walls different types - Gravity, Cantilever-counter fort and Crib types. Basement or foundation retaining walls. Design principles of retaining walls, Design and Construction of Reinforced Soil Walls, Reinforced Soil Wall (A Case Study),Geosynthetics for Warehouse Grade Slab and Retaining Wall,Geogrid-Reinforced Retaining Walls, Restoration of Wharf Road by Geosynthetic Reinforced Soil Wall, Abutments and wing walls and allowable bearing capacity settlement tilting. Safety against general slip failure. Type of Failures of Retaining Walls Stability Requirements Drainage behind Retaining walls Provision of Joints Relief Shells.

Braced cuts Lateral Pressure in Braced cuts Design of Various Components of a Braced cut Stability of Braced cuts Bottom Heave in cuts.

Sheet Pile Structures Types of Sheet piles Cantilever sheet piles in sands and clays –Anchored sheet piles Free earth and fixed earth support methods Row's moment Reduction method Location of anchors, Forces in anchors.

Soil reinforcement Reinforced earth - Different components their functions Mechanics of reinforced earth Failure modes-Failure theories Design of Embankments on problematic soils.

Cofferdams types, suitability, merits and demerits Design of single wall Cofferdams and their stability aspects TVA method and Cummins' methods.

Text Books :

1. Gopal Ranjan and A.S.R. Rao "Basics and Applied soil mechanics", New age International Publishing, second edition, 2007
2. G Venkatapparao P.K. Banerjee, J.T.Shahu, G.V. Ramana By Geo-Synthetics-New Horizons - 2004
3. P.C.Varghese Foundation Engineering Prentice-Hall of India Pvt Ltd , New Delhi - 2006

Reference Books:

1. Braja M. Das, Principles of foundation engineering PWS-KENT Publishing company,boston
2. Bowles, Foundation analysis and design JE- McGraw Hill
3. Prakash, Analysis and design of foundation and retaining structures, SSaritha Prakashan, Mearut

GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES

Course code : 15 CE 4163 **L T P :** 3-0-0

Pre Requisite : 15 CE 3111 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand about Geosynthetics and Reinforced Soil retaining wall and Identifying suitable testing methods for Geosynthetics	c	2
CO2	Able to understand the stability of slopes and application of geosynthetics in foundations	i	2
CO 3	Able to understand the application of geosynthetics in pavement and the use in construction of landfills	i	2
CO 4	Able to identify different land filling techniques	i	2

SYLLABUS:

Introduction: Historical background of reinforced soil, Principles of reinforced soil through Mohr circle analysis.Different types of geosynthetics:Types of geosynthetics like geotextiles, geogrids, geonets,geocells, geo-composites, their manufacturing methods.

Testing methods for geosynthetics: Techniques for testing of different index properties,strength properties, Apparent Opening Size, In-plane and cross-plane permeability tests, assessment of construction induced damage, extrapolation of long term strength properties from short term tests.

Reinforced Soil retaining walls: Different types of walls like wrap-around walls, full-height panel walls, discrete-facing panel walls, modular block walls Design methods as per BS-8006 and FHWA methods Construction methods for reinforced soil retaining walls.

Reinforced soil slopes: Basal reinforcement for construction on soft clay soils,construction of steep slopes with reinforcement layers on comptenet soils, Different slope stability analysis methods like planar wedge method, bi-linear wedge method, circular slip methods. Erosion control on slopes using geosynthetics.

Applications in foundations: Binquet and Lee's approach for analysis of foundations with reinforcement layers. Drainage and filtration applications of geosynthetics:Different filtration requirements, filtration in different types of soils and criteria for selection of geotextiles, estimation of flow of water in retaining walls, pavements, etc. and selection of geosynthetics.

Pavement application: Geosynthetics for separation and reinforcement in flexible pavements, design by Giroud-Noiray approach, reflectioncracking and control using geosynthetics.Use of geosynthetics for construction of heavy containeryards and raiway lines.

Construction of landfills using geosynthetics: Different components of modern landfills, collection techniques for leachate, application of differentgeosynthetics like geonets, geotextiles for drainage in landfills, use of geomembranes and Geosynthetic ClayLiner (GCL) as barriers.

Text Books:

1. Koerner, R.M. "Designing with Geosynthetics", Prentice Hall, New Jersey, USA, 4th edition, 1999.
2. Jewell, R.A., "Soil Reinforcement with Geotextiles", Special Publication No. 123, CIRIA, Thomas Telford. London, UK, 1996.
3. Eds. G.V. Rao, PK Banerjee, J.T. Shahu, G.V. Ramana, Geosynthetics - New Horizons Asian Books Private Ltd., New Delhi, 2004.

DESIGN OF HYDRAULICS STRUCTURES

Course code : 15 CE 3253 **L T P :** 3-0-0

Pre Requisite : 15 CE 2102 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To Design vertical drop weir on foundations	a	1
CO 2	To Design vertical drop weir on a canal regulator, irrigation canal,direct sluice and surplus weir of tank	c	3
CO 3	To design Profile of a Ogee spillway	c	3
CO 4	To design Profile of a Cross Drainage works.	c	3

SYLLABUS:

Design and Drawing of Vertical drop weir on permeable foundations, Canal regulator, Irrigation canal, direct sluice, Surplus weir of a tank, Profile of a Ogee spillway, Cross Drainage works.

Text Books:

1. C.Satyanarayana Murthy, Design of minor irrigation and canal structures Wiley stern Ltd.
2. S.K.Garg, Irrigation engineering and Hydraulic structures Standard Book House

ADVANCED WATER RESOURCES ENGINEERING

Course code : 15 CE 4164 **L T P :** 3-0-0

Pre Requisite : 15 CE 2209 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand stream flow and its measurements	a	1
CO2	Understand the classification of the rivers and design of cross drainage works	c	3
CO3	Understand the reservoir planning and classification of dams	c	3
CO 4	Able to design gravity and earth dams	c	3

SYLLABUS:

Stream Gauging: Necessity; Selection of gauging sites; Methods of discharge measurement; Area-Velocity method; Venturi flume; Chemical method; weir method; Measurement of velocity; Floats Surface float, Sub–surface float or Double float, Twin float, Velocity rod or Rod float; Pitot tube; Current meter; Working of current meter; rating of current meter; Measurement of area of flow; Measurement of width - Pivot point method; Measurement of depth Sounding rod, Echo- sounder.

River Engineering: Classification of rivers; Meandering; Causes of meandering; Basic factors controlling process of meandering; general features of meandering; Classification of river training works; groynes or spur.

Cross Drainage Works: Introduction; Types of cross - drainage works; Selection of suitable type & design principles of cross - drainage works; Classification of Aqueducts and Syphon Aqueducts; Selection of a suitable type.

Reservoir Planning: Introduction; Investigations for reservoir planning; Selection of site for a reservoir; Zones of storage in a reservoir; Storage capacity and yield; Mass inflow curve and demand curve; Calculation of reservoir capacity for a specified yield from the mass inflow curve; Determination of safe yield from a reservoir of a given capacity; Sediment flow in streams; Life of reservoir; Reservoir sediment control; flood routing. Various types of Spillways.

Dams: Introduction; Classification; Physical factors governing selection of type of dam and selection of site for a dam.

Gravity Dams: Introduction; Forces acting on a gravity dam; Combination of loading for design; Modes of failure and criteria for stability requirements; Stability analysis; Elementary profile of a gravity dam; Practical profile of a gravity dam; Limiting height of a gravity dam;

High and low gravity dams; Design of gravity dams–single step method.

Earth Dams: Introduction; Types of earth dams; Causes of failure of earth dams; Criteria for safe design of earth dams; Section of an earth dam; Design to suit available materials; Seepage Slope protection.

Text Books:

1. K.Subramanyam, Engineering hydrology Tata McGraw Hill ,New Delhi.
2. S. K. Garg; Irrigation Engineering and Hydraulic Structure Khanna Publishers, Delhi.

Reference Books:

1. Dr. P.N. Modi, Irrigation Water Resources and Water Power Engineering Standard book house, New Delhi.
2. V.P.Singh Elementary Hydrology, PHI Publishers, New Delhi.
3. Ven Te Chow, Applied Hydrology McGraw-Hill Book Company.

ENVIRONMENTAL IMPACT ASSESSMENT

Course code : 15 CE 4165 **L T P :** 3-0-0

Pre Requisite : 15 CE 2209 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the basic concept of Environmental impact assessment, types of environmental impacts, significance and criteria for selection	c	2
CO 2	Select methodology for identification of environmental impact.	i	2
CO 3	Apply the knowledge of predicting impact of proposed project on air & water	i	2
CO 4	Acquire knowledge of predicting impact of proposed project on Noise, Soil, Biological and Socio-economic conditions, Acquire the skills of preparing environment management plans.	i	2

SYLLABUS:

INTRODUCTION TO EIA: Conceptual Facts of EIA: Introduction, Definition, Scope, Objectives and Basic Principles, Classification, Project Cycle, Grouping of Environmental Impacts: Direct Impacts, Indirect Impacts, Cumulative Impacts and Induced Impacts. Significance of Impacts: Criteria/Methodology to Determine the Significance of the Identified Impacts.

EIA METHODOLOGIES: Methods for Impact Identification: Background Information, Interaction-Matrix Methodologies: simple matrices, stepped matrices, development of a simple matrix, other types of matrices, summary observations on matrices, Network Methodologies: Checklist methodologies, simple checklists, descriptive Checklists, summary observations on simple and descriptive Checklists.

PREDICTION OF IMPACTS (AIR & WATER): Prediction of Impacts (Air and Water): Air Environment: Basic information on air quality, Sources of Pollutants, effects of pollutions, Conceptual approach for addressing air environment impacts, Air quality standards, Impact Prediction, Impact significance. Water Environment: Basic Information on surface-Water Quantity and Quality, Conceptual Approach for Addressing Surface-Water-Environment Impacts, Identification of Surface-Water Quantity or Quality Impacts, Procurement of Relevant Surface-Water Quantity-Quality Standards, Impact Predictions, Assessment of Impact Significance.

PREDICTION OF IMPACTS (NOISE, SOIL, BIOLOGICAL & SOCIO ECONOMIC): Predictions of Impacts (Noise, Soil, Biological and Socio-economic):Basic Information on Noise Key Federal Legislation and Guidelines, Conceptual Approach for Addressing Noise-Environment Impacts, Identification of Noise Impacts, Procurement of Relevant Noise Standards and/ or Guidelines, Impact Prediction, Assessment of Impact Significance. Soil Environment: Human Health and Society, Biological Environment: Basic Information on Biological Systems, Conceptual Approach for Addressing Biological Impacts, Identification of Biological Impacts, Description of Existing Biological Environment Conditions, Procurement of Relevant Legislation and Regulations, Impact Prediction, Assessment of Impact Significance.

ENVIRONMENTAL MANAGEMENT PLAN (EMP): Environmental Management Plan (EMP):Case Study, identification of Impacts, EMP for Air Environment: Dust Control Plan, Procedural Changes, Diesel Generator Set Emission Control Measures, Vehicle Emission Controls and Alternatives, Greenbelt Development. EMP for Noise Environment, EMP for Water Environment: Water Source Development, Minimizing Water Consumption, Domestic and Commercial Usage, Horticulture, Storm Water Management. EMP for land Environment: Construction Debris, hazardous Waste, Waste from temporary Labour settlements.

Text Books:

1. Canter,L.W, Environmental impact assessment Mc Graw Hill, New York,1996.
2. Technological guidance manuals of EIA. MoEF
3. Y.Anjaneyulu and Valli Manickan, Environment Impact Assesement methodologiesB.S.P ublications, Hyderabad.

Reference Books:

1. Hand book of Environment Impact Assesment, Vol. I and II, Blackwell Science, London, 1999.
2. The world bank group, Environmental Impact Assesment source book, Vol. I, II and III.
3. Textbook of Environmental Science & Technology by M.Anji Reddy, BS Publications, 2010

SOLID WASTE MANAGEMENT AND LANDFILLS

Course code : 15 CE 4166 **L T P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand types, sources of solid waste, composition and their Properties.	c	2
CO2	Understand the present scenario, challenges of solid waste management and various waste disposal options available.	i	2
CO3	Understand methods of solid waste disposal methods of land filling, systems adopted for conversion of solid waste and recovery of materials and energy from solid waste.	i	2
CO 4	Understand the components of hazardous waste types, composition, properties and acquire skills of designing of various lining system for landfill and treatment as per MoEF and CPCB	i	2

SYLLABUS:

Municipal Solid Wastes: Types of solid wastes, Sources of Municipal and Hazardous wastes, Properties of solid wastes-Physical and Chemical composition.

Solid Waste Management: An Overview, Introduction Reduction, Reuse and Recovery, Waste Disposal Options, Current Scenario and Challenges Engineered Systems For Solid Waste Management: Functional Elements, Solid waste generation, On-site handling, Storage and Processing, Collection of solid wastes, Transfer and Transport, Processing of Solid wastes, Ultimate disposal.

Conversion of Solid wastes and Recovery: Mechanical processing and Material recovery systems. Biological Conversion-Composting, Anaerobic Digestion. Thermal Conversion-Combustion, Incineration, Gasification, Pyrolysis, Refuse Derived Fuel, Energy recovery systems.

Landfills for Municipal Solid Wastes: Land Filling of Municipal Solid Wastes, Site selection, Planning, Design and Operation. Landfill Gas- composition, Collection. Lechate-environmental effects, Lechate collection systems, Treatment of lechate, MoEF rules, CPCB guidelines for hazardous waste land filling. Lechate Control By Clay Liners: Clay Liners-Types-Compacted clay liners and their design-Construction of clay liners.

Geosynthetic Lining Systems: Geosynthetics Types and Functions-Geosynthetic clay liners-Properties , Hydraulic conductivity, Installation.

Text Books :

1. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous (1985), Environmental Engineering, Mc Graw-Hill International Editions, NewYork.
2. Venkatappa Rao. G and Sasidhar. R.S.(2009), Solid waste management and Engineered

Landfills, Sai Master Geoenvironmental Services Pvt.Ltd, Hyderabad.

Reference Books:

1. P.Aarne Vesilind, Willium Worrell and Debra Reinhart,(2004), Solid waste Engineering Cengage Learning India Private Limited, New Delhi.
2. J.Glynn Henry, Gary W.Heinke,(2004) Environmental Science and Engineering,Low Price Edition, Pearson Education Inc, Singapore.
3. MoEF(2000) Municipal Waste Management and Handling Rules, Govt. of India.
4. CPCB(2001) Criteria for Hazardous waste Landfill(HASWAMS/17/2000-01).
5. M.N.Rao and Razia Sultana, Solid and hazardous waste management BS Publications, Hyderabad.

ADVANCED ENVIRONMENTAL ENGINEERING

Course code : 15 CE 4167 **L T P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the basic concepts of Stream Sanitation & design of Stabilization ponds	c	2
CO 2	Acquire the knowledge of industrial wastewater treatment process	i	2
CO 3	Acquire the knowledge on new concepts in biological waste treatment	i	2
CO 4	Analyze air pollution and plume behavior, measuring of noise pollution, Understand various aspects related to Solid & Hazardous waste management	i	2

SYLLABUS:

Stream Sanitation : Introduction; Self-purification in streams; factors affecting self-purification; Dissolved Oxygen Balance in streams; Streeter-Phelps's Dissolved Oxygen Model; Zones of Self-purification; Impact of pollutants on stream waters and usage of stream water with special reference to flora and fauna.

Low Cost Wastewater Treatment Systems: Introduction - Stabilization ponds (including design aspects), Aerated lagoons, Oxidation ditch, Extended aeration process.

Industrial Wastewater Treatment: Introduction to Industrial Wastewater treatments.

Sugar Plant: Quantity of liquid waste; Characteristics of liquid waste - Methods of its treatment and disposal. Dairy Industry: Quantity of liquid waste - Characteristics of liquid waste - Methods of its treatment and disposal. Pulp and Paper Industry: Quantity of liquid waste; Characteristics of liquid waste - Methods of its treatment and disposal.

New Concepts in Biological Waste Treatment: Introduction, Nitrogen removal by biological nitrification and de-nitrification-Phosphate removal from the activated sludge process-

Rotating Disc Biological Contactor - Anaerobic filters - U-Tube aeration systems. Membrane technologies.

Air Pollution, Meteorology and Noise Pollution: Sources, classification, and effects of air pollution - Atmospheric stability and temperature inversions - Maximum Mixing Depth - Wind direction and speed - Plume behavior - Gaussian Dispersion Model - Plume rise - Wind rose. Control of Air Pollution Objectives - Types of collection equipment: Settling chamber - Inertial separators Cyclones - Filters; Electrostatic Precipitators - Scrubbers. Noise Pollution - Introduction; Levels of noise; Noise rating systems. Measurement of noise - Sources of noise and their noise levels - Acceptable noise levels - Effects of noise - Control of noise.

Solid & Hazardous Waste Management: Perspectives & properties, collection, transfer & transport, Life cycle assessment, Disposal in a landfill, Waste to energy, Composting, Resource conservation & recovery for sustainability. Hazardous Waste Management: The hazard, risk, definition & classification RCRA &HSWA, CERCLA & SARA, Hazardous waste management, Treatment technologies, Land disposal, Groundwater contamination & remediation.

Text Books :

1. M.N. Rao and A.K. Datta; Wastewater Treatment Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Metcalf & Eddy Inc.; Wastewater Engineering, Treatment, Disposal and Reuse Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
3. M.N. Rao and H.V.N. Rao; . Air Pollution Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.
4. Vesilind, Worrell and Reinhart, Solid Waste Engineering, Cengage Learning India.

Reference Books:

1. C.S. Rao; Environmental Pollution Control Engineering Wiley Eastern Ltd., New Delhi.
2. G.M. Fair et all; Water Supply and Wastewater Disposal John Wiley & Sons.
3. S.K. Garg; Sewage Disposal and Air Pollution Engineering Khanna Publications, Delhi.
4. S.K. Kshirasagar; Sewage and Sewage Treatment Roorkee Publishing House, Roorkee.
5. Davis & Cornwell, Environmental Engineering, Mc Graw Hill Int Ed.
6. Peavy, H.S, Rowe, D.R, Tchobanoglous, G, Environmental Engineering, Mc Graw Hill.

ADVANCED HIGHWAY ENGINEERING

Course code : 15 CE 3254 **L T P :** 3-0-0

Pre Requisite : 15 CE 3115 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand about the Alignment, Geometrics, Analyze and Design of Hill Roads	b	3
CO2	Know the Importance of Low Volume roads in Indian scenario & Analyze and design Low Volume Roads including quality control aspects	e	2
CO3	Know the Importance of Desert Roads, and Guidelines for Design	e	2
CO 4	Know the Importance of Roads in Swampy, water-logged areas and in Black cotton Soil, Versatile with various components of Special Roads such as Expressways, Toll Roads, Urban Roads.	e	2

SYLLABUS:

Hill Roads: General Considerations, Alignment of Hill Roads, Geometrics of Hill Roads, Design & Construction of Hill Roads, Drainage in Hill Roads, Maintenance Problems in Hill Roads, Tunnels, Miscellaneous Structures in Hill Roads, Landslides, Snow Removal.

Low Volume Roads: Introduction, Types of Rural Road Pavements, Use of Low Grade Aggregates and Stabilized soil, Pavement Design for Low volume Roads, Technologies in Rural Road Construction and Maintenance, Appropriate Quality control in Rural Road Construction.

Desert Roads: Desert Regions in India, Sand Dunes, their functions and Type, Principles of Road Location in Dune Areas, Guidelines for Design, Maintenance.

Roads in Swampy and water-logged Areas and in Black cotton Soils: Swampy Ground, Water-logged Area its Features, Treatment of Roads in water-logged areas, Roads in Black Cotton Soils.

Special Roads: Expressways - Common Terms, Features of Expressways, Design Standards, Safety Barriers, Expressway Signs and Markings. Toll Roads - Background, Advantages and disadvantages of toll roads, Forms of Toll Projects, International Experience on Toll Roads. Urban Roads - Functional Classification of Roads in Urban Area, Pedestrian Facilities on Urban Roads, Separate Cycle Tracks and Bus Facilities.

Text Books:

1. Dr. L. R. Kadiyali & Dr. N. B. Lal Principles and practices of highway Engineering Khanna publishers, Latest Edition

Reference Books:

1. K.Khanna & C.J.Justo, Highway Engineering Nemchand & Bros., Latest Edition.

CODES:

1. MORT&H Guidelines for Expressways Part-I and Part-II
2. MORT&H Guidelines for Maintenance Management of Primary, Secondary and Urban Roads
3. IRC:86-1983 Geometric Design Standards for Urban Roads in Plains
4. IRC:52-2001 Recommendations About the Alignment Survey and G.Design of Hill Roads
5. IRC:SP:48-1998 Hill Road Manual
6. IRC:SP:72-2007 Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads
7. IRC:SP:20-2010 Rural Roads Manual
8. IRC:SP:62-2004 Guidelines for the D&C of Cement Concrete Pavement for Rural Roads
9. MORD Specifications for Rural Roads
10. MORD Standard Data Book for Analysis of Rates for Rural Roads
11. IRC:34-2011 Recommendations for Road Construction in Areas Affected by Water Logging, Flooding and/or Salts Infestation (First Revision)

Note: Use Latest codes if revised

TRAFFIC ENGINEERING

Course code : 15 CE 4168 **L T P :** 3-0-0

Pre Requisite : 15 CE 3115 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Apply the Concepts of Probability in traffic Engineering	b	2
CO2	Know the Fundamental design concepts of Interchanges, Parking Facilities, Freeways	h	2
CO3	Design Traffic Facilities include Un signalized Intersections (Rotary), Signalized Intersection (signal design)	b	2
CO 4	Know the Accident Situation in India, road safety measures, Understand Detrimental Effects of traffic on the environment	h	2

SYLLABUS:

Statistical Methods for Traffic Engineering: Need, Elementary concepts of Probability, Mean, Standard Deviation and Variance, Poisson and Binomial Distribution, Normal Distribution, Sampling Theory and Significance Testing, Linear Regression and Correlation, Multiple Linear Regression

Traffic Flow Theory: Introduction, Fundamentals of Traffic Flow, Uninterrupted Traffic Flow Stream Characteristics, Data Collection, Microscopic and Macroscopic Traffic flow Parameters, Capacity and LOS, Fundamentals of Interrupted Traffic flow Shock Waves

Design of Traffic Facilities: Introduction, Freeways, Intersections Un signalized Intersections, Signalized Intersections, Interchanges Warrants for Interchanges, Design of Interchanges, Parking Facilities Parking Demand, On street parking, Off street Parking, Parking stalls, Vehicle Circulation, Road Signs.

Traffic Safety: Road Accidents, Accident Situation in National & International, Road, Weather and its effect on accidents, Speed in relation of Safety, Pedestrian Safety, Parking and its Influence, Traffic Management Measures and its Influence, Legislation, Enforcement, Education and Propaganda, Cost of Road Accidents, Road Safety Audit.

Traffic and the Environment: Introduction, Detrimental Effects of traffic on the environment Noise, Air pollution, Vibration, Visual Intrusion and degrading the aesthetics, Severance and Land Consumption, Evaluation Procedures, Environmental Areas, Situation in India.

Text Books:

1. Dr. L. R. Kadiyali & Dr. N. B. Lal Principles and practices of highway Engineering Khanna publishers (2003).
2. Partha Chakroborty and Animesh Das. Principles of Transportation Engineering Prentice Hall of India, New Delhi, 2003.

Reference Books:

1. Principles of Highway Engg., and Traffic Analysis by Fred L. Mannering etc., Wiley Publications, 4th edition, 2012 reprint
2. Transportation Engineering by C . Jotin Khisty, B.Kent Lall, Prentice Hall of India, New Delhi, 2008.

ADVANCED PAVEMENT DESIGN ENGINEERING

Course code : 15 CE 4169 **L T P :** 3-0-0

Pre Requisite : 15 CE 3115 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Characterize pavement materials and also carry the advance tests on bituminous mixtures	b	2
CO 2	Thorough with stresses and strains of flexible and rigid pavements.	h	2
CO 3	Thorough with analysis and design of flexible highway and airport pavements	h	2
CO 4	Thorough with analysis and design of rigid highway and airport pavements	h	2

SYLLABUS:

Material Characterization: Characterization of test types, Plate- Load Tests, Triaxial Compression Test, CBR Test, Stabilometer and Cohesionmeter. Tests for Bituminous Mixtures: Modulus of Rupture, Indirect Tensile Test, Layered input Parameter Tests, Resilient Modulus

Test, Complex (Dynamic) Modulus Test, Diametrical Resilient Modulus, Creep Test, Typical Modulus Values, Poisson's Ratio. Fatigue Testing and Permanent Deformation.

Stresses and Strains in Pavements: Stresses and Strains in Flexible Pavements, Homogeneous Mass, Layered Systems, Viscoelastic Solutions Stresses and Deflections in Rigid Pavements, Stresses Due to Curling, Stresses and Deflections Due to Loading, Stresses Due to Friction

Design of Highway Pavements: Design of Flexible Highway Pavements: Differences between Airport and Highway Pavements, Differences in Design Methods, AASHO Flexible Pavement Design, Multi Layer Elastic Analysis, The asphalt Institute Design. Design of Rigid Highway Pavements: Development of Design, Definition of Pavement types, Design Factors, Load Stresses, Thickness Design, Jointing and Reinforcement Requirements, Joints, Load-transfer Devices, Continuously Reinforced Concrete Pavements, Subgrade and Sub bases, Design of Dowel bars and Tie bars.

Design of Airport Pavements: Design of Flexible Airport Pavements: Corps of Engineers (CBR) Method, FAA, CDOT. Design of Rigid Airport Pavements: Determination of Modulus of Subgrade Reaction, Modulus of Rupture, Factor of Safety, Design Charts, PCA, Corps of Engineers Method, FAA. Base courses, compaction requirements, Joints and Reinforcement Requirements, Joints at Intersections, Design of Steel Reinforcement, and Continuously Reinforced concrete pavements, Use of Steel Section and Junction of Flexible and Rigid Pavements.

Text Books:

1. Yoder & wit zorac Principles of pavement design Jhonwilley & Sons.

Reference Books:

1. Yang H. Huang, Pavement Analysis and Design Pearson.
2. Relevant codes and handouts of abroad practices.

URBAN TRANSPORT SYSTEMS PLANNING

Course code : 15 CE 4170 **L T P :** 3-0-0

Pre Requisite : 15 CE 3115 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Learn the concept of travel demand and supply and modes available for transportation	b	2
CO 2	Understand the different types of Traffic Surveys used in planning	h	2
CO 3	Identify and analyze trips as a part of transport planning	b	2
CO 4	Plan Public Transport Systems, Utilize ITS in Transport Planning	b	2

SYLLABUS:

Transportation Planning: Introduction to transportation planning; systems approach to transportation planning; types of models; concept of travel demand and supply; socio-economic, land use, network, and transport system characteristics affecting transportation planning.

Transportation Survey: Study area definition, zoning principles, cordon and screen lines, data collection through primary and secondary sources, sampling techniques.

Sequential modeling approach: Four-stage sequential modeling approach; trip generation; trip distribution; modal split; trip assignment.

Planning For Public Transport: Public transport planning, Fares and Subsidies Introduction to Intermediate Public Transport Type and Characteristics of IPT Modes in India, Integration of different modes.

Urban and intelligent transportation systems: ITS, first generation of ITS and it's applications, ITS in Various Countries, Mature ITS Applications, Safety and Liability, Second Generation of ITS

Text Books:

1. Dr. L. R. Kadiyali & Dr. N. B. Lal Principles and practices of highway Engineering Khanna publishers (2003).
2. Partha Chakroborty and Animesh Das. Principles of Transportation Engineering Prentice Hall of India, New Delhi, 2003.

Reference Books:

1. Fred L. Mannering etc., Principles of Highway Engg., and Traffic Analysis Wiley Publications, 4^{th} edition, 2012 reprint
2. C. Jotin Khisty, B.Kent Lall, Transportation Engineering Prentice Hall of India, New Delhi, 2008.

RAILWAYS, DOCKS, HARBORS AND AIRPORTS

Course code : 15 CE 4171 **L T P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand about the Classification of Railways, Permanent Way & its components, functions.	b	3
CO2	Analyze track alignment, geometric elements, Horizontal and Vertical curves, super elevation, and Negative Super elevation.	e	2
CO3	Understand about the various factors affecting Selection of site for Airport.	b	3
CO 4	Geometric Design of Runway, Computation of Runway length, Correction for runway length, Understand the layout of port components and operation of navigational aids that involved in functions of ports.	e	2

SYLLABUS:

Railway Engineering: Historical Development of Railways in India, Advantages of Railways, Classification of Railways, Permanent Way & its components, functions. Track volume and Track capacity. Rail Joints, Welding of rails and Creep of rails;

Track Geometric Design - Gradients, Horizontal and Vertical curves, super elevation, Negative Super elevation, Coning of Wheels. Turnouts: Left/ Right Hand Turnout, Track Junctions, Points and crossings, Tracks Drainage, Railway Stations and Yards, Signaling.

Airport Engineering: Factors affecting Selection of site for Airport Aircraft Characteristics

Geometric Design: Geometric Design of Runway- Computation of Runway length Correction for runway length Orientation of Runway –geometric design of taxiway, Wind Rose Diagram Runway Lighting system.

Dock & Harbour Engineering: Layout of Port components Functions Classification of Ports Site selection Natural Phenomenon Tides, Winds, Waves, Currents Drift Navigational aids. Harbours - layouts, shipping lanes, anchoring, location identification; Littoral transport with erosion and deposition; sounding methods; Dry and Wet docks, components and operational Tidal data and analyses.

Text Books:

1. S.C. Saxena & S. Arora. Railway Engineering
2. S.K.Khanna and Arora,Nemchand Bros. Airport Planning and Design
3. Srinivasan Dock & Harbour

Reference Books:

1. Rangwala. Railway Engineering
2. Virendhra Kumar & Statish Chandhra Air Transportation Planning & design Gal Gotia Publishers (1999).
3. Ozha & Ozha Dock & Harbour Engineering

MODERN CONSTRUCTION MATERIALS

Course code : 15 CE 3255 **L T P :** 3-0-0

Pre Requisite : 15 CE 2206 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To understand about structure of solids	e	2
CO 2	To understand about material behaviour	k	2
CO 3	To understand about structural materials	k	2
CO 4	To understand about non structural materials	k	2

SYLLABUS

Basics- Prologue Introduction to the course ,Science, Engineering and Technology of MaterialsMicrostructure- Atomic Bonding, Structure of Solids, Movement of Atoms, Development of Microstructure.

Material Behaviour- Surface Properties, Response to Stress, Failure Theories Fracture Mechanics, Rheology, Thermal Properties

Structural Materials- Review of Construction Materials and Criteria for Selection, Wood and Wood Products, Polymers ,Fibre Reinforced Polymers, Bituminous Materials, Metals, Concrete, Glass,

Non-structural materials, accessories and finishes- Review of Non-structural Materials and Criteria for Selection, Waterproofing materials, Polymer Floor Finishes, Paints, Tiles, Acoustic Treatment, Dry walls, Anchors,

Closure: Environmental Concerns, Social Perception of Construction Materials, Closure,Extra

Videos and Reading Material: Visit to Showroom for Tiles, Fittings and Accessories, Sanitary Fittings, Pipes

Text Book:

1. P.C. Varghese, Building Materials, Prentice-Hall India, 2005.
2. W.D. Callister, . Materials Science and Engineering: An introduction John Wiley, 1994.
3. V. Raghavan, Materials Science and Engineering, Prentice Hall, 1990.

Reference Books:

1. R.A. Higgins, Properties of Engineering Materials Industrial Press, 1994.
2. Eds. J.M. Illston and P.L.J. Domone, Construction materials: Their nature and behaviour 3rd ed., Spon Press, 2001.
3. J. F. Young, S. Mindess, R.J. Gray & A. Bentur, The Science and Technology of Civil Engineering Materials, Prentice Hall, 1998.
4. M. F. Ashby and D.R.H. Jones, Engineering Materials 1: An introduction to their properties & applications,Butterworth Heinemann, 2003.
5. J. P. Schaffer, A. Saxena, S.D. Antolovich, T.H. Sanders and S.B. Warner, The Science and Design of Engineering Materials Irwin, 1995.
6. P. K. Mehta and P.J.M. Monteiro, Concrete: Microstructure, properties and materials, McGraw Hill, 2006.
7. A.M. Neville, Properties of concrete Pearson, 2004.

ADVANCED CONCRETE TECHNOLOGY

Course code : 15 CE 4172 **L T P :** 3-0-0

Pre Requisite : 15 CE 2206 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To identify materials in natural admixtures	e	2
CO2	To undertand about non distructive evaluation and fibre reinforced concerete	k	1
CO3	To know about high performance concrete	k	1
CO4	To know about the materials in high performance concrete	k	1

SYLLABUS:

Materials: Cement, Aggregates, mixing water soundness of aggregate- Fresh and hardened concrete: Admixtures- types of admixtures- purposes of using admixtures- chemical composition- effect of admixtures on fresh and hardened concretes- Natural admixtures.

Non destructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects Visual investigation- Acoustical emission methods- Corrosion activity measurement- chloride content Depth of carbonation- Impact echo methods- Ultrasound pulse velocity methods- Pull out tests.

Fibre reinforced concrete: Properties of constituent materials- Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes.

Light weight concrete: Introduction- properties of light weight concrete- No fines concrete- design of light weight concrete.

Flyash concrete: Introduction- classification of flyash- properties and reaction mechanism of flyash- Properties of flyash concrete in fresh state and hardened state- Durability of flyash concretes.

High performance concretes: Introduction- Development of high performance concretes- Materials of high performance concretes- Properties of high performance concretes.

TEXT BOOKS

1. A.M. Neville, Concrete Technology Pearson Edition.
2. M.E. Grambhir, Concrete Technology Tata Mc Graw- Hill Publishing Company Ltd.
3. M.S Shetty, Concrete technology S. Chand & Company (Pvt) Ltd., New Delhi.
4. Rafat Siddique Special Structural concrete.

ADVANCED SURVEYING

Course code : 15 CE 4173 **L T P :** 3-0-0

Pre Requisite : 15 CE 2105 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand basic concepts of surveying and Applying surveying equipment based on nature of work	a	1
CO 2	Able to make use of total station	k	2
CO 3	Able to understand advanced surveying	k	2
CO 4	Able to survey using GPS as a tool	k	2

SYLLABUS:

Control Surveying: horizontal and vertical control - methods - specifications - triangulation-baseline - instruments and accessories - corrections - satellite stations - reduction to centre-trigonometrical levelling - single and reciprocal observations - traversing gale's table.

Total Station Surveying: basic principle - classifications -electro-optical system: measuring principle, working principle, sources of error, infrared and laser total station instruments. microwave system: measuring principle, working principle, sources of error, microwave total station instruments. comparis on between electro-optical and microwave system. care and maintenance of total station instruments. modern positioning systems - traversing and trilateration.

GPS Surveying: Basic concepts - different segments - space, control and user segments - satellite configuration - signal structure - orbit determination and representation - anti spoofing and selective availability - task of control segment - hand held and geodetic receivers -data processing - traversing and triangulation.

Advanced Topics In Surveying: Route surveying - reconnaissance - route surveys for highways, railways and waterways - simple curves - compound and reverse curves - setting out methods - transition curves - functions and requirements - setting out by offsets and angles - vertical curves - sight distances

TEXT BOOKS:

1. James M. Anderson and Edward M. Mikhail, "Surveying, Theory and Practice", 7th Edition, McGraw Hill, 2001.
2. Bannister and S. Raymond, "Surveying", 7th Edition, Longman 2004.
3. Laurila, S.H. "Electronic Surveying in Practice", John Wiley and Sons Inc, 1993

REFERENCES:

1. Alfred Leick, "GPS satellite surveying", John Wiley & Sons Inc., 3rd Edition, 2004.
2. Guocheng Xu, "GPS Theory, Algorithms and Applications", Springer Berlin, 2003.
3. Satheesh Gopi, rasathishkumar, N. madhu, "Advanced Surveying, Total Station GPS and Remote Sensing" Pearson education, 2007.

GREEN BUILDINGS

Course code : 15 CE 4174 **L T P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand necessity and role of green buildings & regarding Indian green building council	a	1
CO2	Design green buildings considering water, site, material parameters	k	2
CO3	Carry passive solar design	k	2
CO 4	Handle construction and maintenance of green buildings	k	2

SYLLABUS:

Green Buildings, Green Building Principles, Benefits of green building Global warming, requirement of Green Building, Rating Systems IGBC, GRIHA, USGBC, LEED, BREEAM, CASBEE, GBTool, HK–Beam, Requisites for Constructing a Green Building, sustainable construction focus point: site, water, energy, material, indoor air quality, construction procedures.

Rating systems in India, IGBC green home rating system, Benefits of IGBC, procedure to get IGBC certification, procedure to become IGBC certified engineering professional, GRIHA ratings, procedure to get GRIHA certification.

Site issues: site analysis and design, site development and layout, Building and Site Requirements, Transportation, Plant Materials and Management.

Water issues: watershed protection, drainage of concentrated Runoff, water efficiency and conservation, rain water harvesting, water reclamation,

Sustainable materials: Reduce / Reuse / Recycle, Natural Sources, concrete, masonry, metals, wood and plastic, finishes. Green paints

Passive solar design, Day lighting, Building envelope, Renewable energy, Significance, design principle, ventilation control, occupant activity control, significance of acoustics.

Environmental construction guidelines, building operations and maintenance.

Economics of green buildings, Selecting environmentally and economically balanced building materials, Project cost, Income and expenses.

Text Books (**Max. 2 books**):

1. R. K. Gautham, Green homes, BS publications.
2. Public Technology Inc., US Green Building Council. Sustainable building technical manual- Green building design, constructions and operation
3. A bridged reference guide to IGBC Green homes rating system Version 1.0

Reference Books:

1. Tree Hugger Consulting. Green Building A Basic Guide to Building and Remodeling Sustainably

2. Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison; E & FN Spon, an imprint of Thomson Science & Professional Green BIM: Successful Sustainable Design with Building Information Modeling, Eddy Krygiel, Bradley Nies, Green Building Handbook, Volume 1 Willy publishing Inc

CONSTRUCTION MANAGEMENT

Course code : 15 CE 4175 **L T P :** 3-0-0

Pre Requisite : 15 CE 2207 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To understand unique features of construction	a	1
CO2	To know about bar charts and networks and resource scheduling PERT	e	2
CO3	To know about Planning in construction site and resources	e	2
CO4	To know about organizing construction cost and montoring as well as control supervision	e	2

SYLLABUS:

Construction: Unique features of construction, construction project, types and features, phases of a project, agencies involved and their methods of execution.

Construction project planning: Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, estimating durations, sequence of activities, activity utility data.

Techniques of planning: Bar charts, Networks: basic terminology, types of precedence relationships: finish to start, start to start, finish to finish, start to finish, preparation of CPM networks: activity on link and activity on node representation, analysis of single relationship (finish to start) networks, computation of float values, critical and semi critical paths, calendering networks.

Resource Scheduling: Bar chart, line of balance technique, resource constraints and conflicts, resource aggregation, allocation, smoothening and leveling.

PERT: Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion.

Planning and organizing construction site and resources- Site: site layout, developing site organization, record keeping at site, Manpower: planning, organizing, staffing, motivation, Materials: concepts of planning, procurement and inventory control, Equipment: basic concepts of planning and organizing, Funds: cash flow, sources of funds.

Construction costs: Classification of costs, time cost trade-off in construction projects, compression and decompression.

Monitoring & control-Supervision: record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety and health on project sites: accidents; their causes and effects, costs of accidents, occupational health problems in construction, organizing for safety and health.

Text Books

1. Barrie D.S. & Paulson B C, Professional Construction Management, McGraw Hill.
2. Chitkara K K, Construction Project Management, Tata McGraw Hill.

Reference Books

1. P K Joy, Handbook of Construction Management.
2. King & Hudson, Construction Hazard and Safety Handbook, Butterworths.
3. Antill J M & Woodhead R W, Critical Path Methods in Construction Practice, Wiley.

DEAPRTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

DIGITAL SYSTEM DESIGN

Course Code : 15 EC 1101 **L–T–P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand numerical and character representations in digital logic, number system, data codes and the corresponding design of arithmetic circuitry.	e	2
CO2	Understanding Logic gates, Logic theorems, Boolean algebra and SOP/POS expressions.	e	2
CO3	Combinational and sequential systems design using standard gates and filp-flops and minimization methods	e,k	2
CO4	Verilog HDL design for logic gates, combinational and sequential Logic Functions.	e,k	2
CO5	Concepts of Programmable Logic devices.	e,k	2

SYLLABUS:

Basic Principles of Digital Systems: Digital Versus Analog Electronics, Digital Logic Levels, Review of Number systems, Digital Waveforms, Classification of codes. Logic Functions and Gates: Basic Logic Functions, Derived Logic Functions, DeMorgan's Theorems and Gate Equivalence, Enable and Inhibit Properties of Logic Gates, Integrated Circuit Logic Gates.

Boolean Algebra: Boolean Expressions, Logic Diagrams and Truth Tables, Sum of Products and Product of Sums Forms, Theorems of Boolean Algerba, Simplifying SOP and POS Expressions, Simplification by the Karnaugh Map Method, Simplification by DeMorgan

Equivalent Gates, Universal Property of NAND/NOR Gates. Multilevel Circuits Conversions. Verilog Constructions to Logic Gates.

Combinational Logic Functions: Decoders, Endoders, Multiplexers, Demultiplexers, Magnitude Comparators, Parity Generators and Checkers, Adder and Substractor. Sequential Logic Functions: Latches, NAND/NOR Latches Gated Latches, Edge- Triggered Flip-flops. Registers and Counters: Shift register, Register with parallel load, Bidirectional shift register with parallel load. Ripple counter, Synchronous Counters, up-down counter, Ring counter, Johnson Counter, Modulus counter. Finite State machines: Mealy and Moore machines, state diagram, Introduction to ASM charts. Verilog HDL design for Combinational and Sequential Logic Functions.

Programmable Logic Devices: Programmable Logic Array (PLA), Programmable Array Logic (PAL), Programming of PLAs and PALs, Complex Programmable Logic Devices, Fild-Programmable Gate Arrays, Using CAD Tools to Implement Circuits in CPLDs and FPGAs, Applications of CPLDs and FPGAs, Custom chips, Standard Cells, and Gate Arrays.

Text Books

1. Stephen Brown and Zvonko Vrane "Fundamentals of Digital Logic with Verilog Design" Second Edition, McGraw-Hill.
2. Robert K. Dueck, "Digital Design" Cengage Learning-India Edition.
3. M. Morris Mano, "Digital Logic and Computer Design", Pearson

Reference Books

1. R. P. Jain, "Modern Digital Electronics", McGraw-Hill
2. J. Bhasker , "Verilog HDL Synthesis, A Practical Primer", Star Galaxy Publishing.
3. ZviKohavi, "Switching and Finite Automata Theory", 2nd Edition, TMH

ANALOG ELECTRONIC CIRCUIT DESIGN

Course Code : 15 EC 2103 **L–T–P:** 2-4-2

Pre Requisite : NIL **Credits :** 5

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the industrial processes and organizations connected with the profession and relate classroom learning with real life situation by taking into the consideration of various design concepts	c	3
CO2	Understanding the concepts of various diodes and their applications.	c	3
CO3	BJT concepts as operation, biasing and frequency response	c,k	3
CO4	FET concepts as operation, biasing and frequency response	c,k	3
CO5	Feedback concepts and their analysis	c,k	3
CO6	Concepts of various oscillators and applications.	c,k	3

SYLLABUS:

P-N Junctions: Diode theory, forward and reverse-biased junctions, reverse-bias breakdown, load line analysis, diode applications - Limiters, clippers, clampers, voltage multipliers, half wave & full wave rectification, Capacitor filters, ϖ-section filter, ripple factor, Special purpose diodes - Zener diode, Varactor, light emitting diodes, Laser diodes. Regulators: Series and shunt voltage regulator, percentage regulation, Concept of SMPS.

Transistor biasing & stability: Q point, Self-Bias-CE, Compensation techniques, h-model of Transistor, Expression of voltage gain, current gain, input & output impedance, Trans-resistance & Trans-conductance, Emitter follower circuits, High frequency model of Transistor, FET fundamentals, Configurations, current-voltage characteristics, parameters of JFET, Biasing of JFET, Biasing of MOSFET.

Transistor amplifiers: RC coupled amplifier, Function of all components, Equivalent circuit, derivation of voltage gain, Current gain, Input impedance & output impedance, Frequency response characteristics, Lower & upper frequencies, Bandwidth, Concept of Wide band amplifier, FET small signal model, Common drain common gate configurations.

Operational amplifiers: Ideal OPAMP, Differential amplifier, Constant current source, CMRR, Open & closed loop circuits, importance of feedback loop (positive & negative), inverting & non-inverting amplifiers, Voltage follower circuits.

Application of Operational amplifiers: Adder, Integrator & Differentiator, Comparator, Schmitt Trigger, Instrumentation Amplifier, Log & Antilog amplifier, Trans-conductance multiplier, Precision rectifier, Voltage to current & Current to voltage converter.

Filter Circuits: Analysis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier.

Feedback amplifier & Oscillators: Concept of Feedback, Negative & Positive feedback, Voltage/Current, Series/Shunt feedback, Berkhausen criterion, Colpit, Hartley's, Phase shift, Wien bridge, & Crystal oscillators.

Power amplifiers: Class A, B, AB, C, Conversion efficiency, Distortion.

Multivibrators: Monostable, Bistable multivibrators, Monostable & Astable operation using 555 timer.

Special function circuits: VCO & PLL

Text Books:

1. Muhammad H. Rashid, "Microelectronic Circuit Analysis and Design", Oxford Press.
2. Sedra & Smith, "Micro-Electronic Circuits theory and applications" 2nd edition, Cengage Learning.

Reference Books:

1. Jacob Millman & Christos C. Halkias, "Integrated Electronics", Tata -McGraw Hill, 2nd Edition, (2010).
2. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", PHI. 9th Edition.

DESIGN WITH CPLD AND FPGA

Course Code : 15 EC 2204 **L–T–P :** 2-2-2

Pre Requisite : 15 EC 1101 **Credits :** 4

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Study and design of combinational and sequential circuits using PLDs and state machines.	c	2
CO 2	Understand Full-custom & Semi Custom design methodologies of for designing different PLD architectures.	c,k	2
CO 3	To study PLD structures and design process	c	2
CO 4	Study of different CPLD and FPGA architectures	c	2
CO 5	To understand different physical process.	c,k	2

SYLLABUS:

Programmable Logic Design: Combinational circuit realization using: PLDs – ROM, PLA and PAL. Analysis of Clocked Sequential Circuits: State table, State diagram, State Equation, State reduction, state Assignment. Flip Flop Excitation Tables, Design Procedure.

ASIC Design: Full Custom Design; Semicustom Design; Standard Cell Based ASIC, Gate Array Based ASIC, Programmable Logic Devices, CPLDs, FPGA, ASIC Design Flow, Economics of ASICs, ASIC Cell Library. Programmable ASICs: The Antifuse, Static RAM, EPROM and EEPROM.

Programmable Logic Devices: MOS Programmable Logic Device (PLD); Sequential PLD; Complex PLD; Field Programmable Gate Array (FPGA); Xilinx SRAM-Based FPGA; Comparison between FPGA, ASIC and CPLD; FPGA based system design.

Complex Programmable Logic Devices (CPLDs): PAL16L8, PAL20P8, PAL20R8, PALCE16V8, GAL22V10, Altera Series- MAX 7000S, FLEX 10K architectures.

Field Programmable Gate Arrays (FPGAs): Xilinx – XC2000, XC3000, XC4000, Altera – FLEX 8000, Actel – ACT – 1, 2, 3 architectures.

Computer Aided Design Tools: Synthesis: Netlist Generation, Gate Optimization, Technology Mapping. Physical Design: Placement, Routing, Static Timing Analysis.

Text Books

1. Michael John Sebasatian Smith, "Appliction Specific Integrated Circuits" Pearson Education.
2. M. Morris Mano, "Digital Logic and Computer Design", Pearson.
3. Stephen M. Trimberger, "Field-Programmable Gate Array Technology", Springer.
4. Stephen Brown and Zvonko Vranesic "Fundamentals of Digital Logic with Verilog Design" McGraw-Hill.

Reference Books

1. Pak K. Chan, Samiha Mourad, "Digital Design Using Field Programmable Gate Array", Pearson Education (2009).
2. Parag K. Lala, "Digital System Design Programmable Logic Devices", B S Publications
3. Debaprasad Das, "VLSI Design", Oxford (2011).
4. Robert K. Dueck, "Digital Design with CPLD Applications and VHDL", Thomson – Delemar Learning.

COMMUNICATION THEORY-I

Course Code : 15 EC 2205 **L–T–P :** 2-2-2

Pre Requisite : 15 EC 2103 **Credits :** 4

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	have a good understanding of both time and frequency domain representations of signals;	b,k	2
CO2	have a good understanding of analog modulation and demodulation techniques;	b,k	2
CO3	have a good understanding of digital modulation and demodulation techniques; and	b,k	2
CO4	Understanding pulse modulation systems	b,k	2
CO5	Understand and be able to implement noise and error analysis of an analogue system.	b,k	2
CO6	Understand and be able to implement noise and error analysis of an analogue or digital telecommunication system.	b,k	2

SYLLABUS:

Fundamentals of Communication systems: Introduction, Energy-power and their spectral densities, spectral characteristics of periodic signals, random signals and noise, probability distribution functions, mean, correlation and covariance functions and correlation and spectral densities.

Analog Modulation Systems: Need for Modulation, Frequency Translation methods. Linear Modulation techniques: AM, DSB-SC, SSB and VSB modulation techniques. Demodulators: Synchronous, and envelope detectors Superhetrodyne AM Receiver. AM systems in the presence of noise. Angle Modulation: Phase and Frequency Modulation techniques. Narrow Band FM and Wide Band FM, Carson s Rule, Indirect and direct methods of Frequency Modulation. FM receivers, FM systems in the presence of noise. Pre emphasis and De-emphasis, Basic of PLL: AM and FM demodulation using PLL.

Pulse modulation Systems: PAM, PWM and PPM

Digital Modulation Systems: Pulse Modulation: Baseband signals. Sampling process; Quantization Process; Quantization Noise; Pulse-Code Modulation; Noise Considerations in PCM Systems; Differential Pulse-Code Modulation; Amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Multiple Access Techniques: TDMA, FDMA and CDMA.

Information theory and Error Coding: Measure of information – Entropy – Source coding theorem – Channel capacity – Shannon-Hartley law – Shannon's limit-Error, control Codes – Linear codes, Cyclic codes, Convolution Coding.

Text Books:

1. Lathi, "Modern Digital & Analog Communications Systems", 2e,Oxford University Press
2. Simon Haykin and Michael Moher, "An Introduction to Analog & Digital Communications", 2nd Ed., Wiley, (2007).

3. Loen W. Couch, "Modern Communication Systems: Principles & Applications", Prentice Hall, (P621.382/84), (1995).
4. Tomasi, Wayne, "Electronics Communication Systems- Fundamentals through advanced", 4th Edition.

Reference Books:

1. H Taub & D. Schilling, Gautam Sahe, "Principles of Communication Systems", TMH, 3rd Edition, (2007).
2. Bruce Carlson, Paul B. Crilly and Janet C. Rutledge, "Communication Systems: An Introduction to Signals and Noise in Electrical Communications", 4th Edition, McGraw-Hill, (2002).
3. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, (2001).
4. Nevio Benvenuto, Roberto Corvaja, Tomaso Erseghe, and Nicola Laurenti, "Communication Systems: Fundamentals and Design Methods", John Wiley & Sons, (2006).
5. Andrew J. Viterbi & Jim K. O, "Principles of Digital Communication and Coding", McGraw-Hill Book Company.
6. Bernard Sklar, "Digital Communications - Fundamentals and Applications", 2E, Prentice Hall.
7. Sam Shanmugam, K, "Digital and Analog Communication Systems", Wiley publisher (2006).

SIGNAL PROCESSING

Course Code : 15 EC 2103 **L–T–P:** 2-4-2

Pre Requisite : 15 EC 2002 **Credits :** 4

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand various signals and model physical process using them.	e	2
CO2	Acquaint with various a transformation methods and their potential for applicability in various signal analysis conditions	e	2
CO3	Demonstrate sampling and its potential applications in communications, discrete signal acquisition etc.,.	e	2
CO4	Evaluate discrete system behavior and its response to facilitate system design.	e	2
CO5	Design a low pass discrete time system to meet noise elimination like applications	e, k	2,3
CO6	Analyze non stationary signals and analyze them in both time frequency domains.	e, k	2,3

SYLLABUS:

Multi-rate Digital Signal Processing: Decimation by A factor D- Interpolation by a Factor I - Sampling Rate Conversion by a Rational Factor I/D Filter Design and Implementation for sampling rate Conversion: Direct form FIR filter structures – Poly-phase filter structures - Time Variant filter structure, Multistage Implementation of Sampling Rate Conversion, Perfect Reconstruction and Aliasing Removal.

Matrix Analysis: Toeplitz Matrices and Fast Algorithms.

Wavelet Transform: Pyramid and Cascade Algorithms, Daubechies Wavelets, Orthogonal and Biorthogonal Wavelets, Smoothness, Approximation, Boundary Filters and Wavelets, Time-Frequency and Time-Scale Analysis, Second-Generation Wavelets.

Design Methods: Spectral Factorization, Cosine-Modulated Filter Banks, Lattice Structure, Ladder Structure (Lifting.)

Applications: Audio and Image Compression, Quantization Effects, Digital Communication and Multicarrier Modulation, Trans-multiplexers, Text-Image Compression: Lossy and Lossless, Medical Imaging and Scientific Visualization, Edge Detection and Feature Extraction, Seismic Signal Analysis, Geometric Modeling, Matrix Preconditioning, Multiscale Methods for Partial Differential Equations and Integral Equations.

Simulation Software: MATLAB® Wavelet Toolbox, Software for Filter Design, Signal Analysis, Image Compression, PDEs, and Wavelet Transforms on Complex Geometrical Shapes.

Text Books:

1. Strang, and Nguyen. "Wavelets and Filter Banks", Wellesley-Cambridge Press, (1997).

2. M. Vetterli and J. Kovacevic, "Wavelets and Subband Coding", Prentice Hall-PTR, (1995).

CMOS VLSI DESIGN

Course Code : 15 EC 3107 **L–T–P:** 2-2-2

Pre Requisite : 15 EC 1101 **Credits:** 4

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	To understand the VLSI fabrication process and to be able to interact with integrated circuit process engineers	b	2
CO2	To analysis the theory and CV characteristics of MOS transistor	b	2
CO3	To analysis MOS gate static and switching characteristics	b	2
CO4	To design and layout MOS logic circuits	k	3
CO5	Circuit Characterization and Performance Estimation and scaling	k	3
CO6	Logic and Fault Testing	b,k	2,3

SYLLABUS:

Technology Introduction: Introduction to IC Technology – MOS, PMOS, NMOS and CMOS Technologies. VLSI Fabrication, Oxidation, Lithography, Diffusion, Ion Implantation, Metallization. MOS Theory Analysis: Basic Electrical Properties of MOS Circuits: Ids-Vds Relationships, MOS Transistor Threshold Voltage Vth, gm, gds, Figure of Merit □o, Short Channel and Narrow Channel Width Effects. Pass Transistor, Transmission Gate, NMOS Inverter, Various Pull-ups, CMOS Inverter Analysis and Design, Bi-CMOS Inverters, Latch up in CMOS Circuits. CMOS Circuits and Logic Design Rules: MOS Layers, Stick Diagrams, Layout, Design Rules, Rules for Vias and Contacts, Stick Diagrams and Simple Symbolic Encodings for NMOS, CMOS and BiCMOS Logic Gates. Scaling of MOS Circuits. CMOS Circuit Charactersation and Performance Estimation: Delay Estimation, Power Dissipation, Interconnect, Design Margin, Reliability. Logic and Fault Testing: Logic verification, Fault Models, Scan Design Test, Built-in Self Test.

Text Books

1. Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, "Essentials of VLSI Circuits and Systems" PHI, EEE, (2005) Edition.
2. Neil H. E. Weste and David, Harris Ayan Banerjee, "CMOS VLSI Design" Pearson Education, (1999).

References Books

1. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits", TMH (2003).
2. Jan M. Rabaey, "Digital Integrated Circuits" Pearson Education, (2003)
3. Wayne Wolf, "Modern VLSI Design ", 2nd Edition, Prentice Hall, (1998).

Simulation Text Books

1. Etienne Sicard, Sonia Delmas Bendhia, "Basics of CMOS Cell Design", TMH, EEE, (2005).

COMMUNICATION THEORY-II

Course Code : 15 EC 3108 **L–T–P:** 2-2-2

Pre Requisite : 15 EC 2205 **Credits:** 4

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the principles behind microwave transmissions, impedance matching and waveguides	b	2
CO2	Identify different antennas and their parameters	b	2
CO3	Analyze the antenna measurement techniques	b,k	2
CO4	Analyze the microwave components	b,k	2
CO5	Examine the microwave measurements using VNA and SA	b,k	2

SYLLABUS:

Transmission lines-tGeneral Solution, Physical Significance, infinite line, wavelength, propagation, Reflection Coefficient, Open and short circuited lines, Insertion loss, standing wave ratio, input impedance of open and short circuited lines, power and impedance measurement on lines, Impedance matching–single and double-stub matching, smith chart and its applications, Transmission of TM, TE and TEM waves between parallel planes, characteristic impedance, Attenuators, Rectangular and Circular Waveguides

Antenna Types: Design considerations of Resonant Antennas, Dipole antenna, Folded Dipole antenna, Yagi –Uda Antenna, Horn antenna, Slot antenna, Log periodic antenna, Microstrip antenna, Types of feeds, antenna parameters-Radiation Patterns, Radiation Intensity, Radiation

Power Density, Beam Width, Beam Area, Beam Efficiency, Directivity, Gain, Radiation Resistance, Main Lobe, Polarization, Antenna efficiency, Half Power Beam width, Effective Length and Effective Area, Antenna Arrays- Two Element Arrays, N- Element Linear Arrays, Uniform spacing, mutual coupling effects, Antenna Measurements: Introduction, Impedance/ VSWR measurements, Radiation Pattern measurements, Gain Measurements

Microwave Components Microwave Passive Devices: Impedance transformer filters, adapters, matched loads, variable attenuators, Cavity Resonators, phase shifters, Microwave Bends, Twists, Transitions, S-Parameters, E-Plane, H-Plane and Hybrid Tee, directional couplers, Isolators, circulators, frequency and wave meters, Microwave diodes-Schottky, PIN, Tunnel, Gunn, Reflex klystrons, Microwave measurements using Spectrum analyzers and Vector Network analyzers

Text Books

1. John D Ryder , "Netwotk Lines and fields", 2nd Edition, PHI
2. E. C. Jordan and Balmain, "Electro Magnetic Waves and Radiating Systems", PHI, (1968), Reprint (2003).
3. Balanis, "Antenna Theory", John Wiley & Sons, second edition, (2003).
4. Samuel Lio, "Microwave Devices and Circuits", PHI.

Reference Books

1. John D.Kraus and Ronalatory Marhefka, "Antennas", Tata McGraw-Hill Book Company, (2002).
2. Sanjiv Guptha, "Microwave Engineering", Khanna Publishers.
3. Nathan Ida, "Engineering Electromagnetics", 2nd edition, Springer (India) Pvt. Ltd., (2005) New Delhi.

COMMUNICATION THEORY-III

Course Code : 15 EC 3209 **L–T–P :** 2-2-2

Pre Requisite : 15 EC 3108 **Credits :** 4

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Describe the types and advantages of spread spectrum modulation formats	b	2
CO2	Identify the radio signal propagation mechanism and different fading concepts	b	2
CO3	Illustrate the growth of communication satellites	b,k	2,1
CO4	Identify the different phases of cellular communication concepts	b,k	2,1
CO5	Understand the optical communication transmission media and principles of operation	b,k	2,1

SYLLABUS:

Spread Spectrum Techniques: Introduction, Pseudo random sequences, a notion of spectrum, direct sequence spread spectrum with coherent BPSK. Signal-space dimensionality and processing gain.

Radio Signal Propagation mechanism: Reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading concepts: multipath and small scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and RMS delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate.

Satellite Communications: Evolution and growth of communication satellites, Kepler's laws of motion, orbits and altitude control.

Cellular Communication concepts: Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G and 3G cellular standards.

Optical communications: Characteristics of optical transmission media, optical fibers - preparation and transmission characteristics, loss and dispersion mechanisms, optical sources - principles of operation.

Introduction to Signal Detection: Integrated and dump filter, Optimum filter and Matched filter, Correlator, Error probabilities of base band signals.

Text Books:

1. Tomasi, Wayne, "Electronic Communication Systems- Fundamentals through advanced", 4th Edition.
2. T. S. Rappaport, "Wireless digital communications: Principles and practice", 2nd ed., Prentice Hall India, (2007).
3. G. Keiser, "Optical Fiber Communication".

Reference Books

1. Lathi, "Modern Digital & Analog Communications Systems", 2ed, Oxford University Press.
2. Simon Haykin and Michael Moher, "An Introduction to Analog & Digital Communications", 2nd Ed., Wiley, (2007).
3. Loen W. Couch, "Modern Communication Systems: Principles & Applications", Prentice Hall, (1995).

DIGITAL IMAGE PROCESSING

Course Code : 15 EC 4110 **L–T–P:** 2-2-2

Pre Requisite : 15 EC 2206 **Credits:** 4

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Acquire the fundamental concepts of a digital image processing system	b	3
CO2	Identify and exploit analogies between the mathematical tools used for 1Dand 2D signal analysis and processing by analysing 2D signals in the frequency domain through the Fourier transform	b,k	3
CO3	Design and implement with Matlab algorithms for digital image processing operations such as histogram equalization, enhancement	b,k	3
CO4	Design and implement with Matlab algorithms such as restoration, filtering, and de-noising which develops an appreciation for the image processing issues.	b,k	3
CO5	New techniques and be able to apply these techniques to real world problems.	b,k	3

SYLLABUS:

Introduction : Digital Image definitions ,Types of Operations ,Types of neighborhoods, Video parameters 2D convolution ,Properties of 2D convolution, 2D Fourier Transforms, Properties of 2D Fourier Transforms , Importance of phase and magnitude , Circularly Symmetric Signals, Examples of 2D Signals and transforms, Statistical Description of Images, Perception, Brightness Sensitivity, Wavelength Sensitivity , Stimulus Sensitivity, Spatial Frequency Sensitivity, Psychophysics of Color vision, Perceived color, Color metrics, CIE chromaticity coordinates, Spatial effects in color vision, Optical illusions. MATLAB Implementations.

Image Sampling: Two dimensional Sampling theory, Extensions of sampling theory, Non rectangular Grid sampling, Hexagonal sampling, Optimal sampling. Image Quantization: The optimum Mean Square Lloyd-Max quantizer, Optimum mean square uniform quantizer for non uniform densities, Analytic Models for practical quantizes, Visual quantization, Vector Quantization. MATLAB Implementations.

Image Transforms: Two dimensional orthogonal and unitary transforms, Separable unitary transforms, Basis images: Dimensionality of Image Transforms, Discrete linear orthogonal, DFT, WHT, KLT, DCT and SVD, Quantization of Transform coefficients, Transform Coding of Color images.

Image Enhancement: Contrast and dynamic Range Modification, Histogram-based operations, Smoothing operations, Edge Detection-derivative based operation, Image Interpolation and Motion Estimation, Pseudo coloring.

Image Restoration: Degradation Estimation, Reduction of Additive Noise, Reduction of Image Blurring, Simultaneous reduction of noise and blurring, Reduction of Signal dependent noise, Temporal filtering for Image Restoration, Extrapolation of Band limited Signals.

Simulation Software: MATLAB® Image processing Toolbox, Simulink for Image Analysis, PDEs, and Applications to Image Analysis.

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 3rd Edition, Hardcover August 31, (2007).
2. J. R. Parker, "Algorithms for Image Processing and Computer Vision", Paperback, December 21, (2010).
3. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Hardcover – December 26, (2003).

PROFESSIONAL ELECTIVES

ANALOG VLSI DESIGN

Course code: 15 EC 3251 **L–T–P:** 3-0-0

Pre Requisite: 15 EC 3107 **Credits:** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the functionality and Electrical Properties of MOS and BJT Devices	h	2
CO2	Analyze different passive MOS loads and frequency responses	h,i	2
CO3	Analyze different active MOS loads and frequency responses	h,i	2
CO4	Study of the different amplifiers and feedback topologies	i	2

SYLLABUS:

Basic MOS Device physics: Introduction to Analog Design, Basic MOS device Physics, second order effects, MOS device large and small signal models: Passive & Active Current Mirrors: Basic current mirrors, Cascade current mirror, Active Current Mirrors - large signal analysis, small signal analysis, Bandgap References-Supply independent biasing, Temperature independent references; Single Stage Amplifiers: Single Stage (CS,CG,CD), Cascade Stage; frequency response of CS,CD,CG; Differential and Operational Amplifiers: Basic Differential Pair, Common mode response, differential pair with MOS loads, Op-Amp topologies-One stage, Two stage, cascade, Folded Cascade, Comparison; Feedback: Properties of Feedback, Feedback equation, Feedback topologies and effect of loading, Effect of Feedback on Noise.

Text Books

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata Mc Graw Hill, (2005)

Reference Books

1. Jacob Baker, "CMOS Mixed Signal Circuit Design", John Wiley, (2008)
2. Gray & Mayer, "Analysis & Design of Analog Integrated Circuits", 4th edition, Wiley, (2001).

APPLICATIONS OF MEMS TECHNOLOGY

Course Code : 15 EC 4154 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3107 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the basic concepts of MEMS technology and Micro system design	i	2
CO2	Analyze the fabrication process methods and micro system level packaging	i,k	2,1
CO3	Study of the switching devices for MEMS devices.	i,k	2,1
CO4	Study of the Actuation mechanisms for MEMS devices	i,k	2,1

SYLLABUS:

Overview of MEMS and Micro Systems: Introduction, miniaturization, Reliability, Advantages of MEMS, working principles of chemical sensors, optical, pressure and thermal sensors, micro actuation: actuation using thermal forces, actuation using piezo electric crystals, actuation using electrostatic forces; micro accelerometers, micro fluidics, MEMS switches, phase shifters, varactors, tunable oscillators. Basics of MEMS technology: Molecular theory of matter and intermolecular forces, doping of semiconductors, the diffusion process, scaling laws in miniaturization, Engineering mechanics: static bending of thin plates, mechanical vibrations, thermo mechanics, fluid flow in nano scale. Micro system Design: Introduction, design considerations, process design, mechanical design, micro system packaging, essential packaging technologies, 3D packaging, assembly, selection of materials. Fabrication methods: Lithography: Introduction, wafers, masks, spinning resist and soft baking, exposure and post exposure treatment, resolution, mathematical expression of resist profiles ,image reversal, interface effects, radiation and resist profiles, ion implantation, diffusion, oxidation, RIE , Chemical Vapor Deposition (CVD), Physical vapor Deposition (PVD), deposition by epitaxy, comparison of bulk and surface micromachining, comparison of wet and dry etching, LIGA process, System level packaging, single and multichip packaging. Applications of MEMS-Switching: Introduction- Switch parameters- Basics of switching - Mechanical switches-Electronic switches for RF and microwave applications - Mechanical RF switches - PIN diode RF switches - RF MEMS switches: Integration and biasing issues for RF switches -Actuation mechanisms for MEMS devices-Electrostatic switching - Approaches for low-actuation-voltage switches - Mercury contact switches -Magnetic switching - Electromagnetic switching - Thermal switching.

Text Books

1. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture", Tata McGraw Hill, (2002).
2. Gabriel M.Rebeiz, "RF MEMS Theory, Design and Technology", Wiley India Pvt Ltd.
3. Vijay K.Varadan, K.J.Vinoy and K.A.Jose, "RF MEMS and Their Applications", ISBN 0-470-84308-X, 1st edition, John Wiley & Sons Ltd., West Sussex, England, (2003).

Reference Books

1. Stephen D.Senturia, "Microsystem Design", Springer International Edition, (2010).
2. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC Press, (2002).
3. Chang Liu, "Foundations of MEMS", Second Edition, Pearson Publication.

CAD FOR VLSI DESIGN

Course code : 15 EC 4155 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2204 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the VLSI design methodologies and design rules	h	2
CO2	Analyze the basic concept of floor planning, routing and simulation	h,j	2
CO3	Study of the modeling process	h,j	2
CO4	Study of the synthesis process	h,j	2

SYLLABUS:

VLSI Design Methodologies: Introduction to VLSI Design methodologies - Review of Data structures and algorithms - Review of VLSI Design automation tools - Algorithmic Graph Theory and Computational Complexity - Tractable and Intractable problems - general purpose methods for combinatorial optimization. Design Rules: Layout Compaction - Design rules - problem formulation - algorithms for constraint graph compaction - placement and partitioning - Circuit representation - Placement algorithms - partitioning Floor Planning: Floor planning concepts - shape functions and floor plan sizing - Types of local routing problems - Area routing - channel routing - global routing - algorithms for global routing. Simulation: Simulation - Gate-level modeling and simulation - Switch-level modeling and simulation - Combinational Logic Synthesis - Binary Decision Diagrams - Two Level Logic Synthesis. Modeling And Synthesis: High level Synthesis - Hardware models - Internal representation - Allocation - assignment and scheduling - Simple scheduling algorithm - Assignment problem - High level transformations.

References Books

1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, (2002).

2. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, (2002).

DESIGN FOR TESTABILITY

Course Code : 15 EC 4156 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2204 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the basic concept reliability and modeling of faults as a requisite for achieving manufacturing quality of semiconductor devices and then identifies difficulties in VLSI testing	i	2
CO2	Analyze the fault tolerant system can be viewed as a design moving through different abstraction levels, a historical view of the development of VLSI system	i	2
CO3	Study of the test pattern generation for BIST architectures	i	2
CO4	Study of the specific BIST architectures	i	2

SYLLABUS:

Basic Concepts: Need for testing, Reliability concepts, Reliability and failure rate, Relation between reliability and MTBF, Maintainability, Availability, series and parallel systems, Failure and faults, Modeling of faults, Temporary faults. Fault Diagnosis and Test Generation: Fault diagnosis and testing, Test generation for combinational logic circuits: Fault table method, Path sensitization, Boolean difference, D-Algorithm, PODEM, Kohavi algorithm, Detection of multiple faults in combinational logic circuits, Test generation for sequential logic circuits, Random testing, Transition continuous testing, Signature analysis. PLA Testing: Faults in PLA, PLA minimization, EPC Theorems, PLA folding, Foldable compatibility matrix, the Compact algorithm, the maximum folding. Fault Tolerant Design: Importance of fault tolerance, Basic concepts of fault tolerance, Static redundancy, Dynamic redundancy, Hybrid redundancy, Self purging redundancy, Sift-out reconfiguration scheme, 5MR reconfigurable scheme, Time redundancy, Software redundancy, Fail-Safe Operation, A Scheme for fault tolerant Design of VLSI chips, Fault tolerant VLSI processor arrays Design for Testability: Controllability and Observability, Design of testable combinational circuits, Design of testable sequential circuits: Scan path technique, LSSD, RAS technique; Built in self test: BIST concepts, TPG for BIST, BIST architectures-CSBL, BEST, RTS, LOCST, STUMPS, CBIST,CEBS, RTD, SST, CATS, CSTP, BILBO.

Text Books

1. P.K. Lala, "Digital Circuit Testing and Testability", Academic Press.
2. N.N.Biswas, "Logic Design Theory", Prentice-Hall.

References

1. M. Baranovichi, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico Publishing House.
2. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing For Digital, Memory And Mixed-Signal VLSI Circuits", Kluwer Academic Publishers.
3. A.L Crouch, "Design Test for Digital ICs and Embedded Core Systems", Prentice-Hall International.

DESIGN OF SEMICONDUCTOR MEMORIES

Course Code : 15 EC 4157 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3107 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the basic semiconductor memories and memory technologies	i	2
CO2	Analyze the fault modeling, testing of Ics, memory reliability and radiation effects	i,k	2,1
CO3	Study of the advanced Memory Technologies	i,k	2,1
CO4	Study of the High-Density Memory Packaging Technologies	i,k	2,1

SYLLABUS:

Random Access Memory Technologies: Static Random Access Memories (SRAMs): SRAM Cell Structures-MOS SRAM Architecture-MOS SRAM Cell and Peripheral Circuit Operation-Bipolar SRAM Technologies-Silicon On Insulator (SOI) Technology-Advanced SRAM Architectures and Technologies-Application Specific SRAM- Dynamic Random Access Memories (DRAMs): DRAM Technology Development-CMOS DRAMs-DRAMs Cell Theory and Advanced Cell Structures-BiCMOS, DRAMs-Soft Error Failures in DRAMs-Advanced DRAM Designs and Architecture-Application, Specific DRAMs. Nonvolatile Memories: Masked Read-Only Memories (ROMs)-High Density ROMs-Programmable Read-Only Memories (PROMs)-Bipolar PROMs-CMOS, PROMs-Erasable (UV) - Programmable Road- Only Memories (EPROMs)-Floating-Gate EPROM Cell-One-Time Programmable (OTP) EPROMs-Electrically Erasable PROMs (EEPROMs)-EEPROM Technology And Architecture-Nonvolatile SRAM-Flash Memories (EPROMs or EEPROM)-Advanced Flash Memory Architecture. Memory Fault Modeling, Testing, And Memory Design For Testability And Fault Tolerance: RAM Fault Modeling, Electrical Testing, Pseudo Random Testing-Megabit DRAM Testing-Nonvolatile Memory Modeling and Testing-IDDQ Fault Modeling and Testing- Application Specific Memory Testing. Reliability And Radiation Effects: General Reliability Issues-RAM Failure Modes and Mechanism-Nonvolatile Memory Reliability-Reliability Modeling and Failure Rate Prediction-Design for Reliability- Reliability Test Structures-Reliability Screening and Qualification. RAM Fault Modeling, Electrical Testing, Pseudo Random Testing-Megabit DRAM Testing-Nonvolatile Memory Modeling and Testing-IDDQ Fault Modeling and Testing-Application Specific Memory Testing. Packaging Technologies: Radiation Effects-Single Event Phenomenon (SEP)-Radiation Hardening Techniques- Radiation Hardening Process and Design Issues-Radiation Hardened Memory Characteristics-Radiation Hardness Assurance and Testing - Radiation Dosimetry-Water Level Radiation Testing and Test Structures. Ferroelectric Random Access Memories (FRAMs)-Gallium Arsenide (GaAs) FRAMs-Analog Memories-Magneto resistive. Random Access Memories (MRAMs) -Experimental Memory Devices. Memory Hybrids and MCMs (2D)-Memory Stacks and MCMs (3D)-Memory MCM Testing and Reliability Issues- Memory Cards-High Density Memory Packaging Future Directions

Text Books:

1. Ashok K.Sharma, "Semiconductor Memories Technology, Testing and Reliability", Prentice-Hall of India Private Limited, New Delhi, (1997).

Reference Books:

1. Luecke Mize Care, "Semiconductor Memory design & application", Mc-Graw Hill.
2. Belty Prince, "Semiconductor Memory Design Handbook".
3. Mikhail I. Dyakonov, "Spin Physics in Semiconductors to Perel Memory".
4. "Memory Technology design and testing", IEEE International Workshop on: IEEE Computer Society Sponsor (S), (1999).

LOW POWER VLSI DESIGN

Course Code : 15 EC 4158 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3107 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the sources of Power dissipation and approaches to minimize the power dissipation	h	2
CO2	Analyze the functionality of Analog and Digital power analysis	h	2
CO3	Study of the low power system, clock distribution	h	2
CO4	Study of the different Algorithms & Architectural Level Methodologies	h	2

SYLLABUS:

Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches, Physics of power dissipation in CMOS devices. Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing& gate oxide thickness, Impact of technology Scaling, Technology & Device innovation Probabilistic Power Analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. Low Power Design Circuit Level: Power consumption in circuits. Flip Flops & Latches design, high capacitance nodes, low power digital cells library. Logic Level: Gate reorganization, signal gating, logic encoding, state machine encoding, precomputation logic. Low Power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design. Low Power Clock Distribution: Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network.

Algorithm & Architectural Level Methodologies: Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis.

Text Books

1. Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, (2002)
2. Rabaey, Pedram, "Low Power Design Methodologies" Kluwer Academic.

Reference Books

1. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design", Wiley, (2000).
2. Yeo, "CMOS/BiCMOS ULSI Low Voltage Low Power", Pearson Education.

NANO ELECTRONICS

Course Code : 15 EC 4159 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3107 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the recent and past challenges of microelectronic devices	h,j	2,1
CO2	Analyze the Nano computer architectures and fabrication techniques	h,j	2,1
CO3	Study of the Ferro electric thin film properties and gas sensors	h,j	2,1
CO4	Study of the gas sensitive FETs	h,j	2,1

SYLLABUS:

Introduction to Nano electronics – Top down Approach, the bottom up approach, why Nanoelectronics, Nanotechnology potential, the development of Microelectronics, The region of Nanostructures, The complexity Problem, The challenge initiated by Nano electronics. Quantum electron devices – from classical to quantum physics: upcoming electronic devices – electrons in mesoscopic structure – short channel MOS transistor – split gate transistor – Electron wave transistor – Electron spin transistor – quantum cellular automate – quantum dot array. Nano electronics with tunnelling Devices - Tunnelling Element, Technology of RTD, digital circuit design based on RTD, Principles of Single Electron Transistor (SET) – SET circuit design – comparison between FET and SET circuit designs. Nanofabrication – Nano patterning of Metallic/Semiconducting nanostructures (e-beam/ X-ray, Optical lithography, STM/AFM- SEM & Soft-lithography). 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.

Text Books

1. K.Goser, P.Glosekotter & J.Dienstuhl, "Nanoelectronic and Nanosystems–From Transistors to Molecular Quantum Devices", Springer, (2004).
2. Rainer Waser, "Nanoelectronics and Information Technology: Advanced Electronic Materials Novel and Devices", Wiley VCH, (2005).
3. George W. Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, (2008).

References

1. Mick Wilson, Kamali Kannangara, Geoff smith, "Nanotechnology: Basic Science and Emerging Technologies", Overseas press, (2005).

2. W.R. Fahrner, "Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques", Springer, (2010).

3. Branda Paz, "A Handbook on Nanoelectronics", Vedams books, (2008).

VLSI SUBSYSTEM DESIGN

Course Code : 15 EC 4160 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2204 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the different design and programmable design techniques	h,i	2
CO2	Analyze the different memory and array subsystems	h,i	2
CO3	Study of the power and clock distribution for systems	h,i	2
CO4	Study of the custom, cell based design methodologies	h,i	2

SYLLABUS:

Design Methodology: structured design strategies; hierarchy; PLAs; standard-cell design; full-custom design; physical design styles. Data Path Subsystems: adders; one/zero detectors; comparators; counters; shifters; multipliers. Memory and Array Subsystems: SRAM, DRAM, Read Only Memory, Serial Access Memories, Content-addressable Memory. Special-purpose Subsystems: Packaging: package options, chip-to-package connections, package parasitic, heat dissipation. Power distribution I/Os: basic I/O pad circuits, level converters. Clock: Clock system architecture, global clock generation and distribution, local clock gates, clock skew budgets. Implementation Strategies: custom arrays; semicustom and structured arrays; custom circuit design; cell-based design methodology.

Text Books:

1. Neil H. E. Weste, David. Harris and Ayan Banerjee, "CMOS VLSI Design", Pearson Education, Third Edition, (2004).

2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits" Pearson Education, Second Edition, (2003)

Reference Books:

1. Wayne Wolf, "Modern VLSI Design", 2nd Edition, Prentice Hall, (1998).

2. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits", TMH, Third Edition, (2003).

VLSI TECHNOLOGY

Course Code : 15 EC 4161 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3107 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the basic fabrication process and maintenance of Clean Rooms and Wafer Cleaning process	h	2
CO2	Analyze the techniques to deposit various films by using Chemical Vapor Deposition	h,j	2
CO3	Analyze the techniques to deposit various films by using Physical Vapor Deposition and Multilevel Metallization Techniques	h,j	2
CO4	Study of the Rapid Thermal Processing Techniques and Etching Process	h,j	2

SYLLABUS:

Introduction to IC Fabrication: Basic fabrication steps and their Importance. Environment of IC Technology: Concepts of Clean room Classification and Design Concepts, Wafer cleaning processes. Oxidation: Kinetics of Silicon dioxide, Oxidation technologies in VLSI and ULSI, High k and low k dielectrics for ULSI. Impurity Incorporation: Solid State diffusion modeling, Fick's Law, Measurement Techniques; Ion Implantation, Range Theory and Equipment; Annealing. Lithography: Photolithography, E-beam lithography, X-Ray lithography and Ion Lithography. Film Deposition Techniques: Deposition Process, PVD, APCVD, LPCVD, PECVD and other deposition Methods; Types of Epitaxial. Metallization: Introduction, Failure mechanisms in metal interconnects Multi-level Structures. Rapid Thermal Processing: Introduction, RTP techniques; Etching: Reactive Plasma etching Techniques and Equipment, Wet Chemical etching.

Text Books

1. S.M.Sze, "VLSI Technology", 2nd Edition McGraw Hill Companies Inc.
2. C.Y. Chang and S.M. Sze (Ed), "ULSI Technology", McGraw Hill Companies Inc.

Reference Books

1. Stephena, Campbell, "The Science and Engineering of Microelectronic Fabrication", Second Edition, Oxford University Press.
2. James D.Plummer, Michael D. Deal, "Silicon VLSI Technology", Pearson Education.
3. More Madou "Fundamentals of Micro fabrication", CRC Press.

PROFESSIONAL ELECTIVES

COMMUNICATION STREAM

RF SYSTEM DESIGN

Course Code : 15 EC 3252 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3108 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Differentiate different RF components and transmission lines	h,i	2
CO2	Demonstrate the smith chart applications, multiport networks	h,i	2
CO3	Design different RF-Filters based on stability and gain	h,i	2
CO4	Develop different types of RF amplifiers	h,i	2

SYLLABUS:

Introduction: Importance of RF and Microwave Circuit Design-Dimensions and Units-Frequency Spectrum - RF Behavior of Passive Components: High Frequency Resistors, High Frequency Capacitors, High Frequency Inductors, General Introduction, Types of Transmission Lines-Equivalent Circuit representation. The Smith Chart: Introduction, Derivation of Smith Chart, Description of two types of smith chart, Z-Y Smith chart, Distributed Circuit Applications, Lumped Element Circuit Applications. Single And Multiport Networks: Basic Definitions, Interconnecting Networks, Scattering Parameters related problems RF Filter Design: Scattering Parameters: Definition, Meaning, Chain Scattering Matrix, Conversion Between S- and Z-parameters, Signal Flow Chart Modeling, Generalization-Basic Resonator and Filter Configurations: Low Pass, High Pass, Band Pass and Band Stop type Filters-Filter Implementation using Unit Element and Kuroda's Identities Transformations. Stability and Gain Considerations – RF Design RF Source, Transducer Power Gain, Additional Power Relations-Stability Considerations: Stability Circles, Unconditional Stability, and Stabilization Methods-Unilateral and Bilateral Design for Constant Gain- Noise Figure Circles- Constant VSWR Circles. RF Amplifiers – Small Signal Design Introduction, Types and Characteristics of Amplifiers, Small Signal Amplifiers, Design of different types of amplifiers (NBA, HGA, MGA, LNA, MNA, BBA)

Text Books

1. Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, Second Edition.
2. Reinhold Ludwig and Powel Bretchko, "RF Circuit Design – Theory and Applications", Pearson Education Asia, First Edition.

References

1. Joseph . J. Carr, "Secrets of RF Circuit Design", McGraw Hill Publishers, Third Edition.
2. Ulrich L. Rohde and David P. New Kirk, "RF / Microwave Circuit Design", John Wiley & Sons.
3. Roland E. Best, "Phase - Locked Loops: Design, simulation and applications", McGraw Hill Publishers 5th edition.

4. Devendra K.Misra , "Radio Frequency and Microwave Communication Circuits – Analysis and Design", John Wiley & Sons, Inc.
5. Jon B. Hagen, "Radio Frequency Electronics", Cambridge university press, Cambridge.
6. James Hardy, "High Frequency Circuit Design", Resto Publishing Co., NewYork, (1979).
7. Ian Hickman, "RF HandBook", Butter Worth Heinemann Ltd., Oxford, (1993).
8. Ulrich L.Rohde, T.T.N.Bucher, "Communication Receivers", McGraw-Hill, New York, (1998).

RADIATION SYSTEMS

Course Code : 15 EC 4162 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3108 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Demonstrate the radiation mechanism and antenna parameters	i	2
CO2	Distinguish different types of radiation from apertures	i	2
CO3	Select the antennas and arrays based on the specific application	i	2
CO4	Evaluate the antenna performance with measurement techniques	i	2

SYLLABUS:

Basics Concepts Of Radiation: Radiation from surface current and current line current distribution, Basic antenna parameters, Radiation mechanism-Current distribution of Antennas, Impedance concept-Balanced to Unbalanced transformer Radiation From Apertures Field equivalence principle, Rectangular and circular apertures, Uniform distribution on an infinite ground plane, Aperture fields of Horn antenna-Babinets principle, Geometrical theory of diffraction, Reflector antennas, and Design considerations - Slot antennas Synthesis Of Array Antennas Types of linear arrays, current distribution in linear arrays, Phased arrays, Optimization of Array patterns, Continuous aperture sources, Antenna synthesis techniques Micro Strip Antennas Radiation mechanisms, Feeding structure, Rectangular patch, Circular patch, Ring antenna. Input impedance of patch antenna, Microstrip dipole, Microstrip arrays Antenna Measurements: Log periodic, Bi-conical, Log spiral ridge Guide, Multi turn loop, Traveling Wave antenna, Antenna measurement and instrumentation, Amplitude and Phase measurement, Gain, Directivity, Impedance and polarization measurement, Antenna range, Design and Evaluation

Text Books

1. Kraus.J.D., "Antennas", II Edition, John Wiley and Sons.
2. Balanis.A, "Antenna Theory Analysis and Design", John Wiley and Sons, New York, (1982)

References

1. Peter Kinget, "RF System Design", Bell Laboratories, Lucent Technologies Murray Hill,
2. "Practical RF system design", - Technology & Engineering, Wiley-IEEE, (2003).

RADAR AND NAVIGATIONAL AIDS

Course Code : 15 EC 4163 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3108 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Compare different types of radars and their limitations	h,i	2
CO2	Illustrate the operation of MTI Radar and types of tracking methods	h	2
CO3	Differentiate different radar transmitters and receivers	h,i	2
CO4	Compare different types of electronic counter measures	h,i	2

SYLLABUS:

Introduction, Basic Radar , Advantage of Basic Radar, Block Diagram of Pulse Radar, simple form of Radar equation, Detection of signals in noise, Receiver noise and signal to noise ratio, integration of Radar pulses, RCS: RCS of simple targets, RCS of multiple targets, PRF and Range Ambiguities, Doppler Effect, Limitations of CW Radar, FMCW Radar, Altimeter. MTI Radar, Delay line cancellers: Frequency response of single delay line cancellers, Clutter Attenuation, MTI improvement factor, N-pulse delay line canceller, Non recursive and Recursive filters, staggered PRF, Doppler filter banks Tracking: Types of tracking Radar Systems, Sequential Lobing Radar, Conical Scan and Mono pulse Tracking Radar Super heterodyne Receiver, Types of Duplexers and receiver protectors, types of Displays, Radomes. Radar Transmitter: Introduction, Linear- Beam Power Sources, Magnetron, Crossed- Field Amplifiers, Other RF Power Sources. Radar Receivers: The Radar Receivers, Receiver Noise Figure, Super heterodyne Receivers, Duplexers and Receiver Protectors, Radar Displays Electronic Warfare: Objectives an definitions, Noise jamming, Types of Electronic counter measures and Electronic counter to counter measures, Stealth applications. Elementary ideas of Navigational Aids, DME, VOR, DVOR, TACAN, ILS, MLS, GPS, Automatic Direction Finder, Hyperbolic Navigational (LORAN, DECA, OMEGA).

Text Books

1. Merrill I Skolnik, "Introduction to Radar Systems", 3rd Edition, TMH, (2003).
2. GSN Raju, "Radar Engineering and Fundamentals of Navigational Aids", I K International.

Reference Books

1. Peyton Z Peebles Jr, "Radar Principles", John Wiley Inc., (2004).
2. Hamish Meikie, "Modern Radar Systems", Artech House.
3. AK Sen and Dr AB Bhattacharya, "Radar Systems and Radio Aids to Navigation"

Simulation Book

1. Bassem R.Mahafza, "Radar systems Analysis and design using Matlab" Chapman & Hall.

MICROWAVE AND MILLIMETER WAVE CIRCUITS

Course Code : 15 EC 4164 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3209 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Differentiate different Microwave components	i	2
CO2	Identify transformers and microwave resonators	i,j	2
CO3	Design different microwave filters	i,j	2
CO4	Distinguish microwave and millimetric wave circuits	i,j	2

SYLLABUS:

Analysis of Microwave Circuits: Introduction, Microwave Components – E-plane Tee, H-plane Tee, Magic Tee, Directional Coupler, Isolator, Circulator & their Scattering Transformers & Resonators: Parameters, Impedance Transformers – Quarter wave Transformers, Microwave Resonators – Rectangular and Cylindrical Resonators. Filters And Periodic Structures: Design of Narrow Band Low Pass, Band Pass and High Pass Filters, Maximally flat and Chebyshev Designs, Introduction to Periodic Structures, Floquet's Theorem, Circuit Theory Analysis of Infinite and Terminated Structures, Obstacles in Wave Guides: Introduction, Posts in Waveguides, Diaphragms in Waveguides, Waveguide Junctions, Waveguide Feeds, Excitation of Apertures Millimeter Wave Circuits: Wave Propagation in microstriplines, Discontinues in Microstrips, Parallel Coupled lines, Power Dividers and Directional Couplers, Microwave and Millimeter Wave Integrated Circuits.

Text Books

1. Roger F. Harrington, "Time-Harmonic Electromagnetic Fields", Mc Graw-Hill.
2. Robert E Collin, "Foundation for Microwave Engineering", Mc Graw-Hill.

Reference Books

1. "Analysis Methods for RF, Microwave, and Millimeter-Wave Planar Transmission Line Structures", by Cam Nguyun.

EMI/EMC

Course Code : 15 EC 4165 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3108 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Describe the EMI specifications and standards	h	2
CO2	Demonstrate the EMI control techniques and design guidelines	h	2
CO3	Distinguish different passive components for EMC	i	2
CO4	Evaluate the EMI measurements using different techniques	I	2

SYLLABUS:

EMI Environment: Sources of EMI, Conducted and Radiated EMI, Transient EMI, EMI – EMC Definitions and Units of Parameters. EMI Specifications/Standards/Limits: Units of specifications, Civilian Standards and Military Standards EMI Control Techniques: Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal control, Component Selection and mounting. EMC Design Guidelines and Choice of passive components for EMC: EMC Design Guidelines: Typical Sub systems in Electronic Equipment, Transmitters, Receivers, Antenna Systems, Power Supplies, Motors, Control Devices, Digital Circuits, Digital Computers. Choice of Passive Components for EMC: Capacitors, Inductors, Transformers, Resistors, Conductors, Ferrite Beads, Coaxial Connectors, Conductive Gaskets. EMI Measurements: EMI Test Instrument / Systems, EMI Test, EMI Shielded Chamber, Open Area Test Site, TEM cell Antennas

Text Books

1. V P Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE Press,
2. Bernard Kieser, "Principles of Electromagnetic Compatibility", Artech House 3rd Edition.
3. Henry W.Ott, "Electromagnetic Compatibility Engineering", A John Wiley & Sons publication.

Reference

1. Clayton R Paul, "Electromagnetic Compatibility", John Wiley.
2. Tim Williams, "EMC for Product Designer", Elsevier.
3. PR Chatterton, "Electromagnetic Theory to practical design", Wiley.
4. Sonia Ben Dhia, "Electromagnetic Compatibility as Integrated Circuits", Springer.

CELLULAR COMMUNICATIONS

Course Code : 15 EC 4166 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2205 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Demonstrate different wireless communication systems and radio propagation mechanism	i	2
CO 2	Distinguish different equalizers and diversity techniques in propagation	i	2
CO 3	Illustrate different wireless communication system standards	k	1
CO 4	Select OFDM in the channel estimation and implimentation	k	1

SYLLABUS:

Introduction to Mobile Communication: Evolution of Mobile Radio Communication, Examples of Wireless Communication Systems, Cellular telephone Systems, 2G & 3G wireless networks, Cellular concept, frequency reuse, Channel Assignment strategies, Hand off strategies, Interference and system capacity, improving coverage and capacity in cellular systems. Mobile Radio Propagation: Large Scale Fading, Free space propagation model, Three basic propagation mechanisms: Reflection, diffraction, scattering, Small Scale

Fading, Multipath Propagation, Types of small scale fading, Parameters of Mobile Multipath channels, fading effects due to multipath delay Spread and Doppler spread, Statistical models for multipath fading channels. Equalization& Diversity: Fundamentals of Equalizers, Linear equalizers, nonlinear equalizers, Decision feedback equalizers, MLSE, Algorithms for adaptive equalization, Space diversity, MRC, EGC, selection diversity, Polarization diversity, Frequency diversity, Time diversity, Rake receiver. Wireless Systems & Standards: GSM Services, Features, Architecture, channel types, Frame Structure, Signal processing in GSM, CDMA Digital cellular Standards IS-95. OFDM for Wireless Communications: Basic OFDM, FFT Implementation, Cyclic Extension, Power Spectrum, and Efficiency, Comparison with Single-Carrier, Design Example, Baseband versus Passband, Impairments of Wireless Channels to OFDM Signals: Time-Varying Impairments, Effect of Sampling Clock Offset, Effect of Timing Offset, Effect of Delay Spread, System Nonlinearity.

Text Books

1. Theodore S. Rappaport, "Wireless Communications Principles and Practice", 2nd Edition, Pearson Education, (2003).
2. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, (2005).
3. Ye (Geoffrey) Li, Gordon Stuber, "Orthogonal Frequency Division Multiplexing for Wireless Communications", Springer, (2006).

Reference Books

1. W. C. Y. Lee, "Mobile Cellular Communications, 2nd Edition", Mc Graw Hill,
2. Gottapu Sasi Bhushana Rao, "Mobile Cellular Communication", Pearson Education
3. Andrea Goldsmith, "Wireless Communications", Cambridge University Press.
4. Simon R. Saunders, Alejandro Aragon Zavala, "Antennas and Propagation for Wireless Communication Systems", 2nd Edition, John Wiley & Son.
5. Vahid Tarokh "New Directions in Wireless Communications Research", Springer.

SATELLITE COMMUNICATION

Course Code : 15 EC 4167 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3108 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Demonstrate the basic concepts of satellite communication and orbital mechanics	i	2
CO2	Illustrate the satellite subsystems and link design	i	2
CO3	Interpret transmitters and receivers usage in tracking and error control mechanism	i	2
CO4	Develop the GPS based navigation system	j	2

SYLLABUS:

Introduction: Basic Concepts of Satellite Communications, Frequency Allocations for Satellite Services, Applications. Orbital Mechanics And Launchers: Orbital Mechanics, Look

Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance. Satellite Subsystems: Attitude and Orbit Control System, Telemetry, Tracking, Command and Monitoring, Power Systems, Communication Subsystems, Satellite Antennas. Satellite Link Design: Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design of Down Links, Up Link Design, Design Of Satellite Links For Specified C/N, System Design Examples. Earth Station Technology: Introduction, Transmitters, Receivers, Antennas, Tracking Systems, Terrestrial Interface, Primary Power Test Methods. Multiple Access Techniques and Error Control : Frequency Division Multiple Access (FDMA), Inter-modulation, Calculation of C/N, Time Division Multiple Access (TDMA), Frame Structure, Satellite Switched TDMA, Onboard Processing, Code Division Multiple Access (CDMA), Error control requirements for satellite link—ARQ, Concatenated Codes, Interleaving, Turbo codes. Satellite Navigation & Global Positioning System: Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Navigation Message, GPS Signal Levels, GPS Receiver Operation.

Text Books

1. Timothy Pratt, Charles Bostian and Jeremy Allnutt, "Satellite Communications", WSE, Wiley Publications, 2nd Edition, (2003).
2. L.Pritchard, Robert A Nelson and Henri G.Suyderhoud, "Satellite Communications Engineering", Wilbur, 2nd Edition, Pearson Publications.

References

1. M. Richharia, "Satellite Communications: Design Principles", BS Publications, 2nd Edition.
2. K.N. Raja Rao, "Fundamentals of Satellite Communications", PHI, (2004).
3. D.C Agarwal , "Satellite Communication", Khanna Publications, 5th Ed.
4. Dennis Roddy, "Satellite Communications", McGraw Hill, 4th Edition, (2009).
5. Robert M Gagliardi, "Satellite Communications", DTS Publishers Ltd.

OPTICAL COMMUNICATION

Course Code : 15 EC 4168 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2205 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Dramatize the importance of optical communication	i	2
CO2	Demonstrate the transmission characteristics of optical fibers, optical transmitters and detectors	i	2
CO3	Illustrate the advanced optical fiber systems	i	2
CO4	Test the optical fiber transmission and reception mechanism	j	2

SYLLABUS:

Introduction: Advantages of Optical fibers, Applications of Optical Fiber, Ray Theory

Transmission, Total internal reflection, Acceptance angle, Critical Angle, Numerical Aperture, Fiber types: Step Index, Graded Index: Modes of Propagation: single mode and multimode fibers. Transmission Characteristics of Optical Fibers: Attenuation, absorption, scattering and bending losses in fibers, Dispersion: Inter-model and intra-model, Polarization mode dispersion Optical Transmitters and Detectors: LED'S: Principles of Light Emission, Light Emitting Diodes: Simple structure and characteristics. LASER: Principle, Simple structures of semiconductor Laser and its characteristics, Optical Transmitter Circuits. Electro Optic Modulation: Kerr effect, Pockle's effect, Amplitude and Phase modulations. Detectors: Principles of photo detection. PIN Photodiode, Avalanche Photodiode and their characteristics, Optical Receiver Circuit. Optical Fiber Systems: Digital System planning considerations, Optical power budgeting, Advanced Multiplexing Strategies: WDM,OTDM and SCM. Optical Amplifiers: Semiconductor Optical Amplifiers, Raman Amplifiers, Erbium Doped Fiber Amplifiers. Optical Fiber Measurements & Instrumentation: Numerical Aperture, attenuation, refractive index, cutback and OTDR. Advanced Optical Systems: Fiber Optic LAN's, Wavelength routing Networks, Optical switching networks, SONET/SDH, FDDI.

Text Books

1. Keiser G, "Optical Fiber Communication", McGraw-Hill.
2. G. P. Agrawal, "Fiber-Optic Communications Systems", 3rd Edition, John Wiley & Sons.
3. J C Palais , "Fiber Optic Communications", 2nd Edition, PHI.

Reference Books

1. W Tomasi , "Advanced Electronic Communication Systems", PHI.
2. J Powers, "An introduction to fiber optic systems", 2nd Edition, Mc. Graw Hill.
3. John Gowar, "Optical communication systems", PHI.
4. John M Senior, "Optical Fiber Communications: Principles and Practice", 2nd Edition, PHI.

INFORMATION THEORY& CODING

Course Code : 15 EC 4169 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2205 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Describe the basic terminology of information theory and coding	h	2
CO2	Demonstrate the encoding of the source output	h	2
CO3	Illustrate the importance of error control in coding	h	2
CO4	Distinguish different binary cyclic codes and convolution codes	h	2

SYLLABUS:

Introduction: Measure of information, Average information content of symbols in long independent sequences, Average information content of symbols in long dependent sequences, Entropy calculation for extension of source. Mark-off statistical model for information source, Entropy and information rate of mark-off source. Encoding of The Source Output, Shannon's encoding algorithm for dependent and independent sequences. Discrete communication channels, Continuous channels. Source coding theorem, Huffman coding, Discrete memory less Channels, Mutual information, Properties of mutual information, Channel Capacity. Channel coding theorem, Differential entropy and mutual information for continuous ensembles, Channel capacity Theorem Error Control Coding, Introduction, Types of errors, examples, Types of codes Linear Block Codes: Matrix description, Error detection and correction, Standard arrays and table look up for decoding. Binary Cycle Codes, Algebraic structures of cyclic codes, Encoding using an (n-k) bit shift register, Syndrome calculation, BCH codes ,RS Codes, Golay codes, Shortened cyclic codes, Burst error correcting codes. Burst and Random Error correcting codes. Convolution Codes: Block diagram of encoder, Impulse response of encoder, Time domain approach and Transform domain approach. State representation and state diagram, Tree diagram, trellis diagram.

Text Books

1. K. Sam Shanmugam , "Digital and Analog communication systems", John Wiley, (1996).
2. Simon Haykin , "Digital communication", John Wiley, (2003).

Reference Books

1. Ranjan Bose, "ITC and Cryptography", TMH, II edition, (2007)
2. Wells, "Applied Coding and Information Theory for Engineers", Pearson Ed.
3. Glover and Grant, "Digital Communications", Pearson Ed. 2nd Ed (2008)
4. Robert H. Morelos-Zaragoza, "The Art of Error Correcting Coding", John Wiley & Sons.
5. Thomas M. Cover& Joy A. Thomas, "Elements Of Information Theory", Second Edition, John Wiley & Sons, Inc.
6. Michael Purser, "Introduction to Error-Correcting Codes", Artech House.

Simulation Books

1. Yuan Jiang, "A Practical Guide to Error Control Coding Using MATLAB", Artech House.

SOFTWARE DEFINED RADIO

Course Code : 15 EC 4170 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3209 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Demonstrate the concept of Software defined radio	h	2
CO2	Describe the architecture of SDR	h	2
CO3	Illustrate the programming concept of SDR	h	2
CO4	Differentiate the segment design tradeoffs	k	1

SYLLABUS:

What is a Radio?, What Is a Software-Defined Radio?, Why SDR?, Disadvantages of

SDRSDR Standardization: Software Communications Architecture and JTRS, Physical Layer Description, Data Formats. Introduction and Overview: The Ideal Software Radio, The Software Radio Functional Architecture, Basic Signal Processing Streams, Implementation Alternatives, The Acquisition of Software Radios, Broader Implications of the Software Radio. Architecture Evolution: Technology-Demographics, Commercial Architecture Needs, Military Architecture Needs, Open Architecture and Standards Evolution. Systems-Level Architecture Analysis: Disaster-Relief Case Study, Radio Resource Analysis, Network Architecture Analysis, Analyzing the Protocol Stacks. Node-Level Architecture Analysis: Architecture Representation, Industry-Standard Node Architectures, Programmable Digital Radio (PDR) Case Studies, Technology Pathfinders. Segment Design Tradeoffs: Antenna Tradeoffs, RF and IF Processing Tradeoffs, ADC Tradeoffs, Digital Architecture Tradeoffs, Software Architecture Tradeoffs, Performance Management Tradeoffs, End-to-End Tradeoffs.

Text Books

1. Joseph Mitola III, "Software Radio Architecture", Wiley-Interscience.
2. Eugene Grayver, "Implementing Software Defined Radio", Springer.

REFERENCE BOOKS

1. Walter Tuttlebee, "Software Defined Radio Enabling Technologies", John Wiley & Sons.

FUNDAMENTALS OF ELECTRONIC WARFARE

Course Code : 15 EC 4171 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3209 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Distinguish different methods of warfare and target identification	h	2
CO2	Demonstrate the jamming techniques used in electronic warfare	h	2
CO3	Distinguish active jamming and passive jamming	h	2
CO4	Judge the false identification of targets and methods to overcome	h	2

SYLLABUS:

Targets of Electronic Warfare Operations: A General Description of Targets of Electronic Warfare Operations, Mathematical Models of Electronic Systems as Targets of Electronic Warfare, Mathematical Models of Automated Systems for the Control of AAD Fotces as Targets of EW, Mathematical Models of Automated Systems foe the Control of AAD Weapons as Targets of Electronic Wallace. Mathematical Models of Signals, Systems and Techniques for Electronic jamming: A General Description of the Basic Elements of Electronic Jamming, Mathematical Models of Jamming Signals, Mathematical Models of Systems and Techniques for Jamming. Electronic Warfare Effectiveness Criteria: General Characteristics of the Criteria, Information Indicators of the Effectiveness of Jamming Signals, Systems and

Techniques of Electronic Attack, Energy Effectiveness Criteria of Jamming Signals and Techniques of Electronic Jamming, Operational and Tactical Indicators of EW Effectiveness. Active Jamming of Radar- The Jamming Equation: Fundamental Concepts, The Jamming Equation for Mono static Radar Using Active Jamming (the General Case), Reduction of the Jamming Equation to Canonical Form -Methods of Determining Information Damage, Specifics of the Jamming Equation Using Active Jamming against Various Types of Radar, Particulars of Jamming Radar Using Screening Jamming with Limited Information Quality Indicators-Use of the Jamming Equation for Analysis of the Electronic Environment. Passive and Active-Passive Jamming- The Jamming Equation: Types of Passive Jamming, Formation Dynamics and Statistical Characteristics of Clouds, The Equation for Radar Jamming Using Passive Jamming- The Jamming Coefficient for Non-coherent Radar, The Jamming Coefficient Using Passive Jamming for Coherent Pulse-Radar, Effectiveness of Radar Jamming Using Passive Jamming- Determination of the Required Quantity of Chaff. False Radar Targets and Decoys: Types of False Radar Targets, Decoys and Disposable EW Devices, Parameters Simulated by False Radar Targets and Radar Decoys Methods of Increasing the Radar Cross Sections of False Targets and Decoys, Repeaters, Passive Reflectors, Thermal Decoys, The Use of Towed and Launched Decoys.

Text Book

1. Sergei A. Vakin, Lev N. Shustov, "Fundamentals of electronic warfare", Artech.

Reference Books

1. Filippo Neri, "Introduction to Electronic Defense Systems", Second Edition, Artech.
2. David L. Adamy, "Introduction to Electronic Warfare Modeling and Simulation", Artech.
3. Richard A. Poisel, "Electronic Warfare Target Location Methods", Second Edition, Artech.

ELECTRONIC NAVIGATION SYSTEMS

Course code : 15 EC 4172 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3108 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Differentiate different electronic navigational aids	h	2
CO2	Demonstrate the satellite navigation mechanism	h	2
CO3	Illustrate the working principle of GPS antenna system	j	2
CO4	Discriminate ship master compass and automatic steering techniques	j	2

SYLLABUS:

Elementary ideas of Navigational Aids, DME, VOR, DVOR, TACAN, ILS, MLS, GPS, Hyperbolic Navigational (DECA, OMEGA).Loran-C: Introduction, System principles, Basics of the Loran-C System, Loran-C charts ,Position fixing using the Loran-C System, Loran-C coverage, Loran-C receivers. Satellite navigation: Introduction, Basic satellite theory, The Global Positioning System (GPS), The position fix, Dilution of Precision (DOP),Satellite pass prediction, System errors, Differential GPS (DGPS), GPS antenna systems, GPS receiver designation, Generic GPS receiver architecture, GPS user equipment, GPS on the web, Global Orbiting Navigation Satellite System (GLONASS),Project Galileo. Electronic charts: Introduction, Electronic chart types, Electronic chart systems, Chart accuracy, Updating electronic charts, Automatic Identification System (AIS), Navmaster' Electronic navigation System. The ship's master compass: Introduction, Gyroscopic principles, The controlled gyroscope, The north-seeking gyro, A practical gyrocompass, Follow-up systems, Compass errors, Top-heavy control master compass, A digital controlled top-heavy gyrocompass system, A bottom-heavy control gyrocompass, Starting a gyrocompass, Compass repeaters, The magnetic repeating compass. Automatic steering: Introduction, Automatic steering principles, A basic autopilot system, Manual operator controls, Deadband, Phantom rudder, An adaptive autopilot, An adaptive digital steering control system. Radio direction finding: Introduction, Radio waves, Receiving antennae, A fixed loop antenna system, Errors, RDF receiving equipment.

Text Book

1. Tetley, L., "Electronic navigation systems", 3rd edition, Butterworth-Heinemann.

RADAR

Course code : 15 EC 4173 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 3108 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Demonstrate different types of radars	i	2
CO2	Illustrate the working principle of MTI radar and its tracking mechanism	i	2
CO3	Discriminate radar transmitters and receivers	i	2
CO4	Demonstrate basic principles synthetic aperture radar	i	2

SYLLABUS:

Introduction: Basic Radar , Advantage of Basic Radar, Block Diagram of Pulse Radar, simple form of Radar equation, Detection of signals in noise, Receiver noise and signal to noise ratio, integration of Radar pulses, RCS: RCS of simple targets, RCS of multiple targets, PRF and Range Ambiguities, Doppler Effect, Limitations of CW Radar, FMCW Radar, Altimeter. MTI Radar: Delay line cancellers: Frequency response of single delay line cancellers, Clutter Attenuation, MTI improvement factor, N-pulse delay line canceller, Non recursive and Recursive filters, staggered PRF, Doppler filter banks. Tracking: Types of tracking Radar Systems, Sequential Lobing Radar, Conical Scan and Mono pulse Tracking Radar Super heterodyne Receiver, Types of Duplexers and receiver protectors, types of Displays, Radomes. Radar Transmitter: Introduction, Linear- Beam Power Sources, Magnetron, Crossed- Field Amplifiers, Other RF Power Sources. Radar Receivers: The Radar Receivers, Receiver Noise Figure, Super heterodyne Receivers, Duplexers and Receiver Protectors, Radar Displays. Synthetic Aperture Radar: Spotlight Synthetic Aperture Radar, Stripmap SAR, Interferometric SAR and Coherent Exploitation.

Text Books

1. Merrill I Skolnik, " Introduction to Radar Systems", 3rd Edition, TMH, (2003).

2. William L. Melvin, James A. Scheer, "Principles of Modern Radar", SciTech Publishing.

Reference Books

1. Peyton Z Peebles Jr, "Radar Principles", John Wiley Inc., (2004)
2. Hamish Meikie, "Modern Radar Systems", Artech House.

Simulation Book

1. Bassem R.Mahafza "Radar systems Analysis and design using Matlab" Chapman & Hall.

COMPUTATIONAL ELECTROMAGNETICS

Course Code : 15 EC 4174 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2205 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Distinguish different computational techniques	h	2
CO2	Illustration on FEM based methodology approach	h	2
CO3	Illustration on a one-dimensional introduction to the method of moments	k	1
CO4	Illustration on MOM based methodology approach	k	1

SYLLABUS:

An overview of computational electromagnetics for RF and microwave Applications: Introduction, Full-wave CEM techniques, The method of moments (MoM), The finite difference time domain (FDTD) method, The finite element method (FEM), Transmission line matrix (TLM) method, The method of lines (MoL), The generalized multipole technique (GMT). A one-dimensional introduction to the finite element method: Introduction, The variational boundary value problem: the transmission line problem revisited, The model problem, The equivalent variational functional, The finite element approximation of the functional, Evaluating the elemental matrices, Assembling the system, Rendering the functional stationary and solving the problem, Coding the FEM, Results and rate of convergence. The finite element method in two dimensions: scalar and vector elements: Introduction, Finite element solution of the Laplace equation in two dimensions using scalar elements, The variational boundary value problem approach, Some practical issues: assembling the system, An application to microstrip, More on variational functional. The Poisson equation: incorporating a source term, The Galerkin (weighted residual) formulation, Simplex coordinates, Simplex coordinates in one, two and three dimensions, Some properties of simplex coordinates, The high-frequency variational functional, The null space of the curl operator and spurious modes, Vector (edge) elements, An historical perspective, Theory of vector elements, Vector elements on triangles – the Whitney element. The finite element method in three dimensions: The three-dimensional Whitney element, Explicit formula for the tetrahedral elemental matrix entries, Coding, Higher-order elements, Complete versus mixed-order elements, Hierarchal vector basis functions, Properties of hierarchal basis functions, Practical impact of higher-order basis functions in an FEM code, The FEM from the variational boundary value problem viewpoint, A deterministic 3D application:

waveguide obstacle analysis, Introduction, The waveguide formulation. A one-dimensional introduction to the method of moments: modelling thin wires and infinite cylinders: Introduction, An electrostatic example, Some simplifying approximations, Approximating the charge, Collocation, Solving the system of linear equations, Results and discussion, Thin-wire electrodynamics and the MoM, The electrically thin dipole, A caveat regarding thin-wire formulations, More on basis functions, The numerical electromagnetic code (NEC) – method of moments, NEC basis functions, Piecewise linear basis functions, Junction treatments with piecewise linear basis functions, The method of weighted residuals. The method of moments for surface modelling: Electric and magnetic field integral equations, The Rao–Wilton–Glisson (RWG) element ,A mixed potential electric field integral equation for electromagnetic scattering by surfaces of arbitrary shape, The electric field integral equation (EFIE), The RWG basis function revisited, The MoM formulation, Derivation of the matrix entries, Numerical approximation of the matrix entries, Coding issues, Verification, Some examples of surface modelling, Scattering from a sphere, The analytical solution, Modelling homogeneous material bodies using equivalent currents.

Text Book

1. David B. Davidson, "Computational Electromagnetics for RF and microwave engineering", 2nd edition, Cambridge University Press.

Reference Books

1. John L. Volakis, "Finite Element Method for Electromagnetics", IEEE Press
2. Ramesh Garg, "Analytical and Computational Methods in Electromagnetics", Artech House.

SIGNAL PROCESSING STREAM

INTELLIGENT SYSTEMS AND CONTROL

Course Code : 15 EC 3253 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2206 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	To establish the theory necessary to understand and use of Intelligence in system control and related constructions.	h	2
CO2	To establish the theory necessary to understand the Biological foundations to intelligent systems	h	2
CO3	To emphasize on efficient algorithms for ANN based systems.	i	2
CO4	To emphasize on efficient algorithms for Fuzzy based systems.	i	2

SYLLABUS:

Biological foundations to intelligent systems I: Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks. Biological foundations to intelligent systems II: Fuzzy logic, knowledge representation and inference mechanism, genetic algorithm, and fuzzy neural networks. Fuzzy and expert control (standard, Takagi-Sugeno, mathematical characterizations, design example), Parametric optimization of fuzzy logic controller using genetic algorithm. System identification using neural and fuzzy neural networks. Stability analysis: Lyapunov stability theory and Passivity Theory. Adaptive control using neural and fuzzy neural networks, Direct and Indirect adaptive control, and Self-tuning Pill Controllers. Genetic Programming: Genetic Algorithm, Multi objective optimization using Genetic Algorithm. Software Simulations: Applications to pH reactor control, flight control, robot manipulator dynamic control, under actuated systems such as inverted pendulum and inertia wheel pendulum control and visual motor coordination. Simulation models of all fuzzy membership functions. Simulation models of single neurons, Simulation models of ANN algorithms, Speed control of a permanent magnet direct current (PMDC) motor, A tracking controller for moving objects, A door position control system, Additional examples from industry and other sources.

Text Books:

1. Laxmidhar Behera, Indrani Kar, "Intelligent Systems and Control: Principles and Applications" Paperback – 12 Nov 2009.
2. Rao, Vallinu B.,and Rao, Hayagriva, "Neural networks and fuzzy Logic", second edition, BPB Publication.
3. Freeman A. James, Skapura M. David "Neural Networks Algorithms, Applications and Programming Techniques", Pearson Education.
4. J.S.R. Jang, C.T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", Prentice Hall, (1996).

ADAPTIVE SIGNAL PROCESSING

Course Code : 15 EC 4175 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2002 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	To establish the theory necessary to understand and use of Adaptiveness in system control and related constructions.	i	2
CO2	To establish the theory necessary to understand the Wiener filter, search methods and the LMS algorithm	i	2
CO3	To emphasize on efficient algorithms for adaptive systems.	k	2
CO4	To emphasize on Vector space framework for optimal filtering	k	2

SYLLABUS:

Introduction to Adaptive Filters: Adaptive filter structures, issues and examples, Applications of adaptive filters, Channel equalization, active noise control, Echo cancellation, beamforming. Discrete time random processes, Power spectral density – properties, Autocorrelation and covariance structures of discrete time random processes, Eigen-analysis of autocorrelation matrices. Wiener filter, search methods and the LMS algorithm: Wiener FIR filter, Steepest descent search and the LMS algorithm, Extension of optimal filtering to complex valued input, The Complex LMS algorithm. Convergence and Stability Analyses: Convergence analysis of the LMS algorithm, Learning curve and mean square error behavior, Weight error correlation matrix, Dynamics of the steady state mean square error (MSE), mis-adjustment and stability of excess MSE. Variants of the LMS Algorithm: The sign-LMS and the normalized LMS algorithm, Block LMS, Review of circular convolution, overlap and save method, circular correlation, FFT based implementation of the block LMS Algorithm. Vector space framework for optimal filtering: Axioms of a vector space, examples, subspace, Linear independence, basis, dimension, direct sum of subspaces, Linear transformation, examples, Range space and null space, rank and nullity of a linear operator, Inner product space, orthogonality, Gram-Schmidt orthogonalization, Orthogonal projection, orthogonal decomposition of subspaces, Vector space of random variables, optimal filtering as an orthogonal projection computation problem.

Text Books:

1. S. Haykin, Prentice Hall, Englewood Cliffs, NJ, "Adaptive Filter Theory" (end Ed.). (1991).
2. B. Farhang-Boroujeny, John Wiley and Sons, "Adaptive Filters-Theory and Applications", (1999).

STATISTICAL SIGNAL PROCESSING

Course Code : 15 EC 4176 **L–T–P :** 3-0-0

Pre Requisite : 15 MT 2005 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	To establish the theory necessary to understand and use Statistics and related constructions.	i	2
CO2	To emphasize construction of efficient algorithms for real time applications.	i	2
CO3	To study applications in signal processing, communications. The course has computer and research projects involving independent study.	i	2
CO4	To study applications in sensing where statistics and probability play an important role.	i	2

SYLLABUS:

Review of random variables: Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonality principle in estimation, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and auto covariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter, .Random signal modeling: MA(q), AR(p) , ARMA(p,q) models. Parameter Estimation Theory: Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties ; Bayesian estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation. Estimation of signal in presence of white Gaussian Noise: Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Non causal IIR Wiener filter, Wiener filter, Non causal I I R Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters. Spectral analysis: Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Parametric method, AR(p) spectral estimation and detection of Harmonic signals, Burg, ESPRIT, MUSIC algorithm. Kalman filtering: State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.

Simulation Software: MATLAB® SSP Toolbox, Software for Filter Design, Signal Analysis, PDEs, and Applications to Signal Analysis.

Text Books

1. M. Hays, "Statistical Digital Signal Processing and Modelling", John Willey and Sons, (1996).
2. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan, "Statistical Signal Processing with Applications, PHI, (1996).

SPEECH SIGNAL PROCESSING

Course Code : 15 EC 4177 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2206 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	To establish the theory necessary to understand and use speech based systems and related constructions.	h	2
CO2	To emphasize on efficient algorithms for speech based systems.	h	2
CO3	To study applications in speech signal processing, speech based systems. The course has computer and research projects involving independent study.	k	1
CO4	To study applications in speech sensing software in mobile.	k	1

SYLLABUS:

The Speech Production mechanism: Physiological and Mathematical Model, Relating the physiological and mathematical model, Categorization of Speech Sounds based on the source-system and the articulatory model. Basic Speech Signal Processing Concepts: Discrete time speech signals, relevant properties of the fast Fourier transform and Z-transform for speech recognition, convolution, linear and non linear filter banks. Spectral estimation of speech using the Discrete Fourier transform. Pole-zero modeling of speech and linear prediction (LP) analysis of speech. Homomorphic speech signal de convolution, real and complex cepstrum, application of cepstral analysis to speech signals. The Speech Recognition Front End: Feature extraction for speech recognition, Static and dynamic features for speech recognition, robustness issues, discrimination in the feature space, feature selection. Mel frequency cepstral co-efficients (MFCC), linear prediction cepstral coefficients (LPCC), Perceptual LPCC. Distance measures for comparing speech patterns: Log spectral distance, cepstral distances, weighted cepstral distances, distances for linear and warped scales. Dynamic Time Warping for Isolated Word Recognition. Statistical models for speech recognition: Vector quantization models and applications in speaker recognition, Gaussian mixture modeling for speaker and speech recognition, Discrete and Continuous Hidden Markov modeling for isolated word and continuous speech recognition.

Simulation Software: MATLAB® Speech processing Toolbox, Using the HTK toolkit for building a simple speech recognition system.

1. The HTK toolkit for speech recognition http://htk.eng.cam.ac.uk/.
2. The Sphinx toolkit for speech recognition http://cmusphinx.sourceforge.net/html/cmusphinx.php.

Text Books:

1. Thomas F. Qatari, Cloth, "Discrete-Time Speech Signal Processing: Principles and Practice", 816 pp. ISBN: 013242942X Published: Oct 29, (2001).
2. L. Rabiner and B. Juang, "Fundamentals of Speech Recognition", Prentice-Hall Signal Processing Series, Pages: 507, Year of Publication: (1993), ISBN: 0-13-015157-2.
3. B. Gold and N. Morgan, "Speech and Audio Signal Processing: Processing and perception of speech and music", Wiley (2000), ISBN: 0-471-35154-7.

MULTIMEDIA SIGNAL PROCESSING

Course Code : 15 EC 4178 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2002 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	To establish the theory necessary to understand and use of multimedia in system control and related constructions.	h	2
CO2	To establish the theory necessary to understand and use of Motion Estimation	h	2
CO3	To emphasize on efficient algorithms for multimedia based systems.	k	1
CO4	To emphasize on Multimedia Content Representation and Retrieval	k	1

SYLLABUS:

Introduction to Multimedia: Elements of Image Compression System, Video Coding: Fixed-length and Variable-length Codes, Lossless and Lossy Compression, Lossy Compression

Technique, Lossy Compression Technique: Discrete Cosine Transforms, Bit Allocation Strategies for DCT Coefficients-1. Bit Allocation Strategies for DCT Coefficients–2, Limitations of the DCT. Motion Estimation: Matching Criteria, Motion Estimation: Generalized Matching, Generalized Deformation Model in Motion Estimation. Multimedia Standards: Still Image Compression Standards: JPEG, JPEG-2000, Video Compression Standards: An Overview, Video Compression Standards: H.261, Video Compressing Standards: H.261 & H.263 Standards, MPEG-1 Standards: Specifications, MPEG-1 Standards: Continuity & Synchronization. Synchronization of Media: Continuity Aspects of MPEG-1 Multimedia Streams, Multimedia Synchronization, MPEG-2 Standards, the MPEG-2 Scalable Profiles. MPEG- 4 Standards : Introduction, MPEG- 4 Standards : Audio Visual Objects, MPEG- 4 Multifunctional Coding Capabilities, MPEG- 1 Audio Standards, MPEG- 1 Audio Coder, MPEG - Audio - Layer-1 Encoding, MPEG - Audio - Layer-2 Encoding, MPEG - Audio : Bit Allocation and Psychoacoustic Model, MPEG - Audio : Masking Effects and Layer-3 Encoding. Multimedia Content Representation and Retrieval: Video Content Representation, Content-based Video: Motion Representation, Content-based Video: Low to High-level Representation, Content Retrieval Schemes.

Text Books:

1. Saeed V. Vaseghi, "Multimedia Signal Processing: Theory and Applications in Speech, Music and Communications", Hardcover – 5 Oct 2007.
2. Brad Perry et.al. "Content-Based Access to Multimedia Information from Technology Trends to State of the Art", Kluwer Academic Publishers (1999).
3. Mrinal Kr. Mandal, "Multimedia Signals and Systems (The Springer International Series in Engineering and Computer Science)", 31 December 2002.

NEURAL NETWORKS AND FUZZY CONTROL

Course Code : 15 EC 4179 **L–T–P :** 3-0-0

Pre Requisite : 15 EC 2206 **Credits :** 3

Mapping of the Course Outcomes with Student Outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	To establish the theory necessary to understand and use of Intelligence in system control and related constructions.	h	2
CO2	To establish the theory necessary to understand and use of Back propogation networks in system control and related constructions.	h	2
CO3	To emphasize on efficient algorithms for ANN based systems.	k	1
CO4	To emphasize on efficient algorithms for Fuzzy based systems.	k	1

SYLLABUS:

Neural Networks-1(Introduction & Architecture): Neuron, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory. Neural Networks-II (Back propogation networks) Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propogation learning methods, effect of learning rule co-efficient; back propagation algorithm, factors affecting backpropagation training, applications. Neural Networks-III Radial Basis Function Networks: Cover's Theorem, Radial Basis Function Networks: Seperability & Interpolation, Comparison between MLP and RBF. Network Based On Competition: Kohenen Self Organizing Maps.

Fuzzy Logic-I (**Introduction**) Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Fuzzy Logic –II (Fuzzy Membership, Rules) Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller.

Software Simulations(**MATLAB**)**:** students are encouraged to use the Stuttgart Neural Network Simulator (SNNS).Object Recognition Using Neural Networks, Face Recognition Using Neural Networks, Face Detection Using Neural Networks, Fingerprint Recognition Using Neural Networks, Eye-gaze Estimation and Tracking Using Neural Networks, Face-pose Estimation and Tracking Using Neural Networks Fuzzy Sets Applications: Approximate Reasoning, fuzzy arithmetic, decision theory, fuzzy controllers (development, tuning, compilation, deployment), cluster analysis. Hybrid soft computing systems using fuzzy, neural, and evolutionary systems; systems development and case studies. Takagi-Sugeno, mathematical characterizations, design example, Mamdani fuzzy model, System identification using neural and fuzzy neural networks.

Text Books

1. S. Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic Algorithm:Synthesis and Applications", Prentice Hall of India.

2. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press.

Reference Books

1. Siman Haykin, "Neural Netowrks", Prentice Hall of India.

2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley India.

Journals:

1. Fuzzy Sets and Systems (North Holland),

2. International Journal of Approximate Reasoning (Elsevier).

3. IEEE Transactions of Fuzzy Systems

4. IEEE Transactions on Evolutionary Computation

DEPARTMENT OF ELECTRONICS & COMPUTER ENGINEERING

EMBEDDED SYSTEMS

Course code : 15 EM 3103 **L – T – P :** 2 –2 - 2

Pre Requisite : 15 EM 2202 **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to analyze embedded systems, analyze and program on chip peripherals for a single purpose controller	c,k	2,3
CO2	Able to interface and program different off chip peripherals and communication protocols used in embedded systems	c,k	2,3
CO3	Able to understand, evaluate and select appropriate software architectures	c,k	2,3
CO4	Able to analyze and design embedded systems using the features in real time operating systems.	c,k	2,3
CO5	Able to develop a prototype for a real time embedded application using project based labs.	c,k	2,3

SYLLABUS:

Introduction to Embedded Systems: Definition, Comparison with Loaded Systems, Challenges of Embedded systems, Application of Embedded Systems. Hardware fundamentals: Power and decoupling, Open collector out puts, Tristate outputs, Signal loading related issues, Memories type and selectio, Processor types and selection, Timers, Counters, Pulse width Modulators for speed control, LCD Controllers, Key Pad Controllers, Stepper motor controllers, A/D Converters, Sensors and Actuators: Temp Sensors, Flow Control devices, Humidity Control devices, Speed Control devices. Interfacing Sensors and Actuators with microcontrollers. Interfacing: Communication basics, Basic Terminology, Basic Protocol concepts, I/O Addressing: Port Based Addressing, Bus Based addressing, Interfacing Micro Processors through Interrupts, Shared data problems Interrupt Latency and DMA. Overview: Interfacing through Serial Communication using RS232C, I2C, CAN, USB, Wireless Communication using IrDA, Blue Tooth, 802.11g, and Parallel Communication: PCI Bus, AMBA Bus. Software Architectures and RTOS: Overview of Round Robin, Round Robin with Interrupts, Function Queue Scheduling, RTOS architectures and selecting the architecture. Real Time Operating Systems: Tasks and Task data, Scheduler, Reentrancy, Semaphores, Semaphore Problems, Message Queues, Mail Boxes, Pipes, Timer Functions, Event Handling, Memory Management, Interrupt Processing, and Power saving Functions. Analysis, Design and Software Development: Analysis and designing Embedded Systems using RTOS: Overview, General Design Principles, Hardware and software CO design in Embedded Systems, Real Time Scheduling Considerations, Software development process and tools, Testing and Debugging Techniques, Testing and Debugging Tools.

Text Books:

1. An Embedded Software Premier - David E- Simon, PEARSON Education,2009.
2. Embedded System Design - Frank Vahid / Tony Givargis, WILEY India,2009.

Reference Books:

1. Embedded / real - time systems - DR.K.V.K.K.Prasad, dreamtech,2007.
2. Embedded Systems - Raj – Kamal, Second Edition TMH,2009.

COMPUTER ORGANIZATION AND ARCHITECTURE

Course code : 15 EM 2001 **L – T – P :** 2 – 2 - 2

Pre Requisite : 15 EC 1101 **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the functionality and design the CPU functional units - control unit, registers, the arithmetic and logic unit, the instruction execution unit, and the interconnections among these components.	c,k	2
CO2	Understand, analyze and design main, cache and virtual memory organizations.	c,k	2
CO3	Understand, analyze and design different types of I/O transfer techniques.	c,k	2
CO4	Understand the design issues of RISC and CISC CPUs and the design issues of pipeline architectures.	c,k	2
CO5	Able to Design combinational and sequential circuits using LOGISIM	c,k	2

SYLLABUS:

Introduction to computer system and its sub modules, Number System and Representation of information, Arithmetic and Logical operation and hardware implementation of Arithmetic and Logic Unit, Introduction to memory Unit, control unit and Instruction Set. Working with an ALU, Concepts of Machine level programming, Assembly level programming and High level programming. Various addressing modes and designing of an Instruction set. Concepts of subroutine and subroutine call, use of stack for handling subroutine call and return. Introduction to CPU design, Instruction interpretation and execution, Micro-operation and their RTL specification. Hardwired control CPU design. Micro programmed control CPU design. Concepts of semiconductor memory, CPU-memory interaction, organization of memory modules. Cache memory and related mapping and replacement policies. Virtual memory. Introduction to input/output processing, working with video display unit and keyboard and routine to control them. Program controlled I/O transfer. Interrupt controlled I/O transfer, DMA controller. Secondary storage and type of storage devices. Introduction to buses and connecting I/O devices to CPU and memory. Introduction to RISC and CISC paradigm. Design issues of a RISC processor and example of an existing RISC processor. Introduction to pipelining and pipeline hazards, design issues of pipeline architecture. Instruction level parallelism and advanced issues.

Text Books:

1. William Stallings, Computer Organization and Architecture: Designing for Performance,

8/e, Pearson Education India. 2010.

2. D. A. Patterson and J. L. Hennessy, Computer Organization and Design, 4/e, Morgan Kaufmann, 2008.

Reference Books:

1. A. S. Tanenbaum, Structured Computer Organization, 5/e, Prentice Hall of India, 2009.
2. V. C. Hamacher, Z. G. Vranesic and S. G. Zaky, Computer Organization, 5/e, McGraw Hill, 2002.

PROCESSORS AND CONTROLLERS

Course code : 15 EM 2202 **L – T – P :** 2 – 2 - 2

Pre Requisite : 15 EC 1101 **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand and analyze the architectural features of CISC type of General purpose processor Intel 8086 Microprocessor.	e,k	2,3
CO2	Able to understand and analyze the architectural features of CISC type of microcontroller - Intel 8051 Microcontroller.	e,k	2,3
CO3	Able to understand and analyze the architectural features of RISC type of microcontroller – PIC Microcontroller.	e,k	2,3
CO4	Able to program 8086 microprocessor, 8051 and PIC microcontrollers in assembly language using TASM, KEIL, MPLAB and Proteus tools.	e,k	2,3
CO5	Able to Develop a real time application using 8051 & PIC Microcontrollers through project based labs.	e,k	2,3

SYLLABUS:

8086 Microprocessor: Introduction to Microprocessor, Intel Microprocessor families ,8086 Microprocessor architecture, Register Organization, Pin Description, Physical Memory Organization, Modes of operation. 8086 Instruction set & Assembly Language programming: Addressing modes, Instruction set, Assembler directives, simple Programs, Procedures and Macros, 8086 Interrupts. 8051 Microcontroller: Microcontroller families, 8051 Architecture, Signal Description, Register organization, Internal RAM, Special Function Registers, Interrupt control flow, Timer/Counter Operation, Serial Data Communication, and RS-232C Standard.8051 Programming & Interfacing: Addressing modes, Instruction set, Simple Programs involving Arithmetic and Logical Instructions, Timers/Counters, Serial Communication & Interrupts. PIC Microcontroller: Introduction, Architectural overview, Memory organization, interrupts and reset, I/O ports, Timers. Interfacing: Matrix Key Board, Stepper Motor, LCD's, DAC & ADC. using 8051 and PIC Microcontroller.

TEXT BOOKS

1. D.V.Hall "Microprocessor and Interfacing", 2nd Edition Tata McGraw Hill Publishing Company,2006.
2. Mazidi & Mc Kinley "The 8051 Micro controller and Embedded systems: using assembles and C, 2nd edition,2007.

REFERENCE BOOKS

1. A.K. Ray & K. M Bhurchandi, "Advanced Microprocessors & peripherals", Tata Mc Graw Hill Publishing Company 2002.
2. Rajkamal, "Microcontrollers - Architecture, Programming, Interfacing & System

Design", 2nd edition, Pearson Education,2009.

COMMUNICATION SYSTEMS

Course code : 15 EM 3104 **L-T-P :** 2-2-2

Pre requisite : 15 EC 2103 **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	To Understand the basics of Modulation and demodulation techniques, Different types of filtering techniques and Radio Receiver characteristics.	b,k	2
CO2	To Understand the sampling techniques and signal to noise ratio of different pulse modulation schemes.	b,k	2
CO3	To Design the Digital Modulation schemes, band width estimation and clock recovery.	b,k	2
CO4	To Understand the source coding techniques and estimate the error detection and correction of different block codes	b,k	2
CO5	Able to design receivers used for Digital communication system using project based labs	b,k	2

SYLLABUS:

Amplitude Modulation techniques: Introduction to Modulation, Continuous wave AM Generation and Demodulation of AM: DSB, DSB-SC, SSB and VSB. Phase and frequency modulation, narrow band and wide band F.M, Direct and indirect methods of generation of F.M, demodulation of F.M wave.

Transmitters and Revivers: A.M Transmitter and F.M.Transmiter. Armstrong method receiver, AM Superhetrodyne receivers , FM Super hetrodyne receivers.

Pulse modulation techniques: Sampling Process, Types of Sampling, FDM, TDM, Modulation and Demodulation of PAM, PPM & PWM. S/N ratio of PAM, PWM, PWM & PPM, Quantization process, Quantization Noise, PCM, DPCM.

Digital Modulation Techniques: ASK, FSK, BPSK, DPSK, QPSK, QAM, Bandwidth Efficiency, Carrier recovery, Clock recovery.

Information Theory: Uncertainty, Information, Entropy, Source coding theorem: Shannon-Fanon coding, Huffman coding.

Codes: Liner block codes, Cyclic codes, Convolution codes.

Text Books:

1. "Introduction to Analog and Digital Communication System" – By Simon Haykin, 2nd Edition,2009.
2. "Communication Systems" by Singh R.P. and Sapre S.D – TMH,2009.
3. "Advanced Electronic Communication Systems" – By Wayne Tomasi, 6th Edition, PHI, 2010.

Reference Books:

1. "Analog and Digital Communications" – By Sam K.Shanmugam, Wiley, 2009.
2. "Modern Digital & Analog Communication Systems" – By B.P. Lathi, 3rd Edition, 2009.

INTERNET PROGRAMMING

Course code : 15 EM 3105 **L – T – P :** 2-2-2

Pre Requisite : 15 CS 2002 **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to create Static Web pages using basic HTML & apply CSS	e,k	2,3
CO2	Able to apply javascript features for form validations and event handling	e,k	2,3
CO3	Able to create databases using MYSQL and apply JDBC concepts to connect to a database.	e,k	2,3
CO4	Able to create dynamic web pages using servlets & JSP	e,k	2,3
CO5	Must be able to design WEB site considering the user interface, navigation and interaction with database using project based LABS	e,k	2,3

SYLLABUS:

Introduction to HTML5: Headings, Linking, Images, Lists, Tables, Frames, Forms and Input types.

Cascading Style Sheets (CSS3): Inline Styles, Embedded Style Sheets, Linking External Style Sheets, Positioning Elements.

JavaScript: Control Statements-(if, if-else, switch, while, do-while, for), Document Object Model –objects and collections, Event Handling.

Database Access with JDBC: JDBC architecture, Connection Object, Working with statements, Creating and executing SQL statements, working with Result Set.

Servlets & Java Server Pages: Servlet Basics: Handling the Client Request, Generating the Server Response, Overview of JSP Technology, JSP Scripting Elements, Implicit Objects, Accessing MYSQL Database with JDBC.

Developing sample WEB sites: Online Examination System, Shopping cart, Electricity Bill payment

Text Books :

1. Deitel & Deitel & Nieto, "Internet & World Wide Web – How to Program", PEA, Fifth Edition.2010.
2. Falkner & Jones," Servlets and Java Server Pages: The J2EE Technology Web Tier", 1/e, Addison-Wesley Professional,2008.

Reference Books:

1. Chris Bates, "Web Programming Building Internet Applications", 3rd Edition, Wiley India, 2006.
2. Anders Moller, Michael Schwartzbach, "An Introduction to XML and Web Technologies", 1st Edition, Pearson Education, 2006.
3. Ivan BayRoss, "Web Enabled Commercial Application Development using HTML, DHTML, JavaScript, Perl", BPB Publication, 3rd Edition, 2005.
4. Uttam K Roy, "Web Technologies", OXFORD University Press, 2012.
5. "Advanced Java 2 Platform -HOW TO PROGRAM" by H. M.Deitel, P. J. Deitel, S. E. Santry – Prentice Hall.
6. "Beginning Java™ EE 6 Platform with GlassFish 3 From Novice to Professional" by Antonio Goncalves - Apress publication.

VLSI DESIGN

Course Code : 15 EM 3206 **L - T – P :** 2-2-2

Pre Requisite : 15 EC 1101 **Credits :** --4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	To understand the VLSI fabrication process and to be able to interact with integrated circuit process engineers	b,k	2,3
CO2	Able to analyze Circuit Charactersation, Performance Estimation and Fault Testing.	b,k	2,3
CO3	Able to Understand Full-custom & Semi Custom design methodologies to design different PLD architectures	b,k	2,3
CO4	Analyze different CPLD and FPGA architectures	b,k	2,3
CO5	Able to design and simulate digital circuits using Verilog HDL through project based LAbs	b,k	2,3

SYLLABUS:

MOS Basics: MOS IC Modelling and Analysis: Introduction to IC Technology – MOS, PMOS, NMOS, CMOS & Bi-CMOS Technologies. MOS Fabrication Process, Basic Electrical Properties of MOS Circuits : Ids-Vds Relationships, MOS Transistor Threshold Voltage Vth, gm, gds, Figure of Merit ωo, Scaling of MOS transistors, Short Channel and Narrow Channel Width Effects. CMOS Circuits and Test principles: Various form of Pull-ups, CMOS Inverter Analysis and

Design, Bi-CMOS Inverters, Latch up in CMOS Circuits. Simple Symbolic Encodings for NMOS, PMOS, CMOS Logic Gates, MOS Layers, Stick Diagrams, Design Rules and Layouts, CMOS fault models, need for testing, manufacturing test principles. ASIC Design: Full Custom Design; Semicustom Design; Standard Cell Based ASIC, Gate Array Based ASIC, Programmable Logic Devices, CPLDs, FPGA, ASIC Design Flow, Economics of ASICs, Frontend Design: RTL coding and synthesis, Physical Design: ASIC Cell Library. Placement, Routing, Static Timing Analysis. Computer Aided Design Tools: Synthesis: Netlist Generation, Gate Optimization, Technology Mapping. Programmable ASICs:.FPGAs architectures: Field Programmable Gate Array (FPGA); Xilinx SRAM-Based FPGA; Xilinx – XC2000, XC3000, XC4000, Altera – FLEX 8000, The Antifuse, Static RAM, EPROM and EEPROM Actel – ACT – 1, 2, architectures.

TEXT BOOKS:

1. Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, "Essentials of VLSI Circuits and Systems" – PHI EEE, 2005.
2. Neil H. E. Weste and David. Harris Ayan Banerjee,, "CMOS VLSI Design" Pearson Education, 1999.
3. Michael John Sebasatian Smith, "Appliction Specific Integrated Circuits" Pearson Education,2005.
4. Stephen M. Trimberger, "Field-Programmable Gate Array Technology", Springer,2006.

REFERENCE TEXT BOOKS

1. Sung-Mo Kang, Yusuf Leblebici,"CMOS Digital Integrated Circuits" TMH 2003
2. Jan M. Rabaey, "Digital Integrated Circuits" Pearson Education, 2003
3. Pak K. Chan,Samiha Mourad,"Digital Design Using Field Programmable Gate Array", Pearson-2009.
4. Stephen Brown and Zvonko Vranesic "Fundamentals of Digital Logic with Verilog Design" MCH
5. Parag K. Lala, "Digital System Design Programmable Logic Devices", B S Publications,2006.
6. Etienne Sicard, Sonia Delmas Bendhia, "Basics of CMOS Cell Design", TMH, EEE, 2005

AUTOMATA AND COMPILER DESIGN

Course code: 15 EM 3207 **L-T-P :** 2-2-2

Prerequisite : 15 CS 2003 **Credits :** 4

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to analyze formal languages, Grammars and finite automata	a,k	2,3
CO2	Able to analyze the grammar based on top down and bottom up parser.	a,k	2,3
CO3	Able to understand SDT and generate intermediate code	a,k	2,3
CO4	Able to apply code optimization techniques	a,k	2,3
CO5	Able to implement various phases of compiler through project based labs	a,k	2,3

SYLLABUS:

Formal Language and Regular Expressions: Languages, Definition Languages regular expressions, Finite Automata - DFA, NFA. Conversion of regular expression to NFA, NFA to DFA. Applications of Finite Automata to lexical analysis, lex tools.

Context Free grammars and parsing: Context free grammars, derivation, parse trees, ambiguity LL(K) grammars and LL(1) parsing. Bottom up parsing handle pruning LR Grammar Parsing, LALR parsing, parsing ambiguous grammars.

Syntax directed translation, S-attributed and L-attributed grammars, Intermediate code - abstract syntax tree, translation of simple statements and control flow statements. Context Sensitive features - Chomsky hierarchy of languages and recognizers. Type checking, type conversions, equivalence of type expressions, overloading of functions and operations. Run time storage: Storage organization, storage allocation strategies scope access to now local names, parameters, language facilities for dynamics storage allocation. Code optimization : Principal sources of optimization, optimization of basic blocks, peephole optimization, flow graphs, Data flow analysis of flow graphs. Code generation : Machine dependent code generation, object code forms, generic code generation algorithm, Register allocation and assignment. Using DAG representation of Block.

TEXT BOOKS:

1. Introduction to Theory of computation.Sipser,2nd Edition,Thomson., 2009.
2. Compilers Principles, Techniques and Tools Aho, Ullman, Ravisethi, Pearson Education, 2009.

REFERENCES:

1. Introduction Automata theory and formal languages, and computation, John E Hopcraft and JD Ullman, 2007.
2. Modern Compiler Construction in C , Andrew W.Appel Cambridge University Press., 2005.
3. Compiler Construction, LOUDEN, Thomson, 2006.

ADVANCED EMBEDDED PROCESSOR ARCHITECTURES

Course code : 15 EM 3251 **L – T – P :** 3 –0 - 0

Pre Requisite : 15 EM 2001 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand and analyze the 3 and 5 stage pipelines of ARM and able to program the ARM processor.	h,k	2,1
CO2	Able to program the on chip & off chip peripherals of ARM 7 controller.	h,k	2,1
CO3	Understand and analyze the AMBA bus architecture and different advanced ARM cores.	h,k	2,1
CO4	Able to analyze the different SOC applications using ARM cores.	h,k	2,1

SYLLABUS:

ARM Processor as System-on-Chip: Acorn RISC Machine – Architecture inheritance – ARM programming model – ARM development tools – 3 and 5 stage pipeline ARM organization – ARM instruction execution and implementation – ARM Co-processor interface. ARM Assembly Language Programming: ARM instruction types – data transfer, data processing and control flow instructions – ARM instruction set – Co-processor instructions, Thumb Instruction set. Architectural Support for System Development: Advanced Microcontroller bus architecture – ARM memory interface – ARM reference peripheral specification – Hardware system prototyping tools – ARMulator – Debug architecture. ARM Processor Cores: ARM7TDMI, ARM8, ARM9TDMI, ARM10TDMI, The AMULET Asynchronous ARM Processors-AMULET1. Embedded ARM Applications: The VLSI Ruby II Advanced Communication Processor, The VLSI ISDN Subscriber Processor, The OneCTM VWS22100 GSM chip, The Ericssion-VLSI Bluetooth Baseband Controller, The ARM7500 and ARM7500FE

Text Books

1. ARM System on Chip Architecture – Steve Furber – 2nd ed., 2000,Addison Wesley Professional.
2. Design of System on a Chip: Devices and Components – Ricardo Reis, 1st ed., 2004, Springer

Reference Books

1. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology) – Jason Andrews – Newnes, BK and CDROM, 2005.
2. System on Chip Verification – Methodologies and Techniques –Prakash Rashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer Academic Publishers.

EMBEDDED LINUX

Course code :15 EM 4154 **L – T – P :** 3– 0- 0

Pre Requisite : 15 EM 2001 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand embedded Linux development environment, understand and create Linux BSP for a hardware platform.	i,k	2,1
CO 2	Able to program different embedded storage devices	I,k	2,1
CO 3	Able to understand the Linux model for embedded storage, understand and write various embedded Linux drivers such as serial, I2C, and so on.	i,k	2,1
CO 4	Able to port applications to embedded Linux and write real – time applications in embedded Linux.	i,k	2,1

SYLLABUS:

Introduction: History of Embedded Linux, Embedded Linux versus Desktop Linux, Embedded Linux Distributions, Architecture of Embedded Linux, Linux Kernel Architecture, Linux Start-Up Sequence, GNU Cross-p\Platform Tool chain. Board Support Package: Inserting BSP in Kernel Build Procedure, Boot Loader Interface, Memory Map, Interrupt Management, PCI Subsystem, Timers, UART, and Power Management.

Embedded Storage: Flash Map, MTD—Memory Technology Device, MTD Architecture, Flash-Mapping Drivers, MTD Block and Character devices, Embedded File systems, Optimizing Storage Space.

Embedded Drivers: Linux Serial Driver, Ethernet Driver, I2C subsystem on Linux, USB Gadgets, Watchdog Timer, and Kernel Modules.

Porting Applications: Architectural Comparison, Application Porting Road Map, Programming with Pthreads, Operating System Porting Layer (OSPL), Kernel API Driver. Real-Time Linux: Linux and Real-Time, Real-Time Programming in Linux, Hard Real-Time Linux.

Text Books:

1. Embedded Linux System Design and Development, P.Raghavan, Amol Lad, SriramNeelakandan, 2006, Auerbach Publications

Reference Books:

1. Embedded Linux – Hardware, Software and Interfacing,2006.

NETWORKING OF EMBEDDED SYSTEMS

Course code : 15 EM 4155 **L – T – P :** 3 – 0 - 0

Pre Requisite : 15 EM 2001 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand and develop applications using Rs-232C, RS-485 and SPI communication protocols.	h,k	2,1
CO2	Able to understand and develop applications using I2C, USB coomunication protocols.	h,k	2,1
CO3	Able to understand and develop applications using CAN communication protocols	h,k	2,1
CO4	Able to understand and analyze different wireless communication protocols used in Embedded Systems.	h,k	2,1

SYLLABUS:

Networking through Native Serial Communications Systems: RS232 Standard: Features, Configuring UART port of 8051 and LPC 2148 and developing an application. RS 485: Features, Transmission Protocol, Developing an application using RS485 protocol. Synchronous Serial Protocols: Serial Peripheral Interface (SPI) – Features, Master Slave Configuration, Functional Discrepiction, SPL Developing an application using SPI communication interface.

Networking through Inter Integrated Communication (I2C): Drawbacks of RS232C, Features of I2C Starting and Stopping Communication, Receiving data from the Master, Interfacing devices on to the Bus, Acknowledging and Negative acknowledging, Arbitration and Synchronization, Addressing, Developing Applications using PIC based Microcontrollers. Networking through USB bus: Features of USB, Upward and Downward communications, USB device Identification, Speed Identification, Monitoring status of USB bus, Data Packet Identification, USB based data flow methods, Enumeration process for Interfacing USB devices on to the Bus, Configuring Descriptors, and Developing application using USB. Networking through CAN Bus – Features of CAN Protocols, Differentiating Data on CAN Bus, Bus Termination, CAN Communication Standard, Message Frames, Arbitration methods, Frame overloading, Bit stuffing, CAN identified errors, Normal Bit timing Computational Method, CAN Based Synchronization, Application development using PIC. Wireless Embedded Networking: Overview on wireless communication systems covering Wi-Fi, Bluetooth, Zigbee, NFC, Hi-Fi. Wireless sensor networks: Introduction, Applications, Network Topology, Localization, Time Synchronization, Energy efficient MAC protocols, SMAC, Energy efficient and robust routing, Data Centric routing

TEXT BOOKS:

1. Frank Vahid, Givargis 'Embedded Systems Design: A Unified Hardware/Software Introduction', Wiley Publications,2007.
2. Dogan Ibrahim, 'Advanced PIC microcontroller projects in C', Elsevier 2008.

Reference Books:

1. Bhaskar Krishnamachari, 'Networking wireless sensors', Cambridge press 2005.

SYSTEM ON CHIP ARCHITECTURES

Course code : 15 EM 4156 **L – T – P :** 3- 0- 0

Pre Requisite : 15 EM 2001 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand and analyze different Design and Validation methodologies for logic cores such as memories, analog devices and SoCs.	j,k	2,1
CO2	Able to understand On chip Communication Architecture Standards	j,k	2,1
CO3	Able to analyze security issues of On chip Communication Architecture standards	j,k	2,1
CO4	Able to understand and analyze different topologies of Networks on Chip.	j,k	2,1

SYLLABUS:

Introduction, Design Methodology for Logic cores: SoC Design flow, General guide lines for design reuse, design process for soft, firm and hard cores, system integration. Design Methodology for Memory Cores and Analog cores: Design methodology for embedded memories, specifications of analog circuits.

Design Validation: core level validation, core interface verification, SoC design validation. On-chip communication Architectures: A quick overlook, Basic concepts of bus based communication Architectures: Terminology, characteristics of Bus based communication architectures, data transfer modes, Bus topology types.

On chip Communication Architecture Standard: Standard on chip bus based communication architectures; socket based on chip interface standards.

Verification and security Issues in On chip communication Architectures: verification of on chip communication protocols, compliance verification for IP block integration, basic concepts for SoC security, security support in standard bus protocols,

Networks on chip: network topology, switching strategies, routing algorithms, flow control, clocking schemes, NOC architectures.

Text Books:

1. System On a Chip Design and Test? by Rochit Rajsuman, Library of Congress Cataloging-in-Publication Data, 2000.
2. On chip communication Architectures? by Sudeep Pasricha and Nikil Dutt , Morgan Kaufmann Publishers, 2008.

HARDWARE SOFTWARE CO-DESIGN

Course code : 15 EM 4157 **L – T – P :** 3 – 0 - 0

Pre Requisite : 15 EM 2001 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand and Analyze the co-design models like FSM, DFG and target architectures and use the tools required for designing the hardware and software models	i,k	2,1
CO2	Analyze Validation and Verification Techniques, design specification for embedded processor architectures	i,k	2,1
CO3	Analyze the compilation techniques and tools for embedded processor architectures	I,k	2,1
CO4	Understand the standard design methods like COSYMA system and LYCOS systems.	i,k	2,1

SYLLABUS:

Introduction to HW-SW Co- Design: Meaning of HW-SW co-design, Co- Design Models, Architectures, Languages, A Generic Co-design Methodology. HW-SW Co-Synthesis.

Co- Synthesis Algorithms: Hardware software synthesis algorithms: hardware – Algorithms for software partitioning distributed system co-synthesis.

Prototyping and Emulation: Prototyping and emulation techniques, prototyping and emulation environments, future developments in emulation and prototyping.

Target Architectures: Architecture Specialization techniques, System Communication infrastructure, Target Architecture and Application System classes, Architecture for control dominated systems (8051-Architectures for High performance control), Architecture for Data dominated systems (ADSP21060, TMS320C60), Mixed Systems.

Compilation Techniques and Tools for Embedded Processor Architectures: Modern embedded architectures, embedded software development needs, compilation technologies practical consideration in a compiler development environment.

Design Specification and Verification: Design Specification: Design, co-design, the co-design computational model, concurrency coordinating, concurrent computations, interfacing components, **Verification:** Design verification, implementation verification, verification tools, interface verification

Languages for System: Level Specification and Design for homogenous systems System – level specification, design representation for system level synthesis, system level specification languages.

Languages for System: Level Specification and Design in respect of heterogeneous systems, Heterogeneous specifications and multi-language co-simulation the cosyma system and lycos system.

Text Books:

1. Hardware / software co- design Principles and Practice – Jorgen Staunstrup, Wayne Wolf – 2009, Springer.
2. Hardware / software co- design Principles and Practice, 2002, kluwer academic publishers.

SENSORS AND SENSING PRINCIPLES

Course code : 15 EM 3252 **L – T – P :** 3 – 0 - 0

Pre Requisite : 15 CS 2204 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand and analyze the sensor fundamentals, principles and characteristics	i,j	2
CO2	Understand the application of various physical and Chemical sensors	i,j	2
CO3	Understand the application of various optical sensors	i,j	2
CO4	Able to understand the different bio sensors and its limitations.	i,j	2

SYLLABUS

Sensor Fundamentals: Basic sensor technology -sensor characteristics –static and dynamic –Principles of sensing- capacitance- magnetic and electromagnetic induction –resistance – piezoelectric effect –Pyroelectric effect -Hall effect- See beck and Pettier effect-heat transfer-light. Sensor Characteristics: Analysis of experimental data: causes and types of experimental errors – statistical analysis of experimental data –method of least squares –correlation coefficient, multivariable regression – graphical analysis and curve fitting. Physical /Chemical sensors: Position, Displacement and Level sensors, Velocity and Acceleration sensors, Force, Strain, Tactile and pressure sensors. Classification of chemical sensing Mechanism, Potentiometric sensors, Conduct metric Sensors, Amperometric Sensors, Enhanced Catalytic gas Sensors. Optical Sensors: Optical Radiation- Electromagnetic Spectrum, Snell's Law and Total internal reflection, Diffraction principles, Optical Detectors and Sources-Photo diodes and transistors, Photo-darling ton pairs, Photoconductive sensors, CCD sensors, Fiber optic sensors. Solid state light sources- LED , Diode lasers, Semiconductor laser optical cavity resonator. Bio sensors Origin and Transmission of bioelectrical Signals, The Electromyogram (EMG) & the Electrocardiogram (ECG) The Electroencephalogram (EEG) & Blood pressure measurement, Catalytic biosensors, mono-enzyme electrodes, bi-enzyme electrodes. cell based biosensors, biochips and biosensor arrays, problems and limitations.

Text books:

1. Biosensor Principles and Applications, Edited by Loïc J.Blum, Pierre R. Coulet Agarwal, Govind P, "fiber Optic Communication Systems", 2nd edition, Wiley, NewYork,1997
2. Principles of Biochemistry Albert L.Lehninger, David Lee Nelson,Michael M. 2005, 4th Edition.
3. Sensors and Transducers D. Patranabis Prentice-Hall of India Pvt.Ltd August 15, 2004
4. Jacob Fraden, " Hand Book of Modern Sensors: physics, Designs and Applications",3rd ed., Springer, 2003.

WIRELESS COMMUNICATIONS & NETWORKS

Course code : 15 EM 4158 **L – T – P :** 3 – 0- 0

Pre Requisite : 15 CS 2204 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand Transmission fundamentals and communications networks and application protocol architecture	i,j	2
CO2	Able to understand and analyze signal encoding techniques, spectrum and different wireless networks	i,j	2
CO3	Able to understand and analyze various principles of cellular wireless networks	i,j	2
CO4	Able to understand wireless protocols and applications of IEEE802.11 architecture and standards	i,j	2

SYLLABUS:

Introduction: Wireless Comes of Age. The Cellular Revolution. The Global Cellular Network. Broadband. The Trouble with Transmission Fundamentals -Wireless Signals for Conveying Information. Analog and Digital Data Transmission. Channel Capacity. Transmission Media. Multiplexing. Communication Networks- LANs, MANs, and WANs. Switching Techniques. Circuit-Switching. Packet-Switching. Asynchronous Transfer mode. Protocols and the TCP/ IP Suite - The Need for a Protocol Architecture. The TCP/IP Protocol Architecture. The OSI Protocol Architecture, internetworking. WIRELESS COMMUNICATION TECHNOLOGY: Antennas and Propagation- Antennas. Propagation Modes. Line-of-Sight Transmission. Fading in the Mobile Environment. Signal Encoding Techniques- Signal Encoding Criteria. Digital Data, Analog Signals. Analog Data, Analog Signals. Analog Data, Digital signals .Spread Spectrum- The Concept of Spread Spectrum. Frequency Hopping Spread Spectrum. Direct Sequence Spread Spectrum. Code-Division Multiple Access. Generation of Spreading Sequences. Coding and Error Control- WIRELESS NETWORKING- Cellular Wireless Networks Principles of Cellular Networks. First Generation Analog. Second Generation TDMA. Second Generation CDMA. Third Generation Systems . Cordless Systems and Wireless Local Loop- Cordless Systems. Wireless Local Loop. IEEE 802.16 Fixed Broadband Wireless Access Standard. Mobile IP and Wireless Access Protocol- Mobile IP. Wireless Application Protocol. Wireless LAN Technology- Overview. Infrared LANs. Spread Spectrum LANs. Narrowband Microwave LANs. IEEE 802.11 Wireless LAN Standard- IEEE 802 Protocol Architecture. IEEE 802.11 Architecture and Services. IEEE 802.11 Medium Access Control, IEEE 802.11 Physical Layer. Bluetooth- Overview. Radio Specifications. Baseband Specification. Link Manager Specification. Logical Link Control and adaptation protocol.

TEXTBOOKS:

1. William Stallings, "Wireless Communications and Networks", Pearson Education, 2005
2. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education, 2001.

REFERENCES:

1. Kaveh Pahlavan, Prasanth Krishnamoorthy, "Principles of Wireless Networks", First dition, Pearson Education, 2001.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2001.

WIRELESS SENSOR NETWORKS.

Course code : 15 EM 4159 **L – T – P :** 3 – 0 - 0

Pre Requisite : 15 CS 2204 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand Cellular and adhoc networks in detail	i,k	2
CO2	Able to understand wireless sensor networks data communications to other networks which involves its design and principles	i,k	2
CO3	Able to understand various MAC protocols for sensor networks	i,k	2
CO4	Able to understand and analyze various routing techniques of wsn and ad hoc networks	i,k	2

SYLLABUS:

Cellular and Ad Hoc Wireless Networks-Applications of Ad Hoc Wireless Networks, Issues in Ad Hoc Wireless Networks: Medium Access Scheme-Routing-Multicasting Transport Layer Protocols-Pricing Scheme-Quality of Service Provisioning-Self Organization-Security-Addressing and Service Discovery-Energy management Scalability-Deployment Considerations, Ad Hoc Wireless Internet. Comparison with Adhoc wireless networks-Challenges for WSNs – Difference between sensor networks and Traditional sensor networks ,Types of Applications, Enabling Technologies for Wireless Sensor Networks –Single Node Architectures , Hardware Components , Energy Consumption of Sensor Nodes, Issues in Designing aMulticast Routing Protocol.Data Dissemination-Flooding and Gossiping-Data gathering Sensor Network Scenarios –Optimization Goals and Figures of Merit – Design Principles for WSNs Gateway Concepts – Need for gateway – WSN to Internet Communication –Internet to WSN Communication –WSN TunnelingMAC Protocols for Sensor Networks -Location Discovery-Quality of Sensor Networks Evolving Standards-Other Issues-Low duty cycle and wake up concepts- The IEEE802.15.4 MAC Protocols- Energy Efficiency -Geographic Routing Mobile nodes Gossiping and Agent based Unicast Forwarding-Energy Efficient Unicast-Broadcastand Multicast-Geographic Routing-Mobile nodes-Security-Application SpecificSupport - Target detection and tracking-Contour/ edge detection-Field Sampling.

Text Books:

1. Holger Karl and Andreas Wiilig, "Protocols and Architectures for Wireless Sensor Networks" John Wiley & Sons Limited 2008.
2. I.F .Akyildiz and Weillian, "A Survey on Sensor Networks",IEEE Communication Magazine, August 2007.

Reference Books:

1. Wilson , "Sensor Technology hand book," Elsevier publications 2005.
2. Anna Hac "Wireless Sensor Networks Design," John Wiley& Sons Limited Publications 2003.
3. C.Siva Ram Murthy and B.S.Manoj "Ad Hoc Wireless Networks," Pearson Edition 2005.

SENSOR NETWORKS PROGRAMMING

Course code : 15 EM 4160 **L – T – P :** 3 – 0 - 0

Pre Requisite : 15 CS 2204 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand fundamentals of TinyOS and nesC in wsn environment.	i,k	2,1
CO2	Able to understand real world programming of wireless sensor network in different scenarios	i,k	2,1
CO3	Able to understand the performance analysis of power-aware algorithms	I,k	2,1
CO4	Able to understand and develop energy efficient algorithms for wireless sensor networks thru simulation or real time experiments	i,k	2,1

SYLLABUS

Introduction: Some Foundational Information, Next-Generation Sensor Networked Tiny Devices, Sensor Network Software Performance-Driven Network Software Programming, Unique Characteristics of Programming Environments for Sensor Networks, Why TinyOS and NesC, Future Demands on Sensor-Based Software Wireless Sensor Networks :Sensor Network Applications, Characteristics of Sensor Networks, Nature of Data in Sensor Networks Sensor Technology: Sensor Level Server Level, Client Level, Programming Tools. Tiny Operating System (TinyOS) Components of TinyOS,An Introduction to NesC,, Event-Driven Programming. Programming in NesC NesC Programming A Simple Program, SENSOR NETWORK IMPLEMENTATION. Sensor Programming: Programming Challenges in Wireless Sensor Networks, Sensing the World Applications Using the Interface SplitControl. REAL-WORLD SCENARIOS: Sensor Deployment Abstraction:Sensor Network Abstraction Data Aggregation, Collaboration Group Abstractions ,Programming Beyond Individual Nodes 205 Standards for Building Wireless Sensor Network Applications :802.XX Industry Frequency and Data Rates ZigBee Devices and Components ZigBee Application Development Dissemination and Evaluation for Real-Time Environment Motivation and Background, Software Microframework Requirements Performance Analysis of Power-Aware Algorithms: Introduction Service Architecture 242 Approaches To WSN Programmability, Simulation Capabilities, Benchmarking Modeling Sensor Networks Through Design and Simulation: Introduction, Why a New Simulator Currently Available Simulators, Simulation Design, Implementation Details, Experimental Results. MATLAB Simulation of Airport Baggage-Handling System: Introduction, proposed Architecture

Text Books.

1. Fundamentals of Sensor Network Programming: Applications and Technology Hardcover Dec 2010 by S. Sitharama Iyengar ,Nandan Parameshwaran, Vir V. Phoha.
2. Fundamentals of Sensor Network Programming: Applications and Technology S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye ISBN: 978-0-470-87614-5

Reference Books

1. Developing a Wireless Sensor Network Programming Language Application Guide Using Memsic Devices and LabVIEW

REMOTE SENSING

Course code : 15 EM 4161 **L – T – P :** 3 – 0 - 0

Pre Requisite : 15 CS 2204 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to understand relations of remote sensing with atmosphere and earth	i,k	2,1
CO2	Able to understand and remote sensing platforms and sensors for data analysis and interpretation	i,k	2,1
CO3	Understand the basic components of GIS	i,k	2,1
CO4	Understand data storage and analysis of GIS data.	i,k	2,1

SYLLABUS:

EMR AND ITS INTERACTION WITH ATMOSPHERE & EARTH MATERIAL: Definition of remote sensing and its components – Electromagnetic spectrum – wavelength regions important to remote sensing – Wave theory, Particle theory, Stefan-Boltzman and Wein's Displacement Law – Atmospheric scattering, absorption – Atmospheric windows – spectral signature concepts – typical spectral reflective characteristics of water, vegetation and soil.

PLATFORMS AND SENSORS Types of platforms – orbit types, Sun-synchronous and Geosynchronous – Passive and Activesensors – resolution concept – Pay load description of important Earth Resources and Meteorological satellites – Airborne and spaceborne TIR and microwave sensors.

IMAGEINTERPRETATIONANDANALYSIS Types of Data Products – types of image interpretation – basic elements of image interpretation- visual interpretation keys – Digital Image Processing – Pre-processing – image enhancement techniques – multispectral image classification – Supervised and unsupervised.

GEOGRAPHIC INFORMATION SYSTEM Introduction – Maps – Definitions – Map projections – types of map projections – map analysis –GIS definition – basic components of GIS – standard GIS softwares – Data type – Spatial andnon-spatial (attribute) data – measurement scales – Data Base Management Systems (DBMS).

DATAENTRY, STORAGE AND ANALYSIS Data models – vector and raster data – data compression – data input by digitization andscanning – attribute data analysis – integrated data analysis – Modeling in GIS Highway alignment studies – Land Information System.

TEXTBOOKS

1. Lilles and T.M.,Kiefer, R.W. and J.W.Chipman. (2004). Remote Sensing and Image Interpretation. V Edn.JohnWilley and Sons (Asia) Pvt. Ltd., NewDelhi.
2. Anji Reddy, M. (2001). Textbook of Remote Sensing and Geographical Information System. Secondedn.BSPublications, Hyderabad.

REFERENCES

1. Lo. C.P. and A.K.W.Yeung (2002). Concepts and Techniques of Geographic Information Systems.Prentice-HallofIndiaPvt.Ltd.,NewDelhi.Pp:492.
2. Peter A.Burrough, Rachael A.McDonnell (2000). Principles of GIS. Oxford University Press.
3. Ian Heywood (2000). An Introduction to GIS. Pearson Education Asia.

WEB TECHNOLOGIES STREAM

WEB SERVICES

Course code : 15 EM 3253 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2002 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Must be hands-on in developing two tier/ three tier WEB based applications using APACHE and NETBEANS as the Platform	i,j,k	2,2,1
CO2	Must have theoretical knowledge of all the programming languages, WEB services related technologies and API as detailed in the syllabus	i,j,k	2,2,1
CO3	Able to understand fundamentals of SOAP,WSDL & UDDI	i,j,k	2,2,1
CO4	Must be able to design, develop, register, deploy WEB Services and develop a real life application considering WEB services server and UDDI registry	i,j,k	2,2,1

SYLLABUS:

Introduction: Introduction to Web Services, Web Service Architecture, XML Messaging, Service Description: WSDL, Service Discovery: UDDI, Service Transport, Using WEB service technologies together. Standards related to WEB service. XML-RPC Essentials: XML-RPC Overview, the need for XML-RPC, XML-RPC Technical Overview, Developing using XML-RPC, Beyond simple XML-RPC Calls. SOAP Essentials: SOAP 101, The SOAP Message, SOAP Encoding, SOAP via HTTP, SOAP and the W3C, SOAP Implementations, Using Apache SOAP: Installing Apache SOAP, Developing a simple SOAP message, Deploying SOAP Services, Programming using Apache SOAP: Working with Arrays, Working with JavaBeans, Working with Literal XML Documents, Handling SOAP Faults, Maintaining Session State. WSDL: The WSDL Specification, Basic WSDL Example: HelloService.wsdl, Invoking WSDL, Basic WSDL Invocation methods(Part-1) Xmethods, Basic WSDL Invocation methods (Part-2) Xmethods, Generating WSDL Files, XML Schema Data Typing. UDDI Essentials: Introduction to UDDI , UDDI Technical Overview, UDDI Data Model, Searching UDDI, Publishing to UDDI, UDDI Implementations, Web Resources, UDDI Inquiry API: The UDDI Inquiry API, Find Qualifiers, Finding and Retrieving UDDI Data, Publishing UDDI Data, UDDI4J Quick Reference API. Developing Sample Applications using WEB services: Income Tax Calculation, Purchase order processing, Invoicing and Billing

Text Books :

1. Web Services Essentials By Ethan Cerami, Orielly ,2002.

Reference Books:

1. Java Web Services David A. Chappel & Jewell,Oreilly,2009.
2. Web Services Concepts, Architectures and applications by Gustavo Alonso.,Springer,2009.

WEB SEMANTICS

Course code : 15 EM 4162 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2002 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Must Acquire theoretical knowledge related to WEB semantics, ontology learning and languages that can be used for the development of WEB semantics	i,j,k	1,2,1
CO2	Must be knowledgeable using tools to develop web semantics for various real life applications	i,j,k	1,2,1
CO3	Able to understand ontology Management & learning for semantic web	i,j,k	1,2,1
CO4	Must develop a real life application that require use of WEB semantics	i,j,k	1,2,1

SYLLABUS:

Introduction: Introduction to WEB semantics – Meaning and Reason. The Concept of Ontology, The langue of Ontology, Ontological Categories, Knowledge Representation Ontologies, Top Level Ontologies, Linguistic Ontologies, Domain Ontologies, Semantic Web: Need, Foundation, Layers, Architecture. Languages for Semantic Web and Ontologies: Web Documents in XML, RDF – Schema, Web Resource Description using RDF, RDF Properties, Topic Maps and RDF, RDF Overview, RDF Syntax Structure, RDF Semantics, RDF Pragmatics, Brief review of Traditional Ontology Languages: LOOM, OKBC,, OCML, F-logic Ontology, Brief review of Markup Languages: SHOE, OIL, DAML, OIL, OWL .Ontology Learning for Semantic Web: Taxonomy for Ontology Learning,– Layered Approach, Phases of Ontology Learning, Importing and Processing Ontologies and Documents, Ontology Learning Algorithms, Evaluation. Ontology Management and Tools: Need for ontology management, development process, target ontology, ontology mapping, skills management system, ontological class, constraints, issues. Evolution, Development of Tools and Tool Suites, Ontology Merge Tools, Ontology based Annotation Tools. Use of Proteage tool for the development of Ontology. Applications: Developing ontology for the applications such as Insurance system, banking system and a Retail Trading System which are developed using various types of sources that of type structured, unstructured and semi-structured data (HTML. XML, RDBMS)

Text Books:

1. Asuncion Gomez-Perez, Oscar Corcho, Mariano Fernandez-Lopez "Ontological Engineering: with examples from the areas of Knowledge Management, eCommerce and the Semantic Web" Springer, 2004.
2. Grigoris Antoniou, Frank van Harmelen, "A Semantic Web Primer (Cooperative Information Systems)", The MIT Press, 2004.

Reference Books:

1. Alexander Maedche, "Ontology Learning for the Semantic Web", Springer; 1 edition, 2002.
2. John Davies, Dieter Fensel, Frank Van Harmelen, "Towards the Semantic Web: Ontology

– Driven Knowledge Management", John Wiley & Sons Ltd., 2003.

3. John Davies (Editor), Rudi Studer (Co-Editor), Paul Warren (Co-Editor) "Semantic Web Technologies: Trends and Research in Ontology-based Systems"Wiley Publications, Jul 2006
4. Dieter Fensel (Editor), Wolfgang Wahlster, Henry Lieberman, James Hendler, "Spinning the Semantic Web: Bringing the World Wide Web to Its Full Potential", The MIT Press, 2002.
5. Michael C. Daconta, Leo J. Obrst, Kevin T. Smith, "The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management", Wiley, 2003.

ENTERPRISE PROGRAMMING

Course code :15EM4163 **L – T – P :** 3-0-0

Pre Requisite : 15CS2002 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Must acquire theoretical knowledge related to enterprise architectures, development platforms, Application servers, EJB components, EJB query language.	i,j,k	2,2,1
CO2	Must be hands-on developing EJB components using NETBEANS and deploy the components using JBOSS	i,j,k	2,2,1
CO3	Able to understand EJB QL & develop sample applications	i,j,k	2,2,1
CO4	Must develop real life Enterprise wide application based on EJB and JBOSS and SQL server as DBMS engine	i,j,k	2,2,1

SYLLABUS:

Introduction to Enterprise Systems: Meaning of an Enterprise, Difference between an enterprise and a business establishment, EE infrastructure support in JAVA. Multi-Tier Architectures used for implementing IT for enterprises: Single tier systems, Client server and N. Tier Architectures, Features of JAVA EE: Clients, servers, containers, Servlets, JSP, JDBC, EJBS, XML support, WEB services, Transaction support, Security, JAVA EE Architectures: client with EJB, JSP Client with EJB, Applet client with JSP and Database, WEB services oriented implementation. Introduction to application server: Meaning and purpose, Installing JBOSS, developing a sample EJB application and deploying under JBOSS and running the same: Introduction to component technologies, Role of Component technologies in implementing the Enterprise solutions, EJB Fundaments: EJB specification, Kinds of EJB. EJB Session Beans: Purpose, Meaning and Purpose of Stateful and Stateless session beans, Using Stateful and Stateless session beans, Sample application that uses a session bean. SQL and EJB SQL: Introduction to SQL, SQL Objects, SQL Data types, Creating Tables, Selecting Data from Tables, Modifying Table Data, Constructing Joins, Introduction to EJB QL: Entity Bean references, Javax.ejb.Query Object, Building EJB Queries, using relationships. EJB Entity Beans: Working of Entity beans with sessions beans, Anatomy of Entity bean, Entity Bean class, Managing persistence and Entity Manager Interface. EJB Query Language: EJB QL queries, running EJB QL within Session beans, Developing a sample application using Entity Beans. EJB, EJB QL and JDBC: Entity Bean relationships: One-to-Many, Many-to-many, Container managed relationships and EJB QL, Using JDBC with EJB Entity Beans, Message driven beans: Describing MDBs, MDB context, MDB Transactions, Invocation of an Interceptor, Java Message API, EJB Timer services, Developing a sample application using Message driven beans.

Text Books :

1. Kevin Mukhar and Chris Zelenak, "Beginning Java EE From Novice to professional, APRESS publications, 2009.

Reference Books:

1. Antonio Goncalves, "Beginning Java™ EE 6 Platform with GlassFish™ 3 Novice to Professional", Apress, 2009 Edition
2. Jan Graba, "An Introduction to Network Programming with Java", Springer, 2nd edition, 2006.
3. Mark D Hansen, "SOA Using Java web services", Pearson, 2007.
4. Dreamtech Software Team, "Java Server Programming J2EE: Black Book", Wiley, 2007.

CLOUD BASED WEB DEVELOPMENT

Course code : 15 EM 4164 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2002 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Must acquire theoretical knowledge related to WEB Applications, Cloud computing and deploying WEB applications on the cloud	i,j,k	2,2,1
CO2	Must be hands-on developing WEB Applications using Google APP / Open ERA	i,j,k	2,2,1
CO3	Able to understand basic cloud based application development environment	i,j,k	2,2,1
CO4	Must be able to develop real life cloud based applications through Google APP / Open ERA	i,j,k	2,2,1

SYLLABUS:

Web Application development: Overview: Architectures, Technologies: HTML, DHTML, PHP, JSP, JDBC, Overview on Enterprise development: Definition, Architectures, Technologies: Java.Net, Java. Tran, Java. Message, Application server. Component technologies: EJB specification, development, deployment, Developing Applications: WEB based and Enterprise based, Overview on WEB services: Architectures, Technologies. Cloud computing fundamentals: Cloud Computing definition, private, and public and hybrid cloud. Cloud based services ; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture. Application availability, performance, security and disaster recovery; next generation Cloud Applications. Deploying WEB services on the clouds: Technologies and the processes required when deploying web services; deploying a web service from inside and outside a cloud architecture, advantages and disadvantages, Management of WEB services hosted on the clouds: Reliability, availability and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment; Cloud Economics : Cloud Computing infrastructures available for implementing cloud based services. Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs (e.g Amazon, Microsoft and Google, Salesforce.com, Ubuntu and Redhat). Cloud based application development environment: Service creation environments to develop cloud based applications. Development environments for service development; Open ERA, Google App. Analysis of Case Studies when deciding to adopt cloud computing architecture. How to decide if the cloud is right for your requirements. Cloud based service, applications and development deployment so as to improve the total cost of ownership (TCO). Cloud based WEB application development: Technical architecture considerations – concurrency, speed and unpredictable loads. Agile development, team composition (including roles/responsibilities), working with changing requirements and aggressive schedules. Understanding Model View Controller (MVC). Advanced understanding of "views", location, and the presentation layer: Advanced Ajax and JQuery. Presenting to different browsers and devices. Localization and internationalization; Understanding client location and device type.

Text Books:

1. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture Applications", Cambridge University Press; 1 edition, (ISBN: 978- 0521137355), 2010.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach" McGraw-Hill Osborne Media; 1 edition (ISBN: 0071626948), 2009.

Reference Books:

1. Dimitris N. Chorafas, "Cloud Computing Strategies" CRC Press; 1 edition (ISBN: 1439834539), 2010.
2. Eugenio Pace, Dominic Betts, Scott Densmore, Ryan Dunn, Masashi Narumoto, MatiasWoloski, "Developing Applications for the Cloud on the Microsoft Windows Azure Platform" Microsoft Press; 1 edition, (ISBN: 9780735656062) 2010.
3. Dan Wellman, "jQuery UI 1.6" Packt Publishing (ISBN: 9781847195128) 2009.
4. Peter Lubbers, Brian Albers, Frank Salem, Ric Smith, "Pro HTML5 Programming" A press, (ISBN: 9781430227908) 2010.
5. Lee Babin, "Beginning Ajax with PHP" A press; 1 edition, (ISBN: 9781590596678) 2000.

WEB ANALYTICS

Course code : 15 EM 4165 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2002 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Must acquire theoretical knowledge related to WEB Analytics, processing clicked streams, metrics for WEB analytics	i,j,k	2,2,1
CO2	Must be hands-on developing WEB Analytics using NINJA	i,j,k	2,2,1
CO3	Able to understand basics of analytics related to social,mobile & video.	i,j,k	2,2,1
CO4	Must be able to develop applications that require WEB analytics	i,j,k	2,2,1

SYLLABUS:

Introduction- Analytics – WEB Analytics – Meaning, State of WEB Analytics, Elements of WEB Analytics: Clicked streams, Analysis of Multiple Outcomes Analysis, Experimentation and Testing, including the Voice of Customer, Competitive Intelligence , The Strategic Imperative, Tactical Shift, Bonus Analytics. Metrics for WEB analytics - Eight Critical Web Metrics, Visits and Visitors, Time on Page, Time on Site, Bounce Rate, Exit Rate, Conversion Rate, Engagement, Strategically-aligned Impactful Web Metrics, Diagnosing the Root Cause of a Metric's Performance: Conversion, Leveraging Custom Reporting, Starting with Macro Insights. Processing Clickstreams: Web Analytics Primer, getting primitive indicators out of the way, Understanding Visitor Acquisition Strengths, Click Density Analysis, Counting user Visits for purchasing, Reporting Web Analytics, Sources of Traffic, Outcomes, Foundational Analytical Strategies, WEB segmenting, Capturing user Behavior, Analyzing everyday clickstreams, Site Search Analysis, Search Engine Optimization, Pay Per Click / Paid Search Analysis, Direct Traffic Analysis, Email campaign analysis, Rich experience analysis: Flash, Video, and Widgets, Reality Check: Prospect Perspectives on key web analytics challenges, visitor tracking cookies, data sampling, the value of historical data, the usefulness of video playback of customer experience ,the ultimate data reconciliation checklist. Emerging Analytics related to Social, Mobile, and Video: Measuring the new social web: The data challenge, the content democracy evolution ,The twitter revolution ,Analyzing offline customer experiences (Applications), Analyzing mobile customer experiences, Mobile data collection: Options, Mobile Reporting and Analysis, Measuring the success of blogs, raw author contribution, Holistic audience growth, Citations and ripple index ,Cost of blogging, Benefit from blogging ,Quantifying the impact of twitter ,Growth in number of followers ,Message amplification ,Click-through rates and conversions, Conversation rate ,Emerging twitter metrics, Analyzing performance of Videos, Data collection for videos, Key video metrics and Analysis, Advanced video analysis. Working with NINJA WEB Analytic tool –Working with Ninja, Comparing Key Metrics, Performance analysis for different time periods, Providing context through segmenting, Comparing key metrics and segments against site average, Joining PALM (People Against Lonely Metrics) ,Leveraging Industry Benchmarks and Competitive Data, True Value: Measuring latent conversions and visitor behavior, Latent Visitor Behavior Latent Conversions, KPI Measurement Techniques, Averages percentages ratios, Compound or Calculated Metrics, Searching: Achieving the optimal long-tail strategy, Computing head and tail, Understanding branding and category terms, The optimal search marketing strategy ,Executing the optimal long-tail strategy, Measuring the value of upper funnel keywords, Advanced pay-per-click analyses, Identifying keyword arbitrage opportunities

Text Books :

1. "Web Analytics 2.0 The Art of Online Accountability & Science of Customer Centricity", Avinash Koushik, Wiley Publishing, Inc., ISBN: 978-0-470-52939-3.

Reference Books:

1. "Advanced Web Metrics with Google Analytics™, Third Edition, B r i a n C l i f t o n John Wiley & Sons, Inc, ISBN: 978-1-118-16844-8.

INTERNET OF THINGS STREAM

PRINCIPLES OF MICRO COMPUTER AND INTERFACES

Course code : 15 EM 3254 **L – T – P :** 3-0-0

Pre Requisite : 15 EM 2001 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand transducers and 8086 processor	i,j	2
CO2	Understand signal processing and memory interfacing	i,j	2
CO3	Understand the basics of interfacing of various peripherals to PC	I,j	2
CO4	Understand bus interfacing &Apply interfacing to the PC with keyboard, printer, motor using serial data communications	i,j	2

SYLLABUS:

Transducers: Transducers, Measurement systems, Temperature, Light, Position and motion, Force, pressure and flow.

Interfacing: Interfacing, Number systems, Computer architecture, Assembly language, Interfacing, A to D and D to A conversions, Data communications, Programmable logic controllers, Data acquisition project, 8086 assembly language programming.

Signal processing: Signal processing, Transfer function, Active filters, Instrumentation amplifier, Noise, Digital signal processing.

Memory and Memory interfacing: Semiconductor memory fundamentals, Memory address decoding, IBM PC Memory map, Data Integrity in RAM and ROM, 16-bit memory interfacing, ISA Bus memory interfacing,

I/O AND THE 8255; ISA BUS INTERFACING: 8088 I/O Instructions, I/O Address decoding and design, I/O Address Map of X86 PCS, 8255 PPI Chip, PC Interface Trainer And Bus Extender 325, I/O Programming with c/c++ and VB, 8-Bit And 16-Bit I/O Timing in ISA BUS.

Interfacing to the PC: LCD,MOTOR,ADC AND SENSOR: Interfacing an LCD to the PC, Interfacing a stepper motor to a PC, Interfacing DAC to a PC, Interfacing ADC And Sensors to the PC.

Serial data communication and the chips: Basics of serial communication, Accessing IBM pC com ports using DOS And BIOS, Interfacing the NS8250/16450 UART in the IBM PC, Intel 8251 USART And Synchronous Communication,

Keyboard And Printer Interfacing: Interfacing Keyboard to the cpu, PC Keyboard Interfacing And Programming, Printer And Printer Interfacing The IBM PC, Bidirectional Data Bus in Parallel ports, ISA, EISA, MCA, LOCAL AND PCI BUS: ISA,EISA,AND IBM Micro Channel, VL Bus And PCI Local Buses,

Textbook:

1. A.C.Fischer-Cripps,Newnes Interfacing Companion,science direct,2002.
2. The 80x86 IBM PC and Compatible Computers(volumes I&II),Assembly language,Design, and Interfacing, 4th edition, Muhammad ali mazidi,Janice gillispie mazidi. 2006.

Reference text books:

1. Toward Brain-computer Interfacing, Guido Dornhege, MIT Press, 2007.
2. A Friendly Guide to Computer Interfacing and LabVIEW Programming,John K. Eaton, Eaton, Oxford University Press, 1995.

EMBEDDED SYSTEMS DESIGN USING FPGA & VERILOG

Course code : 15 EM 4166 **L– T – P :** 3-0-0

Pre Requisite : 15 EM 2001 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Ability to use high-level hardware description languages such as Verilog for the design of ES	i,j,k	2,2,1
CO2	Understand various principles of system & spatial design	i,j,k	2,2,1
CO3	Understand how to manage band width & scalability designs	i,j,k	2,2,1
CO4	Understand fundamentals of Blocking versus non blocking assignment in verilog	i,j,k	2,2,1

SYLLABUS:

Introduction: Embedded Systems, Design Challenges, Platform FPGAs, Spectrometer Example, Introducing the Platform FPGA Tool Chain.

The Target: CMOS Transistor, Programmable Logic Devices, Field-Programmable Gate Array, Hardware Description Languages, From HDL to Configuration Bitstream, Xilinx Virtex 5, Xilinx Integrated Software Environment, Creating and Generating Custom IP. System Design: Principles of System Design, Control Flow Graph , Hardware Design, Software Design, Platform FPGA Architecture Design, Embedded GNU/Linux System. Partitioning: Overview of Partitioning Problem, Analytical Solution to Partitioning, Communication, Practical Issues, Profiling with Gprof , Linux Kernel. Spatial Design: Principles of Parallelism, Identifying Parallelism, Spatial Parallelism with Platform FPGAs, Useful VHDL Topics for Spatial Design, Debugging Platform FPGA Designs.Managing Bandwidth: Balancing Bandwidth, Platform FPGA Bandwidth Techniques, Scalable Designs, On-Chip Memory Access, Off-Chip Memory Access. Outside World: Point-to-Point Communication, Internetworking Communication, High-Speed Serial Communication, Low-Speed Communication, Generating the Hardware Base System, Testing the Design.Selected Topics of Verilog: Blocking versus non blocking assignment, Alternative coding style for sequential circuit, Use of the signed data type, Use of function in synthesis, Additional constructs for test bench development.

Text books:

1. Embedded systems design with FPGAs,principles and practices,Ron Sass and Andrew G.Schmidt. 2005.
2. embedded SoPC Design with NIOS II processor and verilog examples,pong p.chu(8th chapter). 2005.

Reference books:

1. Embedded Systems Design with FPGAs by Peter Athanas, Dionisios Pnevmatikatos, Nicolas Sklavos, Springer . 2006.
2. Introduction to Embedded System Design Using Field Programmable Gate Arrays.

   By Rahul Dubey, Springer. 2006.
3. Embedded Core Design with FPGAs, Zainalabedin Navabi, McGraw Hill Professional, 13-Sep-2006.

MACHINE-TO-MACHINE COMMUNICATIONS

Course code :15 EM 4167 **L – T – P :** 3-0-0

Pre Requisite :15 CS 2208 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand wireless technologies for the IOT	i,j	2
CO2	Design of M2M to IOT and its architectural overview	i,j	2
CO3	Understand the constraints in the design of IOT in real world	i,j	2
CO4	Understand the working principles of layers, and apply IOT to M2M to real-world problems	i,j	2

SYLLABUS:

Layer 1/2 connectivity: wireless technologies for the iot, layer 3 connectivity: ipv6 technologies for the iot, layer 3 connectivity: mobile ipv6 technologies for the iot, ipv6 over low-power wpan (6lowpan) introduction, the internet of things global context: m2m to iot , the vision, m2m to iot ,a market perspective, m2m to iot , an architectural overview.

Nuts and bolts of m2m and iot: m2m and iot technology fundamentals, iot architecture, real-world design constraints. Implementation examples: asset management, industrial automation, the smart grid, commercial building automation, smart cities, participatory sensing, conclusion and looking ahead.

Textbook:

1. Daniel minoli ,Building the internet of things with ipv6 and mipv6: the evolving world of m2m communications,wiley, 2013.

Reference text books:

1. From Machine-to-Machine to the Internet of Things Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis,Catherine Mulligan. 2012.
2. The Internet of Things: Key Applications and Protocols By Olivier Hersent, David Boswarthick, Omar Elloumi, John Wiley & Sons. 2012.
3. Internet of Things: Converging Technologies for Smart Environments by Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers. 2013.
4. Machine-to-machine (M2M) Communications: Architecture, Performance by Carles Anton-Haro, Mischa Dohler, Elsevier. 2012.

RFID AND SENSOR NETWORKS

Course code : 15 EM 4168 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2208 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand Medium access controls in wireless networks	i,j	2
CO2	Design routing protocols for ad hoc and wireless sensor networks with respect to some protocol design issues	i,j	2
CO3	Understand RFID and security deployment	i,j	2
CO4	Understand the applications of RFID and Sensor networks in Health Care systems	i,j	2

SYLLABUS:

Medium Access Control in RFID, Anti-Collision Algorithm in RFID, Low-Power Transponders for RFID, EPCGen-2StandardforRFID, RFID Authentication and Privacy, RFID Deployment: Supply Chain Case Study, RFID Security, Geographic Routing in Wireless Sensor Networks, Medium Access Control in Wireless Sensor Networks, Localization in Wireless Sensor Networks, Data Aggregation in Wireless Sensor Networks, Clustering in Wireless Sensor Networks, Energy-Efficient Sensing in Wireless Sensor Networks, Mobility in Wireless Sensor Networks, Security in Wireless Sensor Networks, Network Management in Wireless Sensor Networks, Deployment in Wireless Sensor Networks, Integrated RFID and Sensor Networks: Architectures and Applications, Integrated RFID and Sensor Networks for Smart Homes, Integrated RFID and Sensor Networks for Health Care, Integrated RFID and Sensor Networks for Structure Monitoring.

Textbooks:

1. RFID and Sensor Networks: Architectures, Protocols, Security, and Integrations edited by Yan Zhang, Laurence T. Yang, Jiming Chen, CRC Press., 2012.

References:

1. Wireless Communication in Underground Mines: RFID-based Sensor Networking By L. K. Bandyopadhyay, S. K. Chaulya, P. K. Mishra, Springer Science & Business Media. 2012.
2. RFID-Enabled Sensor Design and Applications, By Amin Rida, Li Yang, Manos Tentzeris, Artech House. 2012.
3. RFID and the Internet of Things,Hervé Chabanne, Pascal Urien,Jean-Ferdinand Susini. 2012.

THE CLOUD OF THINGS

Course code : 15 EM 4169 **L – T – P :** 3-0-0

Pre Requisite : 15 CS 2208 **Credits :** 3

Mapping of course outcomes with student outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the fundamentals of Cloud Computing	i,j	2
CO2	Understand the Middle wares for Smart Objects and Smart Environments	i,j	2
CO3	Design Service-Oriented Discovery Framework for Cooperating Smart Objects	i,j	2
CO4	Understand cloud of things related to Smart Grid Cities	i,j	2

SYLLABUS:

Middlewares for Smart Objects and Smart Environments: Overview and Comparison, Service-Oriented Middleware for the Cooperation of Smart Objects and Web Services, A Service-Oriented Discovery Framework for Cooperating Smart Objects, Smart Manufacturing Through Cloud-Based Smart Objects and SWE The Cloud of Things Empowered Smart Grid Cities The Third ICT Wave, Ubiquitous IoT Applications, Four Pillars of IoT, the DNA of IoT MIDDLEWARE FOR IoT: Middleware and IoT, Protocol Standardization for IoT, Architecture Standardization for WoT, THE CLOUD OF THINGS: Cloud Computing.

Reference books:

1. The internet things of things in the cloud a middleware perspective,honbo zhou,crc press.
2. Getting Started with the Internet of Things: Connecting Sensors and ... By Cuno Pfister, "O'Reilly Media, Inc.".
3. Distributed and Cloud Computing: From Parallel Processing to the Internet of ... By Kai Hwang, Jack Dongarra, Geoffrey C. Fox, Morgan Kaufmann.
4. Internet of Things Applications - From Research and Innovation to Market Deployment, Ovidiu Vermesan, Peter Friess,River Publishers.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROFESSIONAL CORE COURSES

ELECTRICAL CIRCUITS

Course code : 15 EE 2103 **L – T – P :** 2 – 2 –2

Pre Requisite : 15 EE 1201 **Credits :** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the concept of mutual inductance, series and parallel resonance, network topology to solve complex networks and 3- phase circuits' voltage and current relations.	b	1
CO 2	Analyze the magnetic circuits, transient response for AC and DC excitation and two port network parameters	b	2
CO 3	Evaluate one port networks using Foster and caur forms	b,k	3
CO 4	Design the prototype low and high pass filters.	b, k	3
CO 5	Test and Evaluate the concepts learnt using any simulation tool or hardware	k	2

SYLLABUS:

Magnetic Coupled Circuits: concept of mutual inductance, dot convention, coefficient of coupling, Magnetic Circuits, Analysis of series and parallel magnetic circuits.

Series and Parallel Resonance: Series and parallel resonance, bandwidth, selectivity, Q factor, current locus diagrams.

Three phase circuits: phase sequence, star and delta connection, Relation between line and phase voltages and currents in balanced systems, Analysis of balanced and unbalanced 3 phase circuits.

Transient Analysis: Response of R-L, R-C, R-L-C (Series and parallel combinations) for impulse, step, ramp excitations. Transient response of R-L, R-C, R-L-C circuits (Series and parallel combinations) for D.C and sinusoidal excitations, initial conditions, time domain and Laplace transform methods of solutions.

Two port networks: one port and two port networks Two port network parameters: Z, Y, Transmission and Hybrid parameters and their relationships. Network functions, driving point and transfer functions – poles and Zeros.

Network topology: definitions, graph, tree, basic cut-set and basic tie set matrices for planar network, Loop and Nodal methods of analysis of networks

Network Synthesis: Positive real functions – Properties and limitations of positive real functions – Synthesis of one port networks, R-L, R-C and L-C networks by Foster and Cauer forms - Numerical problems.

Filters: Low pass, High Pass, Band Pass, Band Elimination, Prototype filters design Low and High pass filter – M - derived filters of Low Pass and High Pass - Numerical Problems.

Text Books:

1. W.H.Hayt and J.E.Kimmerly "Engineering circuit analysis", 5th Edition ,McGraw Hill,(1993).
2. Ravish R Singh, "Network Analysis and Synthesis" McGraw Hill Education (India) Private Limited, (2013).

Reference Books:

1. Mathew NO Sadiku, "Elements of Electromagnetics", Oxford University Press,(2011).
2. William Hart Hayt, John A. Buck , "Engineering Electromagnetics", I edition ,McGraw-Hill Publication, (2012).
3. Dr GSN Raju, "Electromagnetic Field Theory and Transmission Lines", Pearson Education,(2004).
4. N.C.Jagan, C. Lakshmi Narayana., "Network analysis and synthesis" BS Publications,(2004).
5. Wadhwa, C. L., "Network Analysis", 1st Edition, New Age International Publications, (2008).

DC MACHINES & TRANSFORMERS

Course code : 15 EE 2104 **L – T – P :** 2 – 2 – 2

Pre Requisite : 15 EE 2103 **Credits :** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Apply the basic principles of electromechanical energy conversion to electrical machines	e	2
CO 2	Analyze operating characteristics of various types of DC generators.	e	2
CO 3	Identify various speed control methods of DC motor and evaluate this performance	e,k	2
CO 4	Evaluate the performance of a transformers and selecting it for particular application.	e,k	2
CO 5	Test the DC machines and transformers to evaluate their performance	b	2

SYLLABUS:

Electromechanical Energy Conversion: Basic principle Energy, Force and Torque in singly and multiply excited systems.

DC Machines: Working principle, construction and methods of excitation. Armature Winding- Detailed study of simple lap and wave windings. D.C. Generators emf equation. Circuit models, Armature reaction, Effect of brush shift. Compensating winding, Characteristics of various types of generators, applications. D.C. Motors: Torque equation, Circuit models Characteristics of d.c. shunt, series and compound motors, applications. Starting & Speed Control- Starting methods and speed control of d.c. shunt and series motors. Commutation- Causes of bad commutation, Methods of improvement. Testing- Direct and regenerative methods to test d.c. machines. Transformers: Principle, construction and operation of single phase transformers, phasor diagram, equivalent circuit, voltage regulation, losses and efficiency. Testing- Open & short circuit tests, Polarity test, Sumner's test, Separation of hysteresis and eddy current losses. Three phase Transformer: Construction, various types of connection and their comparative features. Parallel operation of single phase and three phase transformers. Autotransformers- Construction, Principle, Applications and Comparison with two winding transformer. Excitation phenomenon in transformers, Harmonics in single phase and three phase transformers, Suppression of harmonics. Phase conversion-Scott connections, Three phase to six phase conversion. Tap changing Transformers- No load and on load tap changing of transformers. Three winding Transformers. Cooling methods of transformers.

Text Books:

1. P.S. Bimbra, "Electrical Machines", 7^{th} ed., Khanna Publishers.,(2007).
2. I.J Nagrath & D.P Kothari, "Electrical Machines", 3^{rd} ed., Tata Mc Graw-Hill,(2009).

Reference Books:

1. A.E. Clayton & Hancock, "Performance and Design of D.C Machines",3^{rd} ed., BPB Publishers, (2004).
2. M.G Say, "Performance and Design of A.C Machines", 3^{rd} ed., BPB Publishers,(2002).
3. A.E.Fitzgerald, C Kingsley and S Umans, "Electric Machinery", 7^{th} ed., McGraw Hill, (2013).

AC MACHINES

Course code : 15 EE 2205 **L – T – P :** 2 – 2 – 2

Prerequisites : 15 EE 2104 **Credits:** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Select from all commercially available 3-□ IM for given application	b	1
CO 2	To understand the construction, operation and armature reaction of a 3-□ synchronous generator and identify the requirements for parallel operation.	b	1
CO 3	Understand and analyze the performance of synchronous motor by varying excitation and varying load.	b,k	1
CO 4	Evaluate the performance of a single phase motor and selecting it for particular application.	b,k	2
CO 5	Test the induction machine and synchronous machine to evaluate their performance	b,k	2

SYLLABUS:

Basic concepts of AC Machines: Winding factors, generated e. m. f., m. m. f. of distributed a.c. winding, rotating magnetic field.

Induction Machines: Constructional features, production of torque, phasor diagram, equivalent circuit, performance analysis, torque-slip characteristics. Testing-Running light and blocked rotor test, load test. Effect of rotor resistance, deep bar and double cage induction motor. Generator Operation, Starting- Starting methods of squirrel cage and wound rotor induction motor.Speed Control- Various methods of speed control of squirrel cage and wound rotor induction motor. Effects of space harmonics. Single phase induction motors- Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split phase starting methods &applications.

Synchronous Machines: Constructional features. Cylindrical rotor machine- Synchronous Generator- Generated e.m.f., circuit model and phasor diagram, armature reaction, synchronous impedance, voltage regulation and different methods for its estimation. Synchronous Motor- Operating principle, circuit model, phasor diagram, effect of load. Operating characteristics of synchronous machines, V-curves, starting methods of synchronous motors. Salient pole Machine- Two reaction theory, analysis of phasor diagram, power angle characteristics, determination of x dand xq. Parallel operation of Alternators-Synchronization and load division.

Text Books:

1. P. S. Bimbra, "Electrical Machines", 7th ed., Khanna Publishers., (2007).
2. I. J Nagrath & D.P Kothari, "Electrical Machines", 3rd ed., Tata Mc Graw-Hill, (2009).

Reference Books:

1. Alexander S Langsdorf "Theory of Alternating Current Machinery",2nd ed., Tata Mc Graw-Hill, (2001).
2. M.G Say, "Performance and Design of A.C Machines", 3rd ed., BPB Publishers,(2002).
3. A.E. Fitzgerald, C.Kingsley and S.Umans, "Electric Machinery", Mc Graw-Hill Companies, 7th edition,(2013).

GENERATION, TRANSMISSION & DISTRIBUTION

Course code : 15 EE 2206 **L – T – P :** 2 – 2 - 2

Pre Requisite : NIL **Credits:** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand various generating stations.	c	1
CO 2	Understand the concepts of transmission line parameters, Corona, Mechanical Sag and Insulators	c	2
CO 3	Analyze the performance of overhead transmission lines and underground cables.	k	2
CO 4	Analyze substation layouts and their design considerations	c	2
CO 5	Test and apply knowledge obtained from Generation, transmission & distribution using any software tool or hardware	k	2

SYLLABUS:

Introduction: Organization of power sector in India, Layout & Operation of Thermal, Hydro, Nuclear and combined cycle power stations. Principle of Solar Power Plant, Wind Power Plant, Overview of Fuel Cells.Economics of generation, load curves, Demand Factor, load factor, diversity factor, Plant Capacity Factor, Plant Use Factor & Utilization Factor, Characteristics of Tariff, Types of Tariff.

Transmission line parameters: Types of conductors - calculation of resistance for solid conductors - Calculation of inductance for single phase and three phase, single and double circuit lines, concept of GMR & GMD, Calculation of capacitance for 2 wire and 3 wire systems, effect of ground on capacitance, capacitance calculations for symmetrical and asymmetrical single and three phase, single and double circuit lines.

Transmission line theory: Introduction, short transmission line, medium transmission line, evaluation of A,B,C,D Constants, Surge Impedance Loading of Long Lines, Wave Length and Velocity of Propagation of Waves, Ferranti effect, Corona, factors affecting corona, critical voltages and power loss; Radio interference due to Corona.

Insulators: Types of Insulators, String efficiency and Methods for improvement, calculation of string efficiency, Capacitance grading and Static Shielding. Introduction to mechanical sag.

Underground cables Types of cables, capacitance grading, Intersheath grading, Capacitance of three core belted type cable. Cable sizing

Substation practice: Classification of substations, layout, bus bar arrangements, ring main.

Text Books:

1. J. Nagarath and D.P Kothari "Power System Engineering" Tata Mc Graw-Hill.
2. C. L. Wadhwa "Electrical Power Systems" New Age International (P) Limited Publishers.

Reference Books:

1. J B Gupta "A Course in Power Systems" S. K. Kataria & Sons.
2. Soni, Gupta and Bhatnagar "A Course in Electric Power" Dhanpat Rai & Sons.
3. S.N.Singh "Electric Power Generation, Transmission & Distribution" Prentice Hall India.

CONTROL SYSTEMS

Course code : 15 EE 2207 **L – T – P :** 2 – 2 - 2

Pre Requisite : NIL **Credits:** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Students can be able to understand control system concepts such as open, closed loop systems, transfer function approach, mathematical modeling of physical systems and can understand analyze the similarities between synchros and ac generators	e	1
CO 2	Students can be able to Analyze the time domain and frequency response of physical systems	e	2
CO 3	Students can be able to understand and analyze stability of given transfer functions in time and Frequency domain and can be able to analyze the process of Converting state space equations into transfer function for the given model.	e	2
CO 4	Students can be able to design and analyze controllers and lead, lag, lead-lag compensators	e, k	2
CO 5	Test and apply the knowledge obtained in the subject by Matlab or hardware.	k	2

SYLLABUS:

Control System Concepts: Control system terminology, examples of simple control systems, open loop and closed loop control systems, Types of control systems.

Mathematical models of physical systems: Analogy with mechanical systems, Formulation of differential equations for electrical systems Transfer functions of open and closed loop systems, DC & AC servomotors, synchro pair as error detector, block diagram representation of control systems; block diagram algebra, signal flow graph, Mason's gain formula.

Time domain analysis: Standard test signals – step, ramp, parabolic and impulse; impulse response, characteristic equation of feedback systems, transient response of first order and second order systems to standard test signals, time domain specifications, steady state error and error constants, Introduction to P, PI, PID controllers.

Stability analysis: Concept of stability and conditions for stability, Routh – Hurwitz criterion, dominant poles of transfer function.

Root Locus Technique: The root locus concept, basic properties, magnitude and angle conditions, properties and construction of the complex root loci, effects of adding poles and zeros to G(s) H(s) on the root loci.

Frequency response Analysis & Design: Introduction, frequency response specifications, correlation between time and frequency response, specifications, polar (Nyquist) plot, Bode plot, phase margin and gain margin; stability analysis from Nyquist plot effect of adding poles & zeros to G(s) H(s) on the shape of polar plots. Preliminary design considerations – Introduction to lead, lag, lead - lag compensation techniques in frequency domain.

State space analysis: Concepts of state, state variables, state vector, input vector, output vector; development of state models for simple systems, solution of state equation, the state transition matrix and its properties; characteristic equation and transfer function from state models, eigen values and eigen vectors. Diagonalization; transformation to phase variable canonical form, diagonal canonical form, Jordan canonical form. Concepts of controllability and observability.

Text Books:

1. J Nagrath & M Gopal, "Control System Engineering", 5th Edition, New Age International Publication, New Delhi (2011).
2. B.C. Kuo," Automatic Control Systems", Eighth Edition ,Prentice Hall India Publications, NewDelhi , (2010).

Reference Books:

1. K Ogata, "Modern Control Engineering", Fifth Edition, Prentice Hall India Publication, New Delhi , (2010).
2. M.Gopal, "Control Systems Principles and Design", Fourth Edition, Tata Mc-Graw Hill Publications, (2012).
3. Dhanesh N. Manik, "Control Systems", First edition, Cengage Learning Pvt. Ltd., (2012).

POWER SYSTEM ANALYSIS

Course code : 15 EE 3108 **L – T – P :** 2-2-2

Pre Requisite : 15 EE 2205 **Credits :** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To analyze the short circuit faults in a power system	e	2
CO 2	To apply numerical methods for the solution of load flow problem	e, k	2
CO 3	To Select the best generators to have Economic Dispatch & to Evaluate the performance of Load Frequency Control	e, k	2
CO 4	To Understand and analyze rotor angle stability	e, k	2
CO 5	Test and Analyze various short circuit faults, load flows, economic dispatch problems, rotor angle stability problems using MATLAB	e, k	2

SYLLABUS:

Fault Analysis: Representation of Power Systems Components, Per Unit System, Short circuit of synchronous machine unloaded, Calculation of symmetrical short circuit currents for simple systems, Symmetrical components transformation, Sequence Impedance and Networks of Power System Components, Unsymmetrical Faults on an Unloaded Generator and Power Systems

Power Flow Solutions: Network model formulation, Formation of YBUS by Direct Inspection Method, Formation of ZBUS, Power flow problem formulation, GS method, NR Method (Polar Coordinate Approach), FDLF.

Economic Dispatch: Optimal operation of generators on a Bus Bar, Optimal Unit Commitment, Optimum Generation Scheduling, Load Frequency control of a Single area system, Automatic Voltage Control.

Power System Stability: Dynamics of a synchronous machine, power angle equation, Single machine connected to infinite bus, two machine system, steady state stability, Equal Area Criterion.

Text Books:

1. John J Grainger,William D Stevenson,"Power System Analysis", 4th edition, TMH Companies, (2005).
2. C.L.Wadhwa ,"Electrical Power Systems", New Age International (P) Limited,(2008).

Reference Books:

1. I.J.Nagarath and D.P.Kothari ,"Modern Power System Analysis", 3rd Edition,Tata McGraw Hill, (2008).
2. B.R. Gupta "Power System Analysis and Design", 3rd edition wheeler publishers (2003).

POWER ELECTRONICS

Course code : 15 EE 3109 **L – T – P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Select appropriate switch for a given power converter	c	1
CO 2	Evaluate the steady state performance of Basic DC-DC converters	c	3
CO 3	Evaluate the performance of Basic Switch-Mode PWM Inverter	c	3
CO 4	Understand and analyze the operation of Basic Phase controlled converters	k	2
CO 5	Test and evaluate basic power electronic converters by using Matlab software or hardware.	k	2

SYLLABUS:

Power Semiconductor Devices: Ideal Switch Characteristics, Power Diodes, SCR, Theory of operation of SCR, Two transistor model of SCR, Characteristics and ratings, SCR turn on and turn off methods, generalized block diagram for SCR firing, R, RC, UJT and Ramp comparator, Protection of SCR, Series and parallel operation of SCRs, Brief overview of these devices with their Characteristics and applications: P-N-P-N devices, SCS, LASCR, DIAC, TRIAC, IGBT, MOSFET.

Line frequency phase controlled converters: Rectifiers and Inverters: Introduction, Single-Phase Semi& fully controlled converters with R,RL & RLE loads, Three-Phase Semi& fully controlled Converters wit R,RL & RLE loads ,Power factor improvements, effect of load and source inductances, Single & Three phase Dual converters, Numerical Problems.

Ac Voltage Controllers: Introduction, Single Phase AC Voltage controllers with R, RL Loads, Three Phase AC Voltage Controllers with different loads, Applications: Induction Motor speed control, Static VAR control.

Cycloconverters: Principle and operation of single-phase cycloconverters and applications, Three phase cycloconverters.

Inverters: Principle of inverter operation with various loads, single phase inverters-Performance analysis and Switch rating determination, three phase inverters (120,180 modes of operation), voltage source inverters, current source inverters, Numerical problems.

Choppers: Principle of choppers, step up and step down choppers, different classes of chopper circuits and their analysis: Speed control of DC motors, Numerical problem

Text Books:

1. Ned Mohan, Undeland, Robbinds, "Power Electronics Converters Applications and Design", 3rd Edition, John Wiley and sons Publications.
2. M.H.Rashid, "Power Electronics, circuits, devices and applications" 3rd Edition, Prentice Hall (India) Publications.

Reference Books:

1. M.D.Singh and Khanchandani, "Power Electronics", 2nd edition , TMH Publications.
2. Dr.P.S Bimbra ,"Power Electronics" Khanna Publishers,(2012).
3. John G.Kassakian,Marfin F Sehelchet,George C Verghese ,"Principles of Power Electronics" First Edition, Pearson Publications (2010).
4. Daniel W.Hart, "Power Electronics", Tata Mcgraw Hills, (2011).

POWER SYSTEM PROTECTION

Course code : 15 EE 3210 **L – T – P :** 2 - 2- 2

Pre Requisite : 15 EE 3108 **Credits :** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To apply per unit system and to draw the reactance diagrams	e	1
CO 2	To analyze the short circuit faults in a power system	e, k	2
CO 3	To Evaluate the performance of different protective relays & Circuit breakers	e	2
CO 4	To understand the concepts of lightning arresters and the neutral grounding	e	1
CO 5	Test and Analyze various power system protection concepts using MATLAB	e, k	2

SYLLABUS:

Representation of Power System Components: Introduction, Single-phase solution of balanced three-networks, Modeling of synchronous machines, transmission lines, two winding transformers and loads, Single-line Diagram, Impedance and reactance diagram, Per Unit System, Selection of base and changing the base, advantages of PU system

Fault Analysis: Short circuit of synchronous machine unloaded, Calculation of symmetrical short circuit currents for simple systems, Symmetrical components transformation, Sequence Impedance and Networks of Power System Components, Unsymmetrical Faults on an Unloaded Generator and Power Systems

Power System Protection: Introduction, need for protective systems, nature and causes of faults, essential qualities of protection, zones of protection, primary and backup protection, Classification of protective relays & Schemes- over current, differential and distance protection, Introduction to Digital Protection, Arc voltage, Arc interruption, re-striking and recovery voltage, resistance switching, current chopping, Classification of circuit breakers and their ratings.

Protection against Over Voltages: Causes of over voltages, ground wires, lightning arresters

Neutral Grounding: Necessity of earthing, step voltage, Types of neutral grounding

Text Books:

1. D. P. Kothari, I. J Nagrath, "Modern Power System Analysis", 3rd Edition, Tata Mc-Graw Hill Publications.
2. Badri Ram, D N Vishwakarma, "Power System Protection and Switchgear", Tata Mc-Graw Hill Publications.

Reference Books:

1. Jhon J Grainger, William D Stevenson Jr., "Power System Analysis", Tata Mc-Graw Hill Publications.
2. Sunil S Rao, "Switch Gear Protections", Khanna Publications.
3. C L Wadhwa, "Electrical Power Systems", New Age International (P) Ltd.,.
4. Van. C. Warrington A.R., "Protective Relays" Vol. 1 & 2, Chapman & Hal

ELECTRIC DRIVES

Course code : 15 EE 3211 **L – T – P :** 2 – 2 – 2

Pre Requisite : 15 EE 3108 **Credits :** 4

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the concept of fundamental torque equations, Modes of operations, equivalent values of drive parameters, converters, DC motors and AC Motors.	e	1
CO 2	Analyze the speed torque characteristics of DC Drives, Induction motor Drive and Synchronous motor Drive	e	2
CO 3	Analyze various control techniques of DC drives and AC drives	e	2
CO 4	Design a DC drive and simulate those circuits with design parameters and observe the output waveforms.	e, k	2
CO 5	Design an AC drive and simulate those circuits with design parameters and observe the output waveforms.	e, k	2

SYLLABUS:

Control of dc motors: Dynamics of electrical drives-Fundamental torque equations, Modes of operation-Equivalent values of drive parameters: Load with rotational motion-Load with Translational motion, Measurement of moment of Inertia- Single Phase and Three phase semi and Fully controlled converters connected to d.c separately excited and d.c series motors – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque Characteristics- Electric Braking – Plugging, Dynamic and Regenerative Braking operations. Four quadrant operation of D.C motors by dual converters - Problems on Converter fed d.c motors. Control of DC motors by Choppers-Single quadrant, Two –quadrant and four quadrant chopper fed dc separately excited and series excited motors – Continuous current operation – Output voltage and current wave forms – Speed torque expressions – speed torque characteristics – Closed loop operation of dc motor drives induction motor drives (Block Diagram Only)- Problems on Chopper fed d.c Motors

Control of induction motors: Stator voltage control - Control of Induction Motor by AC Voltage Controllers – Waveforms –Stator Frequency control- Variable frequency characteristics-Variable frequency control of induction motor by Voltage source and current source inverter and cyclo converters- PWM control – Comparison of VSI and CSI operations –Problems on induction motor drives – Closed loop operation of induction motor drives (Block Diagram Only)- Control of Induction motor of Rotor side-Static rotor resistance control – Slip power recovery – Static Scherbius drive – Static Kramer Drive –Problems

Control of synchronous motors: Separate control & self control of synchronous motors – Operation of self controlled synchronous motors by VSI and CSI cycloconverters. Load commutated CSI fed Synchronous Motor – Operation – Closed Loop control operation of synchronous motor drives (Block Diagram Only)

Text Books:

1. Ned Mohan, "First course on Power Electronics and Drives" Wiley Publications (2011).

2. G. K. Dubey, " Fundamentals of Electrical Drives" 2nd Edition, Narosa publications (2001).

Reference Books:

1. Ned Mohan, "Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB / Simulink", Wiley publications (2014).
2. G. K. Dubey ,"Power Semiconductor controlled drives", Prentice Hall Inc., New Jersey(1989).
3. Vedam Subrahmanyam," Electrical Drives concepts and Applications", Tata McGraw Hill publishers (2008).

PROFESSIONAL ELECTIVES

POWER SYSTEM

DISTRIBUTION SYSTEM PLANNING AND AUTOMATION

Course code : 15 EE 3251 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3108 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the methods to find load forecasting and various tariffs and meters	a, e	1
CO 2	Understand the optimal locations of substation, capacitors and importance of protection and coordination of different protective devices	a, e	1
CO 3	Understanding the SCADA and required components and its function	a, e	1
CO 4	Understanding the design of various earthing schemes	a, e	1

SYLLABUS:

Distribution System Planning and Load Characteristics: Planning and forecasting techniques, present and future role of computer, load forecasting definition, methods of forecasting, regression analysis, correlation analysis and time series analysis, load management, tariff and metering of energy.

Distribution Transformers, Transmission Line and Distribution Sub-Station: Distribution Sub-Station, bus schemes, description and comparison of switching scheme, sub-station location and rating. Types of feeders, voltage levels, radial type feeders, 3-phase primary lines, copper loss, distribution feeder costs, loss reduction and voltage improvement in rural network.

Capacitors in Distribution Systems and System Protection: Effects of series and shunt capacitors, justification of capacitors, procedure to determine optimum capacitor size and location, basic definition and types of over current protection device, objective of distribution system protection.

Distribution System Automation: Reforms in power sector, methods of improvement, reconfiguration, reinforcement, automation, communication systems, sensors, automation systems architecture, software and open architecture, RTU and Data communication, SCADA requirement and application functions, GIS/GPS based mapping of distribution network, communication protocol for distribution systems, integrated substation, metering system, revenue improvement, issuing multi year tariff and availability based tariff.

Grounding System: Earth and safety, nature and size of earth electrodes, design of earthing schemes.

Text Books:

1. Turan Gonen ,"Electrical Power Distribution Engineering", McGraw Hill.

Reference Books:

1. A S Pabla ,"Electric Power Distribution", 5th Ed., Tata Mc-Graw Hill (2004).

RESTRUCTURED POWER SYSTEMS

Course Code : 15 EE 4155 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3108 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Students are able to understand the concept of deregulation market structure, market architecture and power system old vs new	e	1
CO 2	Students can be able to understand electricity sector structures different structure models , bilateral and pool markets and LMP based markets	e, j	1
CO 3	Students can be able to understand and analyze transmission pricing methods, congestion management methods and effect of congestion on LMPs	e	2
CO 4	Students can be able to understand ancillary services system security in deregulation	e, j	1

SYLLABUS:

Need and conditions for deregulation: Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts original cost of generation, least-cost operation, incremental cost of generation.

Power System Operation: Old vs. New. Electricity sector structures and Ownership / management, the forms of Ownership and management. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

Pricing: Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices. Transmission network and market power, Power wheeling transactions and marginal costing, transmission costing, Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices. Ancillary Services and System Security in Deregulation, Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry.

Text Books:

1. K. Bhattacharya, M.H.J. Bollen and J.E. Daalder "Operation of restructured power systems", Kluwer's Power Electronics and Power Systems Series.
2. M. Shahidehpour, H. Yamin and Z. Li, "Market Operations in Electric Power Systems", John Wiley and Sons (2002).

Reference Books:

1. A.J.Wood and B.F.Wollenberg, "Power Generation Operation and Control", John Wiley and sons, New York (1996).
2. Steven Stoft, "Power System Economics: Designing markets for electricity" IEEE Computer Society Press.
3. D Kirschen, G Strbac, "Fundamentals of Power System Economics", Wiley (2004).
4. N. S. Rau, "Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry".
5. Sally Hunt and Graham Shuttleworth, "Competition and Choice in Electricity".

HVDC & FACTS

Course Code : 15 EE 4156 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3109 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Evaluating various HVDC transmission systems converter circuits and its control scheme	a	1, 2
CO 2	Analyzing FACTS devices for improving system stability	b	2
CO 3	Analyzing the knowledge for improving stability in Power System	b	2
CO 4	Understanding the concepts of harmonics and designing of AC filters	b	2

SYLLABUS:

General Considerations of AC And DC Systems: Introduction, Economic advantages of DC over AC transmission, types of DC links, technical advantages of DC over AC transmission, application of DC transmission system, Properties of converter circuits, different kinds of arrangements, choice of converter configuration, analysis of Graetz circuit.

Control of Converter and DC Link: Principles of DC link control, converter control characteristics, system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link ;power control.

FACTS Concept and General System Considerations: FACTS concepts, transmission inter connections, power flow in AC Systems. loading capability limits, dynamic stability considerations, Importance of controllable parameters, Basic types of FACTS controllers, benefits from FACTS controllers.

Static Shunt Compensators: Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, Improvement of transient stability, Power Oscillation damping, SVC & STATCOM.

Static Series Compensators: Concept of series capacitive compensation, Improvement of transient stability, Power Oscillation damping, thyristor switched series capacitor (TSSC), thyristor controlled series capacitor (TCSC), Unified Power Flow Control (UPFC).

Harmonics and Filters: Characteristic harmonics, calculation of AC Harmonics, Non-Characteristic harmonics, adverse effects of harmonics – Calculation of voltage & Current harmonics. Types of AC filters: Design of Single tuned filters.

Text Books:

1. K.R. Padiyar, "HVDC power transmissions systems: Technology and system interactions", Edition 2, New age International (P) Ltd., New Delhi, Eastern (2011).
2. N G Hingorani and L.Gyugyi, "Understanding FACTS devices", IEEE Press (1999).

Reference Books:

1. S.Kamakshiah, V.Kamaraju "HVDC Transmission", Edition-1, Tata Mc Graw-Hill Education (2011).
2. Song, Y.H and Johns, A.T, "Flexible A.C Transmission Systems (FACTS) IEEE Power Engineering Series 30, London (1999).

POWER QUALITY

Course Code : 15 EE 4157 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3109 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand various power quality issues.	e	1
CO 2	Analyze various power quality issues and its causes.	e, k	1,2
CO 3	Analyze the different mitigating techniques for voltage sag and swells.	e	1
CO 4	Design and analyze voltage sag and swell using simulation tools.	e, k	2,3

SYLLABUS:

Introduction - Power or voltage quality, terms and definitions: short duration voltage variations, Interruptions – Voltage sag – Swell – Surges – Harmonics – Voltage fluctuations. Long duration voltage variations: Over voltage – Under voltage – Sustained interruptions,

Transients: Impulse transients – Oscillatory transient, Power quality terms. Long Interruptions - Definition – Interruptions – Causes of long interruptions – Origin of interruptions – Limits for the interruptions frequency – Limits for the interruption duration. Short Interruptions - Definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions. Voltage sag analysis - Voltage sag magnitude – Monitoring - Theoretical calculations – Examples - Sag magnitude in non-radial systems, Voltage calculation in meshed systems, Voltage sag duration, Fault clearing time – Magnitude duration plots- Measurement of sag duration, Magnitude and Phase angle jumps for three phase unbalanced sags – Phase to phase fault – Single phase faults – Two phase to ground faults – High impedance fault – Meshed systems. Mitigation of Interruptions and Voltage Sags- Overview of mitigation methods – From fault to trip, Reducing the number of faults, Reducing the fault clearing time changing the power system, Installing mitigation equipment, Improving equipment immunity, Different events and mitigation methods. System equipment interface – Voltage source converter, series voltage controller, Shunt voltage controller, combined shunt and series controller. Typical wiring and grounding problems.

Text Books:

1. Math H J Bollen, "Understanding Power Quality Problems: voltage sags and interruptions", Wiley-IEEE Press (1999).
2. Roger C Dugan, Surya Santoso, Mark F. Mc Granaghan, H. Wayne Beaty, "Electrical power system quality", Third edition, TMH (2012).

Reference Book:

1. Angelo Baggini, "Hand book of power quality", Wiley publications (2008).
2. Edward F Fuchr, Mohammad A S Masoum "Power Quality in Power System and Electrical Machine", 1st Edition, Elsevier (2008).

SMART GRID TECHNOLOGIES

Course Code : 15 EE 4158 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3210 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To understand the functioning of various devices in Smart Grids	e, j	1
CO 2	To understand communication channels in Smart Grid.	e, j	1
CO 3	To understand the concept of information security for the smart grid	e, j	1
CO 4	To apply knowledge in Smart Metering	e, j, k	3

SYLLABUS:

The smart grid: Introduction – Necessity of smart grid – Definition – Early smart grid initiatives – overview of the technologies required for the smart grid-Information and communication technologies, Sensing measurement, control and automation technologies, Power electronics and energy storage.

Data communication: Introduction – dedicated and shared communication channels – switching techniques – communication channels- layered architecture and protocols; Communication technologies for the smart grid: Introduction –communication technologies – standards for information exchange.

Information Security for the smart grid: Introduction – Encryption and Decryption: Symmetric Key encryption, Public key encryption - Authentication – Digital signature: Secret key signature, Public key signature, Message digest – cyber security standards.

Smart metering and demand side integration: Introduction – smart metering – smart meters – Communication infra structure and protocols for smart metering - Demand side integration.

Introduction to smart grid applications: Introduction – voltage and VAR control and optimization – fault detection, isolation and restoration (FDIR) – Demand response (DR) – Distributed energy resources (DERs) – wide area monitoring, control and protection (WAMCP).

Text Books:

1. Janaka Ekanayake , Kithsiri Liyanage , Jianzhong Wu , Nick Jenkins, "Smart Grid: Technology and Applications" first Edition, John Wiley & sons Limited (2012).
2. Lars T. Berger and Krzysztof Iniewski, "Smart Grid: Applications, communication and security" first Edition ,John Wiley & sons Limited;(2012).

Reference Books:

1. James Momoh "Smart grid: Fundamental of Design and analysis" ,John Wiley & sons Limited IEEE Press (2012).

ADVANCED POWER ELECTRONICS

Course Code : 15 EE 3252 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3109 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand various advanced inverter topologies	e	1
CO 2	Analyze various advanced PWM techniques to control inverters	e	1
CO 3	Analyze the performance of various DC-DC converter s	b, e	2
CO 4	Understand the working of various resonant converter topologies	b	1

SYLLABUS:

Multilevel converters: Multilevel converter topologies- Diode-Clamped Multilevel Converters- Flying-Capacitor Multilevel Converters - Cascaded H-Bridge Multilevel Converters – circuit diagrams-principle of operation, waveforms – advantages and disadvantages of each converter topology – Advanced PWM techniques - Third harmonic injection PWM (THPWM), Delta Modulation- - Selective Harmonic Elimination Technique- Current Controlled PWM (CCPWM) Technique - space vector Modulation(SVM)- - Sub-harmonic PWM Method - Switching Frequency Optimal PWM Method .

Switched mode power conversion: Non-isolated dc-dc converters: Buck, boost, buck-boost, Cuk, SEPIC, Zeta in DCM and CCM. Isolated dc-dc converters: Flyback, forward, Cuk, SEPIC, Zeta, half bridge, push-pull and bridge in DCM and CCM.

Resonant converters: Introduction – Need of resonant converters – examples -Series resonant converter - Parallel resonant converter - Zero current switching- Zero voltage switching - applications

Text Books:

1. Rashid, M H, " Power electronics : circuits, devices, and applications", 2^{nd} ed., Englewood Cliffs, N.J.Prentice Hall.
2. Lander, C W "Power electronics", 3^{rd} ed., London : McGraw-Hill.

Reference Books:

1. Ned Mohan et.al "Power Electronic converters- converters, design and applications", PHI.

ADVANCED ELECTRICAL DRIVES

Course Code : 15 EE 4159 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3211 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the Mathematical Modeling of Synchronous and Asynchronous machines	e	1
CO 2	Analyze various advanced electric drive control techniques for Asynchronous machines	b	2
CO 3	Analyze various advanced electric drive control techniques for Synchronous machines	b	2
CO 4	Analyze various advanced electric drive control techniques for special machines	b	2

SYLLABUS:

Modeling of AC machines: 3-Induction Motor-Voltage and current Equations in stator reference frame – equation in Rotor reference frame – equations in a synchronously rotating frame – Torque equation - Equations Circuits model of a 3ph Synchronous motor – Two axis representation of Syn. Motor. Voltage and current Equations in state – space variable form – Torque equation.

Control of Induction Motor drives: Vector control of Induction Motor Drives: Principles of Vector control – Vector control methods – Direct methods of vector control – Indirect methods of vector control – Adaptive control principles – Self tuning regulator Model referencing control.

Control of Synchronous Motor Drives: Flux weakening operation – Maximum speed – Direct flux weakening algorithm – Constant Torque mode controller – Flux Weakening controller – indirect flux weakening – Maximum permissible torque – speed control scheme – Implementation strategy speed controller design.

Variable Reluctance Motor Drive: Variable Reluctance motor drive – Torque production in the variable reluctance motor Drive characteristics and control principles – Current control variable reluctance motor service drive.

Brushless DC Motor Drives: Three phase full wave Brushless dc motor – Sinusoidal type of Brushless dc motor- current controlled Brushless dc motor Servo drive.

Text Books:

1. Vedam Subranmanyam, "Thyristor control of Electric Drives".
2. Paul C. Krause, Oleg wasynezuk, ScottD. Sudhoff ,"Analysis of electric machinery and Drives systems".

HVDC & FACTS

Course Code : 15 EE 4160 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3109 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Evaluating various HVDC transmission systems converter circuits and its control scheme	a	1, 2
CO 2	Analyzing FACTS devices for improving system stability	b	2
CO 3	Analyzing the knowledge for improving stability in Power System	b	2
CO 4	Understanding the concepts of harmonics and designing of AC filters	b	2

SYLLABUS:

General Considerations of AC And DC Systems: Introduction, Economic advantages of DC over AC transmission, types of DC links, technical advantages of DC over AC transmission, application of DC transmission system, Properties of converter circuits, different kinds of arrangements, choice of converter configuration, analysis of Graetz circuit.

Control of Converter And DC Link: Principles of DC link control, converter control characteristics, system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link ;power control.

FACTS Concept and General System Considerations: FACTS concepts, transmission inter connections, power flow in AC Systems. Loading capability limits, dynamic stability considerations, Importance of controllable parameters, Basic types of FACTS controllers, benefits from FACTS controllers.

Static Shunt Compensators: Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, Improvement of transient stability, Power Oscillation damping, SVC & STATCOM.

Static Series Compensators: Concept of series capacitive compensation, Improvement of transient stability, Power Oscillation damping, thyristor switched series capacitor (TSSC), thyristor controlled series capacitor (TCSC), Unified Power Flow Control (UPFC).

Harmonics And Filters: Characteristic harmonics, calculation of AC Harmonics, Non-Characteristic harmonics, adverse effects of harmonics – Calculation of voltage & Current harmonics. Types of AC filters: Design of Single tuned filters.

Text Books:

1. K.R. Padiyar, "HVDC power transmissions systems: Technology and system interactions", Edition 2, New age International (P) Ltd., New Delhi, Eastern (2011).
2. N G Hingorani and L.Gyugyi, "Understanding FACTS devices", IEEE Press (1999).

Reference Books:

1. S.Kamakshiah, V.Kamaraju "HVDC Transmission", Edition-1,Tata Mc Graw-Hill Education (2011).
2. Song, Y.H and Johns, A.T, "Flexible A.C Transmission Systems (FACTS)", IEEE Power Engineering Series 30, London (1999).

POWER QUALITY

Course Code : 15 EE 4161 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3109 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand various power quality issues.	e	1
CO 2	Analyze various power quality issues and its causes.	e, k	1,2
CO 3	Analyze the different mitigating techniques for voltage sag and swells.	e	1
CO 4	Design and analyze voltage sag and swell using simulation tools.	e, k	2,3

SYLLABUS:

Introduction - Power or voltage quality, terms and definitions: short duration voltage variations, Interruptions – Voltage sag – Swell – Surges – Harmonics – Voltage fluctuations. Long duration voltage variations: Over voltage – Under voltage – Sustained interruptions, Transients: Impulse transients – Oscillatory transient, Power quality terms. Long Interruptions - Definition – Interruptions – Causes of long interruptions – Origin of interruptions – Limits for the interruptions frequency – Limits for the interruption duration. Short Interruptions - Definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions. Voltage sag analysis - Voltage sag magnitude – Monitoring - Theoretical calculations – Examples - Sag magnitude in non-radial systems, Voltage calculation in meshed systems, Voltage sag duration, Fault clearing time – Magnitude duration plots- Measurement of sag duration, Magnitude and Phase angle jumps for three phase unbalanced sags – Phase to phase fault – Single phase faults – Two phase to ground faults – High impedance fault – Meshed systems. Mitigation of Interruptions and Voltage Sags- Overview of mitigation methods – From fault to trip, Reducing the number of faults, Reducing the fault clearing time changing the power system, Installing mitigation equipment, Improving equipment immunity, Different events and mitigation methods. System equipment interface – Voltage source converter, series voltage controller, Shunt voltage controller, combined shunt and series controller. Typical wiring and grounding problems.

Text Books:

1. Math H J Bollen, "Understanding Power Quality Problems: voltage sags and interruptions", Wiley-IEEE Press (1999).
2. Roger C Dugan, Surya Santoso, Mark F. Mc Granaghan, H. Wayne Beaty, "Electrical power system squality", Third edition, TMH (2012).

Reference Books:

1. Angelo Baggini, "Hand book of power quality", Wiley publications (2008).
2. Power Quality in Power System and Electrical Machine by Edward F Fuchr, Mohammad A S Masoum, 1st Edition, Elsevier (2008).

HYBRID ELECTRIC VEHICLES

Course Code : 15 EE 4162 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 3211 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the concepts involved in vehicle mechanics	a, j	1
CO 2	Analyze the battery and Electric Drive performance for HEV	a, c	2
CO 3	Understand the working of Internal combustion engines used for HEV	a, j	1
CO 4	Understand the control strategies for HEV	a	1

SYLLABUS:

Vehicle Mechanics: Laws of motion, Vehicle kinematics, Dynaics of vehicle motion, propulsion power, velocity and acceleration, tire-road force mechanics.

Battery Energy Storage: Batteries in Electric and Hybrid Vehicles, Battery parameters: Open Circuit and Terminal Voltages, Discharge Rate, State of Charge, State of Charge, Specific

Energy, Electric Circuit Models, Traction Batteries, Battery Management Systems, SoC Measurement, Cell Balancing

Electric Motor Drives: Electric Drive Components, D.C. Drives: Two-quadrant Chopper, Open Loop Drives, A.C. Drives: Six Step Operation, Harmonic Analysis, PWM Techniques, Space Vector PWM, SRM Drives: SRM Converters, SRM Controls, Voltage Controlled Drive, Current Controlled Drive, Advanced Controlled Strategies

Internal combustion Engines: Reciprocating Engines, Gas-turbine Engines, Vehicle Fuel Economy, Fuel Economy in Hybrids, Power Train Components and Brakes, Gear Ratio, Torque-speed Characteristics, Differential, Manual and Automatic Transmission, Brakes: Conventional and electromechanical Brake Systems

Hybrid Vehicle Control Strategy: Vehicle Supervisory Controller, Mode Selection Strategy: Electric only, Engine Starting, Parallel Mode, Power=split Mode, Engine Brake Mode, Regenerative Mode.

Text Books:

1. Iqbal Husain, "Electric and Hybrid Vehicles- Design Fundamentals", II Edition, CRC Press.
2. Mehrdad Ehsani, Yimin Gao, Ali Emadi,"Modern Electric, Hybrid Electric and Fuel Cell Vehicles – Fundamentals, Theory and Design", II Edition,CRC Press, Taylor and Francis Group.
3. Sandeep Dhameja,"Electric Vehicle Battery Systems", Newnes Publisher.

STATE ESTIMATION & SYSTEM IDENTIFICATION

Course Code : 15 EE 3253 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2207 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand Various elements of probability theory	a	1
CO 2	Understand and analyze stochastic processes and system models	e	2
CO 3	Analyze and Evaluate Optimal prediction and optimal smoothing for discrete linear systems	e	3
CO 4	Analyze and Evaluate Optimal estimation for continuous linear systems	e	3

SYLLABUS:

Elements of probability theory: definition of probability and random variable, probability functions, expected value, mean and covariance, independence and correlation, Gaussian distribution and its properties. Stochastic processes and system models: Elements of the theory of stochastic processes, mean value function and covariance kernel, independent and correlated stochastic processes, stationery and non sequence model, Gaussian white process. Optimal prediction for discrete linear systems: problem statement, optimal filtering for discrete systems.

Optimal smoothing for discrete linear system, classification of smooth estimates, fixed interval smoothing, fixed point smoothing, fixed lag smoothing, single and double stage optimal smoothing. Optimal estimation for continuous linear systems: problem formulation, optimal filtering and prediction, optimal fixed interval smoothing.

Text Books:

1. Meditch, "Stochastic Optimal Linear Estimation and Control" Mc-Graw Hill Company, (1969).
2. Dan Simon, "Optimal State Estimation", Wiley Intersience, (2006).

DIGITAL CONTROL SYSTEMS

Course Code : 15 EE 4163 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2207 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understanding the importance of Z-Transform in Discrete time systems	e	1
CO 2	Evaluating the stability performance and compensating techniques for Digital control systems	b	2
CO 3	Understand various state variable methods in discrete time systems	e	1
CO 4	Designing of State feedback controllers and observers	e	3

SYLLABUS:

Introduction: sampling process, signal re-construction difference equations, Z–Transforms, inverse Z transform, properties of Z Transform, Z transformer function. Z transform analysis of sampled data control systems: Z Transfer function of OH, closed loop transfer function of discrete systems, Response of linear discrete systems. The Z and s-domain relationship, Stability analysis of discrete systems using Jury's method.

Compensation techniques of discrete system: Time domain technique of designing compensator. Frequency domain technique of designing compensator. Bilinear transformation: Root locus using bilinear transformation, Routh's criterion using bilinear transformation for discrete systems.

State variable methods in discrete time systems: state description of digital systems. Conversion of state variable models to Z Transform function, Eigen values and eigenvectors, solution of state difference equations, controllability and observebility of discrete systems. Digital control systems with state feedback, state regulator design, design of state observers, reduced order observers, Compensator design by separation principle.

Text Books:

1. M.Gopal, "Digital control and state variable methods", Tata McGraw Hill Publishers (2008).
2. B.C.Kuo, "Digital control systems" , Second edition,Oxford University Press (2012).
3. Digital Control of Dynamic Systems, Gene F. Franklin, J. David Powell and Michael Workman, 3rd Edition., Ellis-Kagle Press (1997).

Reference Books:

1. Phillips and Nagle, "Digital Control System Analysis and Design", 3rded., Pearson Publishers (1994).
2. Franklin and Powell , "Digital Control of Dynamic Systems", 3rded., Ellis-Kagle Press (2006).

NON LINEAR CONTROL SYSTEMS

Course Code : 15 EE 4164 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2207 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understanding and analyzing the nonlinearities in the control system	a	1
CO 2	Understand various concepts of stability	e	1
CO 3	Evaluating the stability performance of Nonlinear systems	a	3
CO 4	Understanding and evaluating the performance of Fuzzy controllers for non linear control systems	e	1,3

SYLLABUS:

Introduction: Linear Versus Non Linear systems, Common Non linearity's in control systems, describing function for the non linear elements. Stability analysis by the describing function method.Construction of phase portraits, systems analysis on the phase plane, singular points, Limit cycles.Simple variable structures.

Concept of stability: stability in the sense of Lyapunov and absolute stability, Zero - input and BIBO stability, Second (or direct) method of Lyapunov stability theory for continuous and discrete time systems, Construction of Lyapunov function.

Nonlinear control structures: Feedback linearization Model, Nonlinear Control system identification and generalized predictive control in self tuning mode.

Fuzzy Logic: Introduction – Fuzzy sets- basic Fuzzy set operations – Properties of Fuzzy sets - Membership function- features of membership function - Fuzzy Inference Systems - Methods of FIS – defuzzification methods – centroid method – weighted average method, applications to control systems – PID Control and water level control.

Text Books:

1. Hassan K. Khalil, "Nonlinear Systems", Prentice Hall(1996).
2. Thimothy J Ross, "Fuzzy Logic with Engineering Applications", 3rd Edition, John Willey Publications (2010).

Reference Books:

1. Jean-Jacques Slotine, Weiping Li, "Applied Non Linear Control", Prentice Hall India (1991).
2. Sankar Sastry, "Nonlinear Systems Analysis, Stability and Control", Springer publication (1999).

3. M.Vidyasagar, "Nonlinear Systems Analysis", Prentice - Hall International editions (1993).
4. M.Gopal,"Digital control and state variable methods" Tata Mc-Graw Hill Companies (2012).
5. M N Bandyopadhyay, "Control Engineering", Prentice Hall of India (2009).

OPTIMAL CONTROL SYSTEMS

Course Code : 15 EE 4165 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2207 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To understand the formation of optimal control problem and to know about other optimal control problems	e	1
CO 2	To understand calculus of variations and formulation of constrained minimization problem by using Hamiltonian method	e	1
CO 3	Understand and analyze the concepts of dynamic programming in optimal control	e	2
CO 4	Develop the optimal LTIV system by solving Riccati equations	a	2

SYLLABUS:

Introduction: Formation of optimal control problem, Minimum time, Minimum Energy, Minimum fuel, state regulator problem, output regulator problem, tracking problem.

Calculus of variations: Minimization of functions, minimization of functional, Functional of a single function; Fixed end points problem, Terminal time t1 specified, x(t1)Free, Terminal time t1 free, x(t1)Specified. Both the terminal time t1 and x(t1) free. Constrained minimization, formulation of variation calculus using Hamiltonian method. Minimum principle, Control variable inequality Constraints Control and state variable inequality constraints.

Dynamic Programming: principle of invariant imbedding principle of optimality multistage decision process in continuous time.

Optimal feedback control: continuous time linear state regulator, Numerical solution of Riccati equation. Output regulator problem, tracking control scheme, proportional plus integral state feedback.Sub Optimal Linear regulators: Continuous time systems, Minimum time control linear invariant systems, stochastic optimal linear estimation and stochastic control Processes of linear systems. Response of linear continuous time systems to white noise,optimal estimation for linear continuous time systems. Time invariant linear state estimator.

Text Books:

1. M.Gopal "Modern Control System Theory", New Age International Publishers (2005).
2. Anderson B.D.O and J.B Moore, "Optimal Control Linear Quadratic Methods", Prentice

Hall Information and System Sciences Series (1989).

Reference Books:

1. A.P.Sage and C. C. White, III: Optimum Systems Control (2nd Ed.),Prentice Hall (1977).
2. D.E.Kirk, "Optimal Control Theory: An Introduction",Prentice Hall (1970).

ADAPTIVE CONTROL SYSTEMS

Course Code : 15 EE 4166 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2207 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Modelling and analysis of systems by identification approaches	e	1
CO 2	Understand and analyze the operation of Indirect adaptive control techniques	b	2
CO 3	Understand and analyze the operation of direct cv x--------adaptive control techniques	b	2
CO 4	Evaluate the stability performance of adaptive control system for mitigating the parameter variations.	e	2

SYLLABUS:

Introduction: Basic approaches to adaptive control,applications of adaptive control.

Gradient and least-squares algorithms: Linear error equation.Gradient and normalized gradient algorithms. Convergence properties.Least-squares and modified least-squares algorithms.

Identification: Identification of linear time-invariant systems. Adaptive observers.Equation error and output error methods.

Indirect adaptive control: Pole placement adaptive control. Model reference adaptive control. Adaptive inverse control.Predictive control. Singularity regions and methods to avoid them.

Direct adaptive control: Filtered linear error equation. Gradient and pseudo-gradient algorithms.Strictly positive real transfer functions and Kalman-Yacubovitch-Popov lemma. Lyapunov redesign.Passivity theory. Direct model reference adaptive control.

Frequency-domain analysis and averaging approximations: Averaging theory for one-time scale systems. Application to linear error equations.Sufficient richness condition for identification.Averaging analysis for mixed-time scale systems and application to adaptive control.

Text Books:

1. I.D. Landau, R. Lozano, and M. M'Saad, "Adaptive Control", Springer Verlag, London, (1982).
2. K.J. Astrom and B. Wittenmark, "Adaptive Control", 2nd edition, Addison-Wesley (1995).

3. G.C. Goodwin and K.S. Sin, "Adaptive Filtering, Prediction, and Control", Prentice-Hall, (1984).

Reference Books:

1. P. Ioannou& B. Fidan, "Adaptive Control", SIAM, Philadelpia, PA (2006).
2. P.A. Ioannou& J. Sun, Robust, "Adaptive Control", Prentice Hall, Upper Saddle River, NJ (1996).
3. K.S. Narendra and A.M. Annaswamy, "Stable Adaptive Systems", Prentice-Hall (1989).
4. S. Sastry and M. Bodson, "Adaptive Control: Stability, Convergence, and Robustness", Prentice-Hall (1989).
5. P.E. Wellstead& M.B. Zarrop, "Self-Tuning Systems: Control and Signal Processing", J. Wiley & Sons, Chichester, England (1991).

ENERGY CONSERVATION & AUDIT

Course Code : 15 EE 3254 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2206 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the need for energy conservation and various tariffs	a, b	1
CO 2	Understand the auditing methods and their practice by case studies.	a, b	1
CO 3	Apply the energy conservation techniques to motors, transformers, lighting systems.	a, b	2
CO 4	Understand the optimal operation of cogeneration plants	b	1

SYLLABUS:

System approach and End use approach to efficient use of Electricity; Electricity tariff types; Energy auditing; Types and objectives-audit instruments-ECO assessment and Economic methods-specific energy analysis-Minimum energy paths-consumption models- Energy auditing of a typical industrial unit-case study

Electric motors- Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis-Energy efficient / high efficient Motors-Case study; Load Matching and selection of motors. Variable speed drives; Pumps and Fans-Efficient Control strategies-optimal selection and sizing – Optimal operation and storage; Case study

Transformer Loading/Efficiency analysis, feeder/cable loss evaluation, case study. Reactive power management-Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-placement-Maintenance, case study; Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling-case study;

Lighting-Energy efficient light sources-Energy conservation in Lighting Schemes-Electronic ballast-Power quality issues-Luminaries, case study;

Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study; Electric loads of Air conditioning & Refrigeration-Energy conservation measures-Cold storage, Types –Optimal operation –case study; Electric water heating-Gysers-Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls-software's-EMS.

Text Books:

1. Giovanni and Petrecca "Industrial Energy Management: Principles and Applications", The Kluwer international series-207 (1999).
2. Anthony J.Pansini, Kenneth D.Smalling "Guide to Electric Load Management", Pennwell pub (1988).

Reference Books:

1. Howard E.Jordan "Energy-Efficient Electric Motors and their applications", Plenum pub corp; (1994)
2. Turner, Wayne C, Lilburn, "Energy Management Hand book" The Fairmont press (2001).
3. Albert Thumann "Handbook of Energy Audits ",5th edition, Fairmont Pr; (1998)
4. Recommended practice for Energy Conservation and cost effective planning in Industrial facilities by IEEE Bronze book, IEEE Inc, USA.

UTILIZATION OF ELECTRICAL ENERGY

Course Code : 15 EE 4167 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2206 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the motor ratings for different applications	e	1
CO 2	Analyze the characteristics and intensity of lightning systems for different types of lamps.	c, e	2
CO 3	Analyze the characteristics and control strategies of locomotives for track electrification.	c, e	2
CO 4	To understand electrical circuits used in refrigeration, air conditioning and water coolers	e	1
CO 5	To understand various electrolytic processes and different kinds of electric heating and welding	e	1

SYLLABUS:

Motor power rating and selection: General considerations in selecting motor power rating. Selection of motor capacity for continuous duty. Equivalent current, torque and power methods, selection of capacity for short term and intermittent periodic duty. Heating and cooling of motors, load equalization, fly wheel equalization.

Illumination: Introduction, Nature of radiation, terminology in illumination, Polar curve, Laws of illumination, Luminous efficacy, Photometry, Lumen or flux method of calculation, Types of Lamps, Types of Lighting, Flood Lightning, and calculations, Street lightning, Compact Fluorescent Lamp (CFL), Light Emitting Diode (LED) lightning, Lighting Characteristics, Design of choke and capacitor.

Electric Traction: Introduction-General features, Traction motor, Locomotive, Characteristics and control of locomotives and motor coaches for track electrification, Tramways and Trolley buses, Track equipment and Collector gear, Diesel-Electric equipment, Train movement and Energy consumption, Braking, Requirements of braking system, Types of braking: Mechanical, Hydraulic and Electrical braking.

Electrical Circuits used in Refrigeration, Air Conditioning and Water Coolers: Principle of air conditioning, Description of electrical circuits used in: Refrigerator, Air conditioner and Water cooler.

Electrolytic Processes: Fundamental principles, Extraction and refining of metals, Electro deposition, Manufacture of chemicals, Power supply for electrolytic purposes.

Electric Heating and Welding: Advantages of electrical heating, Design of heating elements, Heating methods: Resistance heating, Induction heating, Electric arc heating, Dielectric arc heating. Advantages of electric welding, Welding methods: Resistance welding, Electric arc welding, Atomic hydrogen welding, Modern welding techniques: Ultrasonic and Laser welding.

Text Books:

1. H. Pratab, "Art & Science of Utilisation of Electrical Energy", Dhanpat Rai & Co.(P) Ltd. (2012).
2. C.L. Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age International (P) Limited, Publishers (2011).

Reference Books:

1. E. Openshaw Taylor, "Utilisation of Electric Energy", Orient Longman (2006).
2. M. L. Soni, P. V. Gupta, U. S. Bhatnagar and A. Chakrabarti, "A Text Book on Power System Engineering", Dhanpat Rai & Co. Pvt. Ltd.,(2001).
3. SL Uppal, "Electrical Power", Khanna Publishers, New Delhi (2006).

SOLAR AND FUEL CELL ENERGY SYSTEMS

Course Code : 15 EE 4168 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2206 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand and analyze solar resources and their variations	a	1
CO 2	Understand and analyze basic concepts of the solar photovoltaic energy conversion system	a	1
CO 3	Analyze the different applications of solar thermal energy	c	2
CO 4	Understand and analyze the fuel cell characteristics, working principle and comparison of different types of fuel cells	a	2

SYLLABUS:

Solar resources: Passage through the atmosphere; global distribution; Solar data; Solar radiation spectrum; Seasonal and daily variation; Effect of Tilt Angle.

Solar photovoltaics : The Photo Voltaic effect; Spectral response; p-n junction; different types of photovoltaic cells; PV cell characteristics; Effect of variation of temperature; insolation level & tilt angle on the characteristics; equivalent circuits; Fabrication and costs of PV cell. Photovoltaic modules; module specifications; module hot spots; bypass diodes Battery storage: Lead and Nickel cadmium batteries; Charge regulators; LVD circuit; Voltage and current Source Inverters. Tracking Systems; Maximum power point tracking.

System applications: Autonomous PV system; Grid Linked PV systems, Remote application of Photovoltaic's; System sizing; System Performance; Economics and future prospects.

Solar thermal: Principles of applied heat transfer, solar thermal collectors: Glazing, evacuation, selective surfaces, concentrators. Solar thermal applications: water and space heating; solar ponds; dryers; distillation; solar cooker. Passive Solar design.

Fuel cells: Basics Fuel cell definition, difference between batteries and fuel cells, fuel cell history, components of fuel cells, principle of working of fuel cell, performance characteristics of fuel cells, efficiency of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant.Types of Fuel Cells Fuel cell types: alkaline fuel cell, , polymer electrolyte fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell.

Text Books:

1. S.P.Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage",TMH.
2. G.D.Rai , "Solar Energy Utilization", Volume-1 & 2 Khanna Publishers.
3. Hand Book of Fuel Cells - Fundamentals and Technology and Application, Wiley & Sons Publishers (2009).

Reference Books:

1. Micheal Boxwell , "Solar Electricity Handbook",Green Stream publishing (2010).
2. G.D.Rai , "Non conventional Energy", Khanna Publishers.

3. Viswanathan, B and M Aulice Scibioh, "Fuel Cells – Principles and Applications", Universities Press (2006)

WIND AND BIOMASS ENERGY SYSTEMS

Course Code : 15 EE 4169 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2206 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand and analyze basic concepts of the wind energy conversion system	a	1
CO 2	Analyze the different types of wind mills, control systems and design parameters	a, b	2
CO 3	Analyze various control systems used in wind systems and their design parameters	a, b	2
CO 4	Apply the basic concepts of the bio energy conversion into different forms of energy	a	2

SYLLABUS:

Introduction: Components of WECS-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine

Wind turbines: HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

Fixed speed systems: Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors- Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model-Generator model for Steady state.

Variable speed systems: Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling –

Grid connected systems: Stand alone and Grid Connected WECS system-Grid connection Issues-Machine side & Grid side controllers-WECS in various countries

Bio energy: Origin of Biomass: Resources: Bio fuels, classification, direct combustion for heat, pyrolysis, gasification and liquefaction and electricity generator, anaerobic digestion for biogas, biogas digester and types. Economics of biogas plant with their environmental and social impacts Bioconversion of substrates into alcohol: methanol & ethanol production, organic acids.

Text Books:

1. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, (1990).
2. Ion Boldea, "Variable speed generators", Taylor & Francis group, (2006).
3. Biomass Renegerable Energy – D.O.hall and R.P. Overeed (John Wiley and Sons, New York, (1987).

Reference Books:

1. E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge, (1976).
2. S.Heir "Grid Integration of WECS", Wiley (1998).
3. Biomass Gasification Principles and Technology, Energy technology review No. 67, T.B. Read Noyes Data Corp. , (1981).

NUCLEAR, GEOTHERMAL AND TIDAL ENERGY SYSTEMS

Course Code : 15 EE 4170 **L – T – P :** 3-0-0

Pre Requisite : 15 EE 2206 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the basic concepts of nuclear energy conversion system	a	1
CO 2	Understand various nuclear reactors, nuclear detectors and accelerators	a	1
CO 3	Analyze the geothermal energy conversion systems	a, b	2
CO 4	Analyze the tidal characteristics and different types of tidal power generation systems	a	2

SYLLABUS:

Basic concepts in nuclear energy: Nuclear constituents – charge, mass, shape, and size of nucleus, Binding energy, packing fraction, nuclear magnetic moment, saturation and short range nuclear forces, Radioactivity – Laws of radioactive decay, half life, mean life, specific activity, Nuclear models.

Nuclear reactors: Types of reactor-Heat generation in fuel elements and temperature distributions. Heat removal, Reactor coolants. Single phase and two phase heat transfer. Boiling and flow regimes. Power conversion cycles.

Nuclear detectors and accelerators: Types of detectors, Geiger-Mueller counter, Scintillation counter, classification of accelerators, Cyclotron, Betterton.

Tidal energy: Introduction to tidal energy, tidal characteristics, tidal range, tidal energy estimation, types of tidal power plants- single basin single effect plant, single basin double effect plant, double basin double effect plants.

Geothermal energy: Introduction to geothermal energy, structure of the earth interior, geothermal gradients, geothermal resources, geothermal power generation- liquid dominated and vapour dominated geothermal electric power plants.

Text books:

1. John Lamarsh, "Introduction to Nuclear Engineering", Edition II, Addison Wesley Publishing Company (1983).

2. D.C.Tayal, "Nuclear Physics", Himalayan Publication house, Bombay (1980).
3. Godfrey Boyle "Renewable Energy", Second edition,Oxford Publications.

Reference books:

1. Cecil Dudley, Gregg King, "Nuclear Power Systems: An Introductory Text", Macmillan (1964).
2. Geoffrey F.Hewitt, John G Collier, "Introduction to Nuclear Power" ,I Edition (2000).
3. G. D. Rai, "Non-Conventional Energy Sources", First edition, Khanna Publishers.

COMPUTER ARCHITECTURE

Course code : 15 EE 3255 **L – T – P :** 3 – 0–0

Pre Requisite : 15 EC 1101 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the evolutionary steps of computer, complex instructions and microprogramming	c, k	1
CO 2	Understand, analyze and design main, cache and virtual memory organizations.	c	2
CO 3	Understand the design issues of complex pipeline architectures and also microprocessor evolution 4004 to 4	c, k	2
CO 4	Understand synchronization and sequential consistency and VLIW/EPIC	c	1

SYLLABUS:

History of Calculation and Computer Architecture; Influence of Technology and Software on Instruction Sets: Up to the dawn of IBM 360; Complex Instruction Set Evolution in the Sixties: Stack and GPR Architectures; Microprogramming; Simple Instruction Pipelining; Pipeline Hazards.

Multilevel Memories – Technology; Cache (Memory) Performance Optimization; Virtual Memory Basics; Virtual Memory: Part Deux.

Complex Pipelining; Out of Order Execution and Register Renaming; Branch Prediction and Speculative Execution; Advanced Superscalar Architectures; Microprocessor Evolution: 4004 to Pentium 4.

Synchronization and Sequential Consistency; Cache Coherence; Cache Coherence (Implementation); Snoopy Protocols; Relaxed Memory Models.

VLIW/EPIC: Statically Scheduled ILP; Vector Computers; Multithreaded Processors; Reliable Architectures; Virtual Machines.

Text books:

1. Hennessy, J. L., and D. A. Patterson, "Computer Architecture: A Quantitative Approach", 3rd ed. San Mateo, CA: Morgan Kaufman, ISBN: 1558605967, (2002).
2. Patterson, D. A., and J. L. Hennessy, "Computer Organization and Design: The Hardware/ Software Interface", 3rd ed. San Mateo, CA: Morgan Kaufman, ISBN: 1558606041 (2004).

PLDs AND FPGAs

Course code : 15 EE 4171 **L – T – P :** 3 – 0–0

Pre Requisite : 15 EC 1101 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand Full-custom & Semi Custom design methodologies of for designing different PLD architectures.	c	1
CO 2	Study and design of combinational and sequential circuits using PLEs.	c, k	2
CO 3	Study and analysis of different CPLD and FPGA architectures	c	2
CO 4	Study of New generation Architectures of Programmable Logic Devices	c	1

SYLLABUS:

Introduction: Full Custom Design; Semicustom Design; Programmable Logic Devices; Notations for Programmable Logic Devices; Design Methodology Using Programmable Logic Devices; Design Soft Ware;

Programmable Read Only Memory (PROM): Mask programmed ROM; EPROM; EEPROM; Programmable Logic Element (PLE); Combinational Logic Design using PLEs; Sequential Circuit Realization using PLEs;

Programmable Logic Devices: Programmable Logic Device (PLD); Sequential PLD; Complex PLD; Field Programmable Gate Array (FPGA); Xilinx SRAM-Based FPGA; Comparison between FPGA, ASIC and CPLD; FPGA based system design;

Field Programmable Gate Arrays: Introduction; The Xilinx logic Cell Array; Advanced futures of the 4000 series; The Actel ACT; Technology Trends;

New generation Architectures of Programmable Logic Device: Erasable Programmable Logic Devices; Reprogrammable Generic Logic Devices; Erasable Programmable Logic Array (EPLA); Generic Array Logic (GAL); Programmable Electrically Erasable Logic (PEEL);

Text Books:

1. Parag K. Lala, "Digital System Design Programmable Logic Devices", B S Publications
2. Debaprasad Das, "VLSI Design", Oxford.
3. Pak K. Chan, SamihaMourad, "Digital Design Using Field Programmable Gate Array", Pearson Education.

Reference Books:

1. Bob Zeidman, "Designing with PFGAs and CPLDs", CMP Books,
2. Stephen Brown Zvonko Vranesic "Fundamentals of Digital Logic with VHDL Design" McGraw-Hill, (2008).

Simulation Book:

1. Ian Grout, "Digital Systems Design with FPGAs and CPLDs", Newnes.
2. Scott Hauck, AndréDehon, "Reconfigurable Computing: The Theory and Practice of FPGA-Based Computing", Elsevier Science.

VLSI DESIGN

Course code : 15 EE 4172 **L – T – P :** 3 – 0–0

Pre Requisite : 15 EC 1101 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To understand the VLSI fabrication process and to be able to interact with integrated circuit process engineers	b	1
CO 2	To analysis the theory and CV characteristics of MOS transistor	b	2
CO 3	To analysis MOS gate static and switching characteristics	b	3
CO 4	To design and layout MOS logic circuits	k	3
CO 5	Circuit Characterization and Performance Estimation and scaling	k	2
CO 6	Analyzing CMOS fault models and test principles	b, k	2

SYLLABUS:

Technology Introduction: Introduction to IC Technology – MOS, PMOS, NMOS, CMOS MOS Theory Analysis: Basic Electrical Properties of MOS Circuits: Ids-Vds Relationships, , gm, gds, Figure of Merit ωo, Pass Transistor, Transmission Gate, NMOS Inverter, Various Pull-ups, CMOS Inverter Analysis and Design, Bi-CMOS Inverters, Latch up in CMOS Circuits. CMOS Circuits and Logic Design Rules: MOS Layers, Stick Diagrams, Lambada Based rules Scaling of CMOS Circuits. CMOS Circuit Characterisation and Performance Estimation: Sheet Resistance RS and its Concept to MOS, Area Capacitance Units, Transistor Sizing, Power Dissipation. CMOS Fault models: need for testing, manufacturing test principles.

Text Books:

1. Kamran Ehraghian, Dauglas A. Pucknell and SholehEshraghiam, "Essentials of VLSI Circuits and Systems" – PHI, EEE, (2005).
2. Neil H. E. Weste and David. Harris Ayan Banerjee,, "CMOS VLSI Design" - Pearson Education, (1999).

Reference Books:

1. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits" TMH (2003).
2. Jan M. Rabaey, "Digital Integrated Circuits" Pearson Education, (2003).
3. Wayne Wolf, "Modern VLSI Design ", 2nd Edition, Prentice Hall, (1998).

Simulation Books:

1. Etienne Sicard, Sonia DelmasBendhia, "Basics of CMOS Cell Design", TMH, EEE, (2005).

EMBEDDED SYSTEM DESIGN

Course code : 15 EE 4173 **L – T – P :** 3 – 0–0

Pre Requisite : 15 EC 1101 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Able to analyze embedded systems, its design cycle, modeling, layers of embedded systems	c, k	2
CO2	Able to understand Processor and Memory Organization and I/O Devices and Networks	c, k	1
CO3	Able to understand, evaluate and select appropriate software architecture and analyze the features real time operating systems.	c, k	2, 3
CO4	Understand various embedded system design methodologies and be able to develop and demonstrate a small embedded system for a real time application.	c, k	2, 3

SYLLABUS:

Introduction to Embedded System: Embedded system processor, hardware unit, soft ware embedded into a system, Example of an embedded system, Embedded Design life cycle, Embedded System modeling (flow graphs, FSM, Petri nets), Layers of Embedded Systems.

Processor and Memory Organization: Bus Organization, Memory Devices and their Characteristics, Instruction Set Architecture (RISC, CISC), Basic Embedded Processor/ Microcontroller Architecture (8051, ARM, DSP, PIC), memory system architecture (cache, virtual, MMU and address translation), DMA, Co-processors and Hardware Accelerators, pipelining.

I/O Devices and Networks: I/O Devices(Timers, Counters, Interrupt Controllers, DMA Controllers, A/D and D/A Converters, Displays, Keyboards, Infrared devices), Memory Interfacing, I/O Device Interfacing (GPIB, FIREWIRE, USB, IRDA), Networks for Embedded systems (CAN, I2C, SPI, USB, RS485, RS 232), Wireless Applications (Bluetooth, Zigbee).

Operating Systems: Basic Features of an Operating System, Kernel Features (polled loop system, interrupt driven system, multi rate system), Processes and Threads, Context Switching, Scheduling(RMA, EDF, fault tolerant scheduling), Inter-process Communication, real Time memory management (process stack management, dynamic allocation), I/O(synchronous and asynchronous I/O, Interrupts Handling, Device drivers), RTOS (VxWorks, RT-LINUX).

Embedded System Development: Design Methodologies(UML as Design tool, UML notation, Requirement Analysis and Use case Modeling), Design Examples (Telephone PBX, Inkjet Printer, PDA, Elevator Control System, ATM System), Fault-tolerance Techniques, Reliability Evaluation Techniques.

Reference Books

1. Wayne Wolf "Computers as components: Principles of Embedded Computing System design" The Morgan Kaufmann Series in Computer Architecture and Design, (2008).
2. Jane W. S., Liu, "Real Time Systems", Pearson Education, (2000).

3. Raj Kamal, "Embedded systems Architecture, Programming and design", Second Edition,(2008).
4. Robert Ashby, "Designer's Guide to the Cypress PSoC" Newnes, (2005).
5. Microblaze processor Reference guide, Xilinx.
6. NIOS II Processor reference Handbook, ALTERA.

DSP PROCESSORS

Course code : 15 EE 4174 **L–T–P :** 3–0–0

Pre Requisite : 15 EC 1101 **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand and analyze the basic concepts of Digital Signal Processing by MATLAB and number systems	a, c, j	2
CO 2	Understand and analyze various architectures for programmable DSP devices	a, c, j	2
CO 3	To understand Programming of TMS320F28335/F2812 Digital Signal Processor	a, c, j	2
CO 4	To understand the implementation of small programs using TMS320F28335/F2812 Digital Signal Processor	a, c	2

SYLLABUS:

Introduction to digital signal processing: Introduction, A Digital Signal processing system, The sampling process, Discrete time sequences. Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time-invariant systems, Analysis and Design tool for DSP Systems MATLAB, DSP using MATLAB.NUMBERING SYSTEMS: Floating, Integer and Fixed point Processors, IEEE-754 Floating-Point Format, Q-Format.

Architectures for programmable dsp devices: Architecture for two selected DSPs, Pipelining process of instructions, Read and write operations, Interrupts, Timers.

Programming for selected DSP (TMS320F28335/F2812): Code composer studio, implementation of small programs like Digital I/O, PID control, Digital Filters, Timer and interrupts, PWM signal generation, Analog to Digital Conversion.

TEXT BOOKS:

1. Sanjit K Mitra , "Digital Signal Processing", Tata Mc-Graw Hill Publications.
2. J G Proakis, D G Manolokis, " Digital Signal Processing Principles, Algorithms, Applications", PHI. TMS320F28335 Manuals.

REFERENCE BOOKS:

1. A V Oppenhiem, R W Schafer , "Discrete-Time Signal Processing", Pearson Education.
2. Emmanuel C Ifeacher Barrie. W. Jervis, "DSP- A Practical Approach", Pearson Education.
3. S. M .Kay, "Modern spectral Estimation techniques", PHI, 1997.

DEPATEMENT OF MECHANICAL ENGINEERING

MATERIAL SCIENCE AND METALLURGY

Course code :15 ME 2105 **L–T–P :** 2 - 2 - 2

Pre Requisite: 15PH 1001 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Identify and differentiate various types of materials. i.e. Metals, Alloys and understand various material testing methods.	a	2
CO-2	Analyze the concept of cooling curves, equilibrium phase diagrams, and heat treatment techniques.	a	2
CO-3	Identify the importance of composites, ceramics and strengthening mechanisms.	b	2
CO-4	Identify various nano material, bio-material, smart material and powder metallurgy process and their applications.	b	2
CO 5	Perform the experiments to identify the microstructure of various materials and analyze the data	b	2

SYLLABUS

Introduction to Engineering materials, Single crystals, polycrystalline, non-crystalline, nano crystalline materials.

Structure, properties and applications of different metals and alloys, Ceramics, Composites, Nano materials, Bio materials, Smart Materials.

Constitution of Alloys, cooling curves, Phase Diagrams- classification, Construction, Invariant reactions.

DEFORMATION: Elastic, Anelastic and Visco-elastic behavior of materials, Deformation by slip & twinning, Mechanism of slip, Dislocation multiplication.

Iron Carbon diagram, TTT and CCT diagrams, Strengthening mechanisms, Heat Treatment of steels,

Classification, Cast iron, alloy steels, non ferrous metals and alloys.

Material testing methods: Destructive and Non Destructive, Powder Metallurgy.

Text Books:

1) Sidney.H.Avner "Introduction to Physical Metallurgy" TMH publications, Second Edition.

2) Dr.VD Kodgire and Dr. SV Kodgire "Material science and Metallurgy" EPH, Edition 1.

Reference Books:

1) C. Daniel Yesudian, D G Harris Samuel "Material science and Metallurgy" Scitech Publications, (2006).

2) V.Raghavan " Materials science and Engineering" Fifth Edition ,PHI..

3) R.A.Higgins, "Engineering Metallurgy, Part I" App. Physical Met, ELBS.

STRENGTH OF MATERIALS

Course code : 15 ME 2106 **L – T – P :** 2 - 2 - 2

Pre Requisite : (15ME 1001) **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Analyze stresses in members with 1D axial loading or torsion	b	3
CO-2	Analyze shear force and bending moment diagrams	b	3
CO-3	Analyze deflections and stresses in beams	e	2
CO-4	Design columns and pressure vessels	e	2
CO 5	Apply the theoretical concepts to conduct various experiments of strength of materials practically and analyze the data.	b	2

SYLLABUS:

Simple Stresses and Strains: Introduction, Types Of Stress, Stress Strain Diagram, Hooke's Law, Types of Strains.

Axially Loaded Members: Deflection of an Axially Loaded Member, Statically Indeterminate Structures (Stiffness Method), Temperature Effects.

Torsion: Introduction, Torsion of a Circular Bar, Non Uniform Torsion, Transmission of Power by Circular Shafts, Strain Energy in Pure Shear and Torsion.

Analysis Of Stress And Strain: Introduction, Principle Stress and Maximum Shear Stress, Mohr's Circle for Plane Stress.

Shearing Forces And Bending Moments: Types of Beams, Shear Force and Bending Moment, Relationship Between Load, Shear Force And Bending Moment, Shear Force And Bending Moment Diagrams.

Stresses In Beams: Introduction, Normal Strains In 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 Pressure Vessels: Concepts of Hoop and Longitudinal Stresses, Simple Problems for Cylinders and Shells.

Columns: Buckling And Stability, Columns with Pinned Ends, Columns with Other Support Conditions, Limitations of Euler's Formula, Rankine's Formula, Columns with Eccentric Axial Loads, Secant Formula.

Text Books:

1. Gere & Timoshenko "Mechanics of Materials" CBS Publishers.

2. L S. Srinath "Strength of Materials".

Reference Books:

1. S.S.Rattan "Strength of Materials" Tata Mcgraw Hill.
2. Pytel A H and Singer F L, Harper Collins "Strength of Materials" , New Delhi.
3. Timoshenko S P And Young D H "Elements of Strength Of Materials" East West Press,New Delhi.
4. Shames, I. H., Pitarresi, J. M "Introduction to Solid Mechanics" , Prentice-Hall, NJ.

GRAPHICS AND VISUALIZATION OF MECHANICAL COMPONENTS

Course code : 15 ME 2207 **L – T – P :** 2-2-2

Pre Requisite : 15ME 1002 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Communicate information about various mechanical components visually through projections	g	2
CO-2	Implement computer aided drafting	g	2
CO-3	Develop part drawings and create different primitives	g	2
CO-4	Current developments in CAD	k	2
CO-5	Develop models using CAD softwares	b	2

SYLLABUS:

SCREWED FASTENERS: Introduction, Screw thread nomenclature, Forms of screw threads, Thread designation, Multi-start threads, Right- and left-hand threads.

Bolts and nuts - Methods of drawing hexagonal and square bolts and nuts, T-headed bolt, Hook bolt, Eye-bolt, Stud, Flanged nut, Cap nut, Dome nut, Bolted joint, Stud joint. Locking arrangement for nuts - Locking by Locknut, Split pin, Castle nut.

SHAFT COUPLING: Introduction. Rigid couplings - Split-muff coupling, Protected flanged coupling. Flexible couplings-Bush pin type flanged coupling. Disengaging couplings - Cone coupling. Non-aligned couplings - Universal coupling (Hooke's joint).

ASSEMBLY DRAWINGS: Introduction, Stuffing box, Eccentric, Screw jack, Swivel Bearing.

PART DRAWINGS: Introduction, Single tool post, Plummer Block, I.C.Engine connecting rod, lathe tail stock.

Fundamentals of CAD, CAD workstation, peripherals, Design process, Applications of computer for design

PRIMITIVES: Points and Lines, Line drawing algorithms, DDA algorithm, Bresenham's line algorithm, Circle generation algorithm, Mid point circle algorithm.

Curves, Surfaces, Solids: Representation of curves – Surfaces modeling techniques– Beizer and B-spline surfaces – Volume modeling Techniques – Boundary models – CSG,

Current developments in CAD: Feature based modelling, design by feature, function, feature linkages, application of feature based models, parametric modelling, Variational Modeling.

Basic transformation techniques

TEXT BOOK:

1. K.L.Narayana, P. Kannaiah and K.Venkata Reddy "Machine Drawing"
2. Chris Mc Mohan and Jimmi Browne "CAD/CAM Principles, practice and manufacturing management", Pearson Education Asia Ltd., (2000).

REFERENCES:

1. Donald Hearn and M.Pauline Baker "Computer Graphics", Prentice Hall, Inc, (1992).
2. IBRAHIM ZEID "CAD/CAM – Theory and Practice" McGraw Hill, International Edition, (1998).
3. K.R. Gopalakrishnan "Machine Drawing".
4. N.D.Bhatt "Machine Drawing".

Note: Course should be implemented through hand drawing and also using modeling software like ProE/ Solidworks/ Inventor

MANUFACTURING SCIENCE AND TECHNOLOGY

Course code : 15 ME 2208 **L – T – P :** 2 - 2 - 2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Implement various primary and secondary manufacturing techniques and processes	b	2
CO-2	Execute machining operations on machine tools	c	2
CO-3	Analyze the parameters of various primary and secondary manufacturing techniques and processes and respective cutting tools	c	2
CO-4	Select and apply proper jigs and fixtures	c	2
CO 5	Apply the theoretical concepts to conduct various experiments practically.	b	3

SYLLABUS:

Introduction to Manufacturing and its evolution, Metal Casting: Casting-its elements, Die casting, Investment casting, Centrifugal casting, Shell moulding, Gating design, Design of patterns, moulds and cores, Solidification and cooling, melting furnaces. Metal Forming: Basic Principles of forging, rolling, drawing and extrusion; Fundamentals of hot and cold working processes; Load estimation for bulk metal forming processes, High energy rate forming; Joining Methods: Principles of Gas, Arc welding, Brazing & Soldering, Advanced Welding Processes TIG & MIG; Adhesive Joining, Metal and non-metal joining; Weldability; Design considerations in Welding. Machining: Turning, Methods of Screw Production, Drilling, Boring, Milling, Gear Manufacturing, Production of flat surfaces, Grinding & Finishing Processes. Mechanics of Metal Cutting: Mechanics of machining, single and multipoint cutting tools, tool geometry and materials, tool life and wear, Variables affecting Tool Life; Jig & fixtures: Classification of jig & fixtures. Principle of location, types of locators. Principle of guiding elements Types of guiding elements, Principle of clamping elements, Types of clamps. Introduction To Software For Manufacturing Applications: Metal forming and flow analysis software (for metallic /plastic components).

Text Books:

1. S. Kalpakjian, "Manufacturing Processes for Engineering Materials", Fifth edition. Pearson Education, (2009).
2. Ghosh and Mallick A. K., "Manufacturing Science". Affiliated East-West Press Pvt. Ltd. (2010).

Reference Books:

1. M. P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Third edition. Wiley India Private Limited, (2009).
2. S. Kalpakjian, "Manufacturing Processes for Engineering Materials", Fifth edition. Pearson Education, (2009).
3. G. K. Lal and S. K. Choudhury, "Fundamentals Of Manufacturing Process", Boca Raton, FL: CRC Press, (2011).
4. M.H.A. Kempster, Introduction to Jigs and fixtures design.
5. Hoffman, Introduction to Jigs and fixtures.

KINEMATICS AND DYNAMICS OF MACHINES

Course code : 15 ME 2209 **L – T – P :** 2 - 2 - 2

Pre Requisite : (15ME 1001) **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Identify, select and analyze kinematically suitable mechanisms for required motion of machinery	k	2
CO-2	Develop velocity and acceleration diagrams and analyze the data	b	2
CO-3	Develop cam profiles	k	2
CO-4	Analyze mechanisms dynamically	e	2
CO 5	Apply the theoretical concepts to design mechanisms by using the simulation software and analyzing the data	b	2

SYLLABUS:

Mechanisms and Machines: Introduction to Plane and Space Mechanisms, Kinematic Pairs, Kinematic Chains and their Inversions, Mobility and range of movement - Kutzbach and Grubler's criterion, Grashof's criterion.

Velocity analysis: Velocity analysis using IC and relative velocity method. Acceleration analysis.

Cams: cam profiles of knife edge, roller and offset followers of reciprocating motion.

Gears and Gear trains: Gears – terminology, fundamental law of gearing, involute profile. Interference and undercutting.

Gear Trains – simple, compound and epicyclic gear trains.

Balancing: Introduction, Static balancing, dynamic balancing, transferring of a Force from one plane to another, Balancing of Several Masses in Different planes, Balancing of Reciprocating Mass, Secondary Balancing.

Dynamic force analysis: Force analysis of Slider crank mechanism.

Gyroscopes: Gyroscopic Effect on Naval Ships, Stability of an Automobile, Stability of a Two-Wheel vehicle.

Text Book:

1. David H. Myszka "Machines and Mechanisms-Applied Kinematic Analysis", 4th Edition, Prentice Hall.
2. Robert Norton "Kinematics and Dynamics of Machinery" 1st Edition, Tata McGraw - Hill Education, (2009)
3. Shigley J.E., and Uicker J.J "Theory of Machines and Mechanisms", McGraw Hill, (1995).

Reference books:

1. Thomas Bevan "Theory of Machine" CBS Publications.
2. Rao, J. S "The Theory of Machines through Solved Problems", New Age International.
3. A.Ghosh and A.K.Mallik "Machanisms and Machine Theory",3rd edition, EWP Pvt.Ltd.
4. S.S.Rattan "Theory of Machine", Mc.Graw Hill.
5. NPTEL lectures : http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Kinematics of Machine/index.htm

APPLIED THERMODYNAMICS

Course code : 15 ME 2210 **L – T – P :** 2 -2 - 2

Pre Requisite : 15ME 1003 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand phase equilibrium of a pure substance, Determine efficiency of Rankine vapor power cycle	a	2
CO-2	Understand working principle of various modern high pressure, critical and super-critical boilers including Velox, Lamont, Benson boilers	a,b	2
CO-3	Estimate dimensional parameters of various steam nozzles including convergent and divergent nozzles, Determine overall efficiency of various steam turbines including impulse and reaction turbines	b	2
CO-4	Compare various steam condensers including jet and surface condensers by estimating condenser vacuum, vacuum efficiency and condenser efficiency	a,b	2
CO-5	Compare various methods of refrigeration by understanding working principles, Understand principle of psychrometry and air-conditioning process	a	2

SYLLABUS:

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, Regenerative cycle, Binary vapour cycle.

STEAM NOZZLES & CONDENSERS: Types of nozzles, isentropic flow through nozzles, effect of friction, nozzle efficiency, critical pressure ratio and maximum discharge, throat and exit areas using Mollier diagram, Condensers - Jet and surface condensers, condenser vacuum and vacuum efficiency, condenser efficiency, thermodynamic analysis.

IC ENGINES: Engine nomenclature, classification of I.C. Engines, working principles of S.I. and C.I. Engines (both 4 stroke and 2-stroke) - valve and port timing diagrams - Differences between SI & CI and 2 stroke & 4 stroke engines and combustion in S.I and CI engines.

REFRIGERATION & AIR CONDITIONING: Methods of refrigeration, Refrigerator & heat pump, Reversed carnot and bell-coleman cycles, Refrigerating effect, COP, Vapour compression and vapour absorption refrigeration systems, Psychrometric properties, psychrometric chart and air-conditioning process.

TEXT BOOKS:

1. Cengel & Boles "Engineering Thermodynamics" ,Mc Graw Hill Publishers.
2. P.K.Nag "Basic and Applied Thermodynamics", TMH, New Delhi.
3. V.Ganesan "I.C. Engines", T.M.H.,.

REFERENCE BOOKS:

1. Vasandhani & D.S.kumar "A treatise on Heat Engineering", Metropolitan Book publishers.
2. P.K.Nag "Engineering Thermodynamics", TMH, New Delhi.
3. R.Yadav "Applied Thermodynamics" CBH, Allahabad.
4. P.K.Nag "Power Plant Engineering (Steam and Nuclear)", TMH.
5. Kearton "Steam Turbines Theory and Practice"-, ELBS.

Note: use of steam tables and refrigeration and air-conditioning tables is permitted in university examinations.

FINITE ELEMENT METHOD

Course code : 15 ME 3111 **L – T – P :** 2 -- 2---2

Pre Requisite : 15 ME 2207 & 15 ME 2106 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Analyse and evaluate 1D problems and plane trusses using FEM	e	2
CO-2	Analyse and evaluate 2D problems using FEM	e	2
CO-3	Analyse and evaluate axisymmetric solids subjected to axisymmetric loading using FEM	k	3
CO-4	Analyze and evaluate solids subjected to dynamic loads	k	3
CO 5	Apply the theoretical concepts to conduct various interpretation by using Analysis software's	b	2

SYLLABUS:

BASIC CONCEPTS OF F.E.M. AND ONE DIMENSIONAL PROBLEMS: Fundamental concepts, Finite Element Modeling, Coordinates and Shape functions, The Potential Energy Approach, The Galerkin Approach, Assembly of the Global Stiffness Matrix and Load Vector, Properties of Global Stiffness Matrix, The Finite Element equations; Treatment of boundary conditions, Examples of Axially Loaded Members. **ANALYSIS OF PLANE TRUSSES:** Introduction, Plane Trusses: Local and Global Coordinate systems, Element Stiffness Matrix, Stress Calculations, Example of plane Truss with three members. **TWO-DIMENSIONAL PROBLEMS USING CONSTANT STRAIN TRIANGLES:** Introduction, Finite Element Modeling, Constant-Strain Triangle (CST), Isoparametric Representation, Potential-Energy Approach, Element Stiffness, Force Terms Stress Calculations, Problem Modeling and Boundary Conditions. **AXISYMMETRIC SOLIDS SUBJECTED TO AXISYMMETRIC LOADING:** Introduction, Axisymmetric Formulation, Finite Element Modeling: Triangular Element, Potential-Energy Approach, Body force Term, Stress Calculations; Problem modeling and Boundary Conditions. Scalar Field Problems: Introduction, steady-state heat transfer, one-dimensional heat conduction, governing equation, boundary conditions, the one dimensional element. **DYNAMIC CONSIDERATIONS:** Introduction, Formulation, Element Mass Matrices, Evaluation of Eigen values and Eigen vectors; properties of Eigen vectors, Eigen value-Eigenvector Evaluation for line only.

TEXT BOOKS:

1. Tirupathi R.Chandrupatla, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice hall of India Pvt. Ltd,

REFERENCE BOOKS:

1. S.S.Rao "Finite Element Method" 4th Edition , ELSEVIER Ltd,
2. C. Krishna Murthy "Finite Element Method", 2nd Edition TMH,.
3. Avid V Hutton, "Fundamentals of Finite Element Analysis" McGraw-Hill Int. Ed.
4. Logan D.L., "A First course in the Finite Element Method", Third Edition, Thomson Learning,
5. Robert D.Cook., David.S, Malkucs Michael E Plesha, "Concepts and Applications of Finite Element Analysis".
6. Reddy J.N, "An Introduction to Finite Element Method", McGraw-Hill International Student Edition.
7. O.C.Zienkiewicz and R.L.Taylor, "The Finite Element Methods", Vol.1. The basic formulation and linear problems, Vol.1, Butterworth Heinemann.

DESIGN OF MACHINE ELEMENTS

Course code : 15 ME 3112 **L – T – P :** 2 - 2 -2

Pre Requisite : Strength of materials (15ME2106) **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Design of machine elements for simple and combined static stresses, fatigue strength	c	2
CO-2	Design shaft and couplings under static and dynamic loads, Flywheel	c	2
CO-3	Design of Power screws, bolted and welded joints and springs.	e	3
CO-4	Design of bolted and welded joints and springs.	e	3
CO 5	Apply the theoretical concepts to conduct various experiments on design of machine elements practically and analyze the data.	b	2

SYLLABUS:

Basics: Phases of Design, General Considerations and Procedure In Machine Design, Standardization, Preferred Numbers, Mechanical Properties of Materials.

Design For Static Strength: Simple Stresses - Combined Stresses - Torsional And Bending Stresses - Factor of Safety and Theories of Failure.

Design For Fatigue Strength: Stress Concentration – Methods of Reducing Stress Concentration Factor, Design for Fluctuating Stresses, Fatigue Strength and Endurance Limit, Goodman Diagram and Soderberg Methods For Combination of Stresses, Applications of Soderberg's Equation.

Power Screws: Types - Mechanics of Power Screws, Efficiency.

Design of Bolted Joints (Along With Eccentric Loading),

Welded Joints: Design of Welded Joints, Strength of Welded Joints, Welded Joint With Eccentric Loading.

Design Of Shafts And Couplings: Shaft And Its Design Based on Strength, Design of Shaft For Variable Load And Based on Stiffness. Introduction, Types, Uses, Design Procedures For Rigid And Flexible Rubber-Bushed Couplings.

Design Of Springs: Types, Design of Helical Spring Against Static and Fluctuating Loads, Torsion Springs, Spiral Springs, Leaf Springs.

Flywheel: Torque Analysis, Solid Disc Flywheel, Rimmed Flywheel, Stresses In Rimmed Flywheel.

Text Books:

1. Shigley J.E, "Mechanical Engineering Design", Mcgraw-Hill, (1996).
2. Bhandari, V B "Design of Machine Elements" Mcgraw-Hill
3. Black P.H. and O. Eugene Adams, "Machine Design", Mcgraw Hill Book Co. Ltd

Reference Books:

1. Budynas, R. G., & Nisbett, J. K. Shigley's "Mechanical Engineering Design" Mcgraw-Hill.
2. Norton, R. L. "Machine Design: An Integrated Approach" Prentice Hall
3. Spotts, M. F., Shoup, T. E., & Hornberger, L. E. "Design of Machine Elements" Pearson /Prentice Hall
4. Hamrock, B.J. Et.Al., "Fundamentals of Machine Elements", Mcgraw Hill
5. Bhandari "Design Of Machine Elements", Tata Mcgraw Hill Book Co.
6. Dr.N.C.Pandya & Dr. C.S.Shah "Machine Design", Charotar Publishing House "Usage Of: "Design Data", P.S.G. College of Technology, Coimbatore Is Recommended".

ADVANCED MANUFACTURING TECHNOLOGY

Course code : 15 ME 3113 **L–T–P :** 2 -2 -2

Pre Requisite : 15 ME 2208 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Implement various modern and advanced manufacturing techniques and processes	b	2
CO-2	Analyze the parameters related to economics of machining	b	2
CO-3	Understand NC, DNC and CNC systems	k	3
CO-4	Identify various techniques for processing of MEMS	k	3
CO 5	Apply the theoretical concepts to conduct various experiments on Unconventional machines	b	2

SYLLABUS:

Unconventional Machining Processes: Abrasive Jet Machining, Ultrasonic Machining; Electron Beam Machining; Laser Beam Machining, electric discharge wire cutting; electro chemical machining, electro chemical grinding, equipments, applications, advantages and limitations..

Computer Aided Manufacturing: Numerical control – definition – components of NC systems –development of NC – DNC – CNC and adaptive control systems, fundamentals of part programming, path generation, post processing and verification; simulation of part programs through simulation software packages; Computer Aided Process Planning: Computer Aided Inspection and quality control, Coordinate Measuring Machine, Limitations of CMM, Computer Aided Testing, Group Technology in Automated Manufacturing System.

Micro-Manufacturing: Miniaturization and its importance, Micro-Manufacturing Processes (Additive, formative and Removal), Scaling laws with emphasis on micro-Manufacturing. Nano manufacturing techniques and micromachining.

MEMS: Introduction, history, development, and need of micro-electro-mechanical systems, IC fabrication processes used for MEMS; Mechanical process techniques and process models for micromachining.

Economics of machining: Minimum Production Cost Criterion, Maximum Production Rate and Maximum Profit Rate Criteria; manufacturing process simulation, virtual and distributed manufacturing.

Text Books:

1. S. Kalpakjian, "Manufacturing Processes for Engineering Materials", Fifth edition. Pearson Education, (2009).
2. Ghosh and Mallick A. K., "Manufacturing Science". Affiliated East-West Press Pvt. Ltd. (2010).

Reference Books:

1. M. P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Third edition. Wiley India Private Limited, (2009).
2. Rao, P. N. "CAD/CAM: Principles and Applications". 3rd edition. New Delhi: Mcgraw-Hill Education, (2010).
3. G. K. Lal and S. K. Choudhury, "Fundamentals Of Manufacturing Process", (2009)
4. M. J. Madou, "Fundamentals of Microfabrication and Nanotechnology", 3rd Edition, CRC Press, (2011).

TURBO MACHINES

Course code : 15 EE 4174 **L–T–P :** 3–0–0

Course code : 15 ME 3114 **L–T–P :** 2 -2 -2

Pre Requisite : (15ME 1003) **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Design of rotor systems	b	2
CO-2	Design of compressor and fan blades	b,e	2
CO-3	Design of pumps	b,e	2
CO-4	Design of turbines	b,e	2
CO 5	Apply the theoretical concepts to conduct various experiments practically and analyze the data.	b	2

SYLLABUS:

STEAM TURBINES: Types, Pressure and velocity compounding, velocity diagrams, work output, power, blade efficiency and stage efficiency, degree of reaction, Governing of turbines, overall efficiency and reheat factor.

GAS TURBINES: Closed and open Brayton cycle gas turbines,Analysis of closed cycle gas turbine,Compressor and turbine Efficiencies,Gas turbine cycle with intercooling,reheat and regeneration.

HYDRAULIC PUMPS: Definition of pump, classification, description & general principle of working, priming & methods, work done & efficiencies of a centrifugal pump, Minimum starting speed, cavitation in centrifugal pumps, Multistage pumps, problems on centrifugal pumps.

HYDRAULIC TURBINES: Elements of hydroelectric power plants, Heads and efficiencies of a turbine, Classification- Pelton, Francis and Kaplan turbines, Working, proportions of turbines comparison and selection of turbines, Problems. Draft tube theory.

FANS, BLOWERS AND COMPRESSORS: Fans – types, principle and working, Blowers – Roots & vane type, working, Compressors-principle of operation, Velocity diagrams and energy transfer per stage, degree of reaction, isentropic efficiency, polytropic efficiencySurging, Choking and Stalling, Centrifugal compressor versus axial flow compressor.

TEXT BOOKS:

1. S.M.Yahya "Pumps & Compressors" -P.H.I.
2. Modi & Seth "Hydraolics & Hydraulic Machines" ,Dhanpat Rai Publishing, New Delhi.

REFERENCE BOOKS:

1. William W. Peng "Fundamentals of Turbo machinery".
2. "Hydraulics & Hydraulic Machines" John Wiley Publishers.

FEEDBACK AND CONTROL SYSTEMS

Course code : 15 ME 3115 **L–T–P :** 2 - 2 -2

Pre Requisite : 15 GN 1003 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Acquire ability to analyze, evaluate and simulate time response of a Mechatronic system	b	2
CO-2	Understand Quantizing theory and Data acquisition systems	c	2
CO-3	Understand the role of PLCs and microcontrollers in the design of control systems for mechatronic systems to achieve desired performance characteristics	c	2
CO-4	Acquire ability to analyze, evaluate and improve system performance using the control strategies viz. P, PD, PI, PID etc.	c	2
CO-5	Modelling of mechanical, hydraulic/ pneumatic and thermal systems using NI LabVIEW Software	b	2

SYLLABUS:

Introduction to control systems, Open loop and closed loop control systems, Block diagram representation, Laplace transform, Transfer function; Introduction to signal conditioning requirements in Mechatronic systems, Quantizing theory, Analog to Digital conversion, Digital to Analog conversion, data acquisition process, Data acquisition systems, Data presentation elements; Introduction to modelling of mechanical, electrical, fluid, and thermal systems containing elements such as sensors and actuators used in feedback control systems, Modelling of composite mechatronic systems; Dynamic response and stability characteristics; Closed loop controllers, Continuous and discrete processes, various control modes, Two-step (ON/OFF) control, Closed loop system analysis considering proportional, integral, and derivative controllers and their combinations viz. PD, PI, PID control strategies; Programmable Logic Controllers, basic architecture of PLCs, I/P and O/P processing, programming, ladder diagrams, Timers, Internal relays and counters, data handling, selection of a PLC.

LABORATORY:

Modelling of mechanical, hydraulic/ pneumatic and thermal systems using NI LabVIEW Software; Determination of Transfer Function of the various Mechatronic systems; Designing algorithm for controlling systems using PLC and/or Microcontroller based digital control systems; Controller design, analysis and verification of system performance under the influence of PD, PI, PID control strategies.

Reference Books:

1. Devdas Shetty, Richard A.Kolk, "Mechatronics System Design", PWS Publishing Company, (1997).
2. Bolton, "Mechatronics-Electronic Control Systems in Mechanical and Electrical Engineering", 2nd Edition, Addison Wesley Longman Ltd., (1999).

3. David G. Alciatore, Michael B. Histand, "Introduction to mechatronics and measurement systems", 2nd Edition, McGraw-Hill Professional, (2002).
4. D.A Bradley, D. Dawson, N.C Burd and A. J. Loader, "Mechatronics" CRC Press, (2010).
5. K. Ogata, "Modern Control Engineering", Prentice Hall India (2002).
6. Gene F. Franklin, J. D. Powell, A E Naeini, "Feedback Control of Dynamic Systems", Pearson (2008).
7. John Van De Vegte, "Feedback Control Systems", Prentice Hall (1993).

DESIGN OF TRANSMISSION ELEMENTS

Course code : 15 ME 3216 **L – T – P :** 2 - 2 - 2

Pre Requisite : 15 ME 3112 **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Design and select suitable bearings for applications	c,e	2,3
CO-2	Design brakes and clutches for given conditions	c,e	2,3
CO-3	Design gears and belt and chain drives for power transmission	c,e	2,3
CO-4	Design of IC engine components - piston, connecting rod and crankshaft.	c,e	2,3
CO 5	Apply the theoretical concepts to conduct various Simulations by using the simulation tool and analyze the data	b	2

SYLLABUS:

Bearings: Classification, Modes of Lubrication, Sliding Contact Bearing Design, Bearing Materials, Selection of Lubricant.

Rolling Contact Bearings- Types, Selection of Ball, Roller Bearings- Under Static Load, Dynamic Load.

Brakes And Clutches: Introduction To Brakes, Types, Analysis And Design Of Block Brakes, Internal Shoe Brakes, End Shoe Brakes, Pivoted Shoe Brakes, Band Brakes, Temperature Rise, Friction Materials.

Introduction To Clutches, Analysis And Design of Simple and Multiple Disc Clutches, Cone Clutches and Centrifugal Clutch, Friction Materials, Comparison of Brakes and Clutches.

Spur Gears: Introduction, Force Analysis, Beam Strength (Lewis) Equation, Velocity Factor, Service Factor, Load Concentration Factor, Effective Load on Gear, Estimation of Module Based on Beam and Wear Strength, Methods of Lubrication.

Helical Gears: Transverse and Normal Module, Virtual Number of Teeth, Force Analysis, Beam and Wear Strengths, Effective Load on Gear Tooth, Estimation of Dynamic Load By Velocity Factor and Buckingham's Equation, Design of Helical Gears.

Design and Analysis of Bevel and Worm Gear Drive

Belt Drives: Materials and Construction of Flat and V-Belts, Geometric Relationships For Length of Belt, Power Rating of Belts, Maximum Power Condition, Selection of Flat and V-Belts From Manufacturer's Catalogue, Belt Tensioning Methods, Relative Advantages And Limitations of Flat and V-Belts, Construction and Applications of Timing Belts.

Chain Drives: Construction and Materials of Roller Chain, Length of Chain and Number of Links, Polygonal Effect, Power Rating of Roller Chains, Construction of Sprocket Wheels, Silent Chains, Relative Advantages and Limitations-of Chain Drives.

I.C.Engine Components: Introduction, Design of Piston, Connecting Rod and Crank Shaft.

TEXT BOOKS:

1. Shigley J.E, "Mechanical Engineering Design", Mcgraw-Hill, (1996).
2. Bhandari, V B " Design of Machine Elements" Mcgraw-Hill.

REFERENCE BOOKS:

1. Budynas, R. G., & Nisbett, J. K. Shigley's "Mechanical Engineering Design" Mcgraw-Hill.
2. Norton, R. L. "Machine Design: An Integrated Approach" Prentice Hall.
3. Dr.N.C.Pandya & Dr. C.S.Shah "Machine Design",

Charotar Publishing House Usage Of following "Design Data", books is recommended.

1. P.S.G. College of Technology, Coimbatore.
2. Mahadevan and Balaveerareddy.

PRODUCTION AND OPERATIONS MANAGEMENT

Course code : 15 ME 3217 **L – T – P :** 2 - 2 - 2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Apply techniques to improve productivity and quality in production system	c,k	2,3
CO-2	Apply the principles of layout design, line balancing, Forecasting	b,c	2
CO-3	Apply the principles of Aggregates planning, Inventory management in operations management	k	3
CO-4	Inspection & Quality control	c	2
CO 5	Apply the theoretical concepts to conduct various experiments practically and analyze the data.	b	2

SYLLABUS:

Operations Management: definition, historical development, evolution, functions.

Forecasting: definition, approaches, types, qualitative approach, judgmental methods, quantitative approach, time series, regression, multiple regression, forecasting error estimation techniques. Introduction to aggregate planning.

Production Management: Types of production systems, Mass production, Batch production, Job order production. Productivity and factors influencing productivity.

Facility layout: definition, types – product layout, process layout, fixed position layout, cellular layout, introduction to computerized layout.

Material handling: definition, objectives, principles, unit load concept, factors affecting choice of MH equipment, classification, benefits.

Scheduling: Introduction, concept of assembly line balancing, scheduling of batch production, scheduling of job order, loading, sequencing,- definition, sequencing of n jobs through one machine, n jobs through 2 machines, (Johnsons' algorithm), sequencing of n jobs through 3 machines, n jobs through m machines.

Inspection & Quality Control: Concept and Types of Inspection, Quality Control Charts – SQC, Charts for variables and charts for attributes, application and construction of charts and problems. Acceptance sampling, Single and double sampling, OC curve, Reliability: definition, failure rate diagram, reliability computation.

Production planning & control: Introduction, definition, functions of PPC.

Brief introduction to: JIT, Lean manufacturing, Six sigma, Supply chain management.

Text Books: `

1. Introduction to work-study – ILO, 3/e, Geneva.(2004).
2. Adam & Ebert "Production & Operations Management" --, Pearson Education, (2008).

Reference Books :

1. M.Mahajan "Operations Management", Pearson Education, (2009).
2. Panner selvam "Production & operations Management", 2/e, PHI, (2010).

HEAT TRANSFER

Course code : 15 ME 3218 **L – T – P:** 2 - 2 - 2

Pre Requisite : NIL **Credits :** 4

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understanding basic principles of conduction, radiation, and convection heat transfer.	e	2
CO-2	Extend the basic principle of conservation of energy to systems which involve conduction, radiation, and heat transfer.	e	2
CO-3	To identify, formulate and solve engineering problems involving conduction convection and radiation heat transfer	k	2
CO-4	To identify, formulate and solve engineering problems of heat exchangers by transforming the physical system into a mathematical model, selecting an appropriate solution technique and evaluating the significance of results.	k	2
CO 5	Apply the theoretical concepts to conduct various experiments of heat transfer practically and analyze the data.	b	2

SYLLABUS:

INTRODUCTION: Basic modes, Thermal conductivity, Convection heat transfer co-efficient, Stefan Boltzman's law.

ONE DIMENSIONAL STEADY STATE HEAT CONDUCTION: Heat diffusion equation in Cartesian coordinates, Boundary and initial conditions. Steady state heat conduction, Thermal resistance, Composite slabs, cylinders and spheres, Critical thickness of insulation, Thermal contact resistance, Heat conduction through fins.

MULTI-DIMENSIONAL STEADY STATE HEAT CONDUCTION: Two-dimensional steady state conduction, analytical solution, conduction shape factor, finite difference and finite volume methods.

UNSTEADY STATE HEAT CONDUCTION: Transient conduction (lumped parameter), Biot number and Fourier number, Exact and approximate solutions. Finite difference methods.

CONVECTION: Thermal boundary layers, Drag and heat transfer coefficient, hydrodynamics, Correlations, flow over a flat plate, Flow across a single cylinder and tube bundles, Free convection.

HEAT EXCHANGERS: Types, Overall heat transfer coefficient, Fouling factor, LMTD, Effectiveness-NTU method, Multi-pass and cross flow heat exchangers.

BOILING AND CONDENSATION: Regimes of boiling, Mechanism, Nusselt's theory, Correlations in solving film wise condensation.

RADIATION HEAT TRANSFER: Black body, Configuration factor, Radiation heat exchange, Radiation shielding.

TEXT BOOKS:

1. Yunus A. Cengel., "Heat Transfer – A practical approach", Second Edition, Tata McGraw-Hill
2. Incropera. F.P.and Dewitt.D.P. "Introduction to Heat Transfer", John Wiley and Sons

REFERENCE BOOKS:

1. Lienhard, J.H., "A Heat Transfer Text Book", Prentice Hall Inc.,
2. Holman, J.P. "Heat Transfer", McGraw-Hill Book Co., Inc., New York
3. M. Necati Özışık, "Heat Transfer – A Basic Approach", McGraw-Hill

Note: use of steam tables and refrigeration and air-conditioning tables is permitted in university examinations.

PROFESSIONAL ELECTIVE

AUTOMOBILE ENGINEERING

Course code : 15 ME 3251 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 2210 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand cooling and lubrication systems	a	2
CO-2	Understand chassis and emission of automobiles	a	2
CO-3	Know the transmission and suspension systems	c	2
CO-4	Analyze the performance of transmission and suspension systems	e	3

SYLLABUS:

INTRODUCTION: Classification of vehicles – applications, prime movers.

ENGINE: Classification, Types of combustion chambers, Valves arrangement and operating Mechanisms, Piston, Firing order; Crankshafts, Flywheel. Fuel Supply systems, Fuel pumps, Carburetors, Electronic petrol injection.

COOLING SYSTEMS: Coolants, properties, Air and water cooling systems.

LUBRICATION STSTEM: Lubricants, Properties, Splash, semi-pressure and full pressure Lubricating systems.

CHASSIS: Components of an automobile, Layout, Specifications, Articulated and rigid vehicles, Wheel drives, Types of Frames, aerodynamics, Bumpers.

EMISSION: Emission from automobiles, pollution standards, national and international-pollution control techniques.

TRANSMISSION: Clutches, Gear Box, Automatic transmission, Overdrive, propeller shaft, Differential.

SUSPENSION: Systems, Springs, Shock absorbers, Axles, Wheel alignment.VEHICLE CONTROL: Steering mechanisms, Power steering, Brakes and actuation mechanisms.

TEXT BOOKS:

1. Joseph Heitner "Automotive Mechanics", Oscar Publications..
2. G.B.S.Narang "Automobile engineering", Khanna Publishers, Delhi

REFERENCE BOOKS:

1. Kirpal Singh "Automobile Engineering" - vol I & II , Standard Poblishers,New Delhi.
2. W.H.Crouse & D.L.Anglin "Automobile Mechanics" ,Mc Graw Hill Publishers.

AUTOMOBILE ENGINE DESIGN

Course code : 15 ME 4155 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 3112 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand and design of engine from first principle	a	2
CO-2	Design and Analyze cooling, lubrication and engine component systems	c	3
CO-3	Design engine components	c	2
CO-4	Understand engine testing equipments	b	2

SYLLABUS:

THERMODYNAMIC ENGINE DESIGN: Thermal cycles, Decision on size, length of stroke, rpm of the engine, Design of engine from first principle.

ENGINE FUNCTIONAL DESIGN: Selection, Stroke & Bore, No. of cylinders, Cylinder arrangement, Design considerations for combustion chamber, Engine balancing, Selection of firing order and cooling system.

DESIGN OF COOLING & LUBRICATION SYSTEM: Heat calculations and Heat balance sheet, Design of radiator, water pump, selection of lubricating oil and pump.

ENGINE COMPONENT DESIGN: Materials, Design of Piston, Piston pin, Connecting rod, Crankshaft, Cylinder liner, cylinder head, Design of Flywheel, Design of Valve, Rocker arm, Push rod, Cam shaft, cam and follower, Failure analysis of critical components.

ENGINE TESTING EQUIPMENT: Fault finding equipment, Vacuum gauge test, Mechanical fuel pump testing, Cylinder power balance, Cylinder compression test, Cylinder leakage test, Ignition timing, Exhaust gas CO and HC analyzer, Oscilloscope engine analyzers, and Distributor dwell-angle.

TEXT BOOKS:

1. S. P. Patil, "Mechanical System Design", Jaico Publications,
2. V. L. Maleev, "I. C. Engine", McGraw Hill Book Co. Ltd., New Delhi, Second Edition
3. Gill P. W., Smith J. H., Zurich E. J., "Fundamentals of I. C. Engine", Oxford & IBH Pub. Co., New Delhi.
4. E. F. Obert, "I.C. Engine & Air Pollution", Harper & Row Publishers, New York
5. J.B. Heywood, "I. C. Engine Fundamentals", McGraw Hill Book Co., New Delhi

REFERENCE BOOKS:

1. Litchy, I. C. Engine, McGraw Hill
2. George E. Dieter, "Engineering Design- A Material and Processing Approach", Second Edition, McGraw-Hill International Edition
3. A. Kolchin and V. Demidov, "Design of Automotive Engines", Mir Publishers, Moscow, (1984)
4. Gordon P.Blair, "Design and Simulation of Four-Stroke Engines", Society of Automotive Engineers, Inc., USA, (1999).
5. D. E. Winterbone and R. J. Pearson, "Design Techniques for Engine Manifolds, Wave action methods for I.C. Engines", Professional Engineering Publishing Ltd., UK, (2000).

AUTOMOTIVE TRANSMISSION

Course code : 15 ME 4156 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 3112 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand functionality of clutches and gear box	c	2
CO-2	Principle of working of drive line systems	c	2
CO-3	Understand transmission of fluid flywheel and torque convertor	c	2
CO-4	Principle of working of automatic transmission systems	c	2

SYLLABUS:

CLUTCHES: Principle, Functions, Requirements, Torque capacity, Types of clutches, Lining materials, Over-running clutch, Clutch control systems.

GEAR BOX: Necessity, Resistance to motion, Types, Sliding mesh, Constant mesh, Synchromesh, Synchronizing unit, Helical gears, Gear selector mechanism, Two wheeler gear box, Lubrication of gear box, Overdrive gears, Wilson Epicyclic gear train, Clutches and brakes in Epicyclic gear train, Compensation for wear, Performance characteristics.

DRIVE LINES: Effect of driving thrust and torque reaction, Propeller shaft-universal joints, hooks and constant velocity U.J., Drive line arrangements – Hotchkiss drive & torque tube drive, Rear & front wheel drive layouts.

FINAL DRIVE & REAR AXLE: Final drive & drive ratio, Types, Need of differential and differential unit, Rear axle, Axle types, Axle shafts, Final drive lubrication.

TRANSMISSION WITH FLUID FLYWHEEL & TORQUE CONVERTOR: Operating principle, Fluid flywheel, Characteristics, Advantages & limitations of fluid coupling, Torque convertor, Performance characteristics, Comparison.

AUTOMATIC TRANSMISSION: Principle of semi automatic & automatic transmission, Hydramatic transmission, Hydraulic control system, Continuous variable transmission (CVT), Advantages and disadvantages.

TEXT BOOKS:

1. Newton, Steed & Garrot, "Motor Vehicles", 13th Edition, Butterworth London.
2. A. W. Judge, "Modern Transmission", Chapman & Hall Std., (1989).
3. Chek Chart, "Automatic Transmission", A Harper & Raw Publications.
4. J. G.Giles, "Steering, Suspension & Tyres", – Lliffe Book Ltd., London.

REFERENCE BOOKS:

1. W. Steed, "Mechanics of Road Vehicles", Lliffe Book Ltd.
2. N. K. Giri, "Automotive Mechanics", Khanna Publishers, Delhi, Eighth Edition.
3. Heisler, "Vehicle and Engine Technology", Second Edition, SAE International Publication.
4. Heisler, "Advanced Vehicle Technology", Second Edition, SAE International Publication.
5. J. Reimpell, H. Stoll and J. W. Betzler, "The Automotive Chassis", SAE International Publication.

AUTOTRONICS & SAFETY

Course code : 15 ME 4157 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 3115 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand working principles of different batteries and ignition system	c	2
CO-2	Understand working principles of ignition system	c	2
CO-3	Understand auto wiring electrical systems	c	2
CO-4	Understand safety concept and safety equipments	c	2

SYLLABUS:

INTRODUCTION TO BATTERY AND ITS PRINCIPLES: Lead acid battery, principles and characteristics, Types, testing, Effect of temperature and battery on capacity and voltage, charging of batteries, sulphation and desulphation, fault diagnosis, maintenance and servicing, new developments in electrical storage.

IGNITION SYSTEM: Conventional Ignition, Crumble zone, safety sandwich construction, Types, Spark advance and retarding mechanism, Types of spark plugs, ignition timing, maintenance, servicing and fault diagnosis, Electronic Ignition systems, programmed ignition, distributor less ignition.

WIRING FOR AUTO ELECTRICAL SYSTEMS: Earth return and insulated return systems, six volt and twelve volt systems, fusing of circuits, low and high voltage cables, wiring diagram of typical automotive wiring systems, maintenance and servicing.

SAFETY CONCEPT: Active safety, conditional safety, perceptibility safety, operating safety – crash safety passive safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact.

SAFTEY EQUIPMENTS: Seat belt, automatic seat belt lightener system, collapsible steering column, tilt able steering wheel, air bags and its electronic system for activation, bumper design for safety, Collision warning system.

TEXT BOOKS:

1. P. L. Kohli "Automotive Electrical Equipment".
2. William H. Crouse "Automotive Electrical Equipment".
3. Bosch Automotive Handbook 5 th edition SAE publication.
4. Jnusz Pawlowski " Vehicle Body Engineering" Business Books Limited (1989).

REFERENCE BOOKS:

1. Kirpal Singh "Automobile Engineering".
2. R.B. Gupta "Automobile Enigneering".

ALTERNATIVE ENERGY SOURCES FOR AUTOMOBILES

Course code : 15 ME4158 **L – T – P :** 3 - 0 - 0

Pre Requisite : NIL **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Application of solar photo voltaic cells	a	2
CO-2	Understand Hydrogen energy	c	2
CO-3	Know the design considerations of electric automobiles	c	2
CO-4	Understand principles of working of electric automobiles	c	2

SYLLABUS:

INTRODUCTION: Need for non-conventional energy sources, Energy alterative: Solar, Photo-voltaic, Hydrogen, Electrical their merits and demerits.

SOLAR PHOTO-VOLTAIC: Solar photo-voltaic conversion, collection and storage, collection devices, principles and working of photo-voltaic conversion, Applications to automobiles.

HYDROGEN ENERGY: Properties of hydrogen, sources of hydrogen, thermodynamics of water splitting production of hydrogen, Electrolysis of water. Thermal decomposition of water, Thermo-chemical production, Biochemical production, Hydrogen fuel, storage and transportation methods, Applications to engines modifications, precaution and safety measures, Performance characteristics and comparison.

ELECTRIC AUTOMOBILES: Design considerations, limitations, opportunities for improvement batteries, Future possibilities, Capacities, Types, Material requirement.

Applicability of electric cars, driving requirements, cost of electric car, comparative use of fuel and energy, Availability of energy for recharging, Impacts on use of fuel and energy, impact on urban air quality, impact on price, material requirement. Traction motors and types.

REFERENCE BOOKS:

1. G. D Rai "Non-conventional sources of energy", khamma lab.
2. William Hamilton "electric automobiles". PHI.
3. S.P. Sukhatme "solar Engery". Tata McGraw Hill.
4. T.N Veziroglu, "Alternative energy sources".

INDUSTRIAL AUTOMATION & CONTROLS

Course code : 15 ME 3252 **L – T – P:** 3 - 0 - 0

Pre Requisite : 15 ME 3115 **Credits:** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understanding Industrial automation and control	c	2
CO-2	Understand working principles of different sensors	c	2
CO-3	Understand working principles of prime movers	c	2
CO-4	Know the working of PLCs	c	2

SYLLABUS:

Introduction to Industrial automation and Control, Automation in Manufacturing, Sensors used in Industrial Automation, Hydraulic/ pneumatic drives, Elements of hydraulic drives, Hydraulic/ pneumatic control circuits, Hydraulic circuit design considerations; Electrically actuated drives: Electrical Machine Drives, design and performance characteristics of DC Motors, Stepper Motors, and Servo motors, AC Induction motors; Relay control system - logic operations, sequence control, feeding device, design of relay circuits, control elements; Programmable Logic Controllers (PLCs) - Comparison with relays circuit, Ladder diagram, Latching, counters, timers, shift registers, Industrial applications.

Reference Books:

1. Tan K .K., Putra A. S., "Drives and control for Industrial Automation", Springer (2011).
2. Sarkar B N, "Fundamentals of Industrial drives", PHI Learning, Eastern Economy Edition.
3. Jon Stenerson, "Industrial Automation and Control", Prentice Hall, 1st Edition, (2002).

ROBOTIC MODELING ANALYSIS AND CONTROL

Course code : 15 ME 4159 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 2209 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Analysis of manipulator kinematics	b	3
CO-2	Understanding manipulator statics	c	2
CO-3	Understanding manipulator dynamics	c	2
CO-4	Understand programming languages	c	2

SYLLABUS:

Robot technology; Manipulator kinematics: Homogeneous transformations and matrix methods, Euler angles; Forward and inverse kinematics, Singularities; Differential Kinematics, Jacobian computation, manipulator statics; Manipulator dynamics: LE and NE formulations;

pertinent effects in joint torque computation; Trajectory planning: Joint space and Cartesian space planning; Manipulator control problem, control architecture, Position control; Force control strategies: Hybrid control, impedance control, and comparison of architectures; Task primitives and programming: Computational aspects, Programming languages; Case study: Legged robots, Mobile robots, Flexible manipulators, Parallel manipulators.

Reference Books:

1. M.W. Spong, M. Vidyasagar, "Robot Dynamics and Control", John Wiley,.
2. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modeling and Control".
3. S.K.Saha, and Himanshu Choudary "Robot Arm Kinematics", Springer Publications.
4. Asitava Ghosal "Robot Analysis":, Tata Mc Graw Hill.

MODELING AND ANALYSIS OF DYNAMIC PHYSICAL SYSTEMS

Course code : 15 ME 4160 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 2209 **Credits:** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Analysis and Synthesis of systems	b	3
CO-2	Understanding system response-Time domain	c	2
CO-3	Understanding system response-Frequency domain	c	2
CO-4	Carried out computer analysis and simulation	b	2

SYLLABUS:

System Engineering Approach, Systems and components, Classification of Systems, System Analysis, Synthesis, and Identification; System Modelling: Mathematical modeling of dynamic physical systems comprising of mechanical, electrical, fluid/thermal, and electromechanical components; System Response: Time-domain and Frequency-domain analysis, Laplace transforms, Transfer functions, Block diagrams and Bode plots; State-space formulation and analysis; Computer analysis and simulation: using Matlab and Simulink package and/ or NI Labview

Reference Books:

1. K. Ogata, "System Dynamics" 4th Edition, Pearson Education Inc., (2004).
2. L. Ljung, T. Glad, "Modeling of Dynamical Systems", Prentice Hall Inc. (1994).
3. D.C. Karnopp, D.L. Margolis and R.C. Rosenberg, "System Dynamics: A Unified Approach", 2nd Edition, Wiley-Interscience (1990).
4. G. Gordon, "System Simulation", 2nd Edition, PHI Learning (2009).
5. V. Giurgiutiu and S. E. Lyshevski, "Micromechatronics, Modeling, Analysis, and Design with MATLAB", 2nd Edition, CRC Press (2009).

THEORY AND DESIGN OF CONTROL SYSTEMS

Course code : 15 ME 4161 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 3115 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand time response design and Digital control	c	2
CO-2	Study different plots like Bode plot, polar plot, Nyquist plot etc.	c	2
CO-3	Understand Modern control systems	c	2
CO-4	Understand Linear control systems	c	2

SYLLABUS:

Time response design: Routh-Hurwitz test, relative stability, Root locus design, construction of root loci, phase lead and phase-lag design; Frequency response design: Bode, polar, Nyquist, Nichols plot, lag-lead compensator, time delay, process plant response curve, PID controller design; Digital control: Sampling process, sample and hold, analog to digital converter, use of z-transform for closed loop transient response, stability analysis using bilinear transform and Jury method, digital control design using state feedback; Modern control: state space model, controllability, observability; pole placement by state feedback, observer based control; Non-Linear Control System: Common non-linear systems, system analysis by phase plane method, stability of non-linear system, stability analysis by describing function method, Liapunov's stability criterion, Popov's stability criterion

Reference Books:

1. K. Ogata, "Modern Control Engineering", Prentice Hall India (2002).
2. Gene F. Franklin, J. D. Powell, A E Naeini, "Feedback Control of Dynamic Systems", Pearson (2008).
3. John Van De Vegte, "Feedback Control Systems", Prentice Hall (1993).
4. Thomas Kailath, "Linear Systems", Prentice Hall (1980).
5. Alok Sinha, "Linear Systems: Optimal and Robust Control", Taylor & Francis (2007).
6. Brian D. O. Anderson and John B. Moore, "Optimal Control: Linear Quadratic Methods", Dover Publications (2007).
7. K. Ogata, "Discrete-Time Control Systems", PHI Learning (2009).
8. H.K. Khalil, "Nonlinear Systems", Prentice Hall (2001).

SMART MATERIALS FOR MECHATRONIC APPLICATIONS

Course code : 15 ME 4162 **L – T – P:** 3 - 0 - 0

Pre Requisite : 15 ME 2105 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand applications of smart materials	c	2
CO-2	Design of smart actuation and control systems	b	2
CO-3	Application of piezoelectric actuators	c	2
CO-4	Know the future applications of smart materials	c	2

SYLLABUS:

Smart materials and their application for sensing and actuation, Piezoelectric materials: Constitutive equations of piezoelectric materials, Piezoelectric actuator types, Control of piezoelectric actuators, Applications of piezoelectric actuators for precise positioning and scanning; Shape memory alloys (SMA): Properties, Shape memory effects, Pseudo-elasticity in SMA, Design of shape memory actuator, Smart actuation and control; Electro-active polymers (EAPs): Ionic polymer metal composites (IPMC), Conductive polymers, Carbon nanotubes, Dielectric elastomers, Design & control issues for EAP actuators, Applications of EAP for biomimetic, tactile display and medical devices; Magnetostrictive materials: Basics of magnetic properties of materials, magnetostriction: constitutive equations, types of magnetostrictive materials, Design & control of magnetostrictive actuators, Applications of magnetostrictive materials for active vibration control; Future applications trends of smart materials and smart materials based actuator technology.

Reference Books:

1. Jose L. Pons, Emerging Actuator Technologies, A Micromechatronics Approach, John Wiley & Sons Ltd, (2005).
2. Ralph Smith, "Smart Material Systems: Model Development", SIAM, Society for Industrial and Applied Mathematics, (2005).
3. F. Carpi, D. De Rossi, R. Kornbluh, R. Pelrine, P. Sommer-Larsen, "Dielectric Elastomers as Electromechanical Transducers", Elsevier, Hungry, (2008).
4. Y. B. Cohen, "Electroactive Polymer (EAP) Actuators as Artificial Muscles Reality", Potential and Challenges, SPIE press, USA, (2004).

FRACTURE MECHANICS

Course code : 15 ME 3253 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 3112 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand Crack growth and fracture mechanics	c	2
CO-2	Development of stress field equations in fracture mechanics	a	2
CO-3	Know the various methods for evaluating stress intensity factors	c	2
CO-4	Understand how to perform fracture toughness testing	b	2

SYLLABUS:

Spectacular failures that triggered the birth of fracture mechanics, Modes of loading, Classification as LEFM and EPFM, Crack growth and fracture mechanisms, Energy release rate, Resistance, Griffith Theory of fracture, Extension of Griffith Theory by Irwin and Orowan, R-Curve, Pop-in phenomena, Crack branching. Necessary and sufficient conditions for fracture, Stress and Displacement fields in the very near and near-tip fields, Westergaard, Williams and Generalised Westergaard solutions, Influence of the T-stress and higher order terms, Role of photoelasticity on the development of stress field equations in fracture mechanics, Equivalence between SIF and G, Various methods for evaluating Stress Intensity Factors, Modeling plastic zone at the crack-tip, Irwin and Dugdale models, Fracture toughness testing, Fedderson's residual strength diagram, Paris law, J-integral, HRR field, Mixed-mode fracture, Crack arrest methodologies.

Text books:

1. D. Broek, "Elementary Fracture Mechanics".
2. T. L. Anderson, "Fracture Mechanics: Fundamentals and Applications

Reference Books:

1. Prashant Kumar "Elements of Fracture Mechanics", Tata Mcgraw Hill
2. K. R. Y. Simha, "Fracture Mechanics for Modern Engineering Design", Universities Press (India) Limited, (2001)
3. R. W. Hertzberg, "Deformation and fracture mechanics of engineering materials".
4. G. Atkins & Y.-W. Mai, "Elastic and Plastic Fracture".
5. J. F. Knott, "Fundamental of Fracture Mechanics".

MECHANICAL VIBRATIONS

Course code : 15 ME 4163 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 1001 **Credit :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand and analyze free and forced vibrations	b	2
CO-2	Understand Torsional vibrations	c	2
CO-3	Understand principle modes of vibrations	a	2
CO-4	Understand Mutli-Degree of freedom systems	c	2

SYLLABUS:

Fundamentals of Vibration:- Introduction, Definitions, vector method of representing Harmonic motions, Addition of two simple Harmonic motion of the same frequency, Beats phenomenon.

Undamped Free Vibrations of single Degree of freedom systems:- Introduction, Derivations of differential equations, solution of differential equation, Torsional vibrations, Equivalent stiffness of spring combinations, Energy method.

Damped free vibrations of single degree of freedom systems:- Introduction, Different types of damping, Free vibrations with viscous damping, Logarithmic Decrement, Viscous dampers, Coulomb damping.

Forced vibrations of single degree of freedom systems:- Introduction, Forced vibrations with constant Harmonic excitation, Forced vibration with rotating and reciprocating unbalance, forced vibrations due to excitation of the support,Vibration isolation and Transmissibility, Critical speed of a light shaft having a single disc without damping, Vibration measuring instruments.

Two Degrees of Freedom systems:- Introduction, principal modes of vibration, other cases of simple two degrees of freedom systems, combined rectilinear and angular modes, undamped forced vibrations with harmonic excitation, undamped dynamic vibration absorber, centrifugal pendulum absorber.

Multi-Degree of freedom systems – Exact analysis:- Introduction, Free vibrations – Equations of motion, co-ordinate coupling, Eigen values and Eigen vectors.

Text Books:

1. Leonard Meirovitch,"Fundamentals Of Vibrations", 1st edition , TataMcGrawHill,(2001)
2. G.K.Grover, "Mechanical Vibrations", 7th Edition ,Neem Chand & Bros.

Reference Books:

1. W.T.Thomson "Mechanical Vibrations", Pearson education, 2nd Edition.
2. S.S.Rao , "Mechanical Vibrations", Pearson education, 4th edition.
3. J. P. Den Hartog, "Mechanical Vibrations", 1st Edition, Dover Publications.

PRODUCT DESIGN

Course code : 15 ME 4164 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 3112 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand design models and product life cycle	c	2
CO-2	Understand concept to Design for Manufacturing	c	2
CO-3	Understand concept to Design for Assembly	c	2
CO-4	Understand concept to Design for environment and design for sustainability	c	2

SYLLABUS:

Design methodology and design philosophy- types of designs, design models, concurrent engineering, product life cycle. Design Teams - Organizations & product Planning. Need Analysis & Scope- mission statement, customer study, Kano diagram. Establishing Product Function- functional decomposition, FAST and SOP, function structure. Product Tear down reverse engineering. Product Specifications- QFD. Generation and evaluation of concepts – TRIZ, Decision matrix etc. Embodiment design- product architecture, configuration, parametric design, systems approach and other consideration of embodiment design, Design for Manufacturing, Design for Assembly, Design for environment, Design for sustainability, Industrial Design - aesthetics and ergonomic aspects of product design. Value Engineering. Failure mode and effects analysis.

Text Books:

1. Kevin Otto and Kristin Wood, " Product design"- Pearson, (2004).
2. David G. Ullman, "The Mechanical Design Process" - McGraw Hill, (2003).
3. George E. Dieter, " Engineering Design" - McGraw Hill, (2000).
4. Karl T. Ulrich and Steven D. Eppinger," Product Design and Development" TataMcGraw Hill, (2007).

Reference Books:

1. Singleton W T "An Introduction to Ergonomics" WHO Generava (1978).
2. McCormic E J and Sansers W "Human Factors in Engg" McGraw Hill (1993).
3. Eirich and Robert "Human Computer Dialogue Design" New York Elsevier, (1986).
4. Paul J G "Form, Function and Design" Dover Publication (1994).
5. Kurt Rowland, "The Development of Shape" Ginn and Company (1994).
6. James F Thorpe, "Mechanical Systems Components". Allyn and Bacon, Boston (1989).

FLEXIBLE MANUFACTURING SYSTEMS

Course code : 15 ME 4165 **L – T – P:** 3 - 0 - 0

Pre Requisite : 15 ME 3113 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand Group Technology Techniques	c	2
CO-2	Understand CAPP techniques	c	2
CO-3	Understand FMS	c	2
CO-4	Understand AGV and ASRS systems	c	2

SYLLABUS:

Group Technology: concept of part family, parts classification and coding, coding structure, MICLASS, OPITZ, benefits of GT. Process planning: Types of process planning; Manual, generative and ccomputer aided process planning (CAPP), computer aided inspection and reverse engineering. CNC part programming: computer aided part programming for Fanuc controller. FMS: introduction to FMS, types of manufacturing, FMS components, FMS layouts, types of FMS : flexible manufacturing cell, flexible turning cell, flexible transfer line, flexible machine systems ,benefits of FMS. Integrated material handling-AGV: working principle and benefits, Automatic Storage and Retrieval Systems (ASRS). CMS: Introduction to cellular manufacturing, concept of group machining, terminologies, cell characteristics, applications, benefits, factors influencing success of cellular manufacturing.

References:

1. Groover, M, "CAD/CAM". First edition. Delhi: Pearson Education, (2003).
2. Lee, Kunwoo, "Principles of CAD/CAM/CAE". 1st edition. Reading, Mass: Prentice Hall, (1999).
3. Rao, P. N. "CAD/CAM: Principles and Applications". 3rd edition. New Delhi: Mcgraw-Hill Education, (2010).
4. Zeid, Ibrahim, and R. Sivasubramanian. "CAD/CAM: THEORY and PRACTICE" Special Indian Edition. 2nd edition. New Delhi: Tata McGraw Hill Education, 2009.
5. S.K.Sinha, "NC Programming", I Edition, Galgotia Publications Pvt. Ltd (2001)
6. Shotbolt, "Metrology for Engineers, McGraw Hill, (1990).

Software's used:

1. Master CAM
2. Edge CAM

REVERSE ENGINEERING AND RAPID PROTOTYPING

Course code : 15 ME 4166 **L – T – P :** 3 - 0 - 0

Pre Requisite : NIL **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Analyze the need of reverse engineering	a	2
CO-2	Understand working principles of RP techniques	c	2
CO-3	Understand Rapid tooling and RP case studies	c	2
CO-4	Understand applications of RP techniques	c	2

SYLLABUS:

Reverse Engineering : Introduction, Need, RE taxonomy, RE types, RE Contact techniques, CMM, RE noncontact techniques, RE Applications. Definition of prototype, Types of Prototype, History (RP) systems, Classification of RP Systems. Data processing for rapid prototyping, Liquid based techniques: Principle of operation, Machine details, Material, Process details of SLA, SGC, SCS, SOUP, two layer beams and applications, Solid based techniques: Principle of operation, Machine details, Material, Process details LOM, FDM, PLT, MJM, MEM and applications, Powder based techniques: Principle of operation, Machine details, Material, Process details of SLS, 3DP, LENS, DSPC, MJS, EBM and applications. Rapid tooling and RP case studies: Introduction, Classification of RT routes- RP of Patterns, Soft tooling, production and bridge tooling, Aerospace Industries, Automotive Industries and Bio Medical application, Case Studies: Wind Tunnel Testing with Rapid Prototyped Models, RP applied to investment casting. integration of reverse engineering and rapid prototyping.

Text Book:

1. Karunakaran K.P,Vijay P Bapat, Ravi B "Rapid Prototyping And Tooling", Rapid Prototyping Cell, IIT-Mumbai.
2. Pham D T and Dimov S S, "Rapid Manufacturing", Verlag, (2001).
3. Paul F Jacobs, "Stereo lithography and other RP&M Technologies", SME, (1996).
4. ElancheZhian C ,Sunder Selwyn T,Shanmuga Sundar G "Computer Aided Manufacturing", Laxmi Publications
5. Ali K Kamrani "Rapid Prototyping: Theory And Practice" Publisher: Springer.

GENERAL ELECTIVES

CONDITION MONITORING AND FAULT DIAGNOSIS

Course code :15 ME 4167 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 GN 1003 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand types of maintenance	c	2
CO-2	Understand Equipment downtime and breakdown analysis	c	2
CO-3	Perform Equipment health monitoring	c	2
CO-4	Perform and analyze vibration characteristics	c	2

SYLLABUS:

Productivity, Quality circle in Maintenance, Reliability, Reliability assurance, Maintainability vs. Reliability.Failure analysis, Equipment downtime analysis, breakdown analysis.

Maintenance type, Breakdown maintenance, Corrective maintenance, Opportunity maintenance, Routine maintenance, Preventive and predictive maintenance, Condition based maintenance systems, Design-out maintenance.

Equipment health monitoring, Signals, Online & off-line monitoring, Visual & temp. Monitoring, Leakage monitoring, Lubricant monitoring and sensors.

Ferrography, Spectroscopy, Crack monitoring, Corrosion monitoring, thickness monitoring. Noise/sound monitoring, Smell/Odour monitoring, Thermography and sensors.

Vibration-characteristics, Causes of vibrations, identification, measurement of machine vibration. C.M.of lubes and hydraulic systems, C.M. of pipe lines, Selection of C.M.techniques Advantages vibration signature, fault diagnosis.

Text Books:

1. Collacott, R.A., Mechanical Fault Diagnosis and Condition Monitoring, Chapman & Hall, London, (1982).
2. John S. Mitchell, Introduction to Machinery Analysis and Monitoring, Penn Well Books, Penn Well Publishing Company, Tulsa, Oklahoma, (1993).

Reference Books:

1. Nakra, B.C. Yadava, G.S. and Thuested, L., "Vibration Measurement and Analysis", National Productivity Council, New Delhi, (1989).
2. Pox and Zenkins, "Time Series Analysis".
3. A.H. Search, "Vibration and Time Series Analysis".

EXPERIMENTAL STRESS ANALYSIS

Course code : 15 ME 4168 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 2106(STRENGTH OF MATERIALS) **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand three-dimensional stress strain relations	c	2
CO-2	Understand Brittle coatings	c	2
CO-3	Understand moiré methods	c	2
CO-4	Understand photo elasticity	c	2

SYLLABUS

Introduction: Theory of Elasticity, Plane stress and plane strain conditions, Compatibility conditions. Problems using plane stress and plane strain conditions, Three-dimensional stress strain relations.

Strain Measurement Methods: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits

Brittle coatings: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.

Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, the displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.

Photo elasticity: Photo elasticity – Polariscope – Plane and circularly polarized light, Bright and dark field setups, Photo elastic materials – Isochromatic fringes – Isoclinics

Three dimensional Photo elasticity: Introduction, locking in model deformation, materials for three-dimensional photo elasticity, machining cementing and slicing three-dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear difference method in three dimensions, applications of the Frozen-stress method, the scattered light method.

Text books:

1. Dally and Riley "Experimental stress analysis",Mc Graw-Hill
2. Timoshenke and Goodier Jr "Theory of Elasticity"

References:

1. LOVE .A.H "A treatise on Mathematical theory of Elasticity"
2. Frocht "Photo Elasticity"

ADVANCED MECHANISMS DESIGN

Course code : 15 ME 4169 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 2209 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Kinematic analysis of mechanisms	c	2
CO-2	Perform path curvature theory	c	2
CO-3	Synthesis of mechanisms	c	2
CO-4	Understand spatial mechanism and robotics	c	2

SYLLABUS:

KINEMATIC ANALYSIS

Review of fundamentals of kinematics - Mobility analysis - Formation of one D.O.F multiloop kinematics chains - Network formula - Gross motion concepts. Position analysis – Vector loop equations for four bar, slider crank, inverted slider crank – Geared five bar and six bar linkages. Analytical method for velocity and acceleration analysis - Four bar linkage jerk analysis – Plane complex mechanisms.

PATH CURVATURE THEORY

Fixed and Moving centrodes, inflection points and inflection circle, Euler Savary equation, Graphical constructions – Cubic of stationary curvature.

SYNTHESIS OF MECHANISMS

Type synthesis – Number synthesis – Associated linkage concept. Dimensional synthesis – Function generation, path generation, motion generation. Graphical methods. Cognate linkage – Coupler curve synthesis, design for six bar mechanisms. Algebraic methods. Application of instant centre in linkage design. Cam mechanism – Determination of optimum size of Cams.

DYNAMIC OF MECHANISMS

Static force analysis with friction – Inertia force analysis – combined static and inertia force analysis. Shaking force, Kinetostatic analysis. Introduction to force and moment balancing of linkages.

SPATIAL MECHANISM AND ROBOTICS

Kinematic analysis of spatial RSSR mechanism – Denavit-Hartenberg parameters. Forward and inverse kinematics of robotic manipulators

Text Books:

1. Sandor G.N. and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, (1984).
2. Shigley J.E., and Uicker J.J., "Theory of Machines and Mechanisms", McGraw Hill, (1995).

References:

1. Amitabha Ghosh and Ashok Kumar Mallik, "Theory of Mechanism and Machines", EWLP,

Delhi, (1999).

2. Nortron R.L., "Design of Machinery", McGraw Hill, (1999).

3. Kenneth J.Waldron, Gray L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons,(1999).

COMPUTATIONAL FLUID DYNAMICS

Course code : 15 ME 4170 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 2104 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand numerical methods	a	2
CO-2	Apply time integration methods	c	2
CO-3	Understand numerical grid generation and mapping	c	2
CO-4	Apply Navier Stokes Equations	c	2

SYLLABUS

INTRODUCTION: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description;

CLASSIFICATION AND OVERVIEW OF NUMERICAL METHODS: Classification, parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods;

FINITE DIFFERENCE TECHNIQUE: Finite difference and volume methods; Taylor series expansion; boundary layer treatment;

METHODS OF SOLUTION: Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform;

TIME INTEGRATION METHODS: Single and multilevel methods; Applications to transient conduction and advection-diffusion problems;

NUMERICAL GRID GENERATION: Numerical grid generation; basic ideas; transformation and mapping;

NAVIER-STOKES EQUATIONS: Explicit and implicit methods; SIMPLE type methods; fractional step methods;

TURBULENCE MODELING: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

TEXT BOOKS:

1. C. Hirsch "Numerical Computation of Internal and External Flows", Vols. I & II, John Wiley & Sons (2004).

2. H. K. Versteeg & W. Malalasekera "An Introduction to Computational Fluid Dynamics", Longman Scientific & Technical (1995).

REFERENCE BOOKS:

1. J. C. Anderson, D. A. Tannehil and R. H. Pletcher "Computational Fluid Mechanics and Heat Transfer" , Taylor & Francis publications, USA (1997).

2. T. K. Sengupta "Fundamentals of CFD", Universities Press (2004).

REFRIGERATION & AIR-CONDITIONING

Course code : 15 ME 4171 **L – T – P :** 3 - 0 - 0

Pre Requisite : 15 ME 2210 **Credits :** 3

Mapping of course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO-1	Understand working principle of air refrigeration system	c	2
CO-2	Understand vapour compression and absorption systems	c	2
CO-3	Understand working of steam jet refrigeration system	c	2
CO-4	Perform Air-conditioning load calulations	b	2

SYLLABUS

INTRODUCTION TO REFRIGERATION: Necessity and applications, unit of refrigeration and COP, methods of refrigeration.

AIR REFRIGERATION: Reversed Carnot Cycle, Bell Coleman cycle, Advantages and disadvantages of air refrigeration, Open and Dense air systems, Actual air craft refrigeration system, types of systems.

REFRIGERANTS: Nomenclature, Desirable properties, common refrigerants used, Eco friendly refrigerants, ODP.

VAPOUR COMPRESSION REFRIGERATION: Working principle, Components, Simple vapour compression refrigeration cycle, Effect of condenser, evaporator pressure, sub cooling and super heating, Multi pressure systems, Use of p–h charts.

SYSTEM COMPONENTS: Compressors, Condensers, Evaporators, Expansion devices.

VAPOUR ABSORPTION SYSTEM: COP, NH3 - water system, Li - Br, H2O system, Three fluid absorption system.

PRODUCTION OF LOW TEMPERATURE: Cascade system, Production of Solid CO2.

STEAM JET REFRIGERATION SYSTEM: Principle, application, merits and demerits.

INTRODUCTION TO AIR CONDITIONING: Psychrometric properties, Heat loads, SHF, Ventilation, Infiltration, Human comfort and Effective temperature, Comfort air conditioning, Industrial air conditioning and requirements, Air conditioning load calculations.

AIR CONDITIONING SYSTEMS: Classification, RSHF, ASHF, ESHF & ADP, filters, grills and registers, deodorants, fans and blowers.

TEXT BOOKS:

1. Stoecker & Jones "Refrigeration and Air conditioning"
2. Jordon and Priester, "Refrigeration and Air Conditioning", Prentice Hall of India Pvt. Ltd., New Delhi.

REFERENCE BOOKS:

1. Dossat. , Thomas J. Horan "Principles of Refrigeration".
2. Manohar Prasad "Refrigeration and Air conditioning", New Age International (P) Ltd. Pub.
3. Billy C. Langley "Heating, Ventilating, Air-Conditioning and Refrigeration", Prentice Hall

DEPARTMENT OF PETROLEUM ENGINEERING

GEOLOGY FOR PETROLEUM ENGINEERS

Course code : 15 PE 2103 L-T-P: 3-0-2

Pre Requisite : NIL **Credits :** 4

Mapping of the course outcomes with student's outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the basics of geology, types of rocks and minerals, sedimentary structures, sedimentary rocks and its significance	a	2
CO 2	Demonstrate the sequence stratigraphy, composition of petroleum and natural gas, Types of organic matter.	a	2
CO 3	Explain the source rocks, Reservoir rocks, generation, migration of hydrocarbons	a	2
CO 4	Explain the accumulation, traps and trapping mechanisms.	a	2
CO 5	Demonstrate the types of rocks based on their physical nature and chemical nature and case studies	b	3

SYLLABUS:

The earth - origin, exterior and interior of the earth

Mineral and rocks - introduction to minerals, introduction to igneous, sedimentary and metamorphic rocks

Sedimentary structures - flume experiment; laminar and turbulent flow, bedload, traction and suspension sedimentation - erosional structures, depositional and post depositional structures

Sedimentary rock textures and its significance - shape, size, sorting, maturity

Lithification and diagenesis :early and late diagenesis- compaction – cementation - porosity and permeability evolution

Classification and description of sedimentary rocks: polymictic, oligomictic, infraformational - extraformation, othoconglomerate, paracongiomerate - arenaceous rocks: arenite, arkose, lithic arenite, greywack - argillaneous rocks: limestone and dolomite - evaporite rocks: gypsum, anhydrite, halite

Concept of facies and sedimentary environments: facies concept - lacustrine environment

Fluvial environment - deltaic environment - linear clastic shore line/barrier island system - carbonate platform - deep sea basin.

Sequence stratigraphy: eustasy, sea level, subsidence and tectonics - system tract and sequence boundary - seismic facies and sequence analysis

Petroleum geology: Source rocks, Reservoir rocks - physical properties of rocks - clastic reservoir rocks - carbonate reservoir rocks, Composition of petroleum and natural gas - oil filed waters, Origin and occurrence of petroleum - theory of origin: organic and inorganic - type of organic matter - production, accumulation and reservation of organic mater -

source rock analysis, Generation, migration and accumulation, Trapping mechanism, types of petroliferous basins - global geologic history and distribution of hydrocarbon resources - sedimentary basin of india - hydrocarbon resources and reserves

Text Books:

1. A. I. Levorsen "Geology of petroleum" hardback edition, (1967)
2. R C Selley,"Elements of petroleum Geology", 2nd Ed , Academic Press, (1985).

Reference Books:

1. H. Blatt, G. Middleton, and R. Murray "Origin of sedimentary rocks", 2nd Ed., Prentice-Hall, Inc., (1980).
2. G. D. Hobson "Developments in Petroleum Geology", Vol. 1 & 2, Elsevier Science Ltd, (1977).
3. Boggs, S. Jr., Merill "Principles of Sedimentology and Stratigraphy" Publ. Co., (1987).
4. A.D. Miall, "Principles of Sedimentary Basin Analysis", Springer Verlag, (1990).
5. H.G. Reading, "Sedimentary Environments and Facies", Blackwell Science, (1996).

DRILLING ENGINEERING & WELL COMPLETION

Course code: 15 PE 2104 **L-T-P:** 2-2-2

Pre Requisite: NIL **Credits:** 4

Mapping of the course outcomes with student's outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the role of drilling engineers, well planning, Rotary drilling method, Apply the general calculation to rig selection.	e	2
CO 2	Ability to design the casing string and drill string.	e	3
CO 3	Understand types of drilling fluids, its characteristics and its applications, determination of drilling fluid properties, ability to design the rig hydraulics, understanding the cementing operations	e	3
CO 4	Understanding the working of well equipment, ability to design well completion program, and design well control problems.	e	2
CO 5	Perform drilling fluid calculations and rheology of the drilling fluids	b	2

SYLLABUS:

Well Planning: Introduction to oil well drilling, Drilling planning approaches.

Rotary Drilling Method: Rig parts, selection and general layout

Drilling Operations & Practices: Hoisting, circulation, Rotation, power plants and Power transmission, Rig wire line system handling & storage.

Casing Design: Design of casing string, Liner design and setting, Casing landing practices, Buckling criteria and Calculation of well head loads. Casing while drilling.

Drill String: Parts function and design.

Drill Bits: Classification and design criteria of drag, rotary, roller, diamond and PDC bits.

Well Problems and Solutions: Fatigue failure, Pipe sticking, Lost-circulation, Sloughing shale, Swabbing, surge, gas cap drilling, Blow out and kick control.

Oil Well Fishing: Fish classification, tools and techniques.

Drilling Fluids: Clay chemistry and its application to drilling fluids, Types of clays, hydration, flocculation, aggregation and dispersion.

Classification, Types and applications of Drilling Fluids: Water based, oil based, emulsion based, polymer based, Surfactant based, Foam based and Aerated drilling fluids.

Drilling Fluid Characteristics: Basic functions, properties, maintenance and treatments of drilling fluids, Drilling fluid calculations.

Rotary Drilling Hydraulics: Rheology of drilling fluids, Pressure loss calculations and Rig hydraulics.

Cementing, Cements & cement slurry: Objectives of cementing, oil well cements, Classification of cement, Slurry design, Slurry additives, Factors influencing cement slurry design, Cementing equipment's.

Cementing Methods: Primary cementing, Stage cementing, Liner cementing, Plugging, Squeeze Cementing techniques in practice. Deep well cementing, Characteristics of good quality cementation.

Well Equipment: Well Head Equipment's, Christmas tree, valves, hangers, flow control devices, packers, tubular and flow lines.

Well Completion Design: Perforating Oil & Gas Wells - Conventional and Unconventional techniques viz. through tubing and tubing conveyed underbalanced perforating techniques, type size and orientation of perforation holes.

Designing Gravel Pack for Sand Control: Sand control techniques, Formation Sand Size analysis, optimum gravel sand ratio, gravel pack thickness, gravel selection, gravel packing fluid & gravel pack techniques.

Text Books:

1. Applied Drilling Engineering, Adam T. Bourgoyne Jr., Keith K. Millheim, Martine E. Chenevert and F. S. Young Jr., Society of Petroleum Engineers, (1991)
2. Well Engineering and Construction, Hussain Rabia, Entrac Consulting, (2002).

Reference Books:

1. Neal Adams and Tommie Charrier, "Drilling Engineering: A Complete Well Planning Approach" PennWell Pub. Co., (1985)
2. Economides, M. J., "Petroleum Well Construction" John Wiley & Sons, (1998).
3. Formulas and Calculation for Drilling, Production and workover, Norton J. Lapeyrouse, 2nd Edition, Gulf Publishing, (2002).
4. Heriot Watt, "Drilling Engineering Handbook".

PETROLEUM EXPLORATION METHODS

Course code: 15 PE 2105 **L-T-P :** 2-2-2

Pre Requisite: 15 PE 2103 **Credits :** 4

Mapping of the course outcomes with student's outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Ability to apply the geological methods to identify the petroleum reserves.	a	2
CO 2	Ability to apply the gravity and magnetic survey to identify the petroleum reserves.	a	2
CO 3	Ability to apply Seismic survey to identify the petroleum reserves,	a	2
CO 4	Understand the special exploration techniques.	a	1
CO 5	Perform the simulation on the tool used for the seismic interpretation to identify the hydrocarbon reservoirs	b	3

SYLLABUS:

Geological Methods

Surface indications of subsurface oil and gas accumulations. Oil accumulation parameters. Regional structural plan and local structures. Time of accumulation vis-avis time of oil generation.

Geochemical methods of prospecting: Soil geochemical surveys; Source rock characterization and Hydro geochemistry as a tool for oil exploration. Development Geology. Theoretical principles of prognostication of hydrocarbon reserve. Role of plane tectonics in Hydrocarbon accumulation onshore and offshore. Sequence of geological methods of oil exploration.

Geophysical Methods

Magnetic Method: The geomagnetic field, Magnetic anomalies. Magnetic survey instrument, Field method of magnetic surveys. Reduction of magnetic data, diurnal and geomagnetic correction. Interpretation of magnetic anomalies. Magnetic response of simple geometric shapes. Application of magnetic survey.

Gravity Method: Units of gravity, gravity measuring instruments, gravity survey, gravity anomalies, Gravity data reduction, Drift, Latitude, Elevation, and Free-air correction. Free-air and Bouguer anomalies. Gravity response of simple geometric shapes. Interpretation of gravity anomalies and application of gravity methods.

Seismic Methods: Geometry of refracted ray path, planar interface. Two layer case with horizontal interface. Methodology of refraction profiling. Field surveys arrangements. Recording instruments and energy source. Corrections applied to refraction data. Interpretation of refraction data. Application of seismic refraction method, Passive seismic

Advanced methods: Geometry of reflected ray path, planar interface, and single horizontal reflector. Importance of seismic reflection survey over seismic refraction survey technique. Common depth point (CDP) profiling and stacking. 2-D data processing and interpretation of reflection data. Introduction to 3-D data acquisition, processing and interpretation.

Applications of seismic method in oil exploration, Concept of 4-D seismic and its application.

Text Books:

1. Philip Kearey, et.al., "An Introduction to Geophysical Exploration", Wiley publications, (2002)
2. Applied geophysics, WM W. M. Telford, L.P Geldart, R.E sherief, Cambridge university press, (1990)

Reference Books:

1. Milton B. Dobrin, and Carl H. Savit, "Introduction to Geophysical Prospecting", 4th Ed., McGraw Hill, (1988)
2. M.B. Ramachandra Rao, "Outlines of Geophysical Prospecting: A Manual for Geologists", EBD Educational Pvt Ltd., (1993)
3. John Milsom and Asger Eriksen, "Field Geophysics" 4th Ed., John Wiley, 2011.
4. J. Guillemot, "Elements of Geology: Oil and Gas Exploration Techniques", Technip, (1991)

RESERVOIR ENGINEERING

Course code : 15 PE 2206 **L-T-P:** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of the course outcomes with student's outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the role of reservoir engineers, rock and fluid properties, driving mechanism, Apply the PVT analysis to reservoir fluids. Estimate the rock and fluid properties.	e	2
CO 2	Ability to apply the fluid flow equation to the porous media for different conditions, Ability to apply the GMBE to different driving mechanisms,	e	2
CO 3	Ability to apply the decline curve analysis during production, Ability to apply water influx calculations to the reservoirs. And case studies	e	3
CO 4	Understand the reservoir filed development, ability to apply the displacement techniques for oil recovery.	e	1
CO 5	Perform the experiments to identify the reservoir rock and fluid properties	b	2

SYLLABUS:

Introduction to reservoir engineering

Reservoir fluid properties: Characteristics of crude oil and natural gas, classification of crude and its physicochemical properties.

Reservoir Rock Properties: Porosity and permeability determination, combination of permeability in parallel & series beds, porosity permeability relationship, fluid saturation determination and significance, effective and relative permeability, wettability, capillary pressure characteristics, measurements and uses. Coring and Core Analysis

PVT Analysis: Phase behavior of hydrocarbon system, ideal & non ideal system, equilibrium ratios, reservoir fluid sampling, PVT properties determination, different correlations and laboratory measurements, data reduction, evaluation and application.

Driving mechanisms: Reservoir drive mechanics and recovery factors

Flow of Fluids through Porous Media: Darcy's law, single and multiphase flow, linear, radial & spherical flow, steady state & unsteady state flow, GOR, WOR equations

Special type of flow: Flow through fractures, Water and gas coning.

Reserve estimation: Resource & Reserve concept, Different reserve estimation techniques: Volumetric, MBE, decline curve analysis. Performance prediction of depletion drive, gas cap drive, water drive and combination drive.

Water influx calculations: steady and unsteady state models

Introduction to oil & gas field development: Rational development plan, Rate and order of drilling well, well spacing & pattern, selection of development scheme, economic aspect of development of oil and gas fields.

Immiscible Displacement processes: Theory & practices- fractional flow of water, Buckley Leverette treatment of fractional flow and frontal advance equations, water flood performance.

Reservoir Management: Concepts, Components and Applications.

Text Books:

1. Tarek Ahmed, "Reservoir Engineering Handbook", Gulf Professional Publishing, 4th ed, (2010).
2. Nnaemeka Ezekwe, "Petroleum Reservoir Engineering Practice", Pearson Education, Inc, (2010).

Reference Books:

1. Benjamin Cole Craft, Murray Free Hawkins, and Ronald E. Terry, "Applied Petroleum Reservoir Engineering" by Prentice Hall, (1991).
2. LP Dake, "Fundamentals of Reservoir Engineering" shell learning and development, (1998).
1. Tarek Ahmed, Paul D. McKinney, "Advanced Reservoir Engineering" Gulf Professional Publishing , 4th ed, (2005).
3. BF Towler, "Fundamental Principles of Reservoir Engineering", SPE, (2002).
4. Heriot Watt, "Reservoir Engineering Handbook"
5. Abhijit Y. Dandekar, "Petroleum Reservoir Rock and Fluid Properties", CRC Press, (2013).

PROCESS HEAT TRANSFER

Course code: 15 PE 2208 **L-T-P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of the course outcomes with student's outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Ability to understand and solve conduction, convection problems	e	1
CO 2	Ability to understand and solve radiation evaporation problems	e	1
CO 3	Ability to design and analyze the performance of heat exchangers and evaporators	e	2
CO 4	Ability to design and analyze reactor heating and cooling system	e	3
CO 5	Apply the theoretical concepts to conduct various experiments of heat transfer practically and analyze the data.	b	3

SYLLABUS:

Introduction: Modes and laws of Heat transfer- Nature of heat flow, conduction, convection, natural and forced convection, radiation., thermal conductivity, Fourier rate equation, Steady state Heat conduction, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres, thermal contact resistance, plane wall: variable conductivity.

Unsteady state heat conduction Equation for one-dimensional conduction, Semi-infinite solid, finite solid. Lumped systems, heat transfer through fins.

Principles of heat flow in fluids: Typical heat exchange equipment, countercurrent and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer.

Heat transfer to fluids with phase change: Heat transfer from condensing vapors-Heat transfer to boiling liquids.

Heat Exchangers: Classification and type of heat exchangers, General design of heat exchange equipment-Heat exchangers-Condensers, boilers; Extended surface equipment, Heat transfer in agitated vessels-Scraped surface, Heat transfer in packed beds. Flow arrangement, overall heat transfer coefficient, Fouling factor, LMTD method of Heat exchanger analysis, correction, Heat exchanger Effectiveness - NTU method;

Evaporation: Principles, application and Equipment

Radiation: Introduction, Radiative Properties, concept of black, white and grey body, Laws of radiation, Stefan-Boltzmann's law; Lamberts cosine law, Kirchhoff's law, Planck's law, Wein's law, Radiation Heat Exchange Between Two Bodies: Shape factor, shape factor algebra, Heat Exchange by radiation between two finite parallel surfaces, Electrical analogy, solid angle and Radiation intensity, Heat exchange by radiation between two finite black and gray surfaces, Radiation shields, Error in temperature measurement.

Text Books:

1. W.L. McCabe, J.C Smith and Peter Harriott, "Unit Operations of Chemical Engineering", 7th Ed, McGraw-Hill, (2005).

2. Yunus A. Cengel and Afshin J. Ghajar "Heat and Mass transfer – Fundamentals and Applications" , 5th Ed., Mc Graw Hill, (2010).

3. R.C.Sachdeva, "Fundamentals of Engineering Heat and Mass Transfer", 4th Ed., New Age International Publishers Ltd. (2009).

Reference Books:

1. D.Q. Kern, "Process Heat Transfer", Tata- McGraw-Hill, (1997).

2. J.P. Holman, "Heat Transfer", 9th Ed, Tata McGraw-Hill, (2008).

3. N.Ozisik, "Heat Transfer - A Basic Approach" Mc Graw Hill.

4. K Ramakrishna & P K Sarma, "Introduction Heat and Mass Transfer" John Wiley.

CHEMICAL REACTION ENGINEERING

Course code: 15 PE 3109 **L-T-P:** 2-2-2

Pre Requisite: NIL **Credits:** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the kinetics and rate equations	e	1
CO 2	Design of reactors for single	e	2
CO 3	Design of reactors for multiple reactions	e	2
CO 4	Analyze the flow behavior of various reactors and kinetics of homogeneous reactions	e	2
CO 5	Apply the theoretical concepts to conduct various experiments on reactors practically and analyze the data.	b	2

SYLLABUS:

Basics of Kinetics: Introduction - kinetics of homogeneous reactions: concentration dependent & temperature dependent term of rate equation – searching for a mechanism - predictability of reaction rate from theory - molecularity and order of the reaction - elementary & non-elementary reactions - feasibility of a chemical reaction; Arrhenius - Collision, Transition State Theories; Interpretation of batch reactor data.

Kinetics of homogeneous reactions: Rate and equilibrium constant of 1st, 2nd, 3rd order irreversible Reactions. - 1st Order Reversible Reaction; Determination of the Rate Equation, Effect of Temperature on Reaction Rate. Displacement of Equilibrium: Le Chateller's Principle

Introduction to reactor design – ideal reactors

Design for single reactions- Introduction to reactor design- general discussion, symbols and relationship between CA and XA. Ideal reactors for a single reaction- Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors Size comparison of single reactors, Multiple- reactor systems, Recycle reactor, Autocatalytic reactions.

Design of reactor for multiple reactions: Design for single and multiple reactions - size comparison of single reactors for single reactions - Multiple Reactor system for single reactions; parallel - series and series - parallel reactions of first order

Heat effects: Temperature and pressure effects on single and multiple reactions.

Flow behavior of Reactors: Non - ideal flow: Residence time distribution studies: C, E, F and I curves, conversion calculations directly from tracer studies. Models for non-ideal flow - dispersion and tanks in series multi-parameter models

Modes of contacting different phases: Self mixing of single fluids, mixing of two miscible fluids, Introduction. Design for heterogeneous reacting systems.

Kinetics of heterogeneous chemical reaction: Kinetics and mechanism of heterogeneous catalytic reactions - models - evaluation and elimination of internal and external diffusional resistances - effectiveness factor; solid catalyzed reactions - heat effects - controlling resistance - rates of chemisorption - adsorption isotherms - rates of adsorption and desorption.

Text Books:

1. Octave Levenspiel, "Chemical Reaction Engineering", 3rd Ed., John Wiley & Sons, (1999).
2. H. Scott Fogler, "Elements of Chemical Reaction Engineering", 4th Ed., Prentice-Hall, (2005)
3. J. M. Smith, "Chemical Kinetics", 3rd Ed., McGraw Hill, New York, (1981).

Reference Books:

1. Ronald W. Missen, Charles A. Minas, Bradley A. Saville, "Introduction to Chemical Reaction Engineering and Kinetics", John Wiley & Sons.
2. Gilbert F. Froment and Kenneth B. Bischoff, "Chemical Reactor Analysis and Design" by John Wiley & Sons.

NATURAL GAS ENGINEERING & PROCESSING

Course code : 15 PE 3110 **L-T-P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand natural gas industry, properties of natural gas and their estimation, and importance of unconventional resources of natural gas.	e	1
CO 2	Ability to design gas compression system and flow measurement system	e	2
CO 3	Understand GGS, Storage, transportation of natural gas	e	1
CO 4	Understand the processing principles of natural gas, LPG, CNG, LNG.	e	1
CO 5	Apply the theoretical concepts to conduct various experiments on design of processing equipment by using the simulation tool	k	2

SYLLABUS:

Introduction: Composition of Natural Gas, Utilization of Natural Gas, Natural Gas Industry, Natural Gas Reserves, Types of Natural Gas Resources, Future of the Natural Gas Industry.

Properties of Natural Gas: Physical properties of natural gas and hydrocarbon liquids associated with natural gas.

Unconventional gas: Coal Bed Methane, Natural Gas Hydrate, Basin Centered Gas, Tight Gas Sands, Shale Gas; Current Technology for Shale Gas and Tight Gas Exploration and Production.

Gas Compression: Types of Compressors, Selection, Thermodynamics of Compressors, Compression calculations. Heat and Mass Transfer Principles and Applications in Natural Gas Engineering, Use of Mollier Diagrams.

Gas Flow Measurement: Process control and instrumentation in natural gas processing plants.

Gas Gathering, Transport and Storage: Gas Gathering System. Steady Flow in Simple Pipeline System, Steady State and unsteady State Flow in Pipelines, Solution for Transient Flow. Transmission of Natural Gas, Specifications. Underground Storage and Conservation of Natural Gas.

Natural Gas Processing: Field separation and oil absorption process, Refrigeration and low temperature processing, Liquefaction Process, Dehydration of Natural Gas, Sweetening of Natural gas and Sulphur recovery.

Processing principle of LPG, CNG systems, Conversion of gas to liquid - LNG: Production and Utilization; Issue and Challenges to Enhance Supply of Natural Gas.

Text Books:

1. Arthur J. Kidnay, William R. Parrish, Taylor and Francis, "Fundamental of Natural Gas Processing", (2006).

2. James G. Speight, "Natural Gas: A Basic Handbook", Gulf Publishing Company, (2007).

Reference Books:

1. Saeid Mokhatab, William A. Poe, James G. Speight, "Handbook of Natural Gas Transmission and Processing", Gulf Professional Publishing, (2006).
2. Ken Arnold, Maurice Stewart, "Surface Production Operations", Volume 2, 2nd Ed, Elsevier Science, (1989).
3. J. Leecraft, "Field Handling of Natural Gas", 4th Edition, PETEX, (2007).
4. Doug Elliot, J.C. Kuo, Pervouz Nasir, "Plant Processing of Natural Gas", 2nd Ed, PETEX, (2012).

PETROLEUM FORMATION EVALUATION

Course code : 15 PE 3111 **L-T-P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Ability to apply of SP LOG, Caliper log, Gamma ray log, NSG log, resistivity log, Focused resistivity log, Micro resistivity log to the formation evaluation	e	2
CO 2	Ability to apply the principles of Density log, Neutron log, sonic log, Cased hole logging, dip meter log, Image logging to the formation evaluation	e	2
CO 3	Ability to apply the NMR logging, production logging techniques, Mud logging, coring to the formation evaluation	e	2
CO 4	Ability to apply the interpretation techniques to identify the reservoir properties	e	2
CO 5	Apply the theoretical concepts to conduct various interpretation by using the simulation tool	k	3

SYLLABUS:

Introduction to well logging: Major components of well logging unit and logging setup; Classification of well logging methods.

Open-hole logging:

SP Log: Origen of SP, uses of SP log-Calculation of salinity of formation water, Shalyness-Factors influence SP log

Caliper log: Principle and application of caliper tool.

Gamma ray log: Principle of radioactivity - Uses of Gamma ray log - Determination of shalyness of formation. API counts - calibration of Gamma ray tool - statistical fluctuation - Time constant.

Natural Spectral Gamma ray log: Principle and application.

Resistivity log: Single point resistance log (SPR), Conventional Resistivity logs, Response of potential and gradient logs over thin and thick conductive and resistive formations, Limitations of conventional Resistivity tools, Focused resistivity log - Advantages of focused resistivity tools over conventional resistivity tools.

Micro Resistivity log: Conventional and focused micro Resistivity logs and their application.

Induction log: Principle of induction tool and the advantages, Criteria for selection of induction and lateral logging tool, Determination of true Resistivity of the formation, Resistivity index, Archie's equation.

Density log: Principle of density tool. Environmental corrections - Porosity determination, Tool calibration - Litho density log - Synthetic seismograms.

Neutron log: Principle and application of Neutron tool - Porosity determination.

Sonic log: Principle and application of Sonic log - Bore-hole compensation - Determination of primary and secondary porosity.

Cased-hole logging: Gamma ray spectral log. Neutron decay time log. Determination of fluid saturation behind casing; Cement bond log, Casing collar log, Depth control, Perforation technique; Free point locater and Plug setting, Casing inspection logs.

Advances in Well logging: Dip meter log, Image logs, Nuclear Magnetic resonance log.

Production logging: Solving production problems with the help of Fluid Density log, Temperature log, and Flow meter logs.

Direct Methods: Mud logging, coring – conventional and Sidewall coring, Core analysis

Interpretation: Quick look interpretation. Cross plots. Neutron- Density, Sonic- Density, Sonic-Neutron cross plots. Hingle plot, Mid plot, Correlation, Hydrocarbon reserve estimate

Text Books:

1. Edward J. Lynch, Harper & Row, "Formation evaluation", (1962).
2. Toby Darling, "Well logging and formation evaluation", Elsevier, New York, (2005).

Reference Book:

1. Hydrocarbon well logging recommended practice, Society of professional well log analysts, (1983).
2. Oberto Serra, Editions Technip, "Well Logging & Reservoir Evaluation", (2007).
3. Richard M. Batemons, "Open - Hole log analysis and formation evaluation", International Human Resources Development Corporation, Bostan, (1985).
4. Darwin V. Ellis, Julian M. Singer, "Well Logging for Earth Scientists", Springer, (2007).
5. Oberto Serra, "Fundamentals of Well Log Interpretation: The Acquisition of Data", Elsevier, (1984).
6. Oberto Serra, "Well Logging Handbook", Editions Technip, (2008).

PIPELINE ENGINEERING & TRANSPORTATION OF OIL AND GAS

Course code: 15 PE 3112 **L-T-P:** 2-2-2

Pre Requisite: NIL **Credits:** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the modes of transportation. Ability to design pipeline under the consideration of fluid flow	c	2
CO 2	Ability to design of pipeline under mechanical consideration. Understand Construction and Maintenance of pipelines	c	2
CO 3	Ability to design pigging system in a pipeline.	c	2
CO 4	Ability to design of offshore pipelines	c	2
CO 5	Apply the theoretical concepts to design pipeline surveying by using the simulation software and analyzing the data	k	3

SYLLABUS:

Mode of Transportation of petroleum products

Objective and scope: Objective and scope of pipeline as a means of fluid transportation with special reference to crude oil/gas/refined products, Economics of Pipeline transportation.

Design of Pipeline: Factors influencing oil, gas and refined products as pipeline design; Hydraulic surge and water hammer, specific heat of liquids, river crossing, pipe size and station spacing etc. Theory and different formulae of the flow of fluids in oil/gas pipelines, basic equations for the flow of fluids through pipes, different flow equations for laminar and turbulent flow of compressible and incompressible fluids (Newtonian); Introduction to the flow of Non-Newtonian fluids through pipes; multiphase flow and loop pipelines.

Pipeline mechanical design: Codes and standards, Location classification, Pipeline design formula, Expansion and flexibility, Joint design for pipes of unequal wall thickness.

Construction and Maintenance of pipelines, Route location survey, materials, project specifications, general equipment specifications (Pipes, valves and fittings), Installation of expansion loops and thermodymetric tapping plant.

Pigging, Pigging Technology: Pig launcher and receiver, intelligent pigging, types of pigs.

Corrosion protection and control: Design of cathodic protection system, Pipeline automation.

Hydrates, Wax & Scale - Formation and prevention - Crude conditioning and use of additives to improve flow conditions.

Offshore Pipeline: Design and control of Sag and Over bend; Description of stinger; and Riser, articulated stinger, construction of offshore pipeline, Method of underwater welding.

Text Books:

1. M. Mahitpour, H. Golshan and M.A. Murray, "Pipeline Design and Construction: A Practical Approach", 2nd Ed, ASME Press, 2007.

2. Henry Liu, "Pipeline Engineering", Lewis Publishers (CRC Press), 2003.

Reference Books:

1. George A. Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair", CRC Press, 2003.
2. E. Shashi Menon, "Pipeline Planning and Construction Field Manual", Gulf Professional Publishing, 2011.
3. E. W. McAllister, "Pipeline Rules of Thumb Handbook", 7th Ed, 2009.
4. E. Shashi Menon, "Liquid Pipeline Hydraulics", Mareel Dekker Inc., 2004.
5. Tian Ran Lin, Boyun Guo, Shanhong Song, Ali Ghalambor, Jacob Chacko, "Offshore Pipelines: Design, Insta llation, and Maintenance", Gulf publishers. 1st Ed, 2005.

MASS TRANSFER

Course code: 15 PE 3113 **L-T-P:** 2-2-2

Pre Requisite: NIL **Credits:** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the basic principles of mass transfer operations. Apply Fick's law of diffusion for measuring diffusivity coefficient on reaction systems.	e	1
CO 2	Apply equilibrium relations, basic principles of distillation, extraction, leaching operations.	e	2
CO 3	Understand the basic principles of adsorption, crystallization.	e	2
CO 4	Apply ion exchange principles to estimate affinity for separation of bio-products	e	2
CO 5	Apply the theoretical concepts to conduct various experiments practically and analyze the data.	b	3

SYLLABUS:

Diffusion and mass transfer – Mtass transfer operations & their applications. Molecular diffusion – Fick's law, steady state molecular diffusion in binary mixtures of gases, liquids and solids, diffusivity in gases and liquids, correlations; Mass transfer theories – Film mass transfer coefficients for the cases of equimolar counter diffusion and diffusion of one component (A) in stagnant component (B).

Interphase mass transfer – overall mass transfer coefficients. Equipment for gas – liquid contact - continuous and stage wise contact equipment, packed columns – Liquid distribution -Mass transfer coefficients in packed columns – Flooding in packed and plate columns – Ideal-plate – Murphree, point, plate and column efficiency – Comparison of packed and plate columns.

Absorption and Stripping – counter current and co-current isothermal absorption and stripping of single component – Operating Lines – Minimum flow rates – Determination of number of transfer units and height of a continuous contact absorbers. Multistage absorption and determination of number plates – absorption factor – Kremser – Brown equation.

Drying and Crystallization: Principles, Mechanisms and equipment

Distillation - Raoult's Law, Ideal Solution, X-Y and T-X-Y, P-X-Y Diagrams, Flash Vaporization and Condensation, Differential Distillation, Steam Distillation, Binary Distillation, McCable Thiele and Ponchon-Savarit Method, Total Reflux, Minimum and Optimum Reflux ratios, Design of Distillation Columns with Open Steam, Multiple Feeds, Side Streams and Partial Condensers, Approximate and Plate to Plate Calculations for Multi Component Distillation.

Solvent extraction - Liquid-Liquid Extraction, Extraction Equipment, Equilibrium Diagram, Choice of Solvent, Single Stage and Multiphase Countercurrent Extraction With/Without Reflux, Continuous Contact Extractors.

Leaching – Principles, Leaching Equipment and Equilibrium, Single and Multistage Cross Current and Counter Current Leaching

Adsorption and Desorption – Principle and mechanism

Text Books:

1. Robert E. Treybal, "Mass Transfer Operations" McGraw-Hill Education India Pvt.Ltd - New Delhi
2. E. L. Cussler, "Diffusion: Mass Transfer in Fluid Systems", Cambridge University Press

Reference Books:

1. Binay K. Dutta, "Principles of Mass Transfer and Separation Processes" by PHI Learing Publisher
2. Incropera and DeWitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons

ENVIRONMENT HAZARDOUS & SAFETY MANAGEMENT

Course code: 15 PE 3214 **L-T-P:** 2-2-2

Pre Requisite: NIL **Credits:** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand Health Hazards in Petroleum Production Refining and Utilization:	h	1
CO 2	Understand Safety System used in chemical and petroleum industry	h	1
CO 3	Understand Environment concepts in petroleum industry	h	1
CO 4	Case studies on the various EHS aspects in the hydrocarbon industry	h	3
CO 5	Apply the theoretical concepts to conduct various experiments practically and analyze the data.	b	2

SYLLABUS:

Health hazards in Petroleum Industry: Toxicity, Physiological, Asphyxiation, respiratory and skin effect of petroleum hydrocarbons, sour gases. Safety System: Manual & automatic shutdown system, blow down systems. Gas detection system. Fire detection and suppression systems. Personal protection system & measures. HSE Policies. Disaster & crisis management in Petroleum Industry. Environment: Environment concepts, impact on eco-system, air, water and soil. The impact of drilling & production operations on environment, Environmental transport of petroleum wastes. Offshore environmental studies. Offshore oil spill and oil spill control. Waste treatment methods.

Text Books:

1. John C. Reis, "Environmental Control in Petroleum Engineering", Gulf Publishing Company, (1996).
2. Oil Industry Safety Directorate (OISD) Guidelines, Ministry of Petroleum & Natural Gas, Government of India and Oil Mines Regulations-1984, Directorate General of Mines Safety, Ministry of Labor and Employment, Government of India.

Reference Books:

1. Guidelines for Process Safety Fundamentals in General Plant Operations Centre for Chemical Process Safety, American Institute of Chemical Engineers, (1995).
2. Dennis P. Nolan, "Application of HAZOP and What if Reviews to the Petroleum, Petrochemical and Chemical Process Industries", Noyes Publications, (1994).
3. Guideline for Process Safety Fundamentals in General Plant Operations, Centre for Chemical Process Safety, AIChE, (1995).

PETROLEUM PRODUCTION ENGINEERING

Course code: 15 PE 3215 **L-T-P:** 2-2-2

Pre Requisite: 15 PE 2206 **Credits:** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Ability to apply IPR, TPR, CPR to the all types of reservoirs.	e	2
CO 2	Ability to understand and design the SRP, ESP	e	2
CO 3	Ability to understand and design gas lift systems,	e	3
CO 4	Ability to understand and design hydraulic piston pumping, progressive cavity pumping, Plunger lift systems	e	3
CO 5	Apply the theoretical concepts to conduct various experiments practically and analyze the data.	k	3

SYLLABUS:

Introduction to Petroleum production system

Reservoir deliverability: Flow Regimes, Inflow Performance Relationship, Construction of IPR

Curves Using Test Points, Composite IPR of Stratified Reservoirs, Future IPR

Well bore performance: Introduction, Single-Phase Liquid Flow, Multiphase Flow in Oil Wells, Single-Phase Gas Flow, Mist Flow in Gas Wells, TPR curves

Choke performance: Sonic and Subsonic Flow, Single-Phase Liquid Flow, Single-Phase Gas Flow, and Multiphase Flow.

Well deliverability: Nodal Analysis, Deliverability of Multilateral Well

Artificial Lift Techniques: Working principles, design and maintenance

Sucker rod pumping, Electrical Submersible Pump, plunger lift, Gas lift design, hydraulic piston pumping, progressive cavity pumping.

Text Books:

1. Boyun Guo, William C. Lyons, Ali Ghalambor, "Petroleum production engineering: A computer assisted approach", Elsevier Science & Technology books, (2007).
2. Brown, K.,E. "The Technology of Artificial Lift Method", Volume 1,2,3,4,5, PennWell Books, Tulsa, Oklahoma, (1982).

Reference Books:

1. M. J. Economides, A. Daniel Hill & C. E. Economides, "Petroleum production systems", Prentice- Hall, N. J – 07488, (1994).
2. "Production Technology I-II", Institute of Petroleum Engineering, Herriot Watt University

OIL AND GAS WELL TESTING

Course code: 15 PE 3216 **L-T-P:** 2-2-2

Pre Requisite: 15 PE 2206 **Credits:** 4

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand and apply the fluid flow equation in porous media to well test analysis, apply the principles of superposition , Horner's approximation	e	2
CO 2	Ability to apply Pressure Transient Tests to determine the petro-physical properties. Ability understand to apply Drill Stem Test.	e	3
CO 3	Ability to apply type curves for well test analysis, understand and apply well testing to gas reservoirs.	e	2
CO 4	Ability to apply all well tests for the horizontal wells, extended reach well etc.	e	3
CO 5	Apply the theoretical concepts to conduct various Simulation by using the simulation tool and analyze the data	k	3

SYLLABUS:

Principles of Fluid Flow for steady state, semi steady state & non steady state conditions. Diffusivity Equation Derivation & Solutions, Radius of investigation, Principle of superposition, Horner's approximation.

Pressure Transient Tests: Drawdown and buildup-test analysis, determination of permeability and skin factor, Analysis of pressure-buildup tests distorted by phase redistribution, Well-test interpretation in hydraulically fractured wells, Interpretation of well-test data in naturally fractured reservoirs. Wellbore effects, Multilayer reservoirs, Injection well testing, Multiple well testing, Wireline formation testing, Wireline while drilling formation testing, Interference testing, Pulse testing.

Drill Stem Testing: Equipment, DST chart observation and preliminary interpretation. Well preparation for testing, Multiple well testing. Effect of reservoir heterogeneities & Well bore conditions, fractured reservoir application

Well-test analysis by use of type curves: Fundamentals of type curves, Ramey's type curve, McKinley's and Gringarten et al type curves.

Gas well testing: Basic theory of gas flow in reservoir, Flow-after-flow test, Isochronal test, etc.

Applications of well testing: Well testing in horizontal wells, Extended Reach wells & multi-laterals wells, tests with and without flow measurement.

Computer–aided well test analysis: Derivative plot, diagonostic plot evaluation, data preparation, nonlinear regression, Introduction to well testing softwares.

Text Books:

1. John Lee, "Well Testing", SPE series, (1982).

2. Tarek Ahmed, Paul D. McKinney, "Advanced Reservoir Engineering". Gulf Professional Publishing, Elsevier, (2005).

Reference Books:

1. Earlougher R.C, "Advances in Well Test Analysis", SPE series (1997)

2. John Lee and Wattenbarger, R.A, "Gas Reservoir Engineering", SPE series, (1996)

3. Dominique Bourdet, "Well test analysis: The use of advanced interpretation models", Elsevier, (2002).

WELL INTERVENTION & STIMULATION TECHNIQUES

Course code: 15 PE 3251 **L-T-P:** 3-0-0

Pre Requisite: 15 PE 2104 **Credits:** 3

Mapping of the course outcomes with student's outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the problem occurring during production, ability to apply the work over operation to control production problems,	e	1
CO 2	Ability to analyze the well by using the Well inflow equations.	e	2
CO 3	Ability to design matrix acidizing technique to improve the recovery factor in economical way	e	3
CO 4	Ability to design hydraulic fracturing technique improve to the recovery factor in economical way	e	3

SYLLABUS:

Work-over operations, Work over fluids. Scraping, well circulation, Water and gas Shut-off, Squeeze cementing. Handling water and gas coning.

Production packers, Packers calculation, Well activation. Repair of wells, Paraffin and scale removal. Planning and evaluation of workover jobs. Corrosion, Bacteria & Scale control

Sand-control, Screens, Gravel packs.

Reservoir Stimulation in Petroleum Production: Inflow performance, Tubing performance and NODAL analysis, Decision process for well stimulation, Reservoir engineering considerations for optimal production enhancement strategies, Stimulation execution.

Hydraulic Fracturing: Introduction, In-situ stress, Mechanics of Hydraulic Fracturing, Fracturing Fluid Chemistry and Proppants, Fracture Treatment Design.

Matrix Treatments: Introduction, Acid–Rock Interaction, Sandstone Acidizing Design, Carbonate Acidizing Design

Thermal stimulation techniques. Down-hole heaters. Horizontal well related development on the subject

Text Books:

1. Thomas O Allen , Alan P. Roberts, "Production Operations: Well Completions, Workover, and Stimulation", (Volume 1 and 2), Oil & Gas Consultants International, (1978).
2. Michael J. Economides Kenneth G. Nolte, "Reservoir stimulation", John Wiley & Sons, 3rd ed, (2000).

Reference Books:

1. Heriot Watt, "Production Engineering Handbook"
2. A. Daniel Hill, Christine Ehlig-Economides, Ding Zhu, Michael J. Economides, "Petroleum Production Systems", 2nd Ed., Prentice Hall, (2012).

3. Boyun Guo, William C. Lyons, Ali Ghalambor, "Petroleum Production Engineering: A computer assisted approach" Elsevier Science and Technology Books, (2007).

RESERVOIR MODELLING AND SIMULATION

Course code : 15 PE 4153 **L-T-P :** 3-0-0

Pre Requisite : 15 PE 2206 **Credits :** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand modelling concepts, designing the reservoir models for different types of reservoirs	e,k	1
CO 2	Ability to apply the reservoir rock and fluid properties to the modelling equations for different gird and time step sizes.	e,k	2
CO 3	Ability to apply the reservoir simulation techniques to well management, production performance.	e,k	3
CO 4	Understanding the special simulation processes	e	1

SYLLABUS:

Introduction & Overview: Organization, Design, Testing, Forecasting, Special processes, Economics, Credibility, decision making, Performance Monitoring, beneficial application, Planning a simulation study, Study Approach, Model design, Programming, History Matching, Predicting & Analyzing results, reporting.

Modeling Concepts: The concept of Grid blocks & Time steps, Representation of wells, Mobility Weighting, Numerical Dispersion, Grid Orientation effects, Explicit & Implicit functions, Treatment of Vertical saturation & Pressure distributions, Well functions, History Matching, Well Management, Solution methods.

Designing the reservoir model: Checklist for model design, Selecting the number of dimensions, Tank models, 1D, 2D (Areal, cross-sectional, radial), Multilayer, 3D, Simplification of complex problems, Pseudo-relative permeability & Capillary pressure functions, VE pseudo functions, Windowed models, Naturally fractured reservoirs, Representation of reservoir fluids, Representation of reservoir rock, Well models.

Selecting reservoir rock and fluid properties data: Data for model construction, Sensitivity of results to data accuracy, Porosity & Permeability: Sources of data, developing reservoir description, rock property distribution, Thickness and depth, Capillary pressure and relative permeability: Selection and assignment of data Fluid properties, Establishing Initial pressure and saturation distribution.

Selecting Grid & Time-step sizes: Selection of grid block size example grids, Selection of time-steps, Numerical dispersion, Grid orientation, Cost considerations.

Selecting the Numerical solution method: Terminology, Formulating the equations, Material Balance & pressure equations, Formulating options, Numerical Dispersion, Choosing the formulation option, Matrix Equations, Solution methods, Selecting the Equation-solving technique.

Well Management: Designing & Controlling Production Parameters.

History Matching: Validity of the Reservoir Model, Strategy & Plans, Adjustment of parameters, Pressures, Pressure gradients, GOR-WOR behavior Automatic History Matching.

Forecasting Future Performance: Planning prediction cases, Preparation of input data, smooth transition from history to predictions, Review & Analysis of predicted performance, Evaluating & Monitoring predicted performance.

Simulating Special Processes: Compositional Simulation, Miscible displacement, Chemical & polymer flooding, Steam simulation and steam drive, In-Situ combustion, Special Data requirements.

Text Books:

1. Jamal H. Abou Kasem, S. M. Fariuq Ali, M. Rafiq Islam, "Petroleum Reservoir Simulation: A Basic Approach", Gulf Publishing Company, (2006).
2. John R. Fanchi, "Principles of Applied Reservoir Simulation", Elsevier, (2005).

Reference Books:

1. Heriot Watt, "Reservoir Simulation Handbook"
2. M.R. Carlson, "Practical Reservoir Simulation", PennWell, (2003).
3. Zhangxin Chen, "Reservoir Simulation: Mathematical Techniques in Oil Recovery", Cambridge University Press, (2008).
4. Richard E. Ewing, "Mathematics of Reservoir Simulation", Society for Industrial and Applied Mathematics (SIAM), (1983).

ENHANCED OIL RECOVERY

Course code : 15 PE 4154 **L-T-P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand flood patterns, microscopic and macroscopic displacement of fluids, water flooding, gas flooding techniques.	e,k	1
CO 2	Understand and apply high pressure gas injection, LPG flooding, CO2 flooding for oil recovery, alcohol flooding	e,k	2
CO 3	Understand and apply, Microbial flooding, polymer flooding for oil recovery	e,k	2
CO 4	Understand and apply thermal recovery process to reservoirs to increase recovery efficiency and Case Study	e,k	3

SYLLABUS:

Introduction: Historical background and review of primary and secondary recovery, injection rate and pressures in secondary recovery.

Flood Patterns and Coverage: Basic flooding networks, directional permeabilities, off pattern wells, natural and induced fractures.

Microscopic displacement of fluids in a reservoir: Capillary forces, viscus forces, phase trapping, mobilization of trapped phases.

Macroscopic displacement of fluids in a reservoir: Areal sweep efficiency, vertical sweep efficiency, displacement efficiency, mobility ratio, well spacing.

Flow of immiscible fluids through porous media: continuity equation, equation of motion, solution methods Water flooding, Fractional flow equation, Frontal advance theory. Recovery efficiency, permeability heterogeneity.

Immiscible displacement processes: Water flooding performance calculations: Frontal advance method, viscous fingering method, Stiles method, Dykstra-Parsons Method, Water for water flooding.

Gas Injection-Immiscible Displacement: Dispersed gas injection, external gas cap gas injection, and foam drive process for oil recovery.

Miscible Displacement Processes: Mechanism of miscible displacement, phase behavior related to miscibility, fluid properties in miscible displacement, design procedure and criteria, high pressure gas injection, enriched gas injection, LPG flooding, Carbon dioxide flooding, alcohol flooding. Microbial oil recovery

Thermal Recovery Processes: mechanism of thermal flooding, hot water flooding, cyclic steam injection, estimation of oil recovery from steam drive, in-situ combustion, air requirement for in-situ combustion.

Surface facilities for EOR processes: Treatment of water for reservoir compatibility. Design consideration for water handling and injection system. Pumps types & sizing, Infectivity problems. Gas compression for injection, gas compressors. Design consideration for gas collection and distribution system for injection EOR Project Evaluation.

Text Books:

1. E. C. Donaldson, G. V. Chilingarian, T. F. Yew, "Enhanced Oil Recovery: Processes and Operations", Elsevier, (1998).
2. Larry W. Lake, "Enhanced Oil Recovery", Prentice Hall, (1998).

Reference Books:

1. H. R. Van Pollew and Associates, "Fundamentals of Enhanced Oil Recovery", PennWell, (1980).
2. Enhanced Oil Recovery, Teknica, Teknica Petroleum Services Ltd.,(2001).
3. Modern Chemical Enhanced Oil Recovery: Theory and Practice, Gulf Professional Publishing, (2011).
4. Aural Carcoane, "Applied Enhanced Oil Recovery", Prentice Hall, (1992).
5. IstvanLaktos, "Recent Advances in Enhanced Oil and Gas Recovery", Academy Kiado, (2001).
6. Don W. Greew, G. Paul Willfite, "Enhanced Oil Recovery", Society of Petroleum Engineers, (1998).
7. Vladmir Alvarado, Eduardo Marriglee, "Enhanced Oil Recovery: Field Planning and Development Strategies", Gulf Professional Publishing, (2010).

COAL BED METHANE-GAS HYDRATES-SHALE GAS

Course code: 15 PE 4155 **L-T-P:** 3-0-0

Pre Requisite: NIL **Credits:** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the CBM formation, coal thermodynamics, exploration and production of CBM.	a,e	1
CO 2	Understand the gas hydrate formation, properties of gas hydrates, phase behavior, kinetics of formation,	a,e	1
CO 3	Understand the gas hydrate reservoirs drilling and completions techniques, production techniques.	a,e	1
CO 4	Understand of shale gas extraction method and production methods	a,e	1

SYLLABUS:

Coal Bed Methane: Present status of coal bed methane. Formation and properties of coal bed methane. Thermodynamics of coal bed methane. Exploration & Evaluation of CBM, logging of coal bed methane wells. Drilling and completion of coal bed methane wells. Hydro-fracturing of coal seam, Activation of well. Production installation and surface facilities. Well operation and production equipment. Treating and disposing produced water. Testing of coal bed methane wells.

Gas Hydrates: Introduction & present status of gas hydrates. Formation and properties of gas hydrates. Thermodynamics of gas hydrates. Exploration & evaluation of gas hydrates. Phase behavior of gas hydrates, Kinetics of gas hydrates. Drilling and completion of gas hydrate wells. Prevention & control of gas hydrates. Gas hydrates accumulation in porous medium. Gas extraction from gas hydrates. Uses and application of gas hydrates.

Shale Gas: History of shale gas production, Extraction methods: development of current practices. Location and size of production areas: estimated reserves and economics.

Text Books:

1. R. E. Rogers, "Coal Bed Methane: Principles and Practice", 3rd Ed, Prentice Hall, (1994).
2. E. Dendy Sloan, Jr., C. Koh, "Clathrate Hydrates of Natural Gases", 3rd Ed, CRC Press, (2007).
3. Amber L tuft, "Unconventional Oil & Shale Gas", Nova Publishers, New York, (2015).

Reference Books:

1. Coal Bed Methane, Society of Petroleum, (1992).
2. John Seidle, "Fundamentals of Coal Bed Methane Reservoir Engineering", Pennwell Corp., (2011).
3. John J. Carroll, "Natural Gas Hydrates: A Guide for Engineers", Gulf Professional Publishers, (2003).
4. Natural Gas Hydrates in Flow Assurance, E. Dendy Sloan, C. Koh, A. K. Sum, A. L. Ballard, J. Creek, M. Eaton, N. McMullen, T. Palermo, G. Shoup and L. Talley, Elsevier, 2010.

DIRECTIONAL DRILLING & OFFSHORE STRUCTURES

Course code : 15 PE 4156 **L-T-P :** 3-0-0

Pre Requisite : 15 PE 2104 **Credits :** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the principle of directional drilling, deflection tools, directional drilling profiles, downhole motors	a,e	1
CO 2	Ability to design drilling program to directional well, horizontal well, slant hole.	a,e	2
CO 3	Demonstrate the principles of the MWD/LWD, and identification of directional drilling problems	a,e	2
CO 4	Demonstration of offshore structure, fixed platforms, mobile units	a,e	2

SYLLABUS:

Directional Drilling: Objectives, Types of deflection tools, tool orientation, Directional well profiles, Well path deflection & correction.

Down Hole Motors: Positive displacement motors and Turbo-drills - motor description, Power calculation and applications; Auto-track and verti-track system; Rotary Steerable motors, Geo-steering tools.

Horizontal Well Drilling: Horizontal well objectives and selection, Different profiles, Drilling techniques, Mud requirements & characteristics, casing and drill string requirements and completion programs.

Slant Hole Drilling: Objectives and selections, Well profiles and applications.

Down the Hole Well Surveying: Well surveying objectives, surveying methods, Surveying Analysis methods and calculations for well coordinates.

Measurements While Drilling: Objectives of MWD/ LWD, SWD, MWD tools, Telemetry system and data interpretation.

Directional drilling problems and their remedies.

Introduction to offshore oil and gas operations.

Offshore Fixed Platforms: Types, description and operations.

Offshore Mobile Units: Types, description and installation; Station keeping methods like conventional mooring & dynamic positioning system.

Offshore Drilling: Difference in drilling from land, from fixed platform, jackup, ships and semi submersibles; Use of conductors and risers; Deep sea drilling.

Offshore Well Completion: Platforms and subsea completions, Deep water applications of subsea technology.

Offshore Production: Oil processing platforms, gas processing platforms, water injection platforms, storage, SPM and SBM, transportation and utilities.

Divers and Safety: Principles of diving use of decompression chambers, life boats.

Offshore Environmental Pollution and Remedial Measures.

Text Books:

1. T. A. Inglis, "Directional Drilling", "Petroleum Engineering and Development Studies"
2. "The Technology of Offshore 'Drilling, Completion and Production", ETA Offshore Seminars, Inc. Penn WellPublishing Company.
3. S. Chakrabarti, "Handbook of Offshore Engineering", Volume 1 & 2, Elsevier, (2005)

Reference Books:

1. Bill Mitchill, "Advanced oil well drilling engineering, hand book and computer programs" SPE.

PETROLEUM PRODUCTION SYSTEM DESIGN

Course code: 15 PE 4157 **L-T-P:** 3-0-0

Pre Requisite: 15 PE 3214 **Credits:** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand production system, GGS, CTF, and GCS. Ability to design tubing for a well	e, k	1
CO 2	Ability to design separators, dehydration systems, treating systems and Case Study	e, k	2,3
CO 3	Ability to design desalting systems, produced water treatment systems, acid gas treating systems, pressure vessels and Case Study	e, k	2,3
CO 4	Ability to design acid gas treating systems, pressure vessels and Case Study	e, k	2,3

SYLLABUS:

Petroleum production system: Introduction

Gathering and collection of oil and gas: GGS, CTF and GCS - layout, sequential treatment, and safety features on installations

Well Tubing design: Introduction, Strength of Tubing, Tubing design

Metering and Measurements: Metering of oil & gas, Sampling and Testing of crude oil. Gauging equipment and methods. Water and sediment determination. Orifice and other metering devices and their characteristics.

Design of oil-gas separators: Principles of phase separators, Sizing of vertical & horizontal two phase and three phase separators, Optimum pressure, Design of single and multistage flash vaporization equipment.

Dehydration systems: Process design of glycol and solid bed dehydration systems.

Design of crude oil treaters: Sizing horizontal and vertical treaters, Design of LTX units and line treaters Design of crude desalting equipment.Design of produced water treatment and disposal.

Design of acid gas treating system design: Design of iron sponge units, Design of H2S and CO2 absorbers and strippers using amine solutions.

Design of pressure vessels: Design considerations, Design temperature and pressure, Maximum allowable stress values, Determination of wall thickness, Corrosion allowance Sizing of different type of storage tanks.

Text Books:

1. Boyun Guo, William C. Lyons, Ali Ghalambor, "Petroleum Production Engineering: A computer assisted approach" Elsevier Science And Technology Books, (2007).
2. Ken Arnold, Maurice Stewart, Butterworth Heinemann, "Surface Production Operations", Vol 1 & 2, (1989).

Reference Books:

1. H.K. Abdel- Aal, Mohamed Aggour, M.A. Fahim, "Petroleum and Gas Field processing", Marcel Dekkar Inc., (2003).
2. A. Daniel Hill, Christine Ehlig-Economides, Ding Zhu, Michael J. Economides, "Petroleum Production Systems", 2nd Ed., Prentice Hall, (2012).
3. Engineering Data Book, 12th Edition (Electronic), FPS Version, Volume I & II, Gas Processers Suppliers Association (GPSA), (2005).

PETROLEUM REFINING & PETROCHEMICAL TECHNOLOGY

Course code : 15 PE 3252 **L-T-P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the properties, products and test methods for crude oil and learn various treatment techniques	a,e	1
CO 2	Develop knowledge of different crude oil refining processes	a,e	2
CO 3	Study various petrochemical products	a,e	2
CO 4	Analyze the enrironmentalf and safety aspects in the petroleum and petrochemical industry	a	2

SYLLABUS:

Primary Processing Of Crude Oil: Classification of crude oil, Atmospheric distillation, Vacuum distillation of residue, Products - Specifications, Properties & Test Methods

Secondary Processing Of Crude Oil: Thermal and Catalytic Cracking, Reforming, Alkylation, Isomerization, Hydro-Processing, Cracking, Visbreaking, coking, Bitumen Production. - Lube Oil Base Stock Production, Classification and Characterization of Propane Deasphalting, Dewaxing, Hydro-Finishing; polymerization.

Treatment Techniques: Treatment techniques for removal of objectionable gases, Odors, to improve performance, Storage stability, Extraction of aromatics, Olefins and recovery operations from petroleum products. Specialty products - Carbon Black, Petroleum Coke and Waxes

Petrochemicals: Chemicals from methane and synthetic gas: Ammonia, Methanol and Hydrogen Cyanide, Chemicals from olefins: Ethylene derivatives, Propylene derivatives and Butylenes derivatives, Aromatics, intermediates for synthetic fibres, Plastics and rubber.

Environmental and Safety Aspects in Refinery and Petrochemicals: Waste water and effluent gases treatment from alkylation units and petrochemical units, safety aspects in the above industries.

Text Books:

1. W.L. Nelson, "Petroleum Refinery Engineering", 4th Ed, McGraw Hill, New York, (1985).
2. B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Ed, Oxford and IBH Publishing Company, New Delhi, (1990.)
3. Uttam Ray Chaudhuri, "Fundamentals of Petroleum and Petrochemical Engineering" CRC Press

Reference Books:

1. Surinder Parkash, "Refining Processes Handbook", Gulf Professional Publishing
2. Robert A. Meyers, "Handbook of Petroleum Refining Processes" Mcgraw-Hill, (1996).
3. James G. Speight, "Handbook of Petroleum Analysis" Wiley-Interscience, (2001).
4. G. D. Hobson and W. Pohl., "Modern Petroleum Technology", Gulf Publishers, 2nd Ed, (1990).

POLYMER SCIENCE & TECHNOLOGY

Course code : 15 PE 4158 **L-T-P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the basic chemistry, properties and applications of polymers	a,e	1
CO 2	Study various polymerization and processing methods	a,e	2
CO 3	Study the properties and manufacturing techniques of various polymer compounds	a,e	2
CO 4	Study various special processing methods	a	2

SYLLABUS:

Introduction and Fundamentals: Definitions and concepts of plastics and polymers, Comer, Co-monomer, Mesomer, Co – polymer, functionality, visco-elasticity classification of polymers Methods determining molecular weights of polymers: Based on colligative properties, Sedimentation equilibrium method. Gel chromatography. Natural polymers: rubber, shellac, rosin, cellulose, and lignin's, Proteins.

Chemistry of Polymerization: Concepts of addition polymerization condensation polymerization and Co – polymerization, glass transition temperature of polymers, Degradation of polymers of following types: Mechanical, Hydrolytic thermal, back bone effects.

Methods of Polymerization: Mass, solution, emulsion, suspension Role of following additives for polymers: Initiators, catalyst inhibitors, solvents, fillers, reinforcing agents, stabilizers plasticizers, lubricants, blowing agents, coupling agents, flame retardants photo-degradants.

Methods of Manufacture, Properties, uses of following addition compounds: Polyethylene (LDPE & HDPE), Polypropylene, PVC and its copolymers, Acetals, PTFE;

Condensation compounds: polyester –PMMA, PET, Alkyd, Epoxy resins, Polyurethanes, Silicones, PF, UF, MF resins.

Description of Following Processing Methods: With principles involved and equipment used mixing and compounding, extrusion, Calendring, laminating, Moulding – compression, transfer, injection and blow moulding.

Text Books:

1. Bill Meyer, "Text Book of Polymer Science", 3rd Ed., John Wiley and Sons, (1984).

2. J.A Bryson Newness – Butterwarths, "Plastic Materials", London, (1989).

Reference Books:

1. J.H. Briston and C.C.Gosselin, "Introduction to Plastics", Newnes, London, (1968).
2. C.C Winding and G.D.Haitt, "Polymeric Materials", Mc Graw Hill Book, (1961).
3. M.S. Bhatnagar, "A Text Book of Polymers", 1st Ed., S. Chand and Company, New Delhi, (2007).

REFINING PROCESS, MODELING & SIMULATION

Course code: 15 PE 4159 **L-T-P:** 3-0-0

Pre Requisite: 15 PE 2102 **Credits:** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the process synthesis and flow sheeting	a, k	1
CO 2	Analyze the Atmospheric distillation unit by modeling and simulation	a, k	2
CO 3	Analyze the Vacuum distillation unit by modeling and simulation	a, k	2
CO 4	Evaluate various process by predictive modeling	a, k	2

SYLLABUS:

Process Synthesis and details, Process Flow Sheeting, Strategy of Process Calculations

Characterization, physical and thermodynamic properties of oil fractions

Atmospheric distillation unit – introduction, process overview, model development, feed characterization, data requirements and validation, representative atmospheric distillation unit

building the model in Aspen HYSYS

Vacuum distillation unit - process description, data reconciliation, model implementation

Predictive modeling of the fluid catalytic cracking (FCC) process, continuous catalyst regeneration (CCR) reforming process, Hydro-processing units

Text Books:

1. Refinery Engineering: Integrated Process Modeling and Optimization by Ai-Fu Chang, Kiran Pashikanti and Y. A. Liu, Wiley-VCH
2. Chemical Process Modeling and Computer Simulation by Jana Amiya K, PHI Publications, (2011).

Reference Books:

1. Robert A. Meyers, "Handbook of Petroleum Refining Processes", Mcgraw-Hill, (1996).
2. William L. Luybean, "Process Modeling, Simulation and Control for Chemical Engineers", McGraw-Hill Companies, (1989)

PETROLEUM REFINING ENGINEERING

Course code: 15 PE 4160 **L-T-P:** 3-0-0

Pre Requisite: NIL **Credits:** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the properties, products and test methods for crude oil and learn the primary processing of crude oil	a	1
CO 2	Study various treatment techniques of crude oil	a, e	2
CO 3	Study different secondary processing methods of crude oil	e	2
CO 4	Study special processing methods of crude oil	e	2

SYLLABUS:

Introduction: Origin, composition and chemistry of petroleum.

Primary Processing Of Crude Oil: Classification of crude oil, Atmospheric distillation, Vacuum distillation of residue, Products - Specifications, Properties & Test Methods

Treatment Techniques: Treatment techniques for removal of objectionable gases, Odours, to improve performance, Storage stability, Extraction of aromatics, Olefins and recovery operations from petroleum products.

Secondary Processing of Crude Oil: Thermal and Catalytic Cracking, Reforming, Alkylation, Isomerization, Hydro-Processing.

Visbreaking, coking, Bitumen Production, Lube Oil Base Stock Production

Propane Deasphalting, Dewaxing, Hydro-Finishing, polymerization.

Environmental issues and New Trends in petroleum refinery operations.

Text Books:

1. W.L. Nelson, "Petroleum Refinery Engineering", 4th Ed, McGraw Hill, New York, (1985).
2. B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Ed, Oxford and IBH Publishing Company, New Delhi, (1990.)
3. John J. McKetta Jr, "Petroleum Processing Handbook", CRC Press.

Reference Books:

1. Robert A Meyers, "Handbook of Petroleum Refining Processes", McGraw-Hill Professional, (2003).
2. Jean-Pierre Wauquier, "Petroleum Refining: Separation Processes", Editions Technip, (2000)
3. James H. Gary and Glenn E. Handwerk, "Petroleum Refining", CRC Press
4. Serge Raseev, "Thermal and Catalytic Processes in Petroleum Refining", CRC Press, (2003).
5. James G. Speight and Baki Ozum, "Petroleum Refining Processes", CRC Press.

CHEMICAL PROCESS EQUIPMENT DESIGN AND DRAWING

Course code: 15 PE 4161 **L-T-P:** 3-0-0

Pre Requisite: 15 PE 2208 **Credits:** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Design of heat transfer equipment	a,k	1
CO 2	Design of Reboilers, vaporizers and evaporators	a,k	3
CO 3	Design of distillation column for single and multi-components	a,k	3
CO 4	Design of pressure vessels	a,k	3

SYLLABUS:

Basic design procedure of heat transfer equipment, overall heat transfer coefficient and dirt factors, shell and tube heat exchangers - construction details, selection algorithm, design codes, mean temperature difference, general design considerations, tube-side heat transfer coefficient and pressure drop, shell-side heat transfer coefficient and pressure drop.

Design of condensers for single vapors, heat transfer coefficient correlations for condensation inside and outside of tubes of the vertical and horizontal condensers, pressure drop in condensers.

Reboilers, vaporizers and evaporators - Pool boiling, convective boiling, selection of reboilers, and vaporizers, design of reboilers, vaporizers and evaporators, drawing of evaporators.

Design of distillation column, degree of freedom analysis, various design methods of distillation column, general design consideration of multicomponent distillation, plate efficiency, tray hydraulics of sieve and valve - trays.

Design of pressure vessel; Introduction of codes for pressure vessel design; design of cylindrical and spherical shells under internal and external pressure, selection and design of closures, Selection of gaskets, selection of standard flanges, optimum selection of bolts for flanges, design of flanges. Design of lug support and saddle support including bearing plates and anchor bolts.

Text Books:

1. Sinnott R. K.; "Coulson and Richardson's Chemical Engineering Series", Vol. VI, 4th Ed., Butterworth-Heinemann.
2. Seader J. D. and Henley E. J., "Separation Process Principles", 2nd Ed., Wiley-India.
3. Bhattacharya B. C., "Introduction of Chemical Equipment Design", CBS Publisher.

Reference Books:

1. Hewitt G.F., Shires G. L. and Bott T. R., "Process Heat Transfer", Begell House.
2. Serth R.W., "Process Heat Transfer: Principles and Applications", Academic Press.
3. Brownell L. E. and Young H. E., "Process Equipment Design", John Wiley.
4. I.S.; 4503 - 1967, Indian Standard Specification for Shell and Tube Type Heat Exchangers.

RESERVOIR ENGINEERING

Course code: 15 PE 2206 **L-T-P :** 2-2-2

Pre Requisite : NIL **Credits :** 4

Mapping of the course outcomes with student's outcomes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the role of reservoir engineers, rock and fluid properties, driving mechanism, Apply the PVT analysis to reservoir fluids. Estimate the rock and fluid properties.	e	2
CO 2	Ability to apply the fluid flow equation to the porous media for different conditions, Ability to apply the GMBE to different driving mechanisms,	e	2
CO 3	Ability to apply the decline curve analysis during production, Ability to apply water influx calculations to the reservoirs. And case studies	e	3
CO 4	Understand the reservoir filed development, ability to apply the displacement techniques for oil recovery.	e	1
CO 5	Perform the experiments to identify the reservoir rock and fluid properties	b	2

SYLLABUS:

Introduction to reservoir engineering

Reservoir fluid properties: Characteristics of crude oil and natural gas, classification of crude and its physicochemical properties.

Reservoir Rock Properties: Porosity and permeability determination, combination of permeability in parallel & series beds, porosity permeability relationship, fluid saturation determination and significance, effective and relative permeability, wettability, capillary pressure characteristics, measurements and uses. Coring and Core Analysis

PVT analysis: Phase behavior of hydrocarbon system, ideal & non ideal system, equilibrium ratios, reservoir fluid sampling, PVT properties determination, different correlations and laboratory measurements, data reduction, evaluation and application.

Driving mechanisms: Reservoir drive mechanics and recovery factors

Flow of Fluids through Porous Media: Darcy's law, single and multiphase flow, linear, radial & spherical flow, steady state & unsteady state flow, GOR, WOR equations

Special type of flow: Flow through fractures, Water and gas coning.

Reserve estimation: Resource & Reserve concept, Different reserve estimation techniques: Volumetric, MBE, decline curve analysis. Performance prediction of depletion drive, gas cap drive, water drive and combination drive.

Water influx calculations: steady and unsteady state models

Introduction to oil & gas field development: Rational development plan, Rate and order of drilling well, well spacing & pattern, selection of development scheme, economic aspect of development of oil and gas fields.

Immiscible Displacement processes: Theory & practices- fractional flow of water, Buckley Leverette treatment of fractional flow and frontal advance equations, water flood performance.

Reservoir Management: Concepts, Components and Applications.

Text Books:

1. Tarek Ahmed, "Reservoir Engineering Handbook", Gulf Professional Publishing, 4th ed, (2010).
2. Nnaemeka Ezekwe, "Petroleum Reservoir Engineering Practice", Pearson Education, Inc, (2010).

Reference Books:

1. Benjamin Cole Craft, Murray Free Hawkins, and Ronald E. Terry, "Applied Petroleum Reservoir Engineering" by Prentice Hall, (1991).
2. LP Dake, "Fundamentals of Reservoir Engineering" shell learning and development, (1998).
3. Tarek Ahmed, Paul D. McKinney, "Advanced Reservoir Engineering" Gulf Professional Publishing , 4th ed, (2005).
4. BF Towler, "Fundamental Principles of Reservoir Engineering", SPE, (2002).
5. Heriot Watt, "Reservoir Engineering Handbook"
6. Abhijits Y. Dandekar, "Petroleum Reservoir Rock and Fluid Properties", CRC Press, (2013).

OPEN ELECTIVES

IPR & PATENT LAWS

Course code: 15 PE 2105 **L-T-P :** 2-2-2

Course Code : 15 BT 30A1 **L-T-P :** 3-0-0

Prerequisite : NIL **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Acquire the knowledge of intellectual property rights	a	1
CO 2	Describe the principles and regulatory affairs	e	2
CO 3	Develop documentation ,Protocols and Case Studies on Patents	k	3
CO 4	Compare various Case Studies on Patents	k	3

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 contest-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 (Basumati rice, turmeric, Neem, and related medicinal plants and byproducts)

Textbooks:

1. S. H. Willig, Good manufacturing practices for Pharmaceuticals, Informa Healthcare (Oct 2000).

Reference books:

1. Industrial Property Rights: Vol. III-4, Kogan Pate, Kogan Pate, Kogan Page (May 1998)

ENVIRONMENTAL POLLUTION CONTROL METHODS

Course Code : 15 CE 30A2 **L-T-P :** 3-0-0

Prerequisite : NIL **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To identify the sources of Air pollution, effects and control methods.	c	2
CO 2	To Identify the sources of water pollution, effects and control methods.	i	2
CO 3	To identify the sources of solid waste and disposal methods.	c	2
CO 4	To identify the sources of noise pollution, effects and control methods.	c	2

SYLLABUS :

Air pollution: Sources, Types, and effects and Fate of air pollutants. Meteorological factors and their impacts on pollutants dispersal. Sampling and measurement of air pollutants. Air quality standards. Air pollution control methods for particulates and gaseous pollutants. Emission Control equipments for particulate and gaseous matter. Water pollution: Sources, Types and Effects of Water pollutants. Measurement of pollution loads: DO, BOD, COD, TOC - Water quality and Effluent discharge standards. Role of Microorganisms in wastewater treatment. Bacterial population dynamics- growth kinetics. Pretreatment, primary treatment, secondary and tertiary treatment of wastewater. Low cost treatment unit processes. Solid waste: Sources and types of Solid wastes – Disposal methods: Land filling - Composting - Incineration – Pyrolysis. Reclamation of polluted and degraded soil by Bioremediation- Phyto-remediation. Human acoustics, Sound and its general features-Noise and its measurement - Noise pollution hazards -Control methods.

Text Books:

1. Environmental Pollution Control Engineering by C.S.Rao (2006), New Age International (P) Limited Publishers, New Delhi.
2. Environmental Engineering by Howard S. Peavy, Donald R. Rowe and George Tchobanoglous (1985), Mc Graw-Hill International Editions, NewYork.

ReferenceBooks:

1. Sewage Disposal And Air pollution Engineering by S.K. Garg, Khanna publishers, New Delhi, 2010.
2. Waste water Engineering by M.N Rao and A.K Dutta, Oxford & IBH Publishing Co.Ltd, 2000.
3. Air Pollution by M.N Rao and H.V.N Rao, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000.
4. Environmental Engineering by Davis Cornvel, McGraw Hill Book Co., New York, 2000.
5. Waste Water Engineering by Met Calf &Eddy, McGraw Hill Book Co., New York, 2006.

SOLID AND HAZARDOUS WASTE MANAGEMENT

Course Code : 15 CE 30A3 **L-T-P :** 3-0-0

Prerequisite : NIL **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the importance types, sources and disposal methods of Solid waste Management.	c	2
CO 2	To understand the importance of conversion and recycling of waste.	c	2
CO 3	Understand the types and Sources of Hazardous waste	i	2
CO 4	Understand the disposal methods of Hazardous waste	i	2

SYLLABUS:

Solid wastes: Sources, Types, reasons for increase in generation, composition and properties of solid waste, Collection and on-site handling , Separation and processing. Solid waste disposal methods, Land filling, methods of land filling, Design of Landfills, gas production, Leachate and its control.

Conversion and recovery: Incineration, Pyrolysis, Composting methods, merits and demerits, Energy recovery, Biomethanation, use of refuse derived fuels (RDF).

Hazardous Waste, Definition, Sources, Classification, Hazardous wastes rules, and Nuclear waste, Biomedical wastes, Chemical wastes, disposal methods, Waste minimization. Treatment methods, Physico-chemical processes, Biological methods, Stabilization and Solidification, Thermal methods, Disposal methods Land disposal. Remedial technologies.

TEXT BOOKS:

1. Solid waste Engineering by P.Aarne Vesilind , William Worrell & Debra Reinhart, Cengage Learning India Pvt. Ltd, New Delhi
2. Environmental pollution control Engineering by C. S. Rao; New age International Publishers, New Delhi.

REFERENCE BOOKS:

1. Venkatappa Rao. G and Sasidhar. R.S.(2009), Solid waste management and Engineered Landfills, Sai Master Geoenvironmental Services Pvt.Ltd, Hyderabad
2. World Health Organization, Global Water Supply and Sanitation Assessment 2000 (Geneva2000).
3. Environment and Pollution Laws: Universal, Universal Law Publishing Co. Pvt.Ltd, Ed 2011.
4. Solid and hazardous waste management by M.N.Rao and Razia Sultana, BS Publications, Hyderabad

REMOTE SENSING AND GIS

Course Code : 15 CE 30A4 **L-T-P :** 3-0-0

Prerequisite : NIL **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	To get the Knowledge of Remote sensing Technology	c	2
CO 2	Strong base of knowledge to Integrate the Remote sensing and GIS	c	2
CO 3	Design of Geospatial Information systems using RS	i	2
CO 4	Design of Geospatial Information systems using GIS in solving societal problems	i	2

SYLLABUS :

Remote sensing basic definition and process, Passive and active remote sensing. Electromagnetic Spectrum, Resolution, Characteristics of Various sensors and satellites, Fundamentals of Image Processing. Map as a model, Spatial elements and terminology, Map scale, Spatial referencing system, Computers in map production, General software's in map production.Types of data products; Image interpretation strategy, Levels of interpretation keys; Topography, Types of Drainage Pattern and Texture, Erosion, ; Basic elements of image interpretation. Overview on visual image interpretation equipment. -

A brief history of GIS, GIS architecture, Components of a GIS, GIS workflow, Theoretical models of GIS: Functional elements, Fundamental operations, Theoretical framework, GIS categories, Levels/scales of measurement. The data stream, Data input methods: Keyboard entry, Manual digitizing, Scanning and automatic digitizing. Stages of GIS data modeling; Raster and Vector data representation, Spatial data models; Data editing, Detecting and correcting errors, Data reduction and generalization Edge matching and Rubber sheeting, Components of data quality,Sources of error in GIS.

Land use /Land cover studies, slope mapping, preparation of structures map, Ground water prospects mapping, Watershed management and Action plan, Water quality modeling, Salt Water intrusion models, pipeline alignment studies, Solid and hazardous waste disposal site selection, Landslides mapping, Urban planning and Management, GPS applications.

TEXT BOOKS:

1. Remote Sensing and Image Interpretation- 5th Edition by Lillesand, Kiefer and Chipman, Published by John Wiley and Sons, Inc, New York, 20072.

2. Text book of Remote sensing and GIS – 3rd Edition by M. Anji Reddy, BS Publications, Hyderabad, 2010.

Reference Books:

1. Geoinformatics for Environmental management" by M. Anji Reddy, B.S Publications, Hyderabad

2. Remote Sensing and GIS- by B. Bhatia Published by Oxford University Press, 2009

DISASTER MANAGEMENT

Course Code : 15 CE 30A5 **L-T-P:** 3-0-0

Prerequisite : NIL **Credits:** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Define and describe types of disasters, related hazards and the causes for disasters	i	2
CO 2	Know the effects, remedial measures, mitigation measures to be taken with respect to the kind of disaster that occur.	c	2
CO 3	To know about the disaster risk, reduction and the various organisations involved with related to disasters	c	2
CO 4	To know about the vulnerability and mitigations of various disasters with the help of case studies	c	2

SYLLABUS:

Introduction and Concept of disasters and hazards related to Earthq uakes, Tsunami, Volcanic eruption, Cyclones, Floods, Drought, Landslides, Forest fires, Avalanches and Pest infestation. Prediction and perception of hazards and adjustments to hazardous activities; Rates of natural cycles and residence time. Landslide: causes, prevention and correction. Landslide hazard mitigation. Earthquakes: intensity and magnitude of earthquakes; geographic distribution of earthquake zones; precursors to the earthquakes, seismic waves, travel-time and location of epicentre; nature of destruction; ground subsidence; protection from earthquake hazards; do's and don'ts during earthquake; Tsunamis causes and consequences. Floods: Causes, nature and frequency of flooding: nature and extent of flood hazard; urban floods, environmental effects of flooding; flood mitigation methods. Tropical cyclone- formation and consequences. Coastal erosion; sea level changes and its impact on coastal areas. Drought: Nature and effect on plant and animal systems. Study of pattern and mitigation of forest fires. Geological and environmental investigations for the construction of dams, bridges, highways and tunnels. Impact of major geotechnical projects on the environment. Disaster Management: Capability- Vulnerability- risk-preparedness and mitigation- Disaster management cycle; Disaster Risk Reduction and Resilience; Disaster Management Act and Policy. Disaster Management case studies.

Text books:

1. Environmental Hazards by Smith, K., Routledge, London,1992.
2. Geological Hazards by Bell, F.G., Routledge, London,1999.

Reference books:

1. Principles of Engineering Geology by Krynine, D.S. and Judd, W.R., CBS, New Delhi, 1998.
2. Natural Hazards by Bryant, E., Cambridge University Press. London, 1985.
3. Landslide Disaster – Assessment and Monitoring Nagarajan, R., Anmol Publications, New Delhi, 2001.

4. Environmental risks and hazards by Cutter, Susan L., Prentice Hall of India, New Delhi.1999.
5. Bill Mc Juire, Ian Mason and C. Killburn (2002) Natural hazards and Environmental change, Oxford University Press, New York.
6. Gupta, Harsh K. (2003) Disaster Management, Universities Press (India) Pvt. Ltd
7. Coppola, Damon P. (2006) Introduction to International Disaster Management, Butterworth -Heinemann
9. Jha, Madan Kumar (2010) Natural and Anthropogenic Disasters: Vulnerability, Preparedness and Mitigation, Springer
10. Glade, Thomas, Malcolm G. Anderson, Michael J. Crozier (2005) Landslide Hazard and Risk, edited Springer
11. Singh, Surendra, Leszek Starkel, Hiambok Jones Syiemlieh (2008) Environmental Changesand Geomorphic Hazards, Bookwell.

FUNDAMENTALS OF DBMS

Course Code : 15 CS 30A6 **L-T-P:** 3-0-0

Prerequisite : NIL **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the fundamentals of database management systems including data models, database architectures, and database manipulations and be able to model ER-diagrams.	b	2
CO 2	Understand the theories and techniques in developing database applications and be able to write queries, functions and procedures with help of SQL	e	2
CO 3	Understand the different normal forms and transaction issues and be familiar with managing database systems, new developments and trends in databases.	b	2

SYLLABUS

Database Fundamentals: DBMS Characteristics & Advantages, Database Environment, Database Users, Database Architecture, Data Independence, Languages, Tools and Interface in DBMS, DBMS types, Data Modeling: ER Model, Notation used in ER Diagram, Constraint, Types, Relationships in ER Model and other considerations in designing ER diagram. SQL: Data Definition and other languages in SQL, Creating tables and Data types, Constraints, DML statements, Functions and writing SQL statements using nested sub queries, complex queries, joining relations, Embedded SQL- Writing functions and procedures with PL/SQL, Relational Model, Relational Algebra, Operators in relational algebra. Normalization: Guidelines for good database design, Normalization- Normal Forms, First, Second, Third Normal Forms, BCNF, Multi value and join dependencies, 4th and 5th normal forms. File storage, Index structures, Indexing and hashing (Basics) Query Processing: Issues in query processing Transaction Processing: Transaction processing issues, Transaction states, problems during multiple transactions processing, ACID properties, system log, Concurrency control techniques: binary locks, exclusive locks, Lock based techniques, Timestamp based techniques,.

TEXT BOOK:

1. Elmasri and Navathe, 'Fundamentals of Database Systems', 2008, 4th edition, Pearson Education. '

REFERENCE BOOKS:

1. Silberschatz, Henry F Korth, S. Sudarshan, "Database System Concepts:, 2003, Fifth Edition, Tata MCGraw-Hill.
2. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", 2004, second Edition, Tata MCGraw Hill.

FUNDAMENTALS OF SOFTWARE ENGINEERING

Course Code : 15 CS 30A7 **L-T-P :** 3-0-0

Prerequisite : Nil **Credits :** 3

Mapping of Course outcomes with Student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Comprehend software development life cycle and prepare SRS document	b	2
CO2	Apply software design and development techniques, understand software process improvement	e	2
CO3	Identify verification and validation methods in a software engineering project	b	2

SYLLABUS :

Software and Software Engineering: Nature of software, software application domains, unique nature of web applications, software engineering, 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, Modeling techniques for Class & Object Diagrams. Behavioral Modeling :Interaction diagrams. Activity Diagrams.Software testing: A strategic approach to software testing, strategic issues, test strategies for conventional software, Black-Box and White-Box testing, validation testing, system testing. Software Process Improvement, SPI, The SPI process, The CMMI.

Text Books:

1. Roger S.Pressman ,"Software Enginering – A Practitioner's Approach 7th Edition, Mc Graw Hill,(2010).

2. Ian Sommerville, 'Software Engineering', Sixth Edition,Pearson Education,(2001).

3. Jim Arlow, Ila Neustadt, "UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design", 2nd Edition, Pearson, (2005).

Reference Books:

1. Craig Larman, "Applying UML and Patterns: An introduction to OOAD and design and interface deployment", Pearson, (2002).

2. Alan Dix, Janet Finlay, Gregory d Abowd, Russel Bealel,"Human Computer Interaction", 3rd edition, Pearson education, (2008).

3. Stephen R.Schach, "Software Engineering", Tata McGraw-Hill Publishing Company Limited,(2007).

FUNDAMENTALS OF INFORMATION TECHNOLOGY

Course Code : 15 CS 30A8 **L-T-P :** 3-0-0

Prerequisite : Nil **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the architectural design of a computer and various basic concepts of operating systems and programming fundamentals	a	2
CO2	Analyze various software development methodologies and gain capability to design databases.	e	2
CO3	Designing various model diagrams using Unified modelling language and understand basic commands that come across in querying a database.	e	2

SYLLABUS:

Fundamentals of Computers: Introduction, Architecture, organization of a small computer, center Processing Unit, Execution cycle, Instruction categories, measures of CPU performance, Memory, Input/output devices, BUS-addressing modes. System Software: Assemblers, Loaders and linkers, compilers and interpreters. Operating System: introduction, memory management schemes, Process management, scheduling, threads. Programming Fundamentals: Problem solving with algorithms, Programming styles, coding Standards and Best practices, Introduction to C Programming, Testing and Debugging. Code reviews. System Development Methodologies: Software development Models. User Interface Design: introduction, the process, Elements of UI design & reports. RDBMS: Introduction, Data processing, the database technology, Data models ER Modeling: Concept, Notations, Extended ER features, Logical database design Normalization: Functional Dependency, Normal Forms. SQL: DDL statements, DML statements, DCL statements, writing Simple queries. SQL tuning techniques: Embedded SQL, OLTP. Object oriented concepts: Object oriented programming, relationship, Inheritance, Abstract classes, polymorphism, UML Diagrams, Object Oriented Design Methodology. Rational Rose Tool: Application of OOC using Rational Rose Tool.

TEXT BOOKS:

1. Andrew S. Tanenbaum, Structured Computer Organization,PHI,3rd ed.,1991
2. Siberschatz and Galvin, Operating System Concepts, 4th ed., Addision-Wesley,1995
3. Dromey R.G., How to solve it by Computers PHI,1994
4. Kernighan, Ritchie, ANSI C language PHI,1992
5. Wilbert o.Galitz essential Guide to user interface design john,wiley,1997
6. Alex Berson, Client server Architecture, McGrew Hill International,1994
7. Rojer Pressman,Softer Engineering-A Practitioners approach, McGraw Hill 5th ed., 2001
8. Alfred V Aho,E Hoproft, Jeffrey D Ullman, Design and Analysis or computer algorithms, Addison Wesley publishing Co..;1998
9. Henny F korth , Abraham Silbefrschatz, Database System concept, 2nd McGraw- Hill international editions,1991
10. Elmasri and Navathe, Fundamentals of Database systems, 4th edition, admison Wesely, Person Eductaion

IMAGE PROCESSING

Course Code : 15 CS 30A9 **L-T-P :** 3-0-0

Prerequisite : Nil **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Acquire the fundamental concepts of a digital image processing system	a	2
CO2	Identify and exploit analogies between the mathematical tools used for 1D and 2D signal analysis and processing by analyzing 2D signals in the frequency domain through the Fourier transform	e	2
CO3	Design and implement with Matlab algorithms for digital image processing operations suchf as histogram equalization, enhancement and restoration, filtering and denoising which develops an appreciation for the image processing issues and techniques and be able to apply these techniques to realf world problems.	e	2

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 FUNDAMENTLS: Elements of Visual perception, Image sampling and Quantization, Basic relationships between Pixels, Linear and Non-linear operations.

DIGITAL IMAGE TRANSFORMS: Image Transforms – The Discrete Fourier Transform, The FFT, Walsh, Hadamard, Discrete Cosine Transform, The Haar Transform, And The Slant Transform,

IMAGE ENHANCEMENT IN SPATIAL DOMAIN: Some basic Grey level transformations, histogram processing, enhancement using Arithmetic/Logic operations, Smoothing Spatial Filters, Sharpening Spatial Filters.

IMAGE ENHANCEMENT IN FREQUENCY DOMAIN: Introduction to 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 Degradations, 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 Descriptors

Text books:

1. Rafael C Gonzalez, Richard E Woods," Digital Image Processing", Second Edition, Pearson Education Asia, 2002. (Chapter 1, 3, 4, 5, 6, 7, 8, 9)
2. Jorg Arndt, " DSP Algorithms for Programmers"(Chapter 3)
3. Gonzalez. R & Woods B.E.," Digital Image Processing", Addison Wesley Longman Pearson Education, 2000.

REFERENCE BOOKS:

1. MilanSonka, Vaclav Hlavac and Roger Boyle, Image Processing Analysis and Machine Vision, Thomson learning, Second Edition, 2001.
2. William J Prati, "Digital Image Processing", John Wiley & sons
3. Tinku Acharya, Ajoy K Ray, "Image Processing Principles and Applications Principles and Applications", Wiley- Inter science.

LINUX PROGRAMMING

Course Code : 15 EM 30B1 **L-T-P :** 3-0-0

Prerequisite: Nil **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Describe and understand the fundamental LINUX operating system and utilities	a,e	2
CO2	apply shell scripts in order to perform basic shell Programming and analyze the Linux file system	k	3
CO3	Analyze the process concepts and create applications using and signal concepts IPC mechanisms	e,k	3

SYLLABUS:

Linux Utilities-File handling utilities, Security by file permissions, Process utilities, Disk utilities Text processing utilities, and Backup utilities Sed- scripts, operation, addresses, commands, applications, Awk execution, field and records , scripts, operation, patterns, actions functions using system commands in awk.

Working with Bourne again Shell (bash) responsibilities, here documents , running shell script, Shell as a programming language, shell meta characters, Control structures, arithmetic in shell, examples Interrupt processing, functions, debugging shell scripts.

Files : file Concept , File System Structure, I nodes, File Attributes, File types Library functions ,standard and formatted I/O in C, stream errors Kernel support for files ,System calls, file descriptors, low level file access File structure related system calls (FILE APIS), file and record locking File and directory management-Directory file APIS, Symbolic links and hard links

Process concept, Kernel support for process, process attributes, process creation , waiting for a process, Process termination ,Zombie process, orphan process, Process APIs Introduction to signals, signal generation and handling ,Kernel support for signals, signal function, unreliable signals , reliable signals Kill ,raise, alarm, pause, abort, sleep functions

Introduction to IPC , pipes, FIFOs- Introduction to three types of IPC-message queues, semaphores and shared memory -Kernel support for messages, Unix system V APIs for messages- Client /Server example

Text Books:

1. Unix and Shell Programming , B. A. Forouzan and R.F Gilberg, Cengage learning
2. Unix Concept and Applications, 4th edn. Sumitabha dasTMH
3. Beginning Linux programming 4th edn. N. Matthew , R stones Wrox Wiley India edn.

Reference Books:

1. Linux system Programming , Robot Love, O;Reilly, SPD
2. Unix Network Programming , W.R. Stevens , PHI
3. Unix Internals , U Vahalia , Pearson Educaiton
4. UnixandshellProgramming,S.G.KochanandP.Word3rdedn.PearsoEdn.

E-COMMERCE

Course Code : 15 EM 30B2 **L-T-P :** 3-0-0

Prerequisite : Nil **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Analyze various E-Commerce Business Models and Infrastructure	j	2
CO2	Understand the Ethical, Social and Political issues in E-Commerce	f	1
CO3	Analyze Marketing communications and Internet resources for E-Commerce	k	2

SYLLABUS

Electronic Commerce: Revolution. E-Commerce Business models and concepts: The Internet and World Wide Web: E-commerce infrastructure. Building an E-commerce web site, online Security and payment systems, E-Commerce Marketing concepts, , Ethical, Social and Political issues in E-Commerce, Retailing on the Web, Online Service industries, B2B E-Commerce: Supply chain management and collaborative commerce. E-Commerce Marketing communications, Internet Resources for Commerce: Technologies for Web Servers, Internet Applications for commerce, Internet Charges, Internet Access and Architecture, Searching the Internet

Text Books:

1. Kenneth C.Laudon, Carol G.Traver , E-Commerce, (Pearson Education)

Reference Books:

1. Daniel Minoli,Emma Minoli,'Web Commerce Technology Handbook',(TMG)
2. Elias M.Awad'Electronic Commerce'(PHI)

RENEWABLE ENERGY RESOURCES

Course Code : 15 EE 30B3 **L-T-P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand and analyze the solar thermal applications and solar photovoltaic cells.	a,i	1
CO 2	Analyze the performance of wind and tidal, wave and Ocean thermal energy conversion systems	b,e	2
CO 3	Understand and analyze the operation of geothermal and bio energy conversion	a,i	1
CO 4	Understand and analyze the biogas digesters and bio power plants	a,i	1

SYLLABUS:

Extraterrestrial solar radiation, terrestrial solar radiation, solar thermal conversion, flat plate and concentrated solar thermal collectors, solar ponds, solar heating/cooling technique, solar distillation, photovoltaic energy conversion, solar cells – 4 models.

Planetary and local winds, vertical axis and horizontal axis wind mills, principles of wind power, maximum power, actual power, wind turbine operation, yaw control, pitch control and stall control mechanisms, derivation of power coefficient.

Ocean temperature differences, principles of OTEC plant operations, wave energy, devices for energy extraction, tides, simple single pool tidal system.

Origin and types, Bio fuels, classification, direct combustion for heat and electricity generator, anaerobic digestion for biogas, biogas digester, power generation.

Biomass energy conversion technologies, Biogas generation – classification of

Biogas plants. Micro hydro electric systems- different types of turbines.

Text books:

1. Godfrey Boyle "Renewable Energy", Oxford Publications, Second edition.
2. G. D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, First edition.

Reference books:

1. Roger H.Charlier, Charles W. "Ocean Energy- Tide and Tidal Power"ISBN: Library of Congress Control Number: 2008929624_c Springer-Verlag Brerlin Heidelberg 2009.
2. John Twidell & Toney Weir: E&F.N. Spon, "Renewable Energy Sources", Taylor & Francis New York, 2nd edition.
3. John F.Walker & N.Jenkins, "Wind Energy Technology", John Willey and Sons Chichester, U.K – 1997

ROBOTICS

Course Code : 15 ME 30B4 **L-T-P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Analyze existing robotic systems with respect to their anatomy, type, performance specifications, end effectors etc.	b	2
CO 2	Suggest a robotic system design with respect to the suitable sensors, actuators for an intended application and simulate its performance	c	2
CO 3	Analyze robot manipulator performance with respect to digital control architecture comprising of PLC's /Microcontroller for an application	b	2
CO 4	Understand different programming languages	c	2

SYLLABUS:

Introduction to Robotics, Major components of a Robot, Robotic like devices, Classification of Robots – Classification by coordinate system and by control method, Specifications of Robots, Fixed versus flexible automation, economic analysis.

ROBOT END EFFECTORS: Introduction, End effectors, interfacing, types of End effectors, grippers and tools, considerations in the selection and design of remote centered devices.

ROBOTIC SENSORY DEVICES: Objective, Non-Optical position sensors – Potentiometers, Synchros, inductosyn, optical position sensors – opto interrupters, Optical encoders (absolute & incremental).

PROXIMITY SENSORS: Contact type, non-contact type – reflected light scanning laser sensors.

TOUCH & SLIP SENSORS: Touch sensors – proximity Rod & Photodetector sensors, Slip sensors – Forced oscillation slip sensor, interrupted type slip sensors, force and torque sensors.

TRANSFORMATIONS AND KINEMATICS: Objectives, homogeneous coordinates, basic transformation operations, forward solution – Denavit Hartenberg procedure, Simple problems involving planar manipulators, inverse or backward solution – problems involved, techniques.

Introduction to Trajectory Planning, the manipulator jacobian.

ROBOT APPLICATIONS: 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 LANGUAGES: Introduction, AL, AML, VAL, RAIL

TEXT BOOK

1. Robotic engineering by Richard D. Klafter, Prentice Hall India
2. Industrial robotics by Mikell P.Groover, Mcgraw Hill Publications

REFERENCE BOOKS:

1. Robotics – K.S. Fu, Gonzalez & Lee, Mcgraw Hill Publications
2. Robotics For Engineers by YoramKkoren, Mcgraw Hill Publications
3. Introduction to Robot Technology, - P.Coiffet and M.Chairenze / Kogam Page Ltd. 1983 London.

MECHATRONICS

Course Code : 15 ME 30B5 **L-T-P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Identify appropriate sensors, actuator, microcontrollers etc. for a given application	c	2
CO 2	Model system performance and estimate the expected system behaviour	b	2
CO 3	Suggest a mechatronic product design for the intended application and evaluate its performance	c	2
CO 4	Understand digital logic and PLC	c	2

SYLLABUS

INTRODUCTION TO MECHATRONICS: Introduction, Elements of Mechatronic system, Applications.

SENSORS AND TRASDUCERS: Introduction, Classification of Sensors, selection of sensors. Classification of transducers - strain gauges, displacement transducers, capacitive and inductive transducers, LVDT, oscillation transducer, piezoelectric, potentiometric, velocity transducers, temperature transducers, optical transducers.
SIGNAL CONDITIONING: Introduction, data acquisition –Quantizing theory, Analog to Digital conversion, Digital to Analog conversion.

DATA PRESENTATION SYSTEMS: Data presentation elements, Data acquisition systems, systems measurement, Testing and calibration.

ACTATION SYSTEMS: Pneumatic and hydraulic actuation systems, Stepper and Servo Motors.

SYSTEM MODELS: Modeling of one and two degrees of freedom Mechanical, Electrical, fluid and thermal systems. Block diagram representations for these systems.

SYSTEM RESPONSE: Introduction, Transfer function, Time response and Frequency response analysis mechanical systems and electrical systems.

CLOSED LOOP CONTROLERS: Continuous and discrete processes, control modes, Two-step, proportional, Derivative, integral, PID controllers.

DIGITAL LOGIC: Logic gates, Boolean algebra, Karnaugh maps.

PLC: Introduction, basic structure, I/P ,O/P processing, programming, ladder diagrams, Timers, Internal relays and counters ,data handling, Analogue Input and Output, selection of a PLC.

DESIGN: Mechatronics system Design, possible design solutions.

CASE STUDY: pick and place Robot, CNC Machine.

TEXT BOOKS:

1. W.Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" , 3rd Edition, Pearson education,2007.
2. David G. Alciatore, Michael B. Histand ," Introduction to mechatronics and measurement systems", 2nd Edition, McGraw-Hill Professional, 2002.

REFERENCE BOOKS:

1. A.K.Sawhney, "A course in Electrical and Electronic Measurement and Instrumentation"- Dhanpat Rai & Sons - 1991.
2. Nitaigour Premchand Mahalik, "Mechatronics", Tata McGraw-Hill, 2003.
3. HMT Limited, "Mechatronics", McGraw-Hill Education (India) Pvt Ltd, 2000.
4. T.G. Beckwith & N.L.Buck, "Mechanical Measurements", 3rd Edition, Addison-Wesley Pub. Co., 1969.

OPERATIONS RESEARCH

Course Code : 15 ME 30B6 **L-T-P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Model and solve for the optimum solutions using LPP	a	2
CO 2	Model and optimize transportation and assignment problems	b	2
CO 3	Model and optimize Game theory, DPP, Queuing theory & Simulation problems	e	2
CO 4	Understand concepts of PERT/CPM	c	2

SYLLABUS:

Introduction to Operation Research: Introduction, Modeling in Operations Research, Phases of OR study, Scope and application of OR. Linear Programming and its Applications: Linear Programming Problem – Graphical solution of LP Problem. Simplex method, Big M method, two phase method, multiple solution, infeasible solution, unbounded solution, degeneracy, Dual Simplex method. Transportation: Introduction – Methods of basic feasible solution, Optimality test, Degeneracy in transportation problem, unbalanced transportation Problem, Assignment Problems: Hungarian method for assignment problem, Traveling salesman problem. Theory of Games: Introduction, to solve the rectangular two person zero sum games, solution of rectangular games in terms of mixed strategies, solution of 2x2 games without saddle point, solution of a two person zero sum 2Xn game, Graphical method for 2Xn and nX2 games. Inventory Control: Introduction – EOQ with uniform rate of demand, Economic lot size with finite rate of replenishment, Quantity discounts, Deterministic model with Shortages, ABC analysis of inventory. Dynamic Programming: Introduction, Bellman's principle of optimality, application to shortest route problem, linear programming, tabular method. Queuing Theory: Introduction, single channel, Poisson arrival, exponential service time with finite population and infinite population, Simulation: Introduction, Monte-Carlo Simulation, Application to Inventory Control. Project Management by PERT/CPM: Introduction, simple network techniques, construction rules of drawing, Fulkerson's rule, Critical path method (CPM)- floats, critical path, project duration, PERT: Introduction, different Time estimates, expected time, variance, expected project duration and probability of completion. Crashing: Introduction, crashing of network, problem

Text Books:

1. Operations Research - Hamdy Taha
2. Operations Research – Hiller & Liberman.

Reference Books:

1. Quantitative Techniques – A.P. Natarajan
2. Operations Research – S.D. Sarma

NANO MATERIALS AND TECHNOLOGY

Course Code : 15 PH30B7 **L-T-P :** 3-0-0

Pre Requisite : NIL **Credits :** 3

Mapping of Course outcomes with student outcomes

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the essentials of nanomaterials and nanotechnology along with various methods used to fabricate nanomaterials. Also, recognize the several techniques used to characterize nanomaterials	c,i	1
CO 2	Understand the mechanical, optical & electrical properties of nanomaterials and also understand the concepts and applications of carbon based nanomaterials	c,i	1

SYLLABUS:

Introduction: Evolution of science and technology, Introduction to Nanotechnology, Nanotechnology-Definition, Difference between Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology, Moore's law, Bottom up and top down approaches, challenges in Nanotechnology .

Nano materials: History of materials, Nanomaterials-Definition, Classification of Nano structured materials, causes of interest in nanomaterials, some present and future applications of nanomaterials, Bio-Medical Applications-Drugs, Drug Delivery, Photodynamic therapy, Molecular motors, Neuro-Electronic Interfaces, Protein Engineering, Nanoluminescent tags.

Synthesis and processing of nanoparticles, thin films: Nanoparticles: Processes for producing ultrafine powders-mechanical milling, wet chemical synthesis, gas condensation process, chemical vapour condensation, laser ablation.

Thin Films: Synthesis techniques- Physical Vapor Deposition: Evaporation, Molecular beam epitaxy, Sputtering. Comparision of evaporation and sputtering.

Special nanomaterials, characterization and tools : Carbon nanotubes, nano composites, carbon fullerenes-An overview over preparation, properties, applications. Electron Microscopy Techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Scanning Probe Microscopy– X ray Diffraction.

MEMS: – Introduction, types of MEMS:- Mechanical, Thermal, Magnetic MEMS; Fabrication of MEMS.

Text Books

1. Nano structures & Nano materials by Guozhong cao, Imperial college press.
2. Micro manufacturing and Nano Technology by N.P.Mahalik.

Reference Books

1. Nano Technology by Mark Ratner & Danier Ratner, Prentice Hall
2. Nano materials by A S Edelstein& R C Cammarata, Institute of physics publishing, Bristol and Philadelphia

SUBSEA ENGINEERING

Course code: 15 PE 31B8 **L-T-P:** 3-0-0

Pre Requisite: NIL **Credits:** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the subsea engineering, field development, distributions system used in subsea.	a	1
CO 2	Apply the surveying to the subsea, understand the control system in subsea, understand the effect of corrosion and scale on the subsea equipment	a,e	2
CO 3	Understand the why normal conventional equipment is not utilized in subsea (well head, X trees, risers, pipelines)	a,e	1

SYLLABUS:

Overview of subsea engineering, subsea field development, distribution systems, subsea surveying positioning and foundation, installation of subsea equipment, subsea control, power supply, subsea hydraulics, subsea corrosion and scale, subsea connections and jumpers, subsea well heads and X-trees, subsea drilling risers, subsea production risers, subsea pipelines, subsea risk and reliability.

Reference Books:

1. Yong Bai, Qiang Bai, "Subsea engineering handbook", Gulf publishers, (2010)
2. Yong Bai, Qiang Bai, "Subsea pipeline and risers", Gulf publishers, (2005)
3. Boyun Guo, Shanhong Song, Jacob Chacko, Ali Ghalambor, "Offshore Pipeline", Gulf publishers, (2005)

OIL AND GAS MANAGEMENT

Course code: 15 PE 41B9 **L-T-P:** 3-0-0

Pre Requisite: NIL **Credits:** 3

Mapping of the course outcomes with student's outcomes.

Co. No.	Course outcome's	Mapped SO	BTL
CO 1	Understand the global oil and gas market	a	1
CO 2	Understand the E&P activities, marketing and transportation of oil and gas	a	1
CO 3	Understand the refining activities, estimating the future of oil and gas industry	a	1

Syllabus:

Global Oil and Gas: Value Chain and Geopolitics of Oil

The Upstream: Exploration, Development, and Production

The Midstream: Markets and Transportation

The Downstream: Refining and Marketing

The Future Oil and Gas Industry

Reference Books:

1. Adedeji B. Badiru Samuel O. Osisanya, "Project Management for the Oil and Gas Industry", CRC Press, 2013.
2. Use Internet sources for present trends.

SELF DEVELOPMENT

Course Code : 15 GN 30C1 **L-T-P** 3-0-0

Prerequisite: Nil **Credits:** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Illustrate and realign values based on goal.	f, h,i	2
CO2	Demonstrate various types of Yoga and identify commonalities of different religions.	f, h,i	2
CO3	Illustrate practices of different Schools of Meditation and self-motivated approach to pursue a balanced life	f, h,i	2
CO4	Demonstrate techniques of stress management and Self-management focused interest in a Spiritual Practice	f, h,i	2

SYLLABUS:

Orientation, Discussion on Values: Understanding Values, Behavior and Attitudes, Application of Values and Universal Values,

Philosophy of Yoga : God, Self and Ultimate goal of yoga, Brief Introduction to various types of yoga and Integration of values in Yoga,

Study of major Religions : Identify commonality, condition of its origin or intention vs. current state,

Art of Meditation : Observation, Introspection, Contemplation, Meditation and Concentration, Schools of Meditation,

Systematic Practice of Meditation: Theories of life, Need for Meditation, Natural Path, Integration Personal Responsibility: Stress Management, Tips for Self-Management, Choices we make, Excellence.

Text Book :

1. Self development modules from Heartfulness Institute Initiative of Shri Ram Chandra Mission (www.heartulness.org)

Reference Books :

1. Complete works of Swami Vivekananda
2. Jonathan –Livingston - Seagull
3. The Monk Who Sold His Ferrari_Robin S. Sharma
4. You can win by shiv khera
5. Many lives Many Masters
6. The road less travelled – Scott Peck
7. As a man thinketh
8. Journey of the Soul
9. The Bhagavad-Gita
10. King James version of the Holy Bible
11. Holy-Quran

INDIAN CULTURE AND HISTORY

Course Code : 15 GN 30C2 **L-T-P:** 3-0-0

Prerequisite : Nil **Credits :** 3

Mapping of Course out comes with student out comes:

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the basic features of Indian Culture and early civilizations of Indian History up to Religious Movements	h	1
CO2	Gain basic knowledge in the major socio political concepts of important kingdoms from Mauryas to Mughals.	h	1
CO3	Gain Knowledge in the aspects of Modern India and Indian National Movement up to	h	1
CO4	Acquire Knowledge in the area of Final Phase of Indian National Movement and partition of India	h	1

SYLLABUS:

Indian culture – characteristics, Salient aspects of Indian Music and Dance - brief introduction of Architecture and Painting.

Pre-Historic Period- Indus Valley Civilization- Vedic Age - Emergence of Mahajanapadas - Age of Religious Movements: Jainism, Buddhism - The Age of the Guptas.

Transformation from the Ancient Phase to Medieval Phase - The Delhi Sultanate - Beginning of Indo-Islamic Culture - Emergence of Provincial Kingdoms - The Mughals - Rise of Independent Autonomous States - The Marathas (1649-1748)

Advent of European Commerce - British Expansion in India - The British Administrative Structure in India- British Policy towards Economy of India - Social and Cultural Awakening in the 19th Century - Education under the British Rule.

The Growth of Nationalism - Foundation of the India National Congress- Growth of Extremism or Militant Nationalism and Partition of Bengal- Beginning of Communalism- Revolutionary Terrorism and Home Rule Movement- Beginning of the Gandhian Era and the Non-Cooperation Movement - Resurgence of Revolutionary Terrorism (1924-1934)- Trade Union Movement - Civil Disobedience Movement - Second world war and the National Movement- Quit India Movement- Subhash Chandrabose and Indian National Army- The Final Phase: Independence and Partition

REFERENCES:

1. Facets of Indian Culture- Spectrum Publications
2. Ancient India: National Council of Educational Research and Training
3. Medieval India: Part I & Part II: National Council of Educational Research and Training.
4. Modern India: National Council of Educational Research and Training.
5. Ancient India: V.D. Mahajan: S. Chand & Company Ltd., New Delhi
6. An Advance History of India: R.C. Majumdar, H.C. Raychaudhuri & Kalikinkar Datt: Macmillan India Ltd.,

7. The Wonder that was India : A. L. Bhasham.
8. India's struggle for Independence 1857-1947: Bipan Chandra: Penguin Books
9. History of Freedom Movement in India: Vol. 1 to IV: Tara Chand: Publications Division
10. Essays on Contemporary India: Bipan Chandra: Har-Anand Publications.

EMOTIONAL INTELLIGENCE

Course Code : 15 GN 30C3 | **L-T-P :** 3-0-0

Prerequisite : NIL | **Credits :** 3

Syllabus:

Course Objective: The main objective of the course is to enable the students understand meaning and importance of emotional intelligence.

Emotional Intelligence: The Concept, dimensions of emotions; Theories of Multiple intelligences; importance of emotions; emotions and the brain; The Role of Emotions in Organizations; Self-Awareness and Self-Control; Empathy; Social Expertness; Personal Influence.

Emotional Intelligence and Personality: relationship between EQ and IQ; human mind; consequences of low and high EQ; EQ development; Emotional Skills; emotional factors: Emotional Competency, Emotional Maturity, and Emotional Sensitivity.

Levels of EI: Models of Emotional Intelligence; emotional intelligence competencies; emotional intelligence and leadership behavior; emotional intelligence and stress management; art of influencing people.

The Role of Emotional Intelligence in Professional Success: Emotional Intelligence and the Complexity of Work; Emotional Intelligence and High IQ Professions; Emotional Intelligence and Leadership; manage emotional upsets; Emotional 'Winner'.

EQ in the Indian Perspective; EQ and Managerial Effectiveness; the soft art of being a tough leader.

Recommended Textbook(s):

1. Dalip Singh - Emotional Intelligence at Work: A Professional Guide – Response Books – 2006.

Reference Books:

1. Daniel Goleman, Emotional Intelligence, Bantam Books, 2006.
2. Moshe Zeidner, Gerald Matthews, and Richard D. Roberts, What We Know About Emotional Intelligence – How It Affects Learning, Work, Relationships, and Our Mental Health, The MIT Press, 2009.
3. James Bradford Terrell and Marcia Hughes , A Coach's Guide to Emotional Intelligence: Strategies for Developing Successful Leaders , Wiley, 2008.
4. Dr. Jeanne Segal , The Language of Emotional Intelligence, McGraw-Hill, 2008

PROFESSIONAL ETHICS AND VALUES

Course Code : 15 GN 30C4 **L-T-P :** 3-0-0

Prerequisite : NIL **Credits :** 3

Syllabus:

Professional Ethics is the application of moral reasoning to established professions such as legal, medical, nursing, engineering, journalistic, and so on. Moral reasoning entails the search for values and principles that promote a good life and human flourishing. Professionals employ their expertise in ways that greatly affects the lives of others. It is critically important that professionals are thoughtful and reflective about the role of ethics in their work. Through successful completion of course readings andf assignments – and through active participation in class discussions – students will hopefully gain the tools to identify and analyze ethical issues.

Values in human society and types of values: Understanding of values; definition; culture and values; The wider applications of values; societal values; aesthetic values; organizational values; spiritual values;

Ethics and ethical values: Importance of values; value crisis at individual level, societal level, cultural level; social disorganization; value crisis management; Canons of ethics; types of ethics.

Professional ethics: Overview; ethics in engineering profession; code of professional ethics; organizational ethics; Violation of code of ethics: causes and consequences; Whistle blowing; Work place ethics, Women related issues; Industry and Industrialization: Problems of man-machine interaction; impact of assembly line and automation; industrial relations; ethics and industrial law.

Science, Technology and Engineering: Engineering as a profession; renewable and non-renewable resources; sustainable development; technology transfer; joint ventures of technology transfer and subsequent Indianization.

Environment and Eco-friendly technology: What is environment? Human development and environment; pollution and pollution control; Eco-friendly technologies, Green pactices.

Recommended Text Book(s):

1. Samita Manna and Suparna Chakraborti, 2010, Values and Ethics in Business and Profession, Published by Asoke K. Ghosh, PHI Learning Pvt. Ltd., M-97, Connaught Circus, New Delhi – 110001

Reference books:

1. William O' Donohue, Kyle Ferguson, 2003, Handbook of Professional Ethics for Psychologists, Sage Publications, Inc., California.
2. S. Dinesh Babu, 2007, Professional Ethics and Human Values, Laxmi Publications, Pvt. Ltd., 113, Golden House, Daryagunj, New Delhi-2.
3. Vaisali R. Khosla, Kavitha Bhagar, 2009, Human Values and Professional Ethics, first edition, Technical Publications, Pune.
4. R S Nagarazan, 2007, A Text Book of Processional Ethics and Values, New Age International.

5. A. Alavudeen, R. Kalil Rahman, M. Jayakumaran, 2008, Professional Ethics and Human Values, Laxmi Publications, Pvt. Ltd., 113, Golden House, Daryagunj, New Delhi

BEHAVIORAL SCIENCES

Course Code : 15 GN 30C5 **L-T-P :** 3-0-0

Prerequisite : NIL **Credits :** 3

Course Objective : The objective of the course is to increase the students' knowledge of behavioral aspects of individuals and interactions among the individuals and the groups.

Introduction to Behavioural Science; Foundations of Individual Behavior: Personality- Personality determinants; Personality traits: The Big Five Model, Major personality attributes influencing OB; Theories of personality; Values – Types of Values.

Learning- Theories of learning; Principles of learning; Attitudes – Source of attitudes; Types of Attitudes, Attitudes and consistency – Cognitive Dissonance theory.

Perception- Perceptual process; Factors influencing Perception; perceptual distortion; Linkage between perception and individual decision making; Motivation – Theories of Motivation – Hierarchy Needs Theory – Two-Factor Theory – Expectancy Theory; Applications of Motivation.

Foundations of Group Behavior: Groups – Nature of groups; Types of groups; Stages of Group Development; Group Cohesiveness; Teams vs Groups

Leadership – Nature; Leadership Styles; Theories of leadership: Trait Theories, Behavioral Theories and Contingency Theories.

Recommended Text Book(s):

1. Aswathappa, Organizational Behaviour, Himalaya Publishing House, 2010.

Reference books:

1. Robbins, Stephen, Timothy, A & Sanghi, S. Organizational Behavior, 13th Edn, Pearson Education. 2009.
2. Fred Luthans, Organizational Behaviour, Prentice Hall, 2007.
3. Udai Pareek, Organizational Behavior, Oxford Publishers, New Delhi, 2008.

List of Management Electives

PARADIGMS IN MANAGEMENT THOUGHT

Course Code : 15 MB 3051 **L-T-P :** 3-0-0

Prerequisite : NIL **Credits :** 3

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the basic management concepts along with an insight into levels of management.	j	2
CO2	Understand the key contributions of classical approach to Management	i	2
CO3	Understand and apply Quantitative methods to improve Management performance.	i	2
CO4	Understand the key contributions of Behavioural and contemporary approaches to Management.	i	2

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: (a) Scientific Management- The advent of Scientific Management – Frederick W Taylor's contributions, - Contribution by Henry L Gantt - Contribution by Frank, Lillian Gilberth.

General Administrative Approach: Henry Fayol's contributions towards general management – Max Weber's Bureaucracy Approach.

Quantitative Approach: Important contributions – TQM – implications in today's management – Six sigma.

Behavioral Approach: Organizational Behaviour – Contributions of Elton Mayo's – .Hawthorne studies – contributions of Mary Parker Follett – Chester Bernard.

Contemporary Approach: Systems Theory – Contingency Theory – Chao's Theory -Peter F Drucker Contributions – C K Prahlad's Contribution – Porter's theory – Worker Management – Employee Engagement – People Capability Maturity Model.

Recommended Text Book(s):

1. Management by Stephen P Robbins, Mary Coulter, Neeharika Vohra – Pearson – 10th edition

Reference Books:

1. Management by Stoner, Freeman, Gilbert – PHI – 7th edition.
2. Management A Global & Entrepreneurial Perspective – Weihrich, Cannice, Koontz – Mc Graw Hill – 13th Edition.
3. The evolution of management thought by Daniel A Wren, Arther G Bedeian: john wiley & sons

INDIAN ECONOMY

Course Code : 15 MB 3052 **L-T-P :** 3-0-0

Prerequisite : NIL **Credits :** 3

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the structure of Indian Economy	j	2
CO2	Understand the role of the Indian Economy in the global context.	i	2
CO3	Develop a perspective on the different problems and approaches to economic planning and development in India	h	2

SYLLABUS:

Economy: Meaning, types, problems and functions – Features of Indian Economy: Circular flow of economic activity: two sector, three sector and four sector models. Sectoral distribution of the economy. Nature and features of Indian Economy; Sectoral contribution of National Income-Share of Public and Private Sectors in GDP.

Agricultural Sector of India: importance and general problems; Land Reforms, Agricultural marketing problems and remedies. Industrial Sector of India: Types, Importance and general problems: Small Scale Sector: Importance and general problems.

Tertiary Sector in India- Importance – Infrastructure Development – Transport – Roadways, Railways – Banking and Insurance –Communication – Science and Technology – Software. Personal Income distribution and causes of inequality - Unemployment causes and remedial measures; Poverty in India- Poverty Line – antipoverty programs. Human development: concept and measurement - Human Development Index.

Economic Planning in India: Role of Planning Commission - Over all Objectives and achievements of various Five Year Plans. 12th Five Year Plan; Economic Liberalisation: LPG strategy-General Agreement on Tariffs and Trade (GATT) - Objectives of GATT and Evolution of WTO – WTO and the Indian Economy, NABARD and World Bank.

Recommended Text Book(s):

1. G.Dutt and K.P.M.Sundaram: Indian Economy (2011), S.Chand&Co., New Delhi.
2. S.K.Mishra and V.K.Puri: Indian Economy, 30th ed., Himalaya Publishing House, New Delhi.
3. M.L.Jingan: Macro Economics, 6th ed., Konark Publishing House.

Reference Books:

1. P.K.Dhar, Indian Economy-Its growing dimension, Kalyani Publishers.
2. Alok Ghosh, Indian Economy, Its Nature and Problem, World Press.
3. A.N.Agarawal, Indian Economy- Problems of Development and Planning, New Age

MANAGING PERSONAL FINANCES

Course Code: 15 MB 3053 **L-T-P :** 3-0-0

Pre-Requisite: Nill **Credits :** 3

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the need for effective financial planning	j	2
CO2	Analyze the basic concepts of money management, tax planning, consumer credit, housing and other consumer decisions, insurance, investments, retirement planning etc.	i	2
CO3	Evaluate various financial tax saving schemes to save money to get tax benefits.	h	2
CO4	Design savings and investment plans.	h	2

Syllabus:

Financial planning process: Introduction-Importance of Financial Planning- Process of financial planning -The planning environment-Determinants of personal income- Financial statements and plans-Concept of Time value of money - Preparing a personal balance sheet - Preparing the income and expense statement-Using personal financial statements - Ratio Analysis.

Managing Taxes: Introduction-Importance of tax planning-Basic concepts of income tax - Personal taxation -Income tax benefits on certain long term investments -Tax planning-Ethical consideration in tax planning.

Making decisions regarding houses and automobiles:- Meeting housing needs-The rental option - The home buying process - Financing the housing transaction - Housing finance institutions in India - Housing schemes in India- Automobile purchase planning.

Planning for Investments: Types of investment vehicles-Factors considered in the choice of investments- Developing the investment strategy-Investing in Equities- Investment Process-Investing in Fixed Income Securities- Bond Market-Bond Investing Strategies-Types of Bonds-Bond Returns- Risks from Investing in Bonds

Insurance & Mutual Funds: Insurance planning - Buying a life insurance - Life insurance products in India- Health Insurance-Need-Types and Sources of health care plans-Providers of Health care-Long term care insurance-Disability income insurance-Health Insurance in India; Mutual funds – Types of mutual fund products – Objectives of investing in Mutual funds.

Recommended Text Book(s):

1. Jack R Kapoor, "Personal Finance" Mc Graw Hill Publications, New Delhi, 2008.
2. KC Mishra and Steward Doss, "Basics of Personal Financial Planning" Cengage Learning, First Edition 2009.

Reference books:

1. Joehnk, Billingsley and Gitman "Planning Your Personal Finances" Cengage Learning India Private Limited, Delhi, 2012.
2. Mark Hirschey and John Nofsinger "Investments Analysis" and Behavior" Mc Graw Hill Publications, New Delhi, 2008.

BASICS OF MARKETING FOR ENGINEERS

Course Code : 15 MB 3054 **L-T-P :** 3-0-0

Pre-Requisite : Nill **Credits :** 3

Co. No.	Course outcome's	Mapped SO	BTL
CO1	Understand the concepts of marketing, factors influencing the consumer behavior, decision making process and strategic areas of 4Ps	j	2
CO2	Analyze the markets and consumers, the changing environmental factors with special focus on technology products	b	2
CO3	Create an appropriate strategy for the marketing of high tech products and services.	c	2

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.

Understanding Consumer Behaviour: nature, scope and importance of consumer behavior – Factors influencing Consumer Behavior - 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, Introduction to market study.

Text Books:

1. Philip Kotler and Gary Armstrong- Principles of Marketing- 15/e, Pearson Education.
2. Jakki J Mohr, Sanjit Sengupta and Stanley Slater, Marketing of High-Technology Products and Innovations, 3/e Pearson India

Reference Books:

1. V.S. Ramaswamy and S.Namakumari – Marketing Management, 4/e, Mc Millan Publications, New Delhi.
2. Rajan Saxena, Marketing Management- 3/e, TMH, New Delhi.

ORGANIZATION MANAGEMENT

Course Code : 15 MB 3055 **L-T-P :** 3-0-0

Prerequisite : NIL **Credits :** 3

SYLLABUS :

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

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

Motivation, Morale and behavioral science—Motivation: Characteristics, importance, Kinds of motivation. Thoughts of motivational philosophy: Gouglass Mc Gregore—X and Y theory; Herzberg's theory. Human needs, Incentive as motivators, Managing dissatisfaction and frustration. Morale, Absenteeism, Behavioral science, Group dynamics, Group behavior. Leadership—Meaning, importance, styles, theories, leaders Vs managers.

Management concept—Management, Administration, Organisation, Difference and Relationship between Management, Administration and Organisation, Importance of Management, Characteristics of management, Managerial Skills, Managerial Objectives, Harmonization of Objectives, Hirechy of Objectives.

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

TEXT BOOKS

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

REFERENCES

1. Banga & Sarma , Industrial Engineering Management including Production management, 11th edition, 2010.
2. O.P. Khanna , Industrial engineering management, Khanna publications, 2006.

RESOURCE, SAFETY AND QUALITY MANAGEMENT

Course Code : 15 MB 3056 **L-T-P:** 3-0-0

Prerequisite: NIL **Credits :** 3

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; Earth moving 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 cost owning and operating the equipment; Equipment maintenance.

Safety and Quality Management:

Accident prevention program; Immediate attention in case of accident; Approaches to improve safety in construction; Safety benefits to employees, 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.

TEXT BOOKS:

1. Construction Engineering and Management by S.Seetharaman; Umesh Publications, Nai Sarakl, Delhi.
2. Fundamentals of PERT/CPM and Project Management by S.K.Bhattacharjee; Khanna Publishers, Nai Sarak; Delhi.

REFERENCE BOOKS:

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

SYLLABUS
FOR
HONORS DEGREE
COURSES

BIOCHEMICAL ENGINEERING

Course Code : 15BT5102 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

Syllabus:

Introduction to Biochemical reactions

Types of reactions (Simple stepwise and Parallel) and their applications in fermentations, reaction rates, kinetics of homogenous reactions, molecularity and order of reaction and temperature dependency of reaction rate.

Design and Operation of Bioreactors

Mass transfer aspect, Bioreactor types and design, Continuous stirred tank bioreactors, fed batch bioreactors, airlift bioreactors, Fluidised bed bioreactor, Bioreactors for plant and animal cell, scale up of bioreactor using constant p/v and constant KLa..

Mass Transfer in Bioprocess Operation

Mass transfer by diffusion, Theories of Diffusional mass transfer film theory, Penetration theory, Surface renewal theory Mass transfer by convection, Gas-liquid mass transfer, correlation for mass transfer coefficient, measurement of KLa, O2 transfer, methodology in fermenters, specific oxygen uptake rate, critical oxygen concentration, maximum cell concentration.

Heterogeneous reactor systems

Classification of reaction systems, (homogenous, heterogeneous), mass transfer consideration in heterogeneous systems, Intra particle diffusion and reaction rates, Effectiveness factor and Thiele modules, observed Thiele modules, criterion for mass transfers limitations.

Non-ideal flow in bioreactors

Reasons for non-ideality, RTD studies (F-Curve, C-Curve for ideal and non-ideal CSTR and plug flow reactors), mean and variance of residence time, conversion using tracer information, modeling of non-ideal flow behavior by dispersion model.

Recommended textbooks:

1. Introduction to Biochemical Engineering by D.G.Rao

2. Biochemical Engineering fundamentals by Bailey and Oliss

Reference Books:

1. Bioprocess Engineering Principles by Pauline and Doran

MOLECULAR BIOLOGY & R-DNA TECHNOLOGY

Course Code : 15BT5103 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

Scope: Recombinant DNA technology is fundamental to molecular biotechnology that is comprised of different scientific disciplines i.e. molecular biology, microbiology, biochemistry, immunology etc. The subject generates a wide range of consumer products (i.e. crops, drugs, vaccines, diagnostics, and livestock). Recombinant DNA technology uses prokaryotic and eukaryotic organisms and is the manipulation of DNA to generate clones, examine gene regulation, and express proteins. The course includes current technical procedures for recombinant DNA technology and its applications.

DNA STRUCTURE & REPLICATION

Structure of DNA:- Watson & Crick's model, Types of DNA, Denaturation and renaturation Kinetics, Replication of DNA- Semi conservative, bi-directional replication. DNA damage and repair: Types of DNA damages- deamination, alkylation, pyrimidine dimmers; Repair mechanisms-Excision, mismatch and SOS repair, Recombination: Homologous and non homologous; rec gene and its role in DNA repair.

TRANSCRIPTION AND TRANSLATION

Structure of Promoters-RNA Polymerases of Prokaryotic and Eukaryotic Organism;

Transcription- Initiation, Elongation and Termination; Prokaryotic & Eukaryotic transcription; Post Transcriptional Processing of Eukaryotic RNA. Translation in prokaryotic and Eukaryotes: initiation of translation, elongation of polypeptide chain, termination of translation. Post-translational modifications.

REGULATION OF GENE EXPRESSION

Regulation of Gene expression in bacteria- Operon concept, lac, trp, ara operons. Control of gene expression by sigma factor and post transcriptional control. Absolute control by antisense RNA's; enhancers, upstream controlling elements, structural Motifs of transcription factors: helix turn, zinc finger motifs, leucine zippers and homeotic genes.

ENZYMES AND VECTORS IN CLONING

Restriction Enzymes; DNA ligase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern, Colony hybridization & FISH, Plasmids; Phagemids; Cosmids; Shuttle vectors, Artificial chromosome vectors (YACs; BACs); Expression vectors: Baculovirus and pichia vectors system; Plant based vectors: Ti and Ri vectors, Construction of cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Yeast two hybrid system; Phage display.

PCR, SEQUENCING & RNA TECHNLOGIES

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR; PCR Applications Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; Introduction to siRNA; siRNA technology; Micro RNA;

Principle and application of gene silencing; Gene knockouts and Gene Therapy; knockout mice; Disease model; Transgenics; Differential gene expression and protein array.

Recommended Text Books:

1. Fundamentals of Molecular Biology by Avinash & Kakoli Upadhyay; Himalaya Publications.

APPLIED BIOINFORMATICS

Course Code : 15BT5104 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

Syllabus:

Scope: The Course aims to prepare the students for understanding biological data at molecular level from both informational and biological perspective and impart conceptual, computational and practical skills to acquire, analyze, process or use the data to address significant problems in the field of Bioinformatics, of both pure and applied nature.

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 modeling - SPDBV, Threading, Ab-initio method; Structure Evaluation – DSSP, ProCheck, Verify 3D; Structure comparison.

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

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.

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 (SBML), E-cell, V-cell simulations and Applications

Recommended Textbooks:

1. G. Gibson and SV Muse, A Primer of Genome Science, Second Edition - Sinauer Associates, Inc.

2. CW Sensen, Essentials of genomics and Bioinformatics, Wiley-VCH publication.

Reference textbooks:

1. Speed T. (ed.) Statistical analysis of gene expression microarray data (CRC, 2003)

IMMUNO TECHNOLOGY

Course Code: 15 BT 5206 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

Immune system overview, innate and acquired immune system. Components of immune system.Phagocytosis; Inflammation, opsonization. Primary and secondary lymphoid organs. Complement. B cell, T cell ontogeny. Characteristics of antigen, T cell dependent and independent antigens and Super antigens. Types and applications of Hapten and Adjuvant.

Immune response

Generation of immune response - Primary and Secondary immune responses. Structure, functions of antibody and BCR.. Generation of Antibody diversity. TCR structure, δ γTCR. MHC I and II gene, polymorphism. T helper, T cytotoxic cells. MHC peptide interaction. Antigen presentation, secondary signaling.

Immunological disorders

mmunological disorders; Hypersensitivity and autoimmune diseases. Immune response to viral and bacterial lymphatic infection. Kinetics of immune response. Techniques in humoral and cellular immunology.

Immunotechnology

Animal models and transgenic animals and their use in immunology. Experimental immunology. Hybridoma technology. Chimeric antibodies, phage display, antibody engineering; Large scale manufacture of antibodies. Manufacturing of immunodiagnostics.

Disease diagnosis and Vaccines

Concept of vaccination & Vaccine development. Strategies for development of vaccines against dreadful diseases – malaria, tuberculosis, HIV. Diagnostic tools and Kit development technology.

Recommended textbooks:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.

2. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.

Reference books:

1. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
2. Paul.W.E, Fundamental of Immunology, 4th edition, Lippencott Raven.

BIOREACTOR MODELING AND SIMULATION

Course Code : 15 MB 3055 **L-T-P :** 3-0-0

Course Code : 15 BT 5207 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

Syllabus:

Fundamentals of Modeling

Different approaches towards modeling, (Empirical and Modeling approach), applications and advantages of modeling and simulations, general flow diagrams for model building, simulation tools (Berkeley-Madonna, Mat Lab- Simu Link)

Enzymes and growth kinetic models

Michaelis-Menten equation, graphical determination of Km and Vmax, Double Michaelis Menten kinetic model, inhibition models (Competitive, Non-Competitive, Uncompetitive, Deactivation Kinetics models) Monad growth kinetics model, equation for inhibition of growth, Product inhibition, , Teisser equation for growth, Contoin equation, Moses equation for growth models.

Modeling of batch cultures

Unstructured growth models, structural kinetic model, metabolic models for batch cultures.

Product formation Kinetics

Product formation kinetic models, unstructured models, chemically structured models, genetically structured models.

Case studies of simulations

Programme for simulation of Batch fermentation, continuous fermentation, steady state and fed batch fermentation.

Recommended textbooks:

1. Biological reaction Engineering- J.J.Dunn, E.Heinzle, J.Ingham, J.E.Presnosil
2. Organic modeling fundamentals with simulation examples.
3. Biochemical Engineering fundamentals- James.E.Bailey and David.F.Ollis, Mc- Graw- Hill international Edition
4. Franks.R.G.E (1973), Modeling and simulation in chemical Engineering, Wiley, New York

Reference Books:

1. Modeling and simulation in Biochemical Engineering. Adv, Biochemical Engineering, 3, 127- 165.
2. Hanm, B, Ruth. B (1997) Modeling dynamic biological systems, Springer-Verlag,New York.

THEORY OF ELASTICITY

Course Code: 15 CE 5102 **L-T-P :** 3-2-0

Prerequisites: Nil **Credits:** 4

Syllabus:

Two-dimensional problems in rectangular coordinates

Plane stress; Plane strain; Differential equations of equilibrium; Boundary conditions; Compatibility equations; Stress function; Governing differential equation; Solution by Polynomials; End effects – Saint-Venant's Principle; Determination of displacements; Bending of a cantilever loaded at the end; Bending of a beam by uniform load

Two-dimensional problems in polar coordinates

General equations in polar coordinates; Stress distribution symmetrical about an axis; Effect of circular holes on stress distribution in plates; Concentrated force at a point of a straight boundary; Concentrated force acting on a beam; Stresses in a circular disc, general solutions of the two dimensional problem in polar coordinates, applications of the general solutions in polar coordinates.

Strain energy methods

Total strain energy; Principle of virtual work; Griffith's theory of rupture; Castigliano's theorem; Principle of least work (Stationary potential energy), applications of the principle of least workrectangular plates, shear lag

Analysis of stress and strain in three dimensions

Stress at a point – components of stress; Principal stresses; Stress ellipsoid and stress director surface; Determination of principal stresses; Stress invariants; Determination of maximum shear stresses; Octahedral shear stress; strain at a point – Components of strain; differential equations of equilibrium, the principle of superposition

Torsion

Torsion of straight bars – Saint Venant's theory; Elliptic cross section; Membrane analogy; Torsion of a bar of narrow rectangular cross-section; Torsion of rolled profile sections; Torsion of thin tubes

Text Books:

1. Theory of Elasticity by Timoshenko, S. and Goodier J.N., McGraw Hill Book Co., Newyork, 1988.

Reference Books

1. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
2. Hearn , E.J. "Mechanics of Materials", Vol.2, Pergamon Press, Oxford, 1985
3. Irving H.Shames and James, M.Pitarresi, "Introduction to Solid Mechanics", Prentice Hall of India Pvt Ltd., New Delhi -2002.

ADVANCED PRESTRESSED CONCRETE

Course Code : 15 CE 5104 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

Introduction, Prestressing Systems and Material Properties

Basic concepts of pre-stressing; Historical development; Advantages and Types of Pre-stressing, Pre-tensioning Systems and Devices, Post-tensioning Systems and Devices, Need for High strength steel and High strength concrete; Losses Of Prestress: Nature of losses of pre-stress; Loss due to elastic deformation of concrete, shrinkage of concrete, creep of concrete, relaxation of stress in steel, friction and anchorage slip; Total losses allowed for in design.

Analysis of Prestressed Member

Analysis of Members under Axial Load: Analysis at Transfer, Analysis at Service , Analysis for Ultimate Strength, Analysis of Member under Flexure:, Analysis at Transfer and at Service, Cracking Moment, Kern Point, Pressure Line, Analysis for Ultimate Strength, design loads and strength, Calculation of Crack Width, Variation of Stress in Steel, Analysis of a Rectangular Section, Analysis of a Flanged Section.

Deflections of Prestressed Concrete Members:

Importance of control of deflections; Factors influencing deflections; Short term deflections of uncracked members. Long term deflection of cracked member; Transmission Of Pre-Stress: Transmission of Pre-stressing force by bond; Transmission length; Bond stresses; Transverse tensile stresses; End zone reinforcement; Flexural bond stresses in pre –tensioned and post – tensioned grouted beams, stress distribution in end block, Anchorage zone reinforcements; Shear And Torsion Resistance Of Prestressed Concrete Member: Shear and Principal stresses; Ultimate shear resistance of pre-stressed concrete members; Design of shear reinforcement, pre-stressed concrete members in torsion, Design of reinforcements for torsion, shear and bending.

Design of Pre-Stressed Members

Design of sections for flexure, Design of Sections for Axial Tension, Design of Sections for compression and bending, design of pre-stressed section for shear and torsion, design of pre-stressed member for bond. Dimensioning of flexural member, design for pre-tensioning member, design of post-tensioning members.

Composite Construction of Prestressed Concrete

Composite structural member, types of composite construction, analysis of stresses, differential shrinkages, deflection of composite member, flexural strength of composite sections, shear strength of composite section; Design of Continuous Prestressed Concrete Member: Advantages of continuous members, ultimate load analysis of continuous pre-stressed member, design of continuous pre-stressed concrete beams.

Text Books: (**supplemented with IS: 1343**)

1. Prestressed Concrete by N. Krishna Raju; Tata Mc Graw - Hill Publishing Company Limited, New Delhi.3rd edition, 1995.
2. Design of Prestressed Concrete Structures by T.Y. Lin & Ned H. Burns; John Wiley & Sons, 3rd edition, 1981.

Reference Books

1. Prestressed concrete by N. Rajagopalan; Narosa Publishing House. 2nd edition, 2005.
2. Design of Prestressed Concrete by A. Nilson; John Willey & Sons. 2nd edition, 1987.

FINITE ELEMENT ANALYSIS

Course Code : 15 CE 5205 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

Basic Principles

Equilibrium equations; Strain-displacement relations; linear constitutive relations; Principle virtual work; Principle of stationary potential energy

Element Properties

Different types of elements; Displacement models; Relation between nodal degrees of freedom and generalized coordinates; Convergence requirements; Compatibility requirement; Geometric invariance; Natural coordinate systems; Shape functions; Element strains and stresses; Element stiffness matrix; Element nodal load vector. Isoparametric elements – Definition, Two-dimensional isoparametric elements – Jacobian transformation, Numerical integration

Direct Stiffness method and Solution Technique

Assemblage of elements–Obtaining Global stiffness matrix and Global load vector; Governing equilibrium equation for static problems; Storage of Global stiffness matrix in banded and skyline form; Incorporation of boundary conditions; Solution to resulting simultaneous equations by Gauss elimination method

Plane-stress and Plane-strain analysis

Solving plane stress and plane-strain problems using constant strain triangle and four nodded isoparametric element

Analysis of plate bending

Basic theory of plate bending; Shear deformation plates; Plate bending analysis using four noded isoparametric elements

Text Books:

1. Introduction to Finite Elements in Engineering by R.T. Chandrupatla and A.D. Belegundu, Prentice Hall of India, 1997.

Reference Books:

1. Finite Element Analysis by Abel and Desai, New Age Publishers, 2007.
2. Finite Element Analysis: Theory and Programming by C. S. Krishnamoorthy, Tata McGraw- Hill, 1995.
3. Finite Element Procedures in Engineering Analysis by K. J. Bathe, Prentice Hall Inc., 1996.
4. The Finite Element Method by O.C. Zienkiewicz, and R.L.Taylor, McGraw – Hill, 1987.

CONSTRUCTION TECHNOLOGY

Course Code : 15 CE 5117 **L-T-P :** 3-0-2

Prerequisites: Nil **Credits :** 4

Syllabus:

Materials - Modular co-ordination, standardization and tolerances-system for prefabrication. Pre-cast concrete manufacturing techniques, Moulds –construction design, maintenance and repair.

Pre-casting techniques - Planning, analysis and design considerations - Handling techniques -Transportation Storage and erection of structures.

Joints -Curing techniques including accelerated curing such as steam curing, hot air blowing etc., -Test on precast elements - skeletal and large panel constructions - Industrial structures.

Pre-cast and pre-fabricating technology for low cost and mass housing schemes. Small pre-cast products like door frames, shutters, Ferro-cement in housing - Water tank service core unit.

Quality control - Repairs and economical aspects on prefabrication.

Lab:

Students have to visit minimum of 10 construction Sites and shall submit the reports on various construction practices which include foundation Practice, Farm Work, Rod bending, Concreting, Slab Work, Highway construction.

TEXT BOOKS

1. Levitt. M., Precast concrete - Materials, Manufacture Properties and Usage, Applied Science Publs. 1982,
2. Konex.T., Handbook of Pre-cast Construction, Vol.1.2&3.

REFERENCES:

1. Richardson, J.G., Pre-cast concrete Production, Cement and Concrete Association, London, 1973.
2. Madhava Rao.A-G., Modern Trends in Housing in Developing Countries, Oxford & UBH Publishing co., 1985. -
3. Lewicki.B., Building with Large Pre-fabrications, Elsevier Publishers.
4. Large Panel Prefabricated Constructions, Proc. of Advance Course conducted by SERC, Madras.
5. Bruggeling.A.S.G., & Huyghe.G.F., Prefabrication with Concrete, A.s.A., Balkema Publishers, Netherland, 1991.

MECHANIZED CONSTRUCTION AND MACHINERY

Course Code : 15 CE 5221 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

STANDARD TYPES OF EQUIPMENT: Special equipment, cost of owning and operating equipment, depreciation costs, investment and operating costs, economic life, sources of construction equipment, factors affecting selection of construction equipment, balancing of equipment. Study of equipment with reference to available types and their types and their capacities, factors affecting their performance

EARTHMOVING EQUIPMENT –I : Tractors and attachments, dozers and rippers, scrapers , shovels, draglines, trenching machines, clamshell, hoes, trucks and wagons, dumpers, rollers and compactors Drilling and blasting equipments,

EARTHMOVING EQUIPMENT –II : Bits, jackhammers, drifters, drills, blasting material, firing charge, safety fuse, electric blasting caps, drilling patterns, transporting and handling of explosives. Pile driving equipments Types, pile driving hammers, single acting and double acting, differential acting hammers, hydraulic and diesel hammers, vibratory drivers

PUMPING EQUIPMENTS : Reciprocating, diaphragm & centrifugal pumps, well point system Stone crushing equipment:- jaw, gyratory and cone crushers, hammer mills, roll crushers, rod and ball crushers, aggregate screens and screening plants,

PUMPING EQUIPMENTS : Portable plants Concrete manufacture, transport, placing and compacting equipment, mixers, central batching and mixing plants, pavers, transit mixers, concrete pumps shotcrete Air Compressor Equipments for moving materials, builder's hoists, forklifts , cranes, belt-conveyors, cableways, ropeways.

Lab:

Students have to visit minimum of 5 construction Sites practicing Pre-cast Construction or Pre Engineering Construction and shall submit the reports on various construction machinery and equipment used and practiced in panels/elements production, transportation, erection, jointing, grouting and finishing.

Text Books

Construction planning, Equipments and methods. R.L.Peurify, TMH, 1996

Reference

1. "Construction Equipment and its Planning and Applications", Mahesh Varma, Metropolitan Book Co.(P) Ltd., New Delhi. India.
2. Construction Machinery and Equipment in India". (A compilation of articles Published in Civil Engineering and Construction Review) Published by Civil Engineering and Construction Review New Delhi, 1991.

SOFTWARE SECURITY

Course Code : 15 CS 5136 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

Syllabus:

Web Security

Evolution of Web applications, Web application security, Core Defense Mechanisms, Web Application Management, Web Architecture, Web Hacking, Internet Filtration, Pornographic evidence, Link Redirection Attacks, Web Messenger, Unblocking applications, OWASP, Code Injecting.

Web Hacking

Review of attack methods and tools, Penetration testing methodology, Port scanning, denial of service, attack on authentication system, and input validation attacks, Web application attacks, SQL injection, Cross-Site Scripting, Directory traversal

Protocol based Attacks

TCP Syn Flooding, Frame busting, Web Anonymity, Cookie Reusing, SSL/TLS Attacks, Forceful browsing, Session Stealing, DNS Changer, APT

Secure coding

Programming Fundamentals, Introduction to JAVA, .NET and PHP, Secure coding for SQL Injection, XSS, XSRF and Response splitting, Buffer overruns and format string problems.

Web Investigation

Web Hacking Investigations, Web site Crime Scene, web Logs, Investigation of hacking incident, database logs, web server intrusion investigations, code bugs.

Books:

1. Security Controls Evaluation, Testing, and Assessment Handbook - Leighton Johnson
2. Securing Systems: Applied Security Architecture and Threat Models - By Brook S. E. Schoenfield

OPERATING SYSTEM DESIGN

Course Code: 15 CS 5205 **L-T-P :** 3-2-0

Prerequisites: Nil **Credits :** 4

Syllabus:

Introduction, The Operating System Interface , Implementing Processes ,Interposes Communication, Processes, Memory ,Virtual Memory , Virtual Memory ,IO Devices , IO Systems ,File Systems , File System Organization , Resource Management, Design Techniques for Two level implementation, Interface design, Models of communication, Static versus dynamic tradeoffs, Caching, Hinting, Indirection

Text Book:

1. Charles Crowley, "Operating Systems: A Design-Oriented Approach , TMH,1998 edition.

References:

1. Silberschatz & Galvin, "Operating System Concepts, 8th edition, John Wiley & Sons Inc,
2. William Stallings, "Operating Systems – Internals and Design Principles", 5/e, Pearson.
3. Andrew S. Tanenbaum, "Modern Operating Systems",2nd Edition, Pearson Edu., 2004.
4. Gary Nutt, "Operating Systems", Third Edition, Pearson Education, 2004.
5. Harvey M. Deital, "Operating Systems", Third Edition, Pearson Education, 2004.

ENTERPRISE DEVICES AND NETWORKS

Course Code : 15 CS 5117 **L-T-P :** 3-2-0

Prerequisites : Nil **Credits :** 4

SYLLABUS:

Devices for Every Kind of User, Desktop PCs Inside and Out, Storage Devices, Peripheral Devices, Networking, Windows Operating System, Open-Source Operating Systems, Meet Macintosh, Notebooks and Net books, Mobile Devices, Thin Clients and Virtualization, Taking it to the Cloud, Business Continuity, Ongoing Maintenance, Troubleshooting, Focus on Design, Network Fundamentals, Hardware Fundamentals, Network Infrastructure, Switches, TCP/IP, Routing, Wireless Networking, Network Design, Network Deployment, Network Administration and Management, Network Operations, Network Security, Troubleshooting, Optimization, Availability and Reliability, PCM+

Text Books:

1. Jean Maurice Merel, HP ASE Network Infrastructure Official Certification HP0-Y32 Exam Guide (HP ExpertONE) Hardcover, HP Press, 2013
2. HP Prescribed Courseware

References:

1. Computer networks, Andrew Tanenbaum, 3/e, PHI.
2. Computer Networks – a system approach – Larry L. Peterson, Bruce S. Davie, 2/e, Harcourt Asia PTE LTD.
3. Data Communication and Networking, 4/e, Forouzan, TMH
4. An engineering approach to computer networking, Kesav, PEA
5. Data and Computer Communications, 8/e, Stallings, PHI
6. Computer communication and networking technologies, Gallo, Hancock, Cengage
7. Understanding data communications, 7/e, Held, PEA
8. Communication Networks, 2/e, Leon-Garcia, TMH

EXPERT SYSTEMS

Course Code : 15 CS 5230 **L-T-P :** 4-0-0

Prerequisites : Nil **Credits :** 4

Syllabus:

Introduction to Expert Systems: Definitions, Advantages, concepts, characteristics, Technologies, applications, domains, languages, shells, tools, elements production systems, procedural paradigms, non-procedural paradigms, inductive learning Knowledge representation: Meaning, production, semantics, object-attribute-value triples, Presentation of semantics in PROLOG Schemata, logics, sets, limitations of predictive logic. Methods of Inference: Trees, lattices, graphs, state and problem spaces, AND-OR trees, deductive logic, Syllogisms, inference rules, logic systems, Resolution Systems, Deduction, shallow and Casual reasoning, other inference methods, Meta-knowledge, Hidden Markov Models Reasoning under Uncertainty: Uncertainty, Types of errors, errors and induction, Classical Probability, Experimental and subjective probabilities, compound probabilities, Hypothetical reasoning, Backward Induction, Temporal reasoning, Markov chains, Sufficiency and necessity, Uncertainty in inference chains, Evidence combinations, Inference nets, propagation of probabilities.Inexact reasoning: Uncertainty and rules, certainty factors, Dumpster-Shafer theory, approximate reasoning, state of uncertainty, fuzzy logics and applications Designing of expert systems: Problem selection, Development stages, Errors in development stages, Software Engineering of expert systems., Life cycle models for development of expert systems. Modular design: execution control and rule efficiency: DEF-templates, Salience, phases, control facts, Misuse of salience, def-module constructs, Importing and exporting facts, Modules and execution control, RETE pattern matching algorithm, Pattern network, join network, pattern order, ordering patterns, Multi-field variables, TEST CE, Pattern matching constraints, Comparison of general rules, specific rules, simple rules and complex rules, Expert systems design examples: A monitoring problems, Certainty factors, decision trees, backward chaining

Text Book

1. Expert systems, Joseph Giarratano, Gary D Riley, 4/e, Cengage Learning Publishers, 2011

Reference Book

1. Introduction to Expert systems, 3/e, Peter Jackson, Person education, 2005

BIG DATA ANALYTICS AND BUSINESS INTELLIGENCE

Course Code : 15 CS 5231 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

Syllabus:

Introduction to Big Data Analytics: Big data overview, state of the practice in analytics role of data scientists, Big Data analytics in industry verticals. End-to-end data analytics life cycle: Key roles for successful analytic project, main phases of life cycle, developing core deliverables for stakeholders Basic Analytic methods: Introduction to "R" analyzing and exploring data with "R", statistics for model building and evaluation. Advanced analytics and statistical modeling for Big Data: Native Bayesian Classifier means Clustering, Association Rules, Decision Trees, Linear and Logistic Regression, Time Series Analysis, Text Analytics, Technology and Tools- Map Reduce/Hadoop, In-database analytics, MADlib and advanced SQL Tools. Introduction to Business Intelligence:, Changing Business Environments and Computerized Decision Support , A Framework for Business Intelligence (BI), Intelligence Creation and Use and BI Governance, Transaction Processing versus Analytic Processing, Successful BI Implementation Major Tools and Techniques of Business Intelligence Business Performance Management: Overview of Business Performance Management (BPM) ,BPM and BI Compared , Strategic Planning ,The Strategy Gap Operational Planning Financial Planning and Budgeting, Monitoring the process, Diagnostic Control Systems Pitfalls of Variance Analysis , Act and Adjust for Needs , Performance Measurement KPIs and Operational Metrics Problems with Existing Performance Measurement Systems , Effective Performance Measurement , BPM Methodologies ,Balanced Scorecard (BSC), Six Sigma, BPM Technologies and Applications, BPM Architecture Commercial BPM Suites , BPM Market versus the BI Platform Market, Performance Dashboards and Scorecards ,Dashboards versus Scorecards , Dashboard Design, What to Look for in a Dashboard, Data Visualization Business Intelligence Implementation: Integration and Emerging Trends Collaboration and Productivity: Implementing BI: An Overview, BI Implementations Factors Managerial Issues Related to BI Implementation, Integration Implementation ,Types of Integration , Levels of BI ,Connecting BI Systems to Databases and Other Enterprise Systems Integrating BI Applications and Back-End Systems , Middleware , On-Demand BI The Limitations of Traditional BI , Issues of Legality, Privacy, and Ethics , Legal Issues, Privacy, Ethics in Decision Making and Support , Emerging Topics in BI, The Future of Business Intelligence: The Web 2.0 Revolution, Representative Characteristics of Web 2.0, Web 2.0 Companies and New Business Models, Online Social Networking, A Definition and Basic Information, Mobile Social Networking, Major Social Network Services, Facebook and Orkut , Implications of Business and Enterprise Social Networks , Virtual Worlds, Social Networks and BI, Collaborative Decision Making, The Rise of Collaborative Decision Making , Collaboration in Virtual Teams' Decision Making.

Text Book:

1. Noreen Burlingame, The little book on Big Data, New Street Publisher (eBook)

References

1. http://www.prlog.org/11800911-just -published-the-little-book-of-big-data-2012-edition.html
2. Norman Matloff, The Art of R programming : A Tour of Statistical Software Design,
3. ISBN-13:978-1-59327-384-2:ISBN-10: 1-59327-384-3
4. http://www.johndcook.com/R_language_for_programmers.html
5. http://bigdatauniversity.com/
6. http://home.ubalt.edu/ntsbarsh/stat-data/topics.htm#rintroduction
7. Efraim Turban, Ramesh Sharda, Dursun Deleii, David King Business Intelligence, A MANAGERIAL APPROACH, , Prentice Hall, 2nd edition
8. Elizabeth Vitt, Michael Luckevich and Stacia Misner, Business Intelligence: Making Better Decisions Faster, Micro soft press

ANTENNA MEASUREMENTS

Course Code : 15 EC 5206 | **L-T-P :** 3-0-2

Prerequisites : Nil | **Credits :** 4

Syllabus:

Antenna Pattern Measurements: Basic Considerations, Pattern Formats, Fresnel Region Measurements, Modeling Techniques,Antenna Range Design and Evaluation: Introduction, Electromagnetic Design Consideration, Antenna Range Evaluation.

Antenna Testing: Introduction, Types of of Ranges: Elevated Ranges, Ground Ranges, Near Field Ranges, Radar Cross Section Ranges.

Far Field Range Design: Introduction, Designing the Range, Source Design, Receiving Site Design, Ground Ranges.

Far Field Antenna Tests: Introduction, Pattern Testing, Gain and Directivity, Polarization. Far Field Pattern Errors: Introduction, Error Estimates, Error Correction, Antenna Errors.

Compact Ranges: Introduction, Room Design, Feed Design, Reflector Design. Near Filed Testing: Introduction, Planar Near Field Ranges, Errors, Cylindrical and Spherical Scanning

TEXT BOOKS

1. Evans, Gray E," Antenna measurements techniques", Artech House, Inc
2. J S Hollis, T J Lyon, L Clayton," Microwave Antenna Measurements" , Scientific Atlants, Inc

STATISTICAL SIGNAL PROCESSING

Course Code : 15 EC 5216 | **L-T-P :** 3-0-2

Prerequisites : Nil | **Credits :** 4

Syllabus:

Review of random variables: Distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Schwarz Inequality Orthogonality principle in estimation, Central Limit theorem, Random processes, wide-sense stationary processes, autocorrelation and auto covariance functions, Spectral representation of random signals, Wiener Khinchin theorem Properties of power spectral density, Gaussian Process and White noise process, Linear System with random input, Spectral factorization theorem and its importance, innovation process and whitening filter, .Random signal modeling: MA(q), AR(p) , ARMA(p,q) models.

Parameter Estimation Theory: Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties ; Bayesian estimation : Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation.

Estimation of signal in presence of white Gaussian Noise: Linear Minimum Mean-Square Error (LMMSE) Filtering: Wiener Hoff Equation, FIR Wiener filter, Causal IIR Wiener filter, Non causal I I R Wiener filter, Wiener filter, Non causal I I R Wiener filter, Linear Prediction of Signals, Forward and Backward Predictions, Levinson Durbin Algorithm, Lattice filter realization of prediction error filters.

Spectral analysis: Estimated autocorrelation function, periodogram, Averaging the periodogram (Bartlett Method), Welch modification, Blackman and Tukey method of smoothing periodogram, Parametric method, AR(p) spectral estimation and detection of Harmonic signals, Burg, ESPRIT, MUSIC algorithm.

Kalman filtering: State-space model and the optimal state estimation problem, discrete Kalman filter, continuous-time Kalman filter, extended Kalman filter.

Simulation Software: MATLAB® SSP Toolbox, Software for Filter Design, Signal Analysis, PDEs, and Applications to Signal Analysis.

TEXT BOOKS

1. M. Hays: Statistical Digital Signal Processing and Modelling, John Willey and Sons, 1996.
2. M.D. Srinath, P.K. Rajasekaran and R. Viswanathan: Statistical Signal Processing with Applications, PHI, 1996.

WAVELETS, FILTER BANKS & APPLICATIONS

Course Code : 15 EC 5109 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

Integral wavelet transform, wavelet frames, orthogonal bases of Wavelets, Wavelet transform: Signal representation using basis function, ideal band pass wavelet, L2 -spaces, Basic properties of wavelet transform, Time frequency representation, Design of wavelet function.

Multi-rate Signal Processing: Filtering, Decimation, Poly-phase, Perfect Reconstruction and Aliasing Removal. Matrix Analysis: Toeplitz Matrices and Fast Algorithms.

Wavelet Transform: Pyramid and Cascade Algorithms, Haar wavelet basis, Daubechies Wavelets, Orthogonal and Biorthogonal Wavelets, Smoothness, Approximation, Boundary Filters and Wavelets, Time-Frequency and Time-Scale Analysis, Second-Generation Wavelets.

Spectral Factorization, Cosine-Modulated Filter Banks, Lattice Structure, Ladder Structure (Lifting.)

Going from piecewise linear to piecewise polynomial. The class of spline wavelets - a case for infinite impulse response (IIR) filter banks. Variants of the wavelet transform and its implementation structures, The wave packet transform, The lattice structure, The lifting scheme.

Audio and Image Compression, Quantization Effects, Digital Communication and Multicarrier Modulation, Trans multiplexers, Text-Image Compression: Lossy and Lossless, Medical Imaging and Scientific Visualization, Edge Detection and Feature Extraction, Seismic Signal Analysis, Geometric Modelling, Matrix Preconditioning, Multi scale Methods for Partial Differential Equations and Integral Equations.

Simulation Software

MATLAB® Wavelet Toolbox, Software for Filter Design, Signal Analysis, Image Compression, PDEs, Wavelet Transforms on Complex Geometrical Shapes.

Text Books:

1. Strang, and Nguyen. Wavelets and Filter Banks. Wellesley-Cambridge Press, 1997.
2. L. Debnath.. Wavelet Transforms and Their Applications, Birkhauser Pub.
3. E. Mallat.. A Wavelet Tour of Signal Processing, Elsevier, Indian Ed.
4. Yves Meyer.. Wavelets and Operators, Cambridge Univ. Press.
5. G. Kaiser.. A Friendly guide to Wavelets, Birkhauser.

REFERENCES

1. Howard L. Resnikoff, Raymond O. Wells, Wavelet Analysis: The Scalable Structure of Information, Springer, 1998.
2. Raghuveer M. Rao, Ajit S. Bopardikar, Inroduction to Wavelet Transforms.
3. K. P. Soman, K. I. Ramachandran, Insight Into Wavelets - From Theory to Practice.
4. Michael W. Frazier, An Introduction to Wavelets Through Linear Algebra, Springer.
5. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education.

ADAPTIVE SIGNAL PROCESSING

Course Code : 15 EC 5112 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

Introduction to Adaptive Filters: Adaptive filter structures, issues and examples, Applications of adaptive filters, Channel equalization, active noise control, Echo cancellation, beamforming. Discrete time random processes, Power spectral density – properties, Autocorrelation and covariance structures of discrete time random processes, Eigen-analysis of autocorrelation matrices.

Wiener filter, search methods and the LMS algorithm: Wiener FIR filter, Steepest descent search and the LMS algorithm, Extension of optimal filtering to complex valued input, The Complex LMS algorithm.

Convergence and Stability Analyses: Convergence analysis of the LMS algorithm, Learning curve and mean square error behavior, Weight error correlation matrix, Dynamics of the steady state mean square error (mse), Mis-adjustment and stability of excess mse.

Variants of the LMS Algorithm: The sign-LMS and the normalized LMS algorithm, Block LMS, Review of circular convolution, Overlap and save method, circular correlation, FFT based implementation of the block LMS Algorithm.

Vector space framework for optimal filtering: Axioms of a vector space, examples, subspace, Linear independence, basis, dimension, direct sum of subspaces, Linear transformation, examples, Range space and null space, rank and nullity of a linear operator, Inner product space, orthogonality, Gram-Schmidt orthogonalization.

Simulation Software

MATLAB® Signal Processing Toolbox.

Text Books:

1. "Adaptive Filter Theory" by S. Haykin, Prentice Hall, Englewood Cliffs, NJ, 1991 (end Ed.).
2. "Adaptive Filters â€" Theory and Applications", by B. Farhang-Boroujeny, John Wiley and Sons, 1999.

VLSI SYSTEM DESIGN

Course Code : 15 EC 5234 **L-T-P :** 3-2-0

Prerequisites : Nil **Credits :** 4

Syllabus:

Design Methodology: Structured design techniques; Programmable logic; Gate array and sea of gates design; cell based design; full custom design; Design flow; Design Economics. Data path Subsystems: Adders; One/zero Detectors; Comparators; Counters; Shifters; Multipliers; Power and Speed Trade-off. Memory and Array Subsystems: SRAM, DRAM, ROM, Serial access memories; CAM, PLAs; Array yield, reliability; Power dissipation in Memories. Special-purpose Subsystems: Packaging; power distribution; I/O pads; Interconnect: Interconnect parameters; Electrical wire models, capacitive parasitics; Resistive parasitics; Inductive parasitic; Crosstalk; Advanced Interconnect Techniques. Timing Issues: Timing classification; Synchronous design; Self-timed circuit design; Clock Synthesis and Synchronization: Synchronizers; Arbiters; Clock Synthesis; PLLs; Clock generation; Clock distribution; Synchronous Vs Asynchronous Design.

TEXT BOOKS

1. Neil H. E. Weste, David. Harris and Ayan Banerjee,, "CMOS VLSI Design" - Pearson Education, Third Edition, 2004.
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits" Pearson Education, Second Edition.

REFERENCES:

1. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits" TMH, Third Edition, 2003
2. Wayne Wolf, "Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.

SIMULATION BOOKS

1. Etienne Sicard, Sonia Delmas Bendhia, "Basics of CMOS Cell Design", TMH, EEE, 2005.

POWER ELECTRONIC CONTROL OF DRIVES

Course Code : 15 EE 5102 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

Syllabus:

Control of induction motor, Review of steady-state operation of Induction motor, Equivalent circuit analysis, torque-speed characteristics. VSI Fed Induction motor drives &CSI Fed Induction motor drives. Control of induction by Slip power recovery schemes. Vector control of Induction Motor: Principles of vector control, Direct vector control, derivation of indirect vector control, implementation – block diagram; estimation of flux, flux weakening operation. Control of Synchronous motor drives: Synchronous motor and its characteristics-Control strategies-Constant torque angle control- power factor control, constant flux control, flux weakening operation, Load commutated inverter fed synchronous motor drive. PMSM and BLDC control of Drives, control of Variable Reluctance Motor Drive .Speed control of dc Motors-Different types of speed control techniques by using single phase& three phase ac systems .Closed loop control of phase controlled DC motor Drives. Open loop Transfer function of DC Motor drive- Closed loop Transfer function of DC Motor drive –Phase-Locked loop control.Closed loop control of chopper fed DC motor Drives, Speed controlled drive system – current control loop – pulse width modulated current controller – hysteresis current controller – modeling of current controller – design of current controller .

Text Books:

1. B. K. Bose , "Modern Power Electronics and AC Drives",Pearson Publications (2005).
2. R.Krishanan,"Electric Motor Drives", Indian Edition,Prentice Hall, (2008).

Reference Books:

1. Shepherd, Hulley, Liang , "Power Electronics and Motor Control",II Edition, Cambridge University Press ,(2004).
2. M. H. Rashid , "Power Electronic Circuits, Devices and Applications, 3rd edition,PHI, (2003).
3. GK Dubey, "Fundamentals of Electrical Drives" , 2nd edition ,Narosa Publishers, (20020.

OPTIMIZATION TECHNIQUES

Course Code : 15 EE 5103 **L-T-P :** 3-2-0

Prerequisites : Nil **Credits :** 4

Syllabus:

Linear Programming: Standard form of Linear programming problem; Simplex method two phase simplex method; Duality in Linear programming, Decomposition Principle .Some simple numerical problems. Non-Linear Programming: Fibonacci method, Univariate method, Pattern directions, Golden section method, Powell's method, Newton's method, Quasi Newton method.Some simple numerical problems. Transportation Problem: Definition of transportation problem, transportation algorithm, North-West corner method, Vogel approximation method, Least cost method, Unbalanced & Transportation Problems. Hungarian method for assignment. Unbalanced Assignment, problems. Project planning through Networks: Arrow diagram representation; Rules for constructing an arrow diagram. PERT and CPM, critical path calculations, Earliest start and latest completion times; Determination of floats. Some simple numerical problems. Dynamic Programming: Multistage decision processes; Types of multistage decision problems, concept of sub-optimization and the principle of sub-optimality computational procedure in dynamic programming. Some simple numerical problems.

Text Books:

1. S.S. Rao ,"Engineering optimization theory and practice",New Age International Publications. A Wiley Interscience publication,(1996).
2. Hamdy A. Taha , "Operations Research, An introduction", PHI learning private Ltd. New Delhi,(2010).

Reference Books:

1. S.D. Sharma, "Operations Research", Kedarnath & Ramnath Publishers, Delhi.
2. Hiller and Liberman , "Introduction to operations research", McGrawHill Eduction Pvt Ltd, (2010).

DESIGN OF POWER CONVERTERS

Course Code : 15 EE 5101 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

DESIGN OF SNUBBER CIRCUITS: Design of snubber circuits for diode, transistor and thyristor-snubbers for bridge circuit configuration- GTO snubber circuit design considerations-Problems. DESIGN OF GATE AND BASE DRIVE CIRCUITS: Preliminary design considerations-DC-coupled drive circuits- electrically isolated drive circuits- cascaded connected drive circuits- thyristor drive circuits- power device protection in drive circuits- Problems. DESIGN

ASPECTS OF HEAT SINKS: control of semiconductor device temperature- Heat transfer by conduction, convection and radiation- Heat sink design-Problems. DESIGN OF MAGNETIC COMPONETS: Analysis of a specific inductor design- Inductor design procedure- Analysis of a specific transformer design- transformer design procedure- comparison of transformer and inductor sizes- Problems. DESIGN OF DC-DC CONVERTERS- Design considerations of DC-DC converters- Current Mode Control- Controller Design- Problems.

Text Books:

1. Ned Mohan, T.M. Undeland and William P. Robbins "Power Electronics: Converters, Applications and Design", 3rd Edition, John Wiley & Sons, (2009).
2. M.H. Rashid "Power Electronics-circuits, Devices and Applications", 3rd Edition, PHI, (2005).
3. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, (2003).

Reference Books:

1. Jai P.Agrawal, "Power Electronics Systems", Second Edition, Pearson Education, (2002).
2. P.T. Krein, Elements of Power Electronics, Oxford University Press, (1998).

POWER SYSTEM DYNAMICS & STABILITY

Course Code : 15 EE 5109 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

POWER SYSTEM STABILITY: Introduction, General basic concept of Power System Stability, swing equations, power angle equations, natural frequencies of oscillations, single machine infinite bus system- equal area criterion- classical model of a multi machines systems.

SMALL SIGNAL STABILITY: Small signal stability of a single machine infinite bus system, Effects of excitation systems, Power system stabilizers

SYNCHRONOUS MACHINE MODELING: Modeling of Synchronous Machine, Park's Transformation, Analysis of Steady State Performance, P. U. Quantities, Equivalent Circuit of Synchronous Machine, Vector diagrams in steady state and transient state, power angles curves of a salient pole machine

EXCITATION SYSTEMS: Typical Excitations configurations and excitation (Automatic) Voltage regulators, Effect of excitation on (a) Power limits, (b) Transient stability, (c) Dynamic stability,

VOLTAGE STABILITY: Basic Concepts Related to Voltage Stability – Voltage Collapse – Voltage Stability Analysis – Prevention of Voltage Collapse.

Text Books:

1. Prabha Kundur, "Power System Stability and Control", TATA McGRAW – HILL, (2006).
2. P. M. Anderson & A.A. Fouad , "Power System Control and Stability",2nd Edition, Wiley IEEE press,(2002).

Reference Books:

1. K.R.Padiyar, "Power System Dynamics Stability & Control",2nd Edition, B.S. Publication, (2002).
2. Kimbark, "Power System Stability",Vol- I, II & III – (1968), Dover Publication Inc, Newyork, (1968).

REAL TIME CONTROL OF POWER SYSTEMS

Course Code : 15 EE 5213 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

Unit Commitment Problem-Introductions to UCP, Economic Dispatch- characteristics of thermal, nuclear and hydro-generator units, Economic dispatch problem- The Lambda iteration method, first order gradient method, base point and participation factors, Load frequency control- single area control, block diagram representation, steady state analysis, dynamic response, AGC multi area system, static and dynamic response, Load frequency control of 2-area system, Computer control of power systems- Energy Control Centre, various levels, SCADA system, data acquisition and controls, EMS system, expert system applications for power system operation, Security control- Security analysis and monitoring, generator and line outages by linear sensitivity factors, State estimation- Power system state estimation, Weighted least square state estimation, state estimation of AC network, Treatment of bad data – network observability and pseudo measurements.

Text Books:

1. Allen J. Wood and Bruce F. Wollenberg "Power Generation, Operation & Control" 2nd edition, John Wiley and Sons, (1996).
2. I.J. Nagarath & D. P. Kothari , "Modern power system analysis" 3rd Edition, TMH, New Delhi, (20030.

Reference Books:

1. Elgard , "Electric Energy Systems Theory – An Introduction" TMH, (1983).
2. Abhijit Chakrabarti & Sunita Halder " Power System Analysis operation and Control " 1st edition, PHI, (2006).
3. Mahalanabis A.K., Kothari D.P. and Ahson S.I., "Computer aided power system analysis and control", 4th Edition, TMH, 2011.

4. J.J.Grainger, W.D.Stevenson JR, "Power system analysis", Tata McGraw Hill N.D. (2007).
5. A. Handschin and E. Petroiaenu," Energy Management Systems, Operations and Control of Electric Energy Transmission Systems", Springer-Verlag, Berlin, Heidelberg, (1991).

MICRO CONTROLLERS FOR EMBEDDED SYSTEM DESIGN

Course Code : 15 EM 5109 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

SYLLABUS:

Introduction to Embedded Systems

Overview of Embedded Systems, Processor Embedded into a system, Embedded Hardware Units and Devices in system, Embedded Software, Complex System Design, Design Process in Embedded System, Formalization of System Design, Classification of Embedded Systems.

Microcontrollers and Processor Architecture & Interfacing

8051 Architecture. Real world interfacing, Introduction to advanced architectures, processor & memory organization, Instruction-level parallelism, and performance metrics.

PIC Microcontroller Hardware

Introduction, Architectural overview, Memory organization, interrupts and reset, I/O ports, Timers

Device Drivers & Interrupt service Mechanism

Programmed-I/O Busy-wait approach without ISM,ISR concept, Interrupt sources, Interrupt service mechanism, Multiple Interrupts, context and the periods for context switching, Interrupt latency and deadline, Classification of processors ISM from context-saving angle, Direct Memory Access, Device driver programming

Devices &Communication Buses for Devices Network

IO Types and examples, Serial communication Devices, Parallel Device ports, Networked Embedded systems, Serial Bus communication protocols

Text Books:

1. Embedded Systems - Architecture Programming and Design – Raj Kamal, 2nd ed., 2008, TMH.
2. Embedded C Programming and the Microchip PIC-Richard Barnett, O" Cull, Cox, 2009, Cengage Learning.

Reference Books:

1. Embedded Microcomputer Systems, Real Time Interfacing – Jonathan W. Valvano – Brookes Cole, 1999, Thomas Learning

Project Based Lab:

The students will do five basic experiments to gain the knowledge and hands on experience with IDE's and Simulators of basic CISC and RISC microcontrollers and the Develop an application using this knowledge.

REAL TIME CONCEPTS FOR EMBEDDED SYSTEMS

Course Code : 15 EM 5110 **L-T-P :** 3-2-0

Prerequisites : Nil **Credits :** 4

Syllabus:

Introduction: Examples of Embedded Systems, Definition of Embedded Systems, Architecture of Embedded Systems, Real- Time Embedded Systems, Design Issues and Current Trends for Embedded Systems

Hard versus soft Real- Time Systems: Jobs and Processes, Release Times, Deadlines and Timing Constraints, Hard and Soft Timing Constraints, Hard Real Time Systems, Soft Real Time Systems

A Reference Model of Real – Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency, Functional Parameters- preemptivity of jobs, criticality of jobs, Resource Parameters of Jobs and Parameters of Resources, Scheduling Hierarchy- Scheduler and Schedules, Feasibility, Optimality and Performance Measures.

Classification of Real Time Scheduling Approaches: Clock- Driven Approach, Weighted Round- Robin Approach, Priority- Driven Approach, Dynamic versus Static Systems, Effective Release Times and Deadlines, optimality of the EDF and LST algorithms, Non optimality of the EDF and LST algorithms, Challenges in validating timing constraints in priority –driven systems Off-line versus On-line Scheduling

Clock-Driven Scheduling: Notations and Assumptions, Static, Timer -Driven Scheduler, General Structure of Cyclic Schedules, Cyclic Executives, Improving the Average Response Time of Aperiodic Jobs, Scheduling Sporadic Jobs-Acceptance test ,EDF Scheduling of accepted jobs and implementation, Pros and Cons of Clock Driven Scheduling,

Priority-Driven Scheduling of Periodic Tasks: Static Assumption, Fixed Priority v/s Dynamic Priority Algorithms, schedulability test for the EDF algorithm, a schedulability test for fixed priority tasks with short response times-time demand analysis, schedulability test for fixed priority tasks with arbitrary response times: busy intervals, general schedulability test, sufficient schedulability conditions for RM & DM algorithms: schedulable utilization of the RM algorithm for tasks with Di=pi, schedulable utilization of fixed priority tasks with arbitrary relative deadlines

Scheduling Aperiodic and Sporadic Jobs in Priority-Driven Systems: Assumptions and Approaches, Deferrable Servers- Operations of Deferrable Servers, Constant utilization server Scheduling of sporadic jobs-a simple acceptance test in deadline driven systems, a simple acceptance test in fixed- priority driven systems

Resources and Resource Access control: Assumptions on Resources and Their Usage, Effects of Resource Contention and Resource Access Control, Non-preemptive Critical Sections, Basic Priority Inheritance Protocol, Basic Priority Ceiling Protocol- Definition, computation of blocking time, controlling accesses to Multiple Unit Resources

Real-Time Operating Systems: Overview- Threads and Tasks, The Kernel, Time Services and Scheduling Mechanisms- Time Services, Scheduling Mechanisms, Other Basic Operating System Functions- Communication and Synchronization, Event Notification and Software Interrupt, Memory Management, I/O and Networking

TEXT BOOKS:

1. Real Time Systems – By Jane W.S.Liu -Low Price Edition , Pearson Education Asia
2. Real-Time Concepts for Embedded Systems - Qing Li with Caroline Yao published by CMP Books.

DIGITAL SIGNAL PROCESSORS AND ARCHITECTURES

Course Code : 15 EM 5214 **L-T-P :** 3-2-0

Prerequisites : Nil **Credits :** 4

Syllabus:

Introduction To Digital Signal Processing: Introduction, A Digital signal-processing system, The sampling process, Discrete time sequences. DiscreteFourier Transform (DFT) and Fast Fourier Transform (FFT), linear time-invariant systems, Digital filters, Decimation and interpolation

Computational Accuracy in DSP Implementations: Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of errorin DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.

Architectures for Programmable DSP Devices: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing.

Programmable Digital Signal Processors: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and Programming, On-Chip Peripherals, Interrupts of TMS320C54XX processors, Pipeline Operation of TMS320C54XX Processors.

Analog Devices Family of DSP Devices: Analog Devices Family of DSP Devices- ALU and MAC block diagram, Shifter Instruction, Base Architecture of ADSP2100, ADSP-2181 high performance Processor.

Introduction to Blackfin Processor – The Blackfin Processor, Introduction to Micro Signal Architecture, Overview of Hardware Processing Units and Register files, Address Arithmetic Unit, Control Unit, Bus Architecture and Memory, Basic Peripherals.

Interfacing Memory And I/O Peripherals To Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA).

Text Books

1. Digital Signal Processing – Avtar Singh and S. Srinivasan, Thomson Publications, 2004.
2. A Practical Approach to Digital Signal Processing – K Padmanabhan, R. Vijayarajeswaran,

Ananthi.S, New Age International, 2006/2009.

3. Embedded Signal Processing with the Micro Signal Architecture Publisher: Woon-Seng Gan, Sen M. Kuo, Wiley-IEEE Press, 2007.

References

1. Digital Signal Processors, Architecture, Programming and Applications – B. Venkataramani and M. Bhaskar, 2002, TMH.
2. Digital Signal Processing – Jonatham Stein, 2005, John Wiley.
3. DSP Processor Fundamentals, Architecture & Features- Lapsley et al. 2000, S. Chand & Co.
4. Digital Signal Processing Applications Using the ADSP-2100 Family by The Applications Engineering Staff of Analog Devices, DSP Division, Edited by Amy Mar, PHI.
5. The Scientist and Engineering's Guide to Digital Signal Processing by Steven W. Smith, Ph.D., California Technical Publishing, ISBN 0-9660176-3-3, 1997.
6. Embedded Media Processing by David J. Katz and Rick Gentile of Analog Devices, Newnes, ISBN 0750679123, 2005.

SENSORS AND SENSING PRINCIPLES

Course Code : 15 EM 5103 **L-T-P :** 3-2-0

Prerequisites : Nil **Credits :** 4

Syllabus:

Sensor Fundamentals:

Basic sensor technology -sensor characteristics –static and dynamic –Principles of sensing- capacitance- magnetic and electromagnetic induction –resistance – piezoelectric effect –Pyroelectric effect -Hall effect- See beck and Pettier effect-heat transfer-light.

Physical sensors:

Position, Displacement and Level sensors, Velocity and Acceleration sensors, Force, Strain, Tactile and pressure sensors.

Chemical sensors:

Classification of chemical sensing Mechanism, Potentiometric sensors, Conduct metric Sensors, Amperometric Sensors, Enhanced Catalytic gas Sensors.

Optical Sensors:

Optical Radiation- Electromagnetic Spectrum, Snell's Law and Total internal reflection, Diffraction principles, Optical Detectors and Sources-Photo diodes and transistors, Photo-darling ton pairs, Photoconductive sensors, CCD sensors, Fiber optic sensors. Solid state light sources- LED , Diode lasers, Semiconductor laser optical cavity resonator.

Bio sensors

Origin and Transmission of bioelectrical Signals, The Electromyogram (EMG) & the Electrocardiogram (ECG) The Electroencephalogram (EEG) & Blood pressure measurement, Catalytic biosensors, mono-enzyme electrodes, bi-enzyme electrodes. cell based biosensors, biochips and biosensor arrays, problems and limitations.

Text books:

1. Biosensor Principles and Applications, Edited by Loïc J.Blum, Pierre R. Coulet Agarwal, Govind P, "fiber Optic Communication Systems", 2nd edition, Wiley, NewYork,1997
2. Principles of Biochemistry Albert L.Lehninger, David Lee Nelson,Michael M. 2005, Fourth Edition.
3. Sensors and Transducers D. Patranabis Prentice-Hall of India Pvt.Ltd August 15, 2004
4. Jacob Fraden, " Hand Book of Modern Sensors: physics, Designs and Applications", 3rd ed.,Springer, 2003.

COMMUNICATION PROTOCOLS AND STANDARDS

Course Code : 15 EM 5206 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

Syllabus:

Networks in process automation

Networks in process automation: Information flow requirements, Hierarchical communication model, Data Communication basics, OSI reference model, Industry Network, Network Topologies.

Communication Protocols:

Communication Protocols: Communication Basics, Basics, Network Classification, Device Networks, Control Networks, Enterprise Networking, Network selection. Proprietary and open networks: Network Architectures, Building blocks

Wired Communication:

Wired: Wired Communication: Industry open protocols (RS-232C, RS- 422, RS-485), CAN bus, I2C, SPI, Ethernet,USB ,OFC, Modbus, Modbus Plus, Data Highway Plus, Advantages and Limitations of Open networks.

Fieldbus Trends

Fieldbus: Fieldbus Trends, Hardware selection, Fieldbus design, Installation, Documentation, Fieldbus advantages and limitations, Automotive Most bus, Hot standby router protocol(HSRP) and Hot 255 modem, Dial up modem, Physical media -Cabling types and noise level conditions, leased line modems.

WPAN

Wireless: WPAN, Wi-Fi, Bluetooth, Zig-Bee, Z-wave, GPRS, GSM. Infrared communication: Routers, Hubs, Bridges, Ethernet switches, Different type of converters - Serial to Ethernet, Ethernet to OFC, Serial to OFC, RS232 to RS485

Outcomes: After completion of these course students should able to, Build sensor networks and Communicate through various media

Text Books:

1. TCIP/IP protocol suite , Behrouz A. Forouzen, III Edition
2. Data communications, computer networks, open systems, Prakash C. Guptha, V Edition

ADVANCED HEAT & MASS TRANSFER

Course Code : 15 ME 5112 **L-T-P :** 3-2-0

Prerequisites : Nil **Credits :** 4

Syllabus:

Introduction - review of heat transfer Fundamentals - transient conduction and extended surface Heat Transfer, Unsteady heat conduction. Lumped capacity model, awareness of one-dimensional unsteady results (charts; Biot and Fourier numbers), Brief review of Steady Laminar and Turbulent Heat Transfer in External and Internal Flows - Heat Transfer at High Speeds - Unsteady Laminar and Turbulent Forced Convection in Ducts and on Plates - Convection with body forces, Boundary layers and internal flows. Awareness of these configurations, some knowledge of internal flow energy balances, Convection correlations. Finding heat transfer coefficients from Reynolds numbers and Rayleigh numbers, Heat Exchangers. Typical configurations and epsilon-NTU analysis, phase-change heat transfer. General awareness of processes of condensation and boiling in a pure substance, some use of correlations, Quenching of metals, Leidenfrost problem, heat transfer of sprays, jets and films, Radiation basics - Radiation in Enclosures - Gas Radiation - Diffusion and Convective Mass Transfer - Combined Heat and Mass Transfer from Plates and in Pipes.

TEXT BOOKS:

1. Heat transfer, A. Bejan, John Wiley & Sons (1993)
2. Advanced Heat and Mass Transfer, A. Faghri, Y. Zhang, J. Howell, Global Digital Press (2010)

REFERENCE BOOKS:

1. A Heat Transfer Text Book, J. H. Lienhard iv, and J. H. Lienhard V, Phlogiston Press (2008)
2. Heat and Mass Transfer, H. D. Baehr, and K. Stephan, Springer-Verlag (1998)
3. Heat transfer, F. M. White, Addision-Wesley (1984)
4. Basic heat and mass transfer, K. C. Rolle, Prentice-Hall (2000)

5. Heat Transfer – A practical approach, Y. A. Cengel, Tata McGraw-Hill (2002)

INCOMPRESSIBLE AND COMPRESSIBLE FLOWS

Course Code : 15 ME 5213 **L-T-P :** 3-2-0

Prerequisites : Nil **Credits :** 4

Syllabus:

Definition and properties of Fluids, Fluid as continuum, Langragian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics, Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equation, Couette flows, Poiseuille flows, Fully developed flows in non-circular cross-sections, Unsteady flows, Creeping flows, Revisit of fluid kinematics, Stream and Velocity potential function, Circulation, Irrotational vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Magnus effect; Kutta-Joukowski lift theorem; Concept of lift and drag, Boundary layer equations, Boundary layer thickness, Boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations, Approximate Methods, Flow separation, Entry flow into a duct, Basic concepts of thermodynamics, governing equations in various forms, concept of Mach number, one dimensional flows and normal shock wave, Rayleigh and Fanno flows, Two dimensional flows and oblique shock waves, θ-B-M relations, understanding of shock interaction and shock reflection with various graphs, Prandtl- Mayer expansion, shock-expansion theory, quasi one dimensional flows, method of characteristics and, unsteady wave motion and introduction to various experimental facilities for these speed ranges.

TEXT BOOKS:

1. Boundary layer theory, H. Schlichting, and K. Gersten, Springer (2000)
2. Elements of gas Dynamics, H. W. Liepmann & A. Roshko, Dover Publications (2002)
3. Viscous fluid flow, F. M. White, Mc-Graw Hill (2005)

REFERENCE BOOKS:

1. Introduction to Fluid Mechanics, E. J. Shaughnessy, I. M. Katz and J. P. Schaffer, Oxford University Press (2004)
2. Compressible fluid flow, M. A. Saad, Prentice Hall (1985)
3. Incompressible flow, R. L. Panton, John Wiley & Sons (2005)
4. Advanced Fluid Mechanics, Som, and Biswas, Tata McGraw Hill (2008)
5. The dynamics and thermodynamics of compressible fluid flow, Vol. 1 & 2, A. H. Shapiro, Ronald Press (1954)

COMPUTATIONAL FLUID DYNAMICS

Course Code : 15 ME 5214 **L-T-P :** 3-0-2

Prerequisites : Nil **Credits :** 4

Syllabus:

Introduction: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description, Classification and Overview of Numerical Methods: Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods, Finite Difference Technique: Finite difference methods; different means for formulating finite difference equation; Taylor series expansion, integration over element, local function method; treatment of boundary conditions; boundary layer treatment; variable property; interface and free surface treatment; accuracy of FD method, Finite Volume Technique: Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem, Finite Element Methods: Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two dimensional elements; applications, Methods of Solution: Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform, Time integration Methods: Single and multilevel methods; predictor-corrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems, Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping, Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods, Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

TEXT BOOKS:

1. Numerical Computation of Internal and External Flows, C. Hirsch, Vols. I & II, John Wiley & Sons (2004)
2. An Introduction to Computational Fluid Dynamics, H. K. Versteeg & W. Malalasekera, Longman Scientific & Technical (1995)

REFERENCE BOOKS:

1. Computational Fluid Mechanics and Heat Transfer, J. C. Anderson, D. A. Tannehil and R. H. Pletcher, Taylor & Francis publications, USA (1997)
2. Fundamentals of CFD, T. K. Sengupta, Universities Press (2004)
3. Computational Fluid Dynamics, T. J. Chung, Cambridge University Press (2002)
4. Computational Methods for Fluid Dynamics, J. H. Ferziger and M. Peric, Springer (1997)
5. Computational Techniques for Fluid Dynamics, C. A. J. Fletcher, Vols. I & II, Springer-Verlag (1996)

MECHANISMS DESIGN AND SIMULATION

Course Code : 15 ME 5222 **L-T-P :** 3-2-0

Pre-requisite : Nil **Credits :** 4

SYLLABUS:

INTRODUCTION : Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms– mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts-Basic kinematic structures of serial and parallel robot manipulators-Compliant mechanisms-Equivalent mechanisms.

KINEMATIC ANALYSIS : Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration Analysis– four bar linkage jerk analysis. Plane complex mechanisms-auxiliary point method. Spatial RSSR mechanism-Denavit-Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

PATH CURVATURE THEORY, COUPLER CURVE : Fixed and moving centrodes, inflection points and inflection circle. Euler Savary equation,

graphical constructions – cubic of stationary curvature. Four bar coupler curve-cusp-crunode coupler driven six-bar mechanisms-straight line mechanisms

SYNTHESIS OF FOUR BAR MECHANISMS : Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods-Pole technique inversion technique-point position reduction-two, three and four position synthesis of four- bar mechanisms. Analytical methods- Freudenstein's Equation-Bloch's Synthesis.

SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS

Cognate Lingages-parallel motion Linkages. Design of six bar mechanisms-single dwell-double dwell-double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms-determination of optimum size of cams. Mechanism defects. Study and use of Mechanism using Simulation Soft-ware packages.

REFERENCE BOOKS:

1. Robert L.Norton., "Design of Machinery",Tata McGraw Hill, 2005.
2. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
3. Uicker, J.J., Pennock, G. R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2005.
4. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi,1999.
5. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.
6. Ramamurti, V., "Mechanics of Machines", Narosa, 2005.

ADVANCED MECHANICS OF SOLIDS

Course Code : 15 ME 5117 **L-T-P :** 3-2-0

Prerequisites : Nil **Credits :** 4

Syllabus:

Theories of stress and strain, Definition of stress at a point, stressnotation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, straintheory, principal strains, strain of a volume element, small displacement theory.

Stress –strain temperature relations: Elastic and non-elastic response of a solid, first law of thermodynamics, Hooke's Law, Anisotropicelasticity, Hooke's Law, Isotropic elasticity, initiation of Yield, Yieldcriteria.

Failure Criteria: Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles N > 106), buckling.

Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potentialenergy, Castigliono's theorem on deflections, Castigliono's theoremon deflections for linear load deflection relations, deflections of statically determinate structures.

Unsymmetrical bending: Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.

Curved beam theory: Winkler Bach formula for circumferential stress –Limitations – Correction factors –Radial stress in curved beams – closedring subjected to concentrated and uniform loads-stresses in chainlinks.

Torsion: Linear elastic solution; Prandtl elastic membrane (Soap-Film)Analogy; Narrow rectangular cross Section; Hollow thin wall torsionmembers, multiple connected Cross Sections.

Contact stresses: Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies

in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

REFERENCE BOOKS:

1. Advanced Mechanics of materials by Boresi& Sidebottom-Wiley International.
2. Theory of elasticity by Timoschenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd Edition
3. Advanced Mechanics of Solids, L.S Srinath
4. Advanced strength of materials by Den Hortog J.P.
5. Theory of plates – Timoshenko.
6. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia
7. Strength of materials by Sadhu Singh

K L University

(Deemed to be University estd. u/s. 3 of the UGC Act, 1956)
(NAAC Accredited "A" Grade University)