KL
(DEEMED TO BE UNIVERSITY)

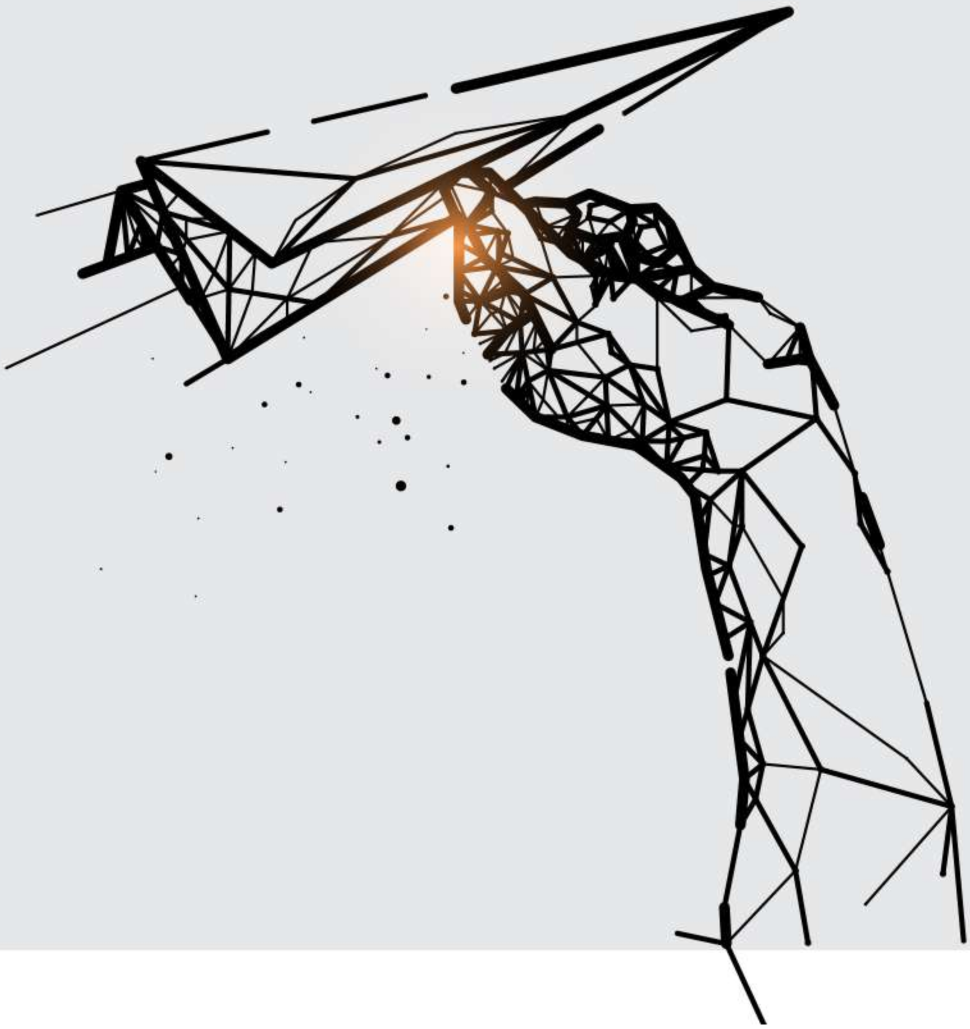
STUDENT handbook 2023-2024

M.Tech

www.kluniversity.in

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.




CATEGORY 1
UNIVERSITY
BY MHRD, Govt. of India
KL ACCREDITED BY
NAAC WITH A++
GRADE
nirf 2023
NATIONAL INSTITUTIONAL RANKING FRAMEWORK
RANKED 28
AMONG ALL
UNIVERSITIES
43 YEARS OF
EDUCATIONAL
LEADERSHIP

Koneru Satyanarayana,
Chancellor

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

Dr. K. S. Jagannatha Rao
Pro-Chancellor

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

Prof. G P S Varma
Vice-Chancellor

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

Dr. A. V. S. Prasad

Pro-Vice Chancellor

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

He has extensive knowledge of administrative system, maintaining statutory norms of bodies like AICTE, UGC etc and has a good understanding of NBA, NAAC procedures and norms. He served as Member, Chairman of Board of Studies at JNTU(A), KLCE(Autonomous) and KL University.

Dr. Venkatram Nidumolu

Pro-Vice Chancellor

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

Acronyms

Sl No	Acronyms	Full Form
1	KLEF	Koneru Lakshmaiah Education Foundation
2	CET	Common Entrance Test
3	KLEEE	KLEF Engineering Entrance Examination
4	JEE	Joint Entrance Examination
5	BT	Biotechnology
6	CE	Civil Engineering
7	CS	Computer Science &Engineering
8	EC	Electronics & Communication Engineering
9	EE	Electrical & Electronics Engineering
10	CM	Computer Engineering
11	ME	Mechanical Engineering
12	AD	Artificial Intelligence & Data Science
13	CI	Computer Science & Information Technology
14	CGPA	Cumulative Grade Point Average
15	SGPA	Semester Grade Point Average
16	LTPS	Lecture, Tutorial Practical, Skill
17	SEE	Semester-End Examinations
18	SIE	Semester-In Examinations
19	OJET	On-the-job Engineering Training
20	IRP	Industrial Relations and Placements
21	PS	Practice-School
22	OPAC	Online Public Access Catalog
23	QCM	Quality Circle Meeting
24	MOOC	Massive Open Online Course
25	MOU	Memorandum of Understanding
26	OD	On Duty
27	(A,B]	Between A and B excluding value A and including value B
28	COE	Controller of Examinations
29	VLSI	Very Large-Scale Integration
30	MTech	Master of Technology
31	COA	Council of Architecture
32	JEE	Joint Entrance Examination
33	NATA	National Aptitude in Architecture

34	PC	Professional Core
35	BSAE	Building Science and Applied Engineering
36	PE	Professional Elective
37	PAECC	Professional Ability Enhancement Compulsory Courses
38	SEC	Skill Enhancement Course
39	OE	Open Elective
40	CTIS	Cloud Technology and Information Security
41	DS	Data Science
42	IoT	Internet of Things
43	IPA	Intelligent Process Automation
44	PCI	Pharmacy Council of India
45	PY	Pharmacy
46	B. Com (H)	Bachelor of Commerce with Honors
47	ACCA	Association of Chartered Certified Accountants
48	HM	Hotel Management
49	BTK	Basic Training Kitchen
50	QTK	Quantitative Training Kitchen
51	ATK	Advanced Training Kitchen
52	MBA	Master of Business Administration
53	BBA	Bachelor of Business Administration
54	MSc (F&C)	Master of Science (Finance & Control)
55	BA	Bachelor of Arts
56	M.Sc.	Master of Science

Chapter 1
Introduction

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, and Accredited by National Assessment and Accreditation Council (NAAC) of UGC as 'A^{++}' with highest Grade of 3.57 CGPA on 4-point scale in 2018, 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 "KLEF".

Location

KLEF is situated in a spacious 100-acre campus on the banks of Buckingham Canal of river Krishna, eight kilometers from Vijayawada city which is well connected by National Highway and Railways with Chennai (440 km), Hyderabad (275 km), and Vizag (385 km) and is a central junction for trains running from North to South India. Daily flights operate from Hyderabad and Bangalore. 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 is situated in a built-up area of around 15, 00,000 S.Ft.

- **NAAC A++ Grade** with 3.57 CGPA on 4-pointscale
- **CATEGORY-1** University by UGC under the categorization of universities for grant of Graded Autonomy
- UGC Recognized under section **12B** of UGC Act1956
- Approved by MHRD & UGC (Under Section 3 of UGC act1956)
- ISO 9001 - 2015 Certified Institution
- NIRF Rank University :28, Engineering: 44, Management:52

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 65,926 electronic journal titles, academic databases and 15,19,512eBooks. Access is available on campus on student computers and remotely. Every department of the college maintains their library to cater to 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 the following library services.

- Circulation of library documentary.
- Inter-library loan services.
- Photo copying services.
- Reference service.
- CD-ROM search services.
- Internet services.
- OPAC
- WEBOPAC
- Audiovisual
- Online lectures

The Data Centre

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

Hardware: A configuration of high-end stream of servers that provides various services.

Supercomputer

HPC Infrastructure (Supercomputer): 5.3 TERA Flops (CPU +GPU) HPSL2304 *SL230sGen8,(2*2.6GHz,32GBRAM,2x500GBHD,10GIBHCA) providing 1.3TFHPSL2502. *SL250sGen8,(2*2.6GHz,32GBRAM,2x500GBHD,10GIBHCA + 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) Q Logic IB QDR 36 Port Switch.Intel® Composer XE for Linux. Servers, Dell and HP Blade Servers, Apple Server X server.

Special Laboratories

The institute is equipped with various Industry Collaborated Labs

S. No	Discipline	Name of the Lab	Research Group Associated

1	Computer Science & Engineering	CISCO	Computer Networks and security
2	Computer Science &Engineering	IBM	Software Engineering
			Knowledge Engineering
3	Computer Science & Engineering	Microsoft	Embedded Systems
			Software Engineering
			Knowledge Engineering
4	Computer Science & Engineering	Adobe	Web technologies
			Image processing
5	Computer Science & Engineering	Oracle	Knowledge Engineering
6	Electronics & Communication Engineering	NI LabView	Communications Systems
7	Mechanical Engineering	APSSDC Dassault Systems lab, with Dassault 3 D experience suite	Design & Manufacturing, Robotics & Mechatronics
8	Mechanical Engineering	Center for system Dynamics & Condition Monitoring	Design & Manufacturing
9	Mechanical Engineering	MSC: NASTRAN/ PATRAN/ ADAMS simulation suite	Design & Manufacturing

Physical Education- Sports Facilities

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

Sport/Game	No. of Courts	Sport/Game	No. of Courts
Athletic track	1	Handball Court	1
Hockey Field	1	Netball Courts	2
Badminton Courts	4	Throw ball courts	2
Tennikoit Courts	2	Beach Volleyball Court	1
Cricket Field with Net practice	3	Football Field	1
Volleyball Courts	2	Basketball Courts	2
Tennis Courts	2	Kabaddi Courts	2
Kho Kho Court	1	Table Tennis	6
Soft Ball	1	Chess	20
Archery	1	Caroms	12

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

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

Accommodation- Hostels

- KLEF 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 their studies.
- A state- of – the- art kitchen and spacious dining area has been provided for both the hostels.
- Generators have been provided as power backup. Emphasis has been laid on hygiene and cleanliness for healthy living. A customized menu caters to the student needs, it keeps changing according to their tastes.
- Teaching staff will have to address the academic and personal problems of the students. Round-the-clock security, communication, dispensary facilities are also available.

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 a separate study room are also available.

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 and Regulations

- Students are hereby informed that while staying in the hostel, it is essential to be responsible for 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. Students must intimate to the hostel authorities before giving police complaints 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 must hand over the keys to security and can collect them on returning 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 the premises.
- Hostel students are not allowed to come into the hostel after 3.00 pm for morning shift students and 6.00pm for day shift students.
- Those students who are utilizing the computer lab, library etc., after the times specified must submit the permission slip to the security while entering the hostel.
- During public holiday outings, those who seek permission to leave the hostel will have to obtain written permission from the 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 is strictly prohibited. Strict study hours from 7.30 am to10.30 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 will only be entertained. Any health problem should be brought to the notice of Warden/Floor In – charge for necessary treatment.

Transportation

The institution runs 80 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 10PM.

Healthcare

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

Cafeteria

KLEF has a spacious canteen with the latest equipment and hygienic environment which provides quality food and prompts service and caters to the needs of all the students and staff. A central cafeteria of 1500 Sq.m. is available on 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

KLEF 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 to enhance 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, and 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 provides career guidance with the help of the Industrial Relations and Placements (IRP) department. A group of 20 students are allotted to each faculty member who counsels them regularly and acts as their mentor.

Social Service Wing

KLEF has a social service wing which is used to channelize the social service activities of the faculty, staff and 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/NCC wings

NCC/NSS is a credit course designed with an intent to transform NCC/NSS activities into curricular activities from an extracurricular thereby providing credits to students involved in NCC/NSS along with other attended advantages to the students in the university.

Hobby Clubs

Wholly and solely managed by the students, contributed much to the cultural life of the campus and to the cultural evolution of the students. Few 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 active members of the Hobby Clubs.

Life Skills and Inner Engineering

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

Technical Festival

KLEF organizes various programs for the all-round development of the students. The technical festival and project exhibition is 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 to exhibit their talents and creativity. Through these festivals KLEF is imparting organizational skills, leadership skills, competitive spirit, and team behavior skills to our students. Along with the knowledge, KLEF festivals provide recreation to the student community.

Center for Innovation, Incubation and Entrepreneurship (CIIE)

KLEF being a pioneering institute supporting Academics and Research in Engineering, Science and Technology is endowed with the entire infrastructure and highly experienced faculty, has a Centre for Innovation, Incubation and Entrepreneurship (CIIE) that comprises of: Innovation Centre which aims to inculcate a spirit of innovation. Incubation Centre which aims to incubate innovations through prototype product development. Entrepreneurship Development Centre (EDC) which aims at fostering entrepreneurial skills among the students.

Chapter 2

PROGRAM EDUCATIONAL OBJECTIVES (PEOs) and PROGRAM OUTCOMES (POs)

Engineering Postgraduate Programs

To be a globally renowned university, as per our vision, we need to produce quality products (Postgraduates) 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. They 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 converted into the Program Educational Objectives (PEOs) and Pos which are best suited to Postgraduate Engineering programs, and are those that complement the university vision, mission.

M.TECH - BIOTECHNOLOGY

PO NO	DESCRIPTION
PO1	Ability to practically apply various Biotechnological concepts.
PO2	Demonstrate knowledge of innovative and modern bio engineering practices.
PO3	Synergize biological sciences with engineering and solve various societal and health problems.

M.TECH-STRUCTURAL ENGINEERING

PO NO	DESCRIPTION
PO1	An ability to independently carry out research/investigation and development work to Solve practical problems.
PO2	An ability to write and present a substantial technical port/document
PO3	Students should be able to demonstrate degree of mastery for designing and solving structural engineering problems.
PO4	An ability to use appropriate modern tools in structural engineering. In doing so he should demonstrate sufficient knowledge of competing tools and their relative merits and demerits
PO5	An ability to demonstrate the traits of learning and unlearning throughout his Professional career, and be willing to learn new techniques, methods and processes
PO6	Tune his knowledge to be a responsible engineer adhering to all established practices of his profession

M.TECH-CONSTRUCTION TECHNOLOGY & MANAGEMENT

PO NO	DESCRIPTION
PO1	An ability to independentlycarryoutresearch/investigationanddevelopmentworkto Solve practical problems.
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4	Students should be able to understand how to implement construction process using effective and efficient project planning tools, they will able to identify the activities and coordinate resources and create goals and objectives to complete individual task
PO5	Students should be able to understand how to use mathematics logic and technology to help effectively and efficiently analysis the project and solve problems required for technical tasks
PO6	Students should be able to understand concepts related to running sustainable projects and business

M.TECH-COMPUTER SCIENCE ENGINEERING

PO NO	DESCRIPTION
PO1	Apply the knowledge of computer engineering principles and paradigms in the design of system components and processes that meet the specific needs of the industry.
PO2	Identify, analyze and formulate solutions to complex engineering problems using innovative and emerging technologies.
PO3	Effectively communicate technical information in speech, presentation and documentation.
PO4	Extract information relevant to novel problems and apply appropriate research methodology to develop scientific knowledge.
PO5	Self-learn and pursue higher studies to upgrade qualifications and attain constructive growth in profession.
PO6	Make valuable contributions to design, developer by practicing related engineering applications and algorithmic methods.
PO7	Provide exposure to latest tools and technologies based on the industry needs and contribute to valuable research findings in the specialized domains.

M.TECH - VLSI

PO NO	DESCRIPTION
PO1	Apply the knowledge of science, mathematics, and engineering principles for developing problem solving attitude and get sound knowledge in the theory, Principles and applications

	of VLSI Circuits and Systems.
PO2	Configure recent EDA tools, apply test conditions, deploy and manage them.
PO3	Design and conduct experiments, analyze and interpret data, imbibe Programming skills for development of simulation experiments.
PO4	Ability to demonstrate the knowledge of engineering solutions, and function as A member of a multi disciplinary team with sense of ethics, integrity and social responsibility.
PO5	To develop, design and implement projects with given specifications, in order to Cater industrial needs.
PO6	Ability to investigate develops and carries out research to solve industrial Problems related to designing and testing of VLSI systems.
PO7	Design a system, component or process as per social needs and specifications and also will be aware of contemporary issues.

M.TECH-RADAR & COMMUNICATION

PO NO	DESCRIPTION
PO1	An ability to identify, formulate, research literature, analyze complex Engineering problems in the area of communications and RADAR to cater national and industrial needs.
PO2	An ability to develop solutions for complex problems in communication system design and RADAR system component or processes that meet the specified needs considering.
PO3	Ability to create and apply appropriate techniques using modern industrial and Research tools for modeling and testing of antennas, communications system modules and RADAR systems.
PO4	An ability to design the experiments, analysis and interpretation of data and synthesis of the information using various modern and industrial tools to obtain solutions for complex problems in industries, military and social needs.
PO5	Ability to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, ethical principles of Engineering practices and the consequent responsibilities relevant to the RADAR engineering.
PO6	Exposure to prerequisite math's and a mathematically rigorous approach to Communication theory will provide him with all the necessary background to pursue a career in any field of communications going forward in his career.
PO7	An ability to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings for project management by demonstrating the knowledge and understanding of principles of communication systems and radar, and apply those one's own work, as a member and leader in team, to manage projects and in multi-disciplinary environments.

M.TECH – ROBOTICS AND AUTOMATION

PO NO	Description

PO1	Acquire in-depth understanding of the Robotic control engineering and navigational, robotic sensors concepts of contemporary issues, apply them to identify, formulate and analyze complex engineering problems.
PO2	Critical Thinking - Analyze complex robotics and automation engineering problems critically, apply independent judgement for synthesizing Robotics intellectual and creative advances for conducting research in a wider theoretical, practical and policy context.
PO3	Understanding the Human Activity Assistive Technology (HAAT) model. Understanding of the Assistive Robotic Manipulators (ARM) Justify the use of robots in rehabilitation. Discuss the current international safety standards for robotic assistive technologies
PO4	Ability to investigate develops and carries out designing and implementation of Human Machine Interface, Brain Machine Interface, and Robotics.
PO5	Robotics Programming skill set to modern simulation tools - Create, select, learn, and apply appropriate techniques, resources, including prediction and modelling.
PO6	Problem Solving - Think laterally and originally, conceptualize, and solve robotics and engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal, and environmental factors in the core areas of expertise.
PO7	Capacity to design and develop an industry-based robotics systems, ability to enriching Robotics System Engineering and Artificial Intelligence based optimization algorithms and operational research.

M.TECH - POWER ELECTRONICS AND POWER SYSTEMS

PO NO	Description
PO1	An ability to independently carry out research / investigation and development work to solve practical problems pertaining to applications of power electronics and power systems
PO2	An ability to write and present a substantial technical report/ document.
PO3	An ability to design and control power electronic systems for sustainable power conversion and delivery

M.TECH – THERMAL ENGINEERING

PO NO	Description
PO1	Advanced knowledge of a broad range of modeling methodologies, and under lying mechanical science, commonly used in the development and analysis of Thermal engineering systems.

PO2	Knowledge off under mental design issues relevant to Thermal engineering, and an understanding of how to formulate and Analyse design solutions in various engineering contexts.
PO3	Working knowledge of arrange of modern mathematical methods and tools used in the development and analysis of Thermal engineering systems.
PO4	In-depth knowledge of one or more of the following (depending of selection of option modules and project area): specific engineering systems, design methods, modeling techniques, mathematical and/or numerical techniques.
PO5	Knowledge of basic research and development principles and practices relevant to main streaming Ineering industry.
PO6	Knowledge of key professional, safety and ethical issues arising in modern engineering industry.
PO7	Knowledge of time- management and work planning issues related to the Organization, implementation and successful completion, including reporting, of an individual, Masters level, engineering based project.

M. Tech – MACHINE DESIGN

PO NO	**Description**
PO1	Advanced knowledge of a broad range of modeling methodologies, and underlying principles of mechanics, commonly used in the development and an analysis of mechanical machines and systems.
PO2	Knowledge off under mental design issues relevant to machine or mechanical component, and an understanding of how to formulate and analyse design solutions in various engineering contexts.
PO3	Working knowledge of a range of modern mathematical methods and tools used in the development and analysis of machines and mechanical systems.
PO4	In-depth knowledge of one or more of the following (depending of selection of option modules and project area): specific engineering systems, design methods, modeling techniques, mathematical and/ or numerical techniques.
PO5	Knowledge of basic research and development principles and practices relevant to main stream engineering industry.
PO6	Knowledge of key professional, safety and ethical issues arising in modern engineering industry.
PO7	Knowledge of time- management and work planning issues related to the organisation, implementation and successful completion, including reporting, of an individual, Masters level, engineering based project.

Chapter 3
Programs & Eligibility Criteria

S.no	Program	Duration (Years)	Eligibility
1	Master of Technology - Bio Technology	2	Bachelor's degree in the relevant engineering program with a minimum of 60 percent aggregate marks or an equivalent CGPA.
2	Master of Technology - Structural Engineering	2	
3	Master of Technology - Construction Technology & Management	2	
4	Master of Technology - Geo Informatics	2	
5	Master of Technology - Computer Science & Engineering	2	
6	Master of Technology - VLSI	2	
7	Master of Technology - Radar & Communication	2	
8	Master of Technology - Robotics and Automation	2	
9	Master of Technology - Embedded Systems	2	
10	Master of Technology - Power Electronics and Power Systems	2	
11	Master of Technology - Electrical and Electronics Engineering	2	
12	Master of Technology - Thermal Engineering	2	
13	Master of Technology - Machine Design	2	
14	Master of Technology - Mechanical Engineering	2	

Chapter 4
Academic Regulations

This document supplements the KLEF rules and regulations to assist all students. It is required that every individual must abide by these regulations.

- **Note**: The regulations stated in this document are subject to change or can be relaxed / modified without prior notice at the discretion of the Hon’ble Vice Chancellor.

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. The 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 has zero credits and has a “Satisfactory” or an “Unsatisfactory” grade.
- **Backlog Course:** A course is considered to bea backlog 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 another.
- **Compulsory course:** Course required to be undertaken for the award of the degree as per the program.
- **Course:** A course is a subject offered by the University for learning in a particular semester.
- **Course Handout:** Course Handout is a document which gives a complete plan of the course. It contains the details of the course viz. Course title, Course code, Pre-requisite, Credit structure,

team of instructors, Course objectives, Course rationale, Course Outcomes and the relevant syllabus, textbook(s) and reference books, Course delivery plan and session plan, evaluation method, chamber consultation hour, course notices and other course related aspects. In essence, course handout is an agreement between students (learners) and the instructor.

- **Course Outcomes:** The essential skills that need to be acquired by every student through a course.
- **Credit:** A credit is a unit that gives weight to the value, level or time requirements of an academic course. The number of 'Contact Hours' in a week of a particular course determines its credit value. One credit is equivalent to one lecture hour per week or two hours per week of tutorials/ self-learning/ practical/ field work during a semester.
- **Credit point:** It is the product of grade point and number of credits for a course.
- **Credit Transfer:** The procedure of granting credit(s) to a student for course(s) undertaken at another institution.
- **Cumulative Grade Point Average (CGPA):** It is a measure of cumulative performance of a student over all the completed semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
- **Curriculum:** Curriculum is a standards-based sequence of planned experiences where students practice and achieve proficiency in content and applied learning skills. Curriculum is the central guide for all educators as to what is essential for teaching and learning, so that every student has access to rigorous academic experiences.
- **Degree:** A student who fulfils 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 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.
- **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 ofhis/her Academic Year to meet the final requirements for the award of B.Tech 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 thatProgram.
- **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.
- **Supplementary**: 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-Registration:** Student who are detained in courses due to attendance or marks criteria as per their regulation are given a chance to re-register for the same and complete it during the summer term.
- **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 socialawareness 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’s 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 for a semester in that Program.
- **Course Withdrawal:** Withdrawing from a Course means that a student can drop from a course within the first two weeks of the odd or even Semester (deadlines aredifferent 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.

Academic Instructions

General Behaviour

- Student should communicate in English with faculty and other students while he/ she is in campus.
- Students are expected to wish/greet all officials of the KLEF with due respect.
- Students should be courteous and polite while communicating with all Faculty & staff.
- Students should maintain silence and/or speak in a polite way in and around the classrooms, library, laboratories, and offices of the Deans, Program Chairs, Senior Officials, faculty rooms and corridors of academic buildings.
- It must be noted that shouting, talking in loud voice or in chorus, using indecent, abusive and discourteous language anywhere within the institution premises are considered serious acts of indiscipline and are punishable.
- Students should not loiter during the free time in the university campus.
- Students should not issue any public or press statement, send letters to editors, government, public servants or notaries without prior permission and approval of the Registrar of KLEF in writing.
- Students should keep the status, dignity, prestige and reputation of KLEF high and not engage in anything that might directly or indirectly undermine the standing of the institution.
- Students must always adhere to a prescribed/decent dress code befitting the dignity of a technical/professional student within the campus.
- Ragging of any student is a serious act of indiscipline and has been totally banned by the Hon'ble Supreme Court of India.
- A student found involved in any form of ragging, verbal or physical, inside or outside the institutional campus, hostels, or buses shall be treated as per the anti-ragging rules of the KLEF.
- Students must not be involved in quarrelling or fighting or any indecent verbal or physical activity among themselves, or with staff and faculty or visitors.

- Direct or indirect involvement in any such activity will be considered as serious breach of discipline and strict disciplinary action will be taken against the students that engage in such activities.
- Students are not allowed to sit on the steps, boundary walls on the higher floors of any building, or engage in gossiping, making noise or any other such activity.

KLEF Working Hours

- KLEF operates between 7:20 AM to 5.00 PM (in shifts) on all weekdays.

Class Environment

The institute is a community of learners. Students have a responsibility of creating and maintaining an environment that supports effective learning to receive effective instructions in classrooms and laboratories. KLEF expects students to conduct themselves in an orderly and cooperative manner by adhering to University Rules & Regulations.

Laboratory Environment

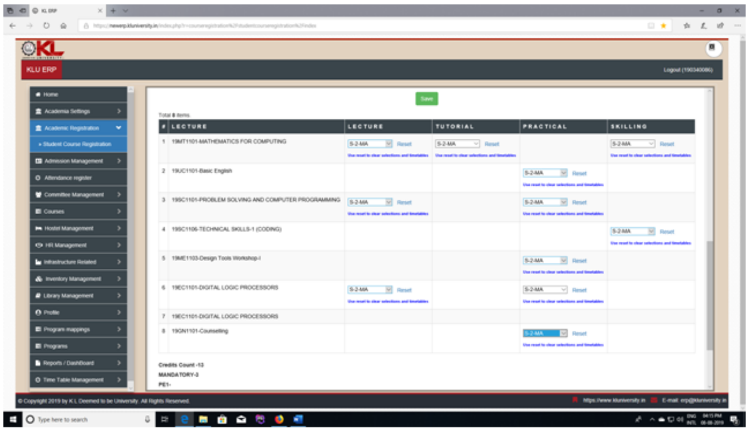
- A conducive learning environment in the laboratory is essential and the students are advised to follow the guidelines mentioned below:
- Always listen carefully to the faculty especially for the safety precautions to take in the laboratories. Accidents resulting in injuries may occur if precautions are not taken.
- Eating in laboratories is strictly prohibited.
- Proper dress code is to be followed as prescribed by faculty in each lab.
- Students should familiarize themselves with the location of all the safety equipment which may be available.
- Follow evacuation procedures quickly and quietly, if needed.
- Students should always conduct themselves in a responsible and cautious manner. Risky behaviours such as pushing, running, jumping etc., are unwarranted.
- Only materials required to complete and record the experiment instructions, (e.g. pencils or graph paper, etc.) should be brought into the laboratory.
- Equipment must be carefully handled to prevent breakage or damage, otherwise appropriate penalties/disciplinary-action May believed/imposed.
- Lab station must be cleaned prior to leaving a lab.
- Any accident, no matter how small or big, must be reported to the concerned faculty immediately.

Registration Process

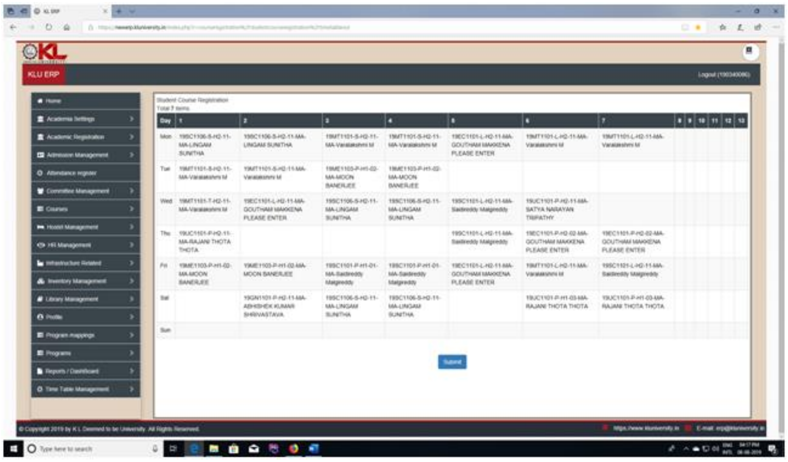
- For every course, the student must undertake the registration process prior to commencement of the coursework, based on the following conditions.
- Registration into a course will be permitted only for such courses, which are offered by KLEF in that semester.
- A student must clear the pre-requisite(s) if any, to register into course.
- KLEF reserves the right to register.
- Registration for add/drop/change of a course will be permitted only within one week from the scheduled date of commencement of classes.
- Students can register up to a maximum of 32 credits of their choice in a semester to meet their program requirements.
- Students, who wish to register for additional credits through Overloading or less credits through Under loading, must seek prior permission from Dean- Academics.
- Students who have opted for minor degree, Honors degree, can register for a greater number of credits in a semester through Overloading (subjected to guidelines appropriate to compliance on eligibility) .
- KLEF reserves the right to withdraw within one week of the commencement of the semester any elective course offered, if adequate number of students have not registered or for any other administrative 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.
- KLEF reserves the right to cancel the registration of a student from a course or a semester or debar from the degree on disciplinary / plagiarism grounds.
- A student is solely responsible to ensure that all conditions for proper registration are satisfied. If, there is any clash in the timetable, it should be immediately brought to the notice of the Department Year coordinator for necessary corrective action. The registration may be cancelled for a course or the entire semester by KLEF if any irregularity is found at a later stage.

Student Course Registration Process:

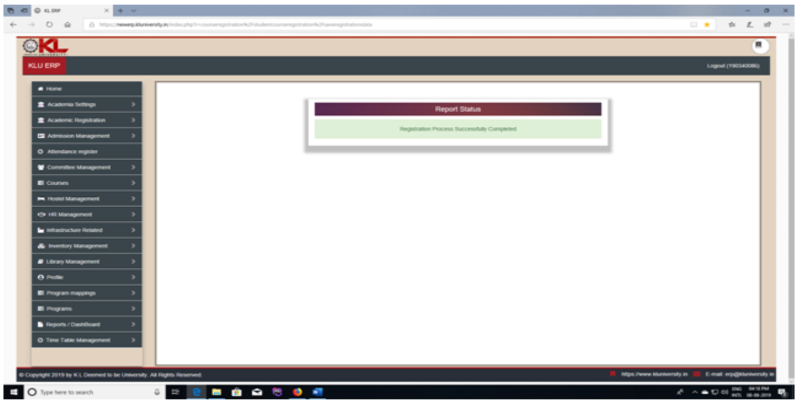
- To complete the student registration, student login to new ERP portal with their valid login credentials.
- After login student should click on Academic Registrations Student Course Registration. Now Student can view the courses and sections in dropdown menus.
- Student can select the sections against the courses on their own choice as mentioned in the following screen shot.
- Student can view the timetable on top of the selection of each course and section.



After completing the selection, student need to click on save to save the time table which will be directed to the following screenshot



After duly verifying the timetable, student needs to clink on submit to complete the registration process.



After clicking the submit, the above screen will be displayed and contains the message “ student registration successfully completed”.

Chapter 5
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 / Skill / Project / Self Study / Capstone Design etc.), in the Choice Based Credit System. However, all such are essentially designed, implemented and assessed in Outcome Based Education Framework.

Program Structure

An Academic Year is made of two semesters each is of, approximately 16±1 week duration and each semester is classified as:

Odd Semester (July–December)

Even Semester (December –May).

KLEF may offer summer term between May and June.

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

Students have the flexibility to choose courses of their own choice prescribed by the KLEF.

From 3rd Semester onwards a student can register for a maximum of 30 credits, 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).

Every course has a Lecture -Tutorial/Studio-Practice-Skill (L-T/ST-P-S) component attached to it.

Based upon the L-T-P-S structure the credits are allotted to a course using the following criteria.

- Every Lecture / Tutorial hour is equivalent to one credit.
- Every Practical hour is equivalent to half credit.
- Every skill-based practice hour is equivalent to quarter credit.
- If the calculated value of credit is a fraction, it is rounded to the next integer.
- Every (ST) Studio hour is equivalent to one and a half credit.

Audit Courses

Any course offered in the University that has no assessment of student performance and no grading.

Induction Courses:

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

Value-Added courses:

Courses leading to global certification and those which are conducted exclusively for employability are referred to as value added courses. Though “Satisfactory” completion of value added courses doesn’t acquire any credit but they are part of the graduation requirements. Refer Section 3.1 for list of Value-added courses.

Bridge Courses:

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

Course Precedence

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

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

Summer Term Courses

KLEF offers summer term courses during May and June. The following are the guidelines to register in to courses offered in Summer Semester.

- A student may register for course/s in each summer term by payingthestipulated fee.
- Students registering for more than one (1) summer course must ensure that there is no clash inthe time table.
- A student can register into a detained course or a not-registered course (course offered in regular semester, but student failed to register due to the non- compliance of pre-requisite condition but has paid the fee.) A student can also register for other than the above two mentioned categories of courses only if they are permitted foracceleration.
- In any case, a student can register only for a maximum of 12 credits during summer term.
- Attendance & Promotion policy for summer term is same as compared to the regular semester except for condonation policy. Condonation is not applicable for summer termcourses.

Practice School

The Practice School (PS) program forms an important component of education at KLEF. It is an attempt to bridge the gap between an academic institution and the industry. The Program, which would be a simulation of real work environment, requires the students to undergo the rigor of professional environment, both inform and in substance. In the process, it provides an opportunity for the students to satisfy their inquisitiveness about the corporate world provides exposure to practicing professional skills and helps them acquire social skills by being in constant interaction with the professionals of an organization. During Practice School, some of the students may be offered stipend and/or job offer as per the discretion of the concerned industry.

Practice School Duration

Practice School is usually offered for a period of one semester. Should the need be, a student may put a request through the organization and the Head of the Department to the Dean Academics requesting for extension of the duration.

Eligibility

- Students who have not registered with placement (IRP) can only apply for PS- 1 in (VII semester).
- Students who have registered with placement (IRP) and after getting placement will be allowed in PS-2 (VIII semester).

Guidelines

The following are the guidelines for attending Practice-School.

- Practice School program carries six credits for a semester. Therefore, it involves substantial effort and requires seriousness, commitment and dedication from the students. One has to hard work for good experience and better placement opportunities. Students must be disciplined, hardworking and possess attitude to undergo On the Job Training (OJT).
- Students must abide by the rules and regulations of the company and the University.
- Practice School is not mandatory for the students. However, Practice School experience enhances the opportunities for placement.
- Circular will be sent regarding schedule of the selections as and when a company is visiting the campus. Interested students shall attend the selection process for the companies.
- The students who were not selected by the companies in the campus will be allotted a company by the Director, Practice School. Allotment of company is done based on the CGPA of the students and the availability of vacancies in the companies of their relevant branch of engineering.
- Students who have submitted the Registration-cum-Data Form will not be guaranteed opportunity to attend the Practice School. The number of students sent to the practice school purely depends on the number of vacancies by various companies.
- At the time of allotment of companies, the students should be ready for opting companies in any location (Hyderabad, Bengaluru, Vizag, Chennai and Vijayawada etc.) depending on the availability of the vacancies in their respective branches. Once the students are selected by a company or allotted to a company, they shall not be allowed either to change company or to cancel the practice school program.

Chapter 6
Requirements for the award of degree

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

- Must successfully earn a minimum of 80 credits, as stipulated in the program structure.
- Must successfully undertake specific training in focused areas that enable students to be successful in their chosen career tracks. The focused areas are: (a) Employment in MNCs, (b) Civil Services (c) Higher Studies (d) Research and (e) Entrepreneurship.
- Must have successfully obtained a minimum CGPA of 5.5 at the end of the program.
- 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 KLEF or debarred from the KLEF.

Award of Degree

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

a. $5.5 \leq$ CGPA < 5.75 will be awarded Pass class
b. $5.75 \leq$ CGPA < 6.75 will be awarded Second class
c. $6.75 \leq$ CGPA < 7.75 will be awarded First class

CGPA ≥ 7.75 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 within the specified minimum years duration.

Chapter 8
Attendance Rules & Detention Policy

Attendance policy for promotion in a course:

The student must maintain minimum 85% of attendance to be promoted in a course and to appear for Sem End Examination. In case of medical exigencies, the student/parent should inform the principal within a week by submitting necessary proofs and in such cases the attendance can be condoned up to an extent of 10% by Principal on the recommendation of the committee established for condonation.

Attendance in a course shall be counted from the date of commencement of the classwork only and not from the date of his/her registration.

Attendance for the students who are transferred from other institutes and for new admissions, attendance must be considered from the date of his/her admission.

In case of attendance falling marginally below 75% due to severe medical reasons or any other valid reasons, the Principal / Program chair may bring such cases, along with valid and adequate evidence to the notice of the Dean Academics. The condonation board formed by Vice-Chancellor under the chairman ship of Dean-Academics will consider any further relaxation in attendance from the minimum attendance percentage requirement condition after going through case by case.

Attendance based Marks: 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 the respective course handouts which should duly be approved by the Dean Academics. For any course, not more than 5% marks can be allotted for attendance.

The distribution of marks for attendance is [85,88]=1 mark, [89,91]=2marks, [92,94]=3marks,[95,97]=4marks and [98,100]=5marks, below 85%, even in case of condonation,"0" marks. The marks, if allotted for attendance will have to be considered for all L-T-P-S components of a course cumulatively but not specifically for theory component for any course.

Attendance Waiver: Students maintaining a CGPA ≥ 9.00 and SGPA ≥ 9.00 in the latest completed semester get a waiver for attendance in the following semester. Students who thus utilize an attendance waiver will be awarded the marks allocated for attendance (if any) based on their performance in an advanced assignment specified by the course coordinator (emerging topics related to the course). S/he can appear in all assessments and evaluation components without being marked ineligible due to attendance-based regulations.

Attendance Condonation for Participation in KLEF / National / International Events: Only those students nominated / sponsored by the KLEF to represent in various forums like seminars / conferences / workshops / competitions or taking part in co- curricular / extra- curricular events will be given compensatory attendance provided the student applies in writing for such a leave in advance and obtain sanction from the Principal basing on the recommendations of the Head of the Department (HoD) for academic related requests; or from the Dean Student Affairs for extracurricular related requests. For participation in the KLEF's placement process the names of students will be forwarded by the placement cell in-charge to the respective Heads of the Departments. Students participating in KLEF/National/International events like technical fests, workshops, conferences etc., will be condoned for 10% of total classes conducted for each course in the semester. This condonation is not applicable for summer term.

Course Based Detention Policy:

In any course, a student must maintain a minimum attendance as per the **attendance policy for promotion in a course**, to be eligible for appearing in the Sem-End examination. Failing to fulfill this condition, will deem such student to be detained in that course and become ineligible to take semester end exam.

Eligibility for appearing Sem – End Examination:

A Student registered for a course and maintained minimum attendance of 85% is eligible to write the Semester-End Examination for that course unless found ineligible due to one or more of the following reasons:

- Shortfall of attendance
- Acts of indiscipline
- withdrawal from a course

Absence in Assessment and Examination

If a student fails to take any formative assessment component (due to ill-health or any valid reason), no second chance will be given, and zero marks will be awarded for the same. In cases of excused absence, the instructor may provide an opportunity to the student to reappear in quizzes or assignments or any other internal assessment criteria based on the approval from the principal & the concerned Head of the Department in written.

If a student fails to write Sem-In Exam-I or obtained less than 50% marks in Sem-In Exam-I, he must attend remedial classes and maintain a minimum 85% of attendance in remedial classes to be eligible for Make-up test for Sem-In exam-I. The marks scored in such remedial makeup will be considered. Further, the number of remedial classes to be conducted shall be 50% of regular classes held till the SEM-In exam-I. However, there is no make-up test for Sem-In Exam-II or for the Laboratory exams.

A student's absence for a Sem-In Exams under the following circumstances are only considered for makeup test:

Pre-approved participation in University/State/National/International co- curricular and extra-curricular activities

Ill health and medical emergencies for the student leading to hospitalization with certification by the doctor stating inability of student to attend Sem-In exams clearly within the necessary dates.

Death of immediate family member

Remedial Classes

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

- Students who did not attend or obtain a minimum of 50% marks in the Sem-In exam1
- Students those for whom CO1/CO2 is (are) not attained in Sem-In Exam 1

- Any other student may also be permitted to attend remedial classes as per the discretion of the Principal.

The following are the guidelines to conduct remedial classes:

- Remedial classes which are scheduled to be conducted usually one- or two- weeks post conclusion of Sem-In exam1.
- The number of remedial classes to be conducted shall be 50% of regular classes held till the Sem-In exam-I.
- Remedial classes MUST NOT be scheduled during regular class work hours.

Chapter 9
Assessment & Evaluation

The assessment in each theory subject consists of two Sem-In Exams (Sem-in Exam-I and Sem-In Exam -II), in-class quizzes/tutorials/home-assignments/Active Learning Methods (continues assessment), and the Semester-End Exanimation (SEE). The distribution of weightage for each assessment step is listed below. The distribution of internal marks in the table below is only a guideline. Instructors at their discretion may apportion some marks for attendance beyond 75%. In such cases, the marks shown for quizzes and assignments will accordingly be adjusted. Students are advised to refer to the course handout to get more detailed information on assessment.

a. The Sem-In 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 Dean Academics with the approval of the Vice-Chancellor.

c. Students may have to take more than one examination in a day during Sem-In exams, Semester-End Examinations /Supplementary examinations.

Semester-In Evaluation

The following guidelines are followed for the Semester-In evaluation.

- The process of evaluation is continuous throughout the semester.
- The distribution of marks for Semester-In evaluation is 60% of aggregate marks of the course.

a. The distribution of weightage for various evaluation components are decided and notified by the course coordinator through the course handout after approval by the Dean Academics, prior to the beginning of the semester.
b. In order to maintain transparency in evaluation, answer scripts are shown to the students for verification, within one week of conduct of exam. If there is any discrepancy in evaluation, the student can request the course-coordinator to re-evaluate.
c. The solution key and scheme of evaluation for all examinations are displayed by the Course-Coordinator in the appropriate web portal of the course, on the day of the conduct of examination.
d. In case the student is unable to appear for any evaluation component owing to hospitalization, participation in extra/ co-curricular activities representing KLEF/ state/ country; the Dean Academics can permit to conduct of re- examination for such students.
e. In case a student has missed any of the two in-semester evaluations, S/he is eligible for and will be provided with an opportunity of appearing for re- examination.

Semester End Examination

f. The pattern and duration of such examination are decided and notified by the Course Coordinator through the Course handout, after approval from the Dean Academic.
g. To maintain transparency in evaluation, answer scripts are shown to the students for verification. If there is any discrepancy in evaluation, the student can request the Controller of

Examinations to re-evaluate.

h. If a student earns F grade in any of the courses of a semester, an instant supplementary exam (for only Semester End Exam component) will be provided within a fortnight of the declaration of the results.

Assessment of Project/Research-Based Subjects

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

Grading Process

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

Absolute Grading

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

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

Relative Grading

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

Letter Grade	Grade Point	Grade Calculation
O	10	total marks >= 90% and total marks >= mean + 1.50σ
A^+	9	$\mu+0.50\sigma <=$ total marks $< \mu+1.50\sigma$
A	8	$\mu <=$ total marks $< \mu+0.50\sigma$

B^+	7	μ-0.50σ <= total marks < μ
B	6	μ-1.00σ <= total marks < μ-0.50σ
C	5	μ-1.25σ <= total marks < μ-1.00σ
P	4	μ-1.50σ <= total marks < μ-1.25σ or ≥40
F	0	total marks <μ-1.50σ or total marks <=39
AB	0	Absent

Betterment

A student may reappear for semester end examination for betterment only in the theory part of the course for improving the grade, subject to the condition that, the student has passed the course, his/her CGPA is ≤ 6.75 and the grade in the respective course to be equal to or lower than "C". In the case of reappearing for a course, the best of the two grades will be considered.

A Student can re-register in any course in any semester during the program for improvement of grade if the current grade in the course is lower than B^+ and with due approval from Dean Academics in accordance with academic regulations.

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

A student is not eligible for award of B.Tech. Degree with Honors, and any Program Degree with distinction, in case s/he takes up the betterment option.

Course Based Detention Policy

In any course, a student must maintain a minimum attendance as per the attendance policy referred in Chapter 9, to be eligible for appearing in the Sem-End examination. Failing to fulfill this condition, will deem such student to be detained in that course and become ineligible to take semester end exam.

Chapter 10
Promotion

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

The rules governing change of branch are as listed below:

- Top 1% (based on CGPA until 2ndsemester) students will be permitted to change to any branch of their choice within the program discipline.
- 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 KLEF.
- All changes of Branch will be effective from third semester. Change of branch shall not be permitted thereafter.
- 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.
- Students in clause a and b may be permitted subject to the availability of seats in the desired branch.

Credit transfer

Credit transfer between KLEF and other institution

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

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

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

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

- When a student seeks transfer, equivalent credits will be assigned to the student based on the courses studied by the student.
- To determine the equivalent credits for a course from a previous institution on a 10-point scale at KLEF, the number of credits of the course is multiplied by the equivalent grade

point of the previous institution and then divided by the number of credits of the corresponding course at KLEF.

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

Credit Transfer Through MOOCs:

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

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 one tutorial hour per week or two hours per week of practical/ field work or four hours per week of skilling or one studio hour is equivalent to 1.5 credit during a semester.

Re Evaluation

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

There is no provision for re-evaluation in case of Lab/Practical/skilling exams,
student project, viva-voce exam or seminar/design/mini-project courses.

The final grades awarded to each course shall be announced by the COE and the same will be made available to students through the website/notice boards.

Academic Counseling Board (ACB)

Academic Counselling Board is constituted by the Dean Academics. This board shall comprise of the Chairman, Convener, Principal/Director, HOD and Professor/Associate Professor. A student will be put under Academic Counselling Board in the following circumstances:

- Has CGPA of less than 6.00.
- Has 'F' grade or 'Detained' in multiple courses.

The first level of Counselling such students will be done by the Mentor of the student and the HoD followed by the ACB and the list of students who have to undergo the ACB counselling be forwarded by the HoD to the Office of Dean Academics.

The students undergoing the Academic Counselling Board process may be allowed to register only for a few courses based on the recommendation of Academic Counselling Board.

Backlog Courses

A course is considered to be a backlog if the student has obtained 'F' grade in the course.

Rustication

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

Award of medals

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

a. The grade obtained through betterment/ supplementary will not be considered for this award.

b. S/he must have obtained first class with distinction for the award of Gold or Silver-medal.

CHAPTER 11
STUDENT COUNSELING & FEEDBACK

Counselling

Student counselling / mentoring service ensures that every student gets to know the academic structure of the University and utilize maximum opportunities that the institute offers to fulfill their career and personal life goals. The objective of "Student counselling/Mentoring Service" is to provide friendly support to the students for their well-being during their stay in the campus and for their holistic development.

Counsellors offer individual counselling to help students resolve personal or interpersonal problems. They may also offer small group counselling to help students enhance listening and social skills, learn to empathize with others, and find social support through healthy peer relationships. Counsellors also provide support to faculty by assisting with classroom management techniques and the development of programs to improve quality or safety. When necessary, counsellors may also intervene in a disrupted learning environment.

However, the benefits of counsellor-student relationships are as follows:

Maintain academic standards and set goals for academic success.

Develop skills to improve organization, study habits, and time management.

Work through personal problems that may affect academics or relationships.

Improve social skills.

Cope with university or community-related violence, accidents.

Identify interests, strengths, and aptitudes through assessment.

counselling Policy:

Student counselling takes great place in K L University. counselling is designed to facilitate student achievement, improve student behaviour, subject analysis levels, attendance, and help students develop socially, professionals with bachelor's, master's degrees or beyond. Faculty counsellors provide counselling and serve an educational role in K L University. We have Mentors, Academic, Career, Physiological, Co-Curricular & Extra Curricular activities counsellors in order to support students who are experiencing personal or academic challenges, help students choose careers and plan for university and intervene when students face behavioural, physical, or mental health challenges.

Feedback System

At KLEF, monitoring of feedback is a continuous process. Feedback is obtained from students and parents on various aspects. Feedback is taken through personal interaction with students, interaction with parents in addition to mid-semester and end-semester feedback.

The institution assesses the learning levels of the students, after admission and organizes special programs for advanced learners and slow learners.

Feedback Types:

In first year SWEAR analysis is done for every student in such a way it identifies their interests, pre-existing knowledge, aspects to improve technical and logical skills based on their career choice. The following are the different types of feedback taken at regular intervals:

(i). Student General Feedback (Twice in a Sem.)

(ii). Student Satisfaction Survey (Once in a Sem.)

(iii). Student Exit Feedback (Once in a Year)

(iv). Academic Peers Feedback on Curriculum (Once in a Sem.)

(v). Parents Feedback on Curriculum (Once in a Sem.)

(vi). Alumni Feedback on Curriculum (Once in a Sem.)

(vii). Industry Personnel Feedback on Curriculum (Once in a Sem.)

(viii). Student Feedback on Curriculum (Once in a Sem.)

(ix). Faculty Satisfaction Survey (Once in a Sem.)

(x). Parent Teacher Association (Once in a Sem.)

Feedback Procedure:

- General Feedback to be taken from the students on the aspects like Course Contents, Teaching Learning Process, Outcomes, Resources and Evaluation twice in every semester (Mid semester and End Semester Feedback) in a structured format floated by dean academics office.
- Student Satisfaction Survey (SSS) to all innovative methods and approaches should be recorded at appropriate intervals and the process should be refined based on that. Students should be sensitized on the process and methods and their understanding of the same should be assured.
- Exit survey feedback to be taken from the final year students on the aspects like entrance test, admission process, Course Contents, Teaching Learning Process, Outcomes, Resources and Evaluation, placements etc.
- Structured feedback for design and review of syllabus – semester wise / year wise is received

from Students, Alumni, Peers, Parent, Industry Personnel.

- Satisfaction Survey to be taken from the existing faculty on Course Contents, Teaching Learning Process, Outcomes, Resources and Evaluation once in every semester in a structured format floated by dean academics office.
- Parent Teacher Association (PTA) to develop the potential of parents and to strengthen their relationship with their children through planning and conducting a variety of developmental and recreational activities.
- Online Feedback is collected from all the students once at the end of the semester using well designed questionnaire. Informal feedback will be collected in parallel from selected student representatives within 4-5 weeks of commencement of the semester by the Office of Dean Academics.
- HODs have to submit monthly /semester / Academic Year Feedback reports with necessary comments and proofs to Dean Academics office duly signed by concerned Principal/Director. Visit following link https://www.kluniversity.in/site/feedsys.htm

Y23 - M.TECH PROGRAM STRUCTURE																											
Sl No	**PROGRAM**	**Category**	**Course Code**	**Course Title**	**MODE**	**L**	**T**	**P**	**S**	**Cr**	**CH**	**Pre-Requisite**	**BT**	**CSE**	**SE**	**CTM**	**GI**	**R&A**	**VLSI**	**R&C**	**ES**	**EEE**	**PEPS**	**ME**	**MD**	**TE**
1	M.TECH	AUC	23UC5201	PROFESSIONAL COMMUNICATION SKILLS	R	0	0	4	0	0	4	NIL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	M.TECH	AUC	23BT5101	BIOREACTOR MODELLING AND SIMULATION	R	0	0	4	0	0	4	NIL	Y													
3	M.TECH	AUC	23CS5206	JUNIPER NETWORKS CERTIFIED ASSOCIATE, JUNOS (JNCIA-JUNOS)	R	0	0	4	0	0	4	NIL		Y												
4	M.TECH	AUC	23CE5226	MS PROJECTS	R	0	0	4	0	0	2	NIL				Y	Y									
5	M.TECH	AUC	23CE5208	STRUCTURAL DETAILING	R	0	0	4	0	0	2	NIL			Y											
6	M.TECH	AUC	23VL5203	LOW POWER VLSI SYSTEM DESIGN	R	0	0	4	0	0	4	NIL							Y							
7	M.TECH	AUC	23ES5204	REAL TIME EMBEDDED SYSTEMS	R	0	0	4	0	0	4	NIL									Y					
8	M.TECH	AUC	23RA5204	ADVANCED ROBOTIC WIRELESS SENSOR NETWORKS	R	0	0	4	0	0	4	NIL						Y								
9	M.TECH	AUC	23RC5204	MODERN RADARS & AUTONOMOUS VEHICLES	R	0	0	4	0	0	4	NIL							Y							
10	M.TECH	AUC	23EE5207	MATLAB PROGRAMMING FOR ENGINEERS	R	0	0	4	0	0	4	NIL										Y	Y			
11	M.TECH	AUC	23ME5101	NEW PRODUCT DESIGN	R	0	0	4	0	0	4	NIL												Y		
12	M.TECH	AUC	23MD5101	DESIGN OF EXPERIMENTS	R	0	0	4	0	0	4	NIL													Y	
13	M.TECH	AUC	23TE5101	ADVANCED THERMAL ENGINEERING LABORATORY	R	0	0	4	0	0	4	NIL														Y
					TOTAL CREDITS								**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
14	M.TECH	ESC	23MT5001	MATHEMATICS AND BIOSTATISTICS	R	2	2	0	0	4	4	NIL	Y													
15	M.TECH	ESC	23MT5002	DISCRETE STRUCTURES AND MATRIX COMPUTATION	R	2	2	0	0	4	4	NIL		Y												
16	M.TECH	ESC	23MT5003	NUMERICAL METHODS	R	2	2	0	0	4	4	NIL			Y	Y	Y									
17	M.TECH	ESC	23MT5004	NON-LINEAR SYSTEMS AND CONTROL OPTIMIZATION FOR ROBOTICS	R	2	2	0	0	4	4	NIL						Y								
18	M.TECH	ESC	23MT5005	TRANSFORMATION TECHNIQUES, RANDOM VARIABLES & STOCHASTIC PROCESSES	R	2	2	0	0	4	4	NIL							Y							
19	M.TECH	ESC	23MT5006	RANDOM VARIABLES & STOCHASTIC PROCESSES	R	2	2	0	0	4	4	NIL								Y	Y					
20	M.TECH	ESC	23MT5007	PYTHON PROGRAMMING FOR ELECTRICAL SYSTEMS	R	2	2	0	0	4	4	NIL										Y	Y			
21	M.TECH	ESC	23MT5008	COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION	R	2	2	0	0	4	4	NIL												Y	Y	Y
					TOTAL CREDITS								**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
22	M.TECH	PCC	23BT5102	BIOCHEMICAL ENGINEERING	R	2	0	2	4	4	8	NIL	Y													
23	M.TECH	PCC	23BT5103	MOLECULAR BIOLOGY AND r-DNA TECHNOLOGY	R	3	0	2	0	4	5	NIL	Y													
24	M.TECH	PCC	23BT5104	ADVANCED BIOINFORMATICS	R	3	0	2	0	4	5	NIL	Y													
25	M.TECH	PCC	23BT5105	IMMUNOTECHNOLOGY	R	3	0	2	0	4	5	NIL	Y													
26	M.TECH	PCC	23BT5106	BIOSEPARATIONS ENGINEERING	R	2	0	2	0	3	4	NIL	Y													

Sl No	PROGRAM	Category	Course Code	Course Title	MODE	L	T	P	S	Cr	CH	Pre-Requisite	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	ES	EEE	PEPS	ME	MD	TE
27	M.TECH	PCC	23CS5101	OBJECT ORIENTED PROGRAMMING	R	2	0	2	4	4	8	NIL		Y												
28	M.TECH	PCC	23CS5102	ECLECTIC DATABASE SYSTEMS	R	3	0	2	0	4	5	NIL		Y												
29	M.TECH	PCC	23CS5103	ADVANCED OPERATING SYSTEMS	R	3	0	2	0	4	5	NIL		Y												
30	M.TECH	PCC	23CS5204	DATA STRUCTURES AND ALGORITHMS	R	3	0	2	0	4	5	NIL		Y												
31	M.TECH	PCC	23CS5205	AGILE BASED SOFTWARE ENGINEERING	R	2	0	2	0	3	4	NIL		Y												
32	M.TECH	PCC	23CE5103	STRUCTURAL DYNAMICS	R	2	0	2	4	4	8	NIL			Y											
33	M.TECH	PCC	23CE5104	ADMIXTURES AND SPECIAL CONCRETE	R	3	0	2	0	4	5	NIL			Y	Y										
34	M.TECH	PCC	23CE5105	ADVANCED PRESTRESSED CONCRETE STRUCTURES	R	3	0	2	0	4	5	NIL			Y											
35	M.TECH	PCC	23CE5206	FINITE ELEMENT ANALYSIS FOR STRUCTURAL ENGINEERING	R	3	0	2	0	4	5	NIL			Y											
36	M.TECH	PCC	23CE5207	DESIGN STRUCTURES FOR BRIDGE ENGINEERING	R	2	0	2	0	3	4	NIL			Y											
37	M.TECH	PCC	23CE5121	CONSTRUCTION PLANNING SCHEDULING AND CONTROL	R	2	0	2	4	4	8	NIL				Y										
38	M.TECH	PCC	23CE5123	PRE-ENGINEERING CONSTRUCTION AND TECHNOLOGY	R	3	0	2	0	4	5	NIL				Y										
39	M.TECH	PCC	23CE5224	MECHANIZED CONSTRUCTION AND MACHINERY	R	3	0	2	0	4	5	NIL				Y										
40	M.TECH	PCC	23CE5225	BUILDING INFORMATION MODELLING AND COMPUTER APPLICATION	R	2	0	2	0	3	4	NIL				Y										
41	M.TECH	PCC	23CE5131	GEOGRAPHICAL INFORMATION SYSTEM	R	2	0	2	4	4	8	NIL					Y									
42	M.TECH	PCC	23CE5132	FUNDAMENTALS OF GEOSPATIAL TECHNOLOGY	R	3	0	2	0	4	5	NIL					Y									
43	M.TECH	PCC	23CE5133	PHOTOGRAMMETRY	R	3	0	2	0	4	5	NIL					Y									
44	M.TECH	PCC	23CE5234	DIGITAL IMAGE PROCESSING	R	3	0	2	0	4	5	NIL					Y									
45	M.TECH	PCC	23CE5235	GIS DATA ANALYSIS & MODELLING	R	2	0	2	0	3	4	NIL					Y									
46	M.TECH	PCC	23RA5101	ROBOTICS: CYBER PHYSICAL SYSTEMS	R	3	0	2	0	4	5	NIL						Y								
47	M.TECH	PCC	23RA5102	IIOE 4.0 FOR AUTOMATION AND ROBOTIC SYSTEMS	R	3	0	2	0	4	5	NIL						Y								
48	M.TECH	PCC	23RA5103	ALGORITHMS FOR ROBOTICS SENSOR FUSION	R	3	0	2	0	4	5	NIL						Y								
49	M.TECH	PCC	23RA5104	ADVANCED ROBOTIC WIRELESS SENSOR NETWORKS	R	3	0	2	0	4	5	NIL						Y								
50	M.TECH	PCC	23RA5105	AUTONOMOUS MOBILE ROBOTS AND AUTOMOTIVE ELECTRONICS	R	2	0	2	0	3	4	NIL						Y								
51	M.TECH	PCC	22VL5101	MOS CIRCUIT DESIGN	R	3	0	2	0	4	5	NIL							Y							
52	M.TECH	PCC	22VL5102	DIGITAL VLSI DESIGN	R	3	0	2	0	4	5	NIL							Y							
53	M.TECH	PCC	22VL5103	ANALOG IC DESIGN	R	3	0	2	0	4	5	NIL							Y							
54	M.TECH	PCC	22VL5103	LOW POWER VLSI SYSTEM DESIGN	R	3	0	2	0	4	5	NIL							Y							
55	M.TECH	PCC	22VL5104	ASIC AND FPGA DESIGN	R	2	0	2	0	3	4	NIL							Y							
56	M.TECH	PCC	23RC5101	WIRELESS COMMUNICATION AND DATA NETWORKS	R	3	0	2	0	4	5	NIL								Y						
57	M.TECH	PCC	23RC5102	SMART ANTENNAS	R	3	0	2	0	4	5	NIL								Y						

Sl No	PROGRAM	Category	Course Code	Course Title	MODE	L	T	P	S	Cr	CH	Pre-Requisite	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	ES	EEE	PEPS	ME	MD	TE
58	M.TECH	PCC	23RC5103	MODERN SATELLITE COMMUNICATION SYSTEMS	R	3	0	2	0	4	5	NIL								Y						
59	M.TECH	PCC	23RC5104	5G NR - NEXT GENERATION WIRELESS TECHNOLOGIES	R	3	0	2	0	4	5	NIL								Y						
60	M.TECH	PCC	23RC5105	RF SYSTEM DESIGN	R	2	0	2	0	3	4	NIL								Y						
61	M.TECH	PCC	23RC5101	EMBEDDED CONTROLLERS & SOCS	R	3	0	2	0	4	5	NIL									Y					
62	M.TECH	PCC	23RC5102	INTERNET OF THINGS ARCHITECTURE AND PROTOCOLS	R	3	0	2	0	4	5	NIL									Y					
63	M.TECH	PCC	23RC5103	IOT CLOUD COMPUTING	R	3	0	2	0	4	5	NIL									Y					
64	M.TECH	PCC	23RC5104	IOT SYSTEM DESIGN TECHNIQUES	R	3	0	2	0	4	5	NIL									Y					
65	M.TECH	PCC	23RC5105	WIRELESS SENSOR NETWORK AND SECURITY	R	2	0	2	0	3	4	NIL									Y					
66	M.TECH	PCC	23EE5102	ADVANCED POWER CONVERTERS	R	2	0	2	4	4	8	NIL										Y				
67	M.TECH	PCC	23EE5103	ADVANCED POWER SYSTEM ANALYSIS & PROTECTION	R	3	1	0	0	4	4	NIL										Y				
68	M.TECH	PCC	23EE5104	POWER SYSTEM STABILITY& CONTROL	R	3	0	2	0	4	5	NIL										Y				
69	M.TECH	PCC	23EE5205	DIGITAL CONTROL SYSTEMS	R	3	1	0	0	4	4	NIL										Y				
70	M.TECH	PCC	23EE5206	SMART GRID TECHNOLOGIES	R	2	1	0	0	3	3	NIL										Y				
71	M.TECH	PCC	23EE5102	ADVANCE POWER CONVERTERS	R	2	0	2	4	4	8	NIL											Y			
72	M.TECH	PCC	23EE5104	POWER SYSTEM STABILITY & CONTROL	R	3	0	2	0	4	5	NIL											Y			
73	M.TECH	PCC	23EE5111	MODELLING AND ANALYSIS OF ELECTRICAL MACHINES	R	3	1	0	0	4	4	NIL											Y			
74	M.TECH	PCC	23EE5212	ADVANCED ELECTRIC DRIVES	R	3	1	0	0	4	4	NIL											Y			
75	M.TECH	PCC	23EE5213	DIGITAL CONTROLLERS	R	2	0	2	0	3	4	NIL											Y			
76	M.TECH	PCC	23ME5102	MODELLING AND ANALYSIS OF MECHANICAL ELEMENTS	R	2	0	2	4	4	8	NIL												Y	Y	
77	M.TECH	PCC	23ME5103	DIGITAL MANUFACTURING	R	3	0	2	0	4	5	NIL												Y		
78	M.TECH	PCC	23ME5104	PROJECT MANAGEMENT	R	3	0	2	0	4	5	NIL												Y		
79	M.TECH	PCC	23ME5205	WEB AND NETWORKING TECHNOLOGIES	R	3	0	2	0	4	5	NIL												Y		
80	M.TECH	PCC	23ME5206	SUPPLY CHAIN MANAGEMENT	R	2	0	2	0	3	4	NIL												Y		
82	M.TECH	PCC	23MD5102	ROBOTICS: MANIPULATOR DESIGN AND ANALYSIS	R	3	0	2	0	4	5	NIL													Y	
83	M.TECH	PCC	23MD5103	MECHANICAL BEHAVIOUR OF MATERIALS	R	3	1	0	0	4	4	NIL													Y	
84	M.TECH	PCC	23MD5204	ADVANCED STRENGTH OF MATERIALS	R	3	0	2	0	4	5	NIL													Y	
85	M.TECH	PCC	23MD5205	MECHANICAL VIBRATIONS	R	2	0	2	0	3	4	NIL													Y	
86	M.TECH	PCC	23TE5102	DESIGN OF THERMAL SYSTEMS	R	2	0	2	4	4	8	NIL														Y
87	M.TECH	PCC	23TE5103	ADVANCED THERMODYNAMICS	R	3	0	2	0	4	5	NIL														Y
88	M.TECH	PCC	23TE5104	COMPUTATIONAL FLUID DYNAMICS	R	3	0	2	0	4	5	NIL														Y
89	M.TECH	PCC	23TE5205	ADVANCED HEAT AND MASS TRANSFER	R	3	0	2	0	4	5	NIL														Y
90	M.TECH	PCC	23TE5206	MEASUREMENTS IN THERMAL ENGINEERING	R	2	0	2	0	3	4	NIL														Y
					TOTAL CREDITS								**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**

Sl No	PROGRAM	Category	Course Code	Course Title	MODE	L	T	P	S	Cr	CH	Pre-Requisite	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	ES	EEE	PEPS	ME	MD	TE
91	M.TECH	PEC	PE-1	PROFESSIONAL ELECTIVE - 1	R	2	0	2	0	3	4	NIL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
92	M.TECH	PEC	PE-2	PROFESSIONAL ELECTIVE - 2	R	2	0	2	0	3	4	NIL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
93	M.TECH	PEC	PE-3	PROFESSIONAL ELECTIVE - 3	R	3	0	2	0	4	5	NIL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
94	M.TECH	PEC	PE-4	PROFESSIONAL ELECTIVE - 4	R	3	0	0	0	3	3	NIL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
95	M.TECH	PEC	PE-5	PROFESSIONAL ELECTIVE - 5	M	3	0	0	0	3	3	NIL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
					TOTAL CREDITS								**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**
96	M.TECH	PRI	23IE5201	ESSENTIALS OF RESEARCH DESIGN	R	1	1	0	0	2	2		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
97	M.TECH	PRI	23IE5149	TERM PAPER	R	0	0	8	0	4	8		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
98	M.TECH	PRI	23IE6051	INTERNSHIP-1	R	0	0	32	0	16	32		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
99	M.TECH	PRI	23IE6052	INTERNSHIP-2	R	0	0	32	0	16	32		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
100	M.TECH	PRI	23IE6150	DISSERTATION-1	R	0	0	32	0	16	32		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
101	M.TECH	PRI	23IE6250	DISSERTATION-2	R	0	0	32	0	16	32		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
					TOTAL CREDITS								**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**
102	M.TECH	OEC	OE-1	OPEN ELECTIVE - 1	R/M	3	0	0	0	3	3	NIL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
					TOTAL CREDITS								**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
103	M.TECH	VAC	VAC-1	VALUE ADDED COURSE-1	R/M	0	0	0	8	0	0	NIL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
104	M.TECH	VAC	VAC-2	VALUE ADDED COURSE-2	R/M	0	0	0	8	0	0	NIL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
					GRAND TOTAL CREDITS								**112**	**112**	**112**	**112**	**112**	**112**	**112**	**112**	**112**	**112**	**112**	**112**	**112**	**112**

LIST OF PROFESSIONAL ELECTIVE COURSES - Y23 M.TECH																									
Sl No	#PE	Course Code	Course Title	Mode	L	T	P	S	Cr	CH	PRE-REQUISITE	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	IoT	EEE	PEPS	ME	MD	TE
1	PEC-1	23CE51A1	PRE ENGINEERED STRUCTURES	R	2	0	2	0	3	4	NIL			Y											
2	PEC-1	23CE51A2	DESIGN OF OFFSHORE STRUCTURES	R	2	0	2	0	3	4	NIL			Y											
3	PEC-1	23CE51A3	THEORY OF PLATES AND SHELLS	R	2	0	2	0	3	4	NIL			Y											
4	PEC-2	23CE51B1	DESIGN AND DETAILING OF STRUCTURES	R	2	0	2	0	3	4	NIL			Y											
5	PEC-2	23CE51B2	REPAIR AND REHABILITATION OF STRUCTURES	R	2	0	2	0	3	4	NIL			Y											
6	PEC-2	23CE51B3	STRUCTURAL RELIABILITY	R	2	0	2	0	3	4	NIL			Y											
7	PEC-3	23CE52C1	FRACTURE MECHANICS	R	3	0	2	0	4	5	NIL			Y											
8	PEC-3	23CE52C2	DESIGN OF TALL STRUCTURES	R	3	0	2	0	4	5	NIL			Y											
9	PEC-3	23CE52C3	DESIGN OF CONNECTIONS IN STEEL STRUCTURES	R	3	0	2	0	4	5	NIL			Y											
10	PEC-4	23CE52D1	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	R	3	0	0	0	3	3	NIL			Y											
11	PEC-4	23CE52D2	STABILITY OF STRUCTURES	R	3	0	0	0	3	3	NIL			Y											
12	PEC-4	23CE52D3	SOIL STRUCTURE INTERACTION	R	3	0	0	0	3	3	NIL			Y											
13	PEC-5	23CE52R1M	APPLICATIONS OF STRUCTURES IN GREEN BUILDINGS	M	3	0	0	0	3	3	NIL			Y											
14	PEC-5	23CE52R2M	AI IN CIVIL ENGINEERING	M	3	0	0	0	3	3	NIL			Y											
15	PEC-1	23BT51A1	ENZYME SCIENCE AND TECHNOLOGY	R	2	0	2	0	3	4	NIL	Y													
16	PEC-1	23BT51A2	ADVANCED FOOD TECHNOLOGY	R	2	0	2	0	3	4	NIL	Y													
17	PEC-1	23BT51A3	ADVANCED BIOREACTOR OPERATIONS	R	2	0	2	0	3	4	NIL	Y													
18	PEC-2	23BT51B1	ADVANCED BIOMATERIALS	R	2	0	2	0	3	4	NIL	Y													
19	PEC-2	23BT51B2	ADVANCED STEMCELL TECHNOLOGY	R	2	0	2	0	3	4	NIL	Y													
20	PEC-2	23BT51B3	ADVANCED NANOBIOTECHNOLOGY	R	2	0	2	0	3	4	NIL	Y													
21	PEC-3	23BT52C1	ADVANCED BIOMEDICAL INFORMATICS	R	3	0	2	0	4	5	NIL	Y													
22	PEC-3	23BT52C2	ADVANCED MOLECULAR MODELLING AND DRUG DESIGN	R	3	0	2	0	4	5	NIL	Y													
23	PEC-3	23BT52C3	ADVANCED STRUCTURAL BIOLOGY	R	3	0	2	0	4	5	NIL	Y													
24	PEC-4	23BT52D1	ADVANCED MOLECULAR EXPRESSION TECHNOLOGY	R	3	0	0	0	3	3	NIL	Y													
25	PEC-4	23BT52D2	ADVANCED MOLECULAR MARKERS AND DIAGNOSTICS	R	3	0	0	0	3	3	NIL	Y													
26	PEC-4	23BT52D3	ADVANCED MOLECLAR GENETICS AND DNA FORENSICS	R	3	0	0	0	3	3	NIL	Y													
27	PEC-5	23BT52R1M	INDUSTRIAL BIOTECHNOLOGY	M	3	0	0	0	3	3	NIL	Y													
28	PEC-5	23BT52R2M	ADVANCED FERMENTATION TECHNOLOGY	M	3	0	0	0	3	3	NIL	Y													

Sl No	#PE	Course Code	Course Title	Mode	L	T	P	S	Cr	CH	PRE-REQUISITE	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	IoT	EEE	PEPS	ME	MD	TE
29	PEC-5	23BT52R3M	ADVANCED BIOMINING	M	3	0	0	0	3	3	NIL	Y													
30	PEC-1	23CS51A1	ARTIFICIAL NEURAL NETWORKS	R	2	0	2	0	3	4	NIL		Y												
31	PEC-1	23CS51S1	CRYPT ANALYSIS & CYBER DEFENCE	R	2	0	2	0	3	4	NIL		Y												
32	PEC-1	23CS51C1	WIRELESS AND MOBILE SECURITY	R	2	0	2	0	3	4	NIL		Y												
33	PEC-1	23CS51F1	ENTERPRISE PROGRAMMING	R	2	0	2	0	3	4	NIL		Y												
34	PEC-2	23CS52A2	BIG DATA OPTIMIZATION TECHNIQUES	R	2	0	2	0	3	4	NIL		Y												
35	PEC-2	23CS52S2	NETWORK & INFRASTRUCTURE SECURITY	R	2	0	2	0	3	4	NIL		Y												
36	PEC-2	23CS52C2	CLOUD INFRASTRUCTURE SERVICES	R	2	0	2	0	3	4	NIL		Y												
37	PEC-2	23CS52F2	JAVA FULL STACK DEVELOPMENT	R	2	0	2	0	3	4	NIL		Y												
38	PEC-3	23CS52A3	COGNITIVE COMPUTING & ANALYTICS	R	3	0	2	0	4	5	NIL		Y												
39	PEC-3	23CS52S3	SECURITY GOVERNANCE & MANAGEMENT	R	3	0	2	0	4	5	NIL		Y												
40	PEC-3	23CS52C3	CONTINUOUS DELIVERY & DEVOPS	R	3	0	2	0	4	5	NIL		Y												
41	PEC-4	23CS52A4	DEEP LEARNING	R/M	3	0	0	0	3	3	NIL		Y												
42	PEC-4	23CS52S4	SECURITY FOR CLOUD SYSTEMS SERVICES	R/M	3	0	0	0	3	3	NIL		Y												
43	PEC-4	23CS52C4	IMAGE PROCESSING	R/M	3	0	0	0	3	3	NIL		Y												
44	PEC-4	23CS52F4	DATA VISUALIZATION TECHNIQUES	R/M	3	0	0	0	3	3	NIL		Y												
45	PEC-5	23CS61A5	DATA VISUALIZATION TECHNIQUES	M	3	0	0	0	3	0	NIL		Y												
46	PEC-5	23CS61S5	INTRODUCTION TO BLOCKCHAIN & CRYPTO CURRENCIES	M	3	0	0	0	3	0	NIL		Y												
47	PEC-5	23CS61C5	APPLICATION DEVELOPMENT USING AR VR	M	3	0	0	0	3	0	NIL		Y												
48	PEC-5	23CS61F5	PYTHON PROGRAMMING	M	3	0	0	0	3	0	NIL		Y												
49	PEC-1	23EC5101	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	R	2	0	2	0	3	4	NIL						Y	Y	Y	Y					
50	PEC-2	23RA5301	ROBOTICS: DESIGN OF SENSORS, DRIVES AND ACTUATORS	R	2	0	2	0	3	4	23RA5001						Y								
51	PEC-2	23RA5302	AUTONOMOUS MOBILE ROBOT SYSTEMS	R	2	0	2	0	3	4	23RA5001						Y								
52	PEC-2	23RA5303	DEEP NEURAL NETWORK ALGORITHM FOR ROBOTICS	R	2	0	2	0	3	4	23RA5001						Y								
53	PEC-2	23RA5304	SWARM ROBOTICS CONTROL SYSTEMS	R	2	0	2	0	3	4	23RA5001						Y								
54	PEC-3	23RA5401	AUTOMATED DYNAMIC ANALYSIS OF MEMS SENSORS & ACTUATORS	R	3	0	2	0	4	5	23RA5001						Y								
55	PEC-3	23RA5402	HUMAN MACHINE INTERFACE & BRAIN MACHINE INTERFACE	R	3	0	2	0	4	5	23RA5001						Y								
56	PEC-3	23RA5403	LIDAR & RADAR SYSTEM CONTROL	R	3	0	2	0	4	5	23RA5001						Y								
57	PEC-3	23RA5404	COMPUTER VISION & APPLICATIONS	R	3	0	2	0	4	5	23RA5001						Y								

Sl No	#PE	Course Code	Course Title	Mode	L	T	P	S	Cr	CH	PRE-REQUISITE	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	IoT	EEE	PEPS	ME	MD	TE
58	PEC-4	23RA5501	ADAPTIVE MOTION CONTROL SYSTEMS FOR AUTOMATION AND ROBOTICS	R/M	3	0	0	0	3	3	23RA5001						Y								
59	PEC-4	23RA5502	FPGA-BASED WIRELESS SYSTEM DESIGN	R/M	3	0	0	0	3	3	23RA5001						Y								
60	PEC-4	23RA5503	SIGNAL PROCESSING FOR ROBOTICS	R/M	3	0	0	0	3	3	23RA5001						Y								
61	PEC-4	23RA5504	CLOUD ROBOTICS AND AUTOMATION	R/M	3	0	0	0	3	3	23RA5001						Y								
62	PEC-5	23RA5601	MICROELECTROMECHANICAL SENSORS AND ACTUATORS FOR ROBOTICS	M	3	0	0	0	3	0	23RA5301						Y								
63	PEC-5	23RA5602	OPTIMIZATION ALGORITHMS FOR AUTONOMOUS SYSTEMS	M	3	0	0	0	3	0	23RA5301						Y								
64	PEC-5	23RA5603	AUTOMOTIVE ELECTRONICS & AVIONICS	M	3	0	0	0	3	0	23RA5301						Y								
65	PEC-5	23RA5604	OPERATION RESEARCH, SYSTEM ENGINEERING, DESIGN & OPTIMIZATION	M	3	0	0	0	3	0	23RA5301						Y								
66	PEC-5	23RA5605	DESIGN OF AUTOMATION SYSTEMS AND ASSISTIVE ROBOTIC SYSTEMS	M	3	0	0	0	3	0	23RA5301						Y								
67	PEC-2	22VL5301	MEMORY DESIGN AND TESTING	R	2	0	2	0	3	4	22VL5001							Y							
68	PEC-2	22VL5302	VLSI PHYSICAL DESIGN	R	2	0	2	0	3	4	22VL5001							Y							
69	PEC-2	22VL5303	ADVANCED DIGITAL IC DESIGN	R	2	0	2	0	3	4	22VL5001							Y							
70	PEC-2	22VL5304	VLSI SIGNAL PROCESSING	R	2	0	2	0	3	4	22VL5001							Y							
71	PEC-3	22VL5401	TESTING OF VLSI CIRCUITS	R	3	0	2	0	4	5	22VL5001							Y							
72	PEC-4	22VL5501	MEMS SYSTEM DESIGN	R/M	3	0	0	0	3	3	22VL5001							Y							
73	PEC-4	22VL5502	IC FABRICATION TECHNOLOGY	R/M	3	0	0	0	3	3	22VL5001							Y							
74	PEC-4	22VL5503	NANO ELECTRONICS	R/M	3	0	0	0	3	3	22VL5001							Y							
75	PEC-4	22VL5504	SEMICONDUCTOR DEVICE MODELING	R/M	3	0	0	0	3	3	22VL5001							Y							
76	PEC-4	22VL5505	BLOCK CHAIN & CYBER SECURITY	R/M	3	0	0	0	3	3	22VL5001							Y							
77	PEC-5	22VL5506	INTERNET OF THINGS ARCHITECTURE AND PROTOCOLS	M	3	0	0	0	3	0	22VL5301							Y							
78	PEC-5	22VL5507	VLSI CIRCUITS FOR BIO-MEDICAL APPLICATIONS	M	3	0	0	0	3	0	22VL5301							Y							
79	PEC-5	22VL5508	OPTIMIZATION TECHNIQUES IN VLSI DESIGN	M	3	0	0	0	3	0	22VL5301							Y							
80	PEC-5	22VL5509	SYSTEM ON CHIP DESIGN	M	3	0	0	0	3	0	22VL5301							Y							
81	PEC-5	22VL5510	EMBEDDED SYSTEM DESIGN	M	3	0	0	0	3	0	22VL5301							Y							
82	PEC-5	22VL5511	FPGA-BASED WIRELESS SYSTEM DESIGN	M	3	0	0	0	3	0	22VL5301							Y							
83	PEC-5	22VL5512	RF MIXED SIGNAL IC DESIGN	M	3	0	0	0	3	0	22VL5301							Y							
84	PEC-2	23RC5301	LIDAR & RADAR SYSTEM CONTROL	R	2	0	2	0	3	4	23RC5001								Y						

Sl No	#PE	Course Code	Course Title	Mode	L	T	P	S	Cr	CH	PRE-REQUISITE	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	IoT	EEE	PEPS	ME	MD	TE
85	PEC-2	23RC5302	INTERNET OF THINGS ARCHITECTURE AND PROTOCOLS	R	2	0	2	0	3	4	23RC5001								Y						
86	PEC-2	23RC5303	COMPUTER VISION & VIDEO SURVEILLANCE SYSTEMS	R	2	0	2	0	3	4	23RC5001								Y						
87	PEC-2	23RC5304	EMI/EMC & ELECTRONIC WARFARE	R	2	0	2	0	3	4	23RC5001								Y						
88	PEC-2	23RC5305	REMOTE SENSING & SENSORS	R	2	0	2	0	3	4	23RC5001								Y						
89	PEC-3	23RC5401	MACHINE LEARNING FOR WIRELESS COMMUNICATIONS	R	3	0	2	0	4	5	23RC5001								Y						
90	PEC-3	23RC5402	PHASED ARRAY SYSTEMS	R	3	0	2	0	4	5	23RC5001								Y						
91	PEC-3	23RC5403	HIGH PERFORMANCE COMMUNICATION NETWORKING	R	3	0	2	0	4	5	23RC5001								Y						
92	PEC-3	23RC5404	MODERN SATELLITE COMMUNICATION SYSTEMS	R	3	0	2	0	4	5	23RC5001								Y						
93	PEC-3	23RC5405	ESTIMATION & DETECTION THEORY	R	3	0	2	0	4	5	23RC5001								Y						
94	PEC-4	23RC5501	FPGA-BASED WIRELESS SYSTEM DESIGN	R/M	3	0	0	0	3	3	23RC5001								Y						
95	PEC-4	23RC5502	OPTICAL WIRELESS COMMUNICATIONS	R/M	3	0	0	0	3	3	23RC5001								Y						
96	PEC-4	23RC5503	RF MIXED SIGNAL IC DESIGN	R/M	3	0	0	0	3	3	23RC5001								Y						
97	PEC-4	23RC5504	BLOCK CHAIN & CYBER SECURITY	R/M	3	0	0	0	3	3	23RC5001								Y						
98	PEC-5	23RC5601	REMOTE SENSING IMAGE ACQUISITION, ANALYSIS AND APPLICATIONS	M	3	0	0	0	3	0	23RC5101								Y						
99	PEC-5	23RC5602	FOUNDATIONS OF ADVANCED WIRELESS COMMUNICATION	M	3	0	0	0	3	0	23RC5101								Y						
100	PEC-5	23RC5603	AEROECOLOGY: EXPLORING BIODIVERSITY WITH RADAR	M	3	0	0	0	3	0	23RC5101								Y						
101	PEC-2	23ES5301	ADVANCED EMBEDDED SYSTEM DESIGN	R	2	0	2	0	3	4	23ES5001									Y					
102	PEC-2	23ES5302	DIGITAL TWINS MODEL-BASED EMBEDDED SYSTEMS	R	2	0	2	0	3	4	23ES5001									Y					
103	PEC-2	23ES5303	RECONFIGURABLE HARDWARE DESIGN	R	2	0	2	0	3	4	23ES5001									Y					
104	PEC-2	23ES5304	DATA BASES, DATA MODELLING & DATA STRUCTURE	R	2	0	2	0	3	4	23ES5001									Y					
105	PEC-3	23ES5401	ADVANCED EMBEDDED SOFTWARE DEVELOPMENT	R	3	0	2	0	4	5	23ES5001									Y					
106	PEC-3	23ES5402	IOT & EDGE COMPUTING AND MOBILE APPLICATIONS	R	3	0	2	0	4	5	23ES5001									Y					
107	PEC-3	23ES5403	SYSTEM ON CHIP DESIGN	R	3	0	2	0	4	5	23ES5001									Y					
108	PEC-3	23ES5404	BLOCKCHAIN & CYBER SECURITY	R	3	0	2	0	4	5	23ES5001									Y					

Sl No	#PE	Course Code	Course Title	Mode	L	T	P	S	Cr	CH	PRE-REQUISITE	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	IoT	EEE	PEPS	ME	MD	TE
109	PEC-4	23ES5501	INDUSTRIAL AUTOMATION SYSTEM DESIGN	R/M	3	0	0	0	3	3	23ES5001									Y					
110	PEC-4	23ES5502	IIOT 4.0 FOR AUTOMATION IN INDUSTRIES	R/M	3	0	0	0	3	3	23ES5001									Y					
111	PEC-4	23ES5503	MICRO- AND NANO-EMBEDDED SYSTEMS	R/M	3	0	0	0	3	3	23ES5001									Y					
112	PEC-4	23ES5504	ENERGY HARVESTING TECHNOLOGIES FOR IOT	R/M	3	0	0	0	3	3	23ES5001									Y					
113	PEC-5	23ES5601	OPTIMIZATION ALGORITHMS FOR AUTONOMOUS SYSTEMS	M	3	0	0	0	3	0	23ES5301									Y					
114	PEC-5	23ES5602	SMART HOME & SMART BUILDING & SMART CITY	M	3	0	0	0	3	0	23ES5301									Y					
115	PEC-5	23ES5603	MEMS SENSORS AND ACTUATORS	M	3	0	0	0	3	0	23ES5301									Y					
116	PEC-5	23ES5604	CYBER-PHYSICAL SYSTEMS	M	3	0	0	0	3	0	23ES5301									Y					
117	PEC-1	23CE51E1	MATERIAL PROCUREMENT MANAGEMENT	R	2	0	2	0	3	4	NIL				Y										
118	PEC-1	23CE51E2	GREEN BUILDINGS	R	2	0	2	0	3	4	NIL				Y										
119	PEC-1	23CE51E3	SUSTAINABLE ENGINEERING CONCEPTS AND LIFE CYCLE ANALYSIS	R	2	0	2	0	3	4	NIL				Y										
120	PEC-2	23CE51F1	CONSTRUCTION PERSONNEL MANAGEMENT	R	2	0	2	0	3	4	NIL				Y										
121	PEC-2	23CE51F2	LEAN CONSTRUCTION PRACTICES	R	2	0	2	0	3	4	NIL				Y										
122	PEC-2	23CE51F3	INFRASTRUCTURE PLANNING AND MANAGEMENTS	R	2	0	2	0	3	4	NIL				Y										
123	PEC-3	23CE52G1	STATISTICAL METHODS IN CONSTRUCTION	R	3	0	2	0	4	5	NIL				Y										
124	PEC-3	23CE52G2	PROJECT RISK MANAGEMENT	R	3	0	2	0	4	5	NIL				Y										
125	PEC-3	23CE52G3	CHARACTERIZATION OF CONSTRUCTION MATERIALS	R	3	0	2	0	4	5	NIL				Y										
126	PEC-4	23CE52H1	EMERGING CONSTRUCTION TECHNOLOGIES	R	3	0	0	0	3	3	NIL				Y										
127	PEC-4	23CE52H2	RESOURCE MANAGEMENT AND CONTROL IN CONSTRUCTION	R	3	0	0	0	3	3	NIL				Y										
128	PEC-4	23CE52H3	PRINCIPLES OF CONSTRUCTION MANAGEMENT	R	3	0	0	0	3	3	NIL				Y										
129	PEC-4	23CE52S1	QUALITY MANAGEMENT AND SAFETY MANAGEMENT SYSTEMS IN CONSTRUCTION	M	3	0	0	0	3	3	NIL				Y										
130	PEC-5	23CE52R2	AI IN CIVIL ENGINEERING	M	3	0	0	0	3	3	NIL				Y										

Sl No	#PE	Course Code	Course Title	Mode	L	T	P	S	Cr	CH	PRE-REQUISITE	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	IoT	EEE	PEPS	ME	MD	TE
131	PEC-1	23CE51I1	PRINCIPLES OF EARTH & ENVIRONMENT SCIENCES	R	2	0	2	0	3	4	NIL					Y									
132	PEC-1	23CE51I2	STRUCTURAL ANALYSIS USING GEOMATICS	R	2	0	2	0	3	4	NIL					Y									
133	PEC-1	23CE51I3	GEOSPATIAL TECHNOLOGY FOR TRANSPORT ENGINEERING	R	2	0	2	0	3	4	NIL					Y									
134	PEC-2	23CE51J1	STATISTICS AND ADJUSTMENT COMPUTATIONS	R	2	0	2	0	3	4	NIL					Y									
135	PEC-2	23CE51J2	ENVIRONMENTAL GEOINFORMATICS	R	2	0	2	0	3	4	NIL					Y									
136	PEC-2	23CE51J3	GEODESY AND GPS	R	2	0	2	0	3	4	NIL					Y									
137	PEC-3	23CE52K1	ADASTRAL SURVEY AND INFORMATION SYSTEM	R	3	0	2	0	4	5	NIL					Y									
138	PEC-3	23CE52K2	ENGINEERING SURVEY METHODOLOGY AND INSTRUMENTATION	R	3	0	2	0	4	5	NIL					Y									
139	PEC-3	23CE52K3	GEOSPATIAL TECHNOLOGY FOR NATURAL RESOURCES & DISASTER MANAGEMENT	R	3	0	2	0	4	5	NIL					Y									
140	PEC-4	23CE52L1	PRINCIPLES OF GEOMATICS	R	3	0	0	0	3	3	NIL					Y									
141	PEC-4	23CE52L2	GEOSPATIAL TECHNOLOGY FOR RURAL DEVELOPMENT	R	3	0	0	0	3	3	NIL					Y									
142	PEC-4	23CE52L3	COORDINATE SYSTEMS AND MAP PROJECTIONS	R	3	0	0	0	3	3	NIL					Y									
143	PEC-4	23CE52T1	GEOSPATIAL APPLICATION	M	3	0	0	0	3	3	NIL					Y									
144	PEC-5	23CE52T2	GIS IMAGE ANALYSIS IN ARCGIS PRO	M	3	0	0	0	3	3	NIL					Y									
145	PEC-1	23MD51A1	LEAN MANUFACTURING	R	2	0	2	0	3	4	NIL													Y	
146	PEC-1	23MD51A2	PRECISION AND QUALITY ENGINEERING	R	2	0	2	0	3	4	NIL													Y	
147	PEC-1	23MD51A3	BEHAVIOUR OF COMPOSITE MATERIALS	R	2	0	2	0	3	4	NIL													Y	
148	PEC-2	23MD52C1	DESIGN FOR MANUFACTURING	R	2	0	2	0	3	4	NIL													Y	
149	PEC-2	23MD52B1	DESIGN FOR SUSTAINABILITY	R	2	0	2	0	3	4	NIL													Y	
150	PEC-2	23MD52B2	CONCURRENT MANUFACTURING	R	2	0	2	0	3	4	NIL													Y	
151	PEC-3	23MD52C1	ADVANCED FINITE ELEMENT ANALYSIS	R	3	0	2	0	4	5	NIL													Y	
152	PEC-3	23MD52C2	FRACTURE MECHANICS	R	3	0	2	0	4	5	NIL													Y	
153	PEC-3	23MD52C3	TRIBOLOGICAL SYSTEM DESIGN	R	3	0	2	0	4	5	NIL													Y	
154	PEC-4	23MD52D1	DESIGN OF PRESSURE VESSELS AND PLATES	R/M	3	0	0	0	0	0	NIL													Y	
155	PEC-4	23MD52D2	ENGINEERING FAILURE ANALYSIS AND PREVENTION	R/M	3	0	0	0	0	0	NIL													Y	

Sl No	#PE	Course Code	Course Title	Mode	L	T	P	S	Cr	CH	PRE-REQUISITE	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	IoT	EEE	PEPS	ME	MD	TE
156	PEC-4	23MD52D3	MODELING AND SIMULATION OF MECHATRONIC SYSTEMS	R/M	3	0	0	0	0	0	NIL													Y	
157	PEC-5	23MD53E1	DESIGN OF HYBRID VEHICLES	M	3	0	0	0	0	0	NIL													Y	
158	PEC-5	23ME53E1	ENTERPRISE RESOURCE PLANNING FOR MECHANICAL ENGINEERS	M	3	0	0	0	0	0	NIL													Y	
159	PEC-5	23MD52E2	INTERNET OF THINGS IN INDUSTRIES	M	3	0	0	0	0	0	NIL													Y	
160	PEC-1	23TE51A1	GAS TURBINE ENGINEERING	R	2	0	2	0	3	4	NIL														Y
161	PEC-1	23TE51A2	ELECTRIC VEHICLE ENGINEERING	R	2	0	2	0	3	4	NIL														Y
162	PEC-1	23TE51A3	ENERGY CONSERVATION & AUDIT	R	2	0	2	0	3	4	NIL														Y
163	PEC-2	23TE52B1	ADVANCED ENERGY STORAGE TECHNOLOGIES	R	2	0	2	0	3	4	NIL														Y
164	PEC-2	23TE52B2	FOOD PROCESSING, PRESERVATION AND TRANSPORT	R	2	0	2	0	3	4	NIL														Y
165	PEC-2	23TE52B3	CONVECTION AND TWO-PHASE FLOW	R	2	0	2	0	3	4	NIL														Y
166	PEC-3	23TE52C1	RENEWABLE ENERGY SOURCES & TECHNOLOGY	R	3	0	2	0	4	5	NIL														Y
167	PEC-3	23TE52C2	PRINCIPLES OF TURBO MACHINERY	R	3	0	2	0	4	5	NIL														Y
168	PEC-3	23TE52C3	HEAT EXCHANGER DESIGN	R	3	0	2	0	4	5	NIL														Y
169	PEC-4	23TE52D1	REFRIGERATION AND CRYOGENICS	R/M	3	0	0	0	0	0	NIL														Y
170	PEC-4	23TE52D2	AIR CONDITIONING SYSTEMS	R/M	3	0	0	0	0	0	NIL														Y
171	PEC-4	23TE52D3	SOLAR ENERGY & SYSTEMS	R/M	3	0	0	0	0	0	NIL														Y
172	PEC-5	23TE53E1	HYDROGEN AND FUEL CELLS	M	3	0	0	0	0	0	NIL														Y
173	PEC-5	23TE53E2	AIRCRAFT AND JET PROPULSION SYSTEMS	M	3	0	0	0	0	0	NIL														Y
174	PEC-5	23TE53E3	BATTERY AND THERMAL MANAGEMENT SYSTEMS	M	3	0	0	0	0	0	NIL														Y
175	PEC-1	23ME51A1	PROGRAMMING AND DATA MANAGEMENT	R	2	0	2	0	3	4	NIL												Y		
176	PEC-1	23ME51A2	OPERATIONS RESEARCH FOR ENGINEERS	R	2	0	2	0	3	4	NIL												Y		
177	PEC-1	23ME51A3	MATERIALS AND PROCESS SELECTION FOR DESIGN	R	2	0	2	0	3	4	NIL												Y		
178	PEC-2	23ME52B1	PLM ADVANCED CONCEPTS	R	2	0	2	0	3	4	NIL												Y		
179	PEC-2	23ME52B2	MACHINE TOOL DESIGN	R	2	0	2	0	3	4	NIL												Y		
180	PEC-2	23ME52B3	RELIABILITY AND LIFE TESTING	R	2	0	2	0	3	4	NIL												Y		
181	PEC-3	23ME52C1	DESIGN FOR MANUFACTURING	R	3	0	2	0	4	5	NIL												Y		
182	PEC-3	23ME52C2	LEAN MANUFACTURING	R	3	0	2	0	4	5	NIL												Y		
183	PEC-3	23ME52C3	DIMENSIONAL MANAGEMENT	R	3	0	2	0	4	5	NIL												Y		
184	PEC-4	23ME52D1	CUSTOMIZATION OF PLM SOFTWARE	R/M	3	0	0	0	0	0	NIL												Y		

Sl No	#PE	Course Code	Course Title	Mode	L	T	P	S	Cr	CH	PRE-REQUISITE	BT	CSE	SE	CTM	GI	R&A	VLSI	R&C	IoT	EEE	PEPS	ME	MD	TE
185	PEC-4	23ME52D2	COMPOSITES: DESIGN AND MANUFACTURING	R/M	3	0	0	0	0	0	NIL												Y		
186	PEC-4	23ME52D3	PRECISION AND QUALITY ENGINEERING	R/M	3	0	0	0	0	0	NIL												Y		
187	PEC-5	23ME53E1	ENTERPRISE RESOURCE PLANNING FOR MECHANICAL ENGINEERS	M	3	0	0	0	0	0	NIL												Y		
188	PEC-5	23ME53E2	ROBOTICS AND AUTOMATION	M	3	0	0	0	0	0	NIL												Y		
189	PEC-5	23ME53E3	ENGINEERING ECONOMICS AND FINANCIAL ANALYSIS	M	3	0	0	0	0	0	NIL												Y		
190	PEC-1	23EE51F1	OPTIMIZATION TECHNIQUES	R	2	0	2	0	3	4	NIL											Y			
191	PEC-1	23EE51F2	RELIABILITY ENGINEERING & APPLICATION TO POWER SYSTEMS	R	2	0	2	0	3	4	NIL											Y			
192	PEC-1	23EE51A1	ELECTRIC VEHICLE POWER TRAIN DESIGN	R	2	0	2	0	3	4	NIL										Y				
193	PEC-1	23EE51A2	GRID INTEGRATION OF RENEWABLE ENERGY SYSTEMS	R	2	0	2	0	3	4	NIL										Y				
194	PEC-2	23EE51B1	EV BATTERIES & CHARGING SYSTEM	R	2	0	2	0	3	4	NIL										Y	Y			
195	PEC-2	23EE51B2	ENERGY STORAGE SYSTEMS	R	2	0	2	0	3	4	NIL										Y	Y			
196	PEC-3	23EE52G1	FACTS & POWER QUALITY	R	3	1	0	0	4	5	NIL											Y			
197	PEC-3	23EE52C2	ENERGY CONSERVATION & AUDIT	R	3	1	0	0	4	5	NIL										Y	Y			
198	PEC-3	23EE52C1	FAULT DIAGNOSIS AND CONTROL OF ELECTRIC VEHICLE	R	3	1	0	0	4	5	NIL										Y				
199	PEC-4	23EE52H1	DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS	R	3	0	0	0	3	3	NIL											Y			
200	PEC-4	23EE52H2	SWITCHED MODE POWER SUPPLY AND PWM TECHNIQUES	R	3	0	0	0	3	3	NIL											Y			
201	PEC-4	23EE52D1	AI AND IOT FOR MODERN ELECTRICAL VEHICLES	R/M	3	0	0	0	3	3	NIL										Y				
202	PEC-4	23EE52D2	AI AND IOT FOR GREEN ENERGY SYSTEMS	R/M	3	0	0	0	3	3	NIL										Y				
203	PEC-5	23EE53E1	BATTERY MANAGEMENT SYSTEMS	M	3	0	0	0	3	0	NIL										Y	Y			
204	PEC-5	23EE53E2	GREEN BUILDINGS AND SMART CITIES	M	3	0	0	0	3	0	NIL										Y	Y			

M.Tech – Bio Technology

MATHEMATICS & BIOSTATISTICS

COURSE CODE	23BT5124	MODE	R	LTPS	2-2-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Estimate the degree of linear and non-linear relationship between the variables and drawing conclusions	1	PO1
CO2	Interpret and communicate the outcomes in the context of a problem by Designs of Experiment in the context of parametric and non-parametric approach.	2	PO2
CO3	Finding roots for transcendental and algebraic equation in terms of Biology by root finding techniques	2	PO2
CO4	Solving first order differential equations in real time data	3	PO6/PSO1

Syllabus

Module 1	**Statistical Tools for Analysis** Summary Statistics, Correlation and Regression: Linear and Non-Linear Models. Curve fitting: $y=a+bx$, $y=ax^2 +bx+c$, $y=ab^x$, $y=ax^b$. Partial and Multiple Correlation.
Module 2	**Design of Experiments and Non Parametric Tests** Principle of design of experiments, Completely Randomized Design – Randomized Block Design – Least Square Design, Non Parametric Tests: One sample sign test, Sign test for paired Samples, U-tests, and Kurshal Wallis test.
Module 3	**Numerical Methods** Solutions of algebraic and transcendental equations - Bisection Method, New-Raphson Method, Regula-Falsi Method, Iteration method. Solution of linear simultaneous equations, Simpson's rule, Trapezoidal rule
Module 4	**Linear-Differential equation and Applications** 1^{st} order differential equation solutions - variable separable, homogeneous equations, linear and exact equations. Laplace transform and its applications in biotechnology

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Fundamentals of Mathematical Statistics	S.C.Gupta and V.K. Kapoor	Sultan Chand & Sons	1999
2	Advanced Engineering Mathematics	Michael D.Greenberg	Pearson Education	1998
3	Advanced Engineering Mathematics	Ervin Kreyszic	Pearson Education	2002
4	Higher engineering mathematics	Bird john	Pearson Education	2001

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	24
	Tutorials	8	
	Home Assignment & Text Book	8	
In-Sem Summative	Sem-in-Examination-I	18	36
	Sem-in-Examination-II	18	
End-Sem Summative	Paper Based	40	40

BIOCHEMICAL ENGINEERING (BCE)

COURSE CODE	23BT5121	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To understand the basic concept of biochemical engineering and understand various reactions	1	PO1
CO2	Understand and specify reactors used in industrial bioprocesses, develop mathematical models for bioreactors and analyze their behavior (dynamic and steady state).	1	PO2
CO3	Understand basic principles of mass transfer phenomenon in bioprocessing, and its importance and application in aerobic systems	2	PO2, PO3
CO4	Understand various reactor systems and its used in biochemical engineering	3	PO2, PO3
CO5	To learn the application of biochemical engineering while solving the real-time problems	3	PO3

Syllabus

Module 1	**Introduction to biochemical reactions: Type of reactions and their importance in fermentation, order of reaction (Zero, first and second order), calculating reaction rates,** kinetics of homogenous reactions, temperature dependency of reaction rate, mass and energy balance.
Module 2	**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, Ideal reactor operations (batch, fed-batch, continuous), chemostat with cell recycle, continuous plug flow reactor.
Module 3	**Importance of mass transfer in bioprocessing:** Flow and mixing of Newtonian and non-Newtonian fluids, Gas-liquid mass transfer in microbial systems, Oxygen transfer rates, Design of spargers and aeration equipment, Mass transfer across free surface, Basic concept of oxygen transfer coefficient (K_{La}) and its measurement; Correlation of K_{La} with other operating variables; Factors

	affecting the K_{La}, specific oxygen uptake rate, critical oxygen concentration, maximum cell concentration.
Module 4	**Various reactor systems:** Basic reaction theory (yield, rate), cell growth kinetics, 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.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"How to practice GMPs." vandana publication (6) (2001): 58-62.	Sharma, P. P.	TaTa Mc GrawHill	2021
2	Handbook of analytical validation. CRC Press, 2012.	Swartz, Michael E., and Ira S. Krull	Spinger	2009

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignment	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In Sem -1	15	38
	In Sem-2	15	
	Practical In Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End Sem Exam	16	

MOLECULAR BIOLOGY & R-DNA TECHNOLOGY

COURSE CODE	23BT5122	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand DNA Structure & Replication and Transcription And Translation	2	PO1
CO2	Understand the Regulation of Gene Expression	2	PO1
CO3	Acquire knowledge of Enzymes and Vectors In Cloning	1	PO1
CO4	Acquire knowledge of PCR, Sequencing & RNA Technologies, biological models and transgenic	3	PO1,PO2
CO5	Apply the knowledge of Molecular Biology & rDNA Technology methods	3	PO1,PO3

Syllabus

Module 1	**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.
Module 2	**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.
Module 3	**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.

Module 4	**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 Technologies : 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.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Fundamentals of Molecular Biology	Avinash & Kakoli Upadhyay	Himalaya	**2002**
2	Current protocols in Molecular biology	Geankoplis	Wiley Publishers	1989

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignment	7	
	Skilling Continuous Evaluation	7	
In-Sem Summative	In Sem -1	15	38
	In Sem-2	15	
	Skilling in sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End Sem Exam	16	

APPLIED BIOINFORMATICS

COURSE CODE	23BT5123	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Acquire the theoretical basis of applied bioinformatics and understand the access and retrieval of biological information from databases.	2	PO1, PO2
CO2	Explain the proteomic and metabolomic approaches at current trends	2	PO3, PO4, PO2
CO3	Develop gene expression profiling to understand expression in both prokaryotes and eukaryotes	3	PO1, PO2
CO4	Demonstrate the systems biology tools using retrieved complex data from databases.	3	PO1, PO2, PO3, PO4
CO5	Choose the gene sequences, structures of molecules and metabolomic data from the databases.	3	PO1, PO2, PO3, PO4

Syllabus

Module 1	**Comparative Genomics and disease prediction:** Genetic mapping, Physical mapping, SNP and the prediction of diseases, Requirement of control, test sequence datasets, ESTs and GSS in association with high throughput methodologies, Gene prediction strategies and annotation, molecular predictions usually done for a DNA sequence, Human Genome Project.
Module 2	**Protein structure prediction:** Protein modelling methodologies and tools, Model quality assessment strategies and tools, DSSP and need for such libraries.
Module 3	**Protein identification and prediction of its interaction network:** Mascot and GFS; Comparative proteomics methods; Protein-protein interaction requirement and databases including GRID and MINT; Network Mapping; Biological, Metabolic Pathways, prediction and its databases
Module 4	**High-throughput gene expression analysis:** Gene expression and SAGE, Microarray and its types and steps, Challenges for microarray analysis.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	A Primer of Genome Science	G. Gibson and SV Muse	Sinauer Associates, Inc.	1999
2	Essentials of genomics and Bioinformatics	CW Sensen	Wiley-VCH publication	2002
3.	Statistical analysis of gene expression microarray data	Speed T. (ed.)	Wiley-VCH publication	1989

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignment	7	
	Skilling Continuous Evaluation	7	
In-Sem Summative	In Sem -1	15	38
	In Sem-2	15	
	Skilling in sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Skill End Sem Exam	16	

IMMUNO TECHNOLOGY

COURSE CODE	23BT5105	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Acquire the knowledge about immune systems	1	PO3,PO4, PO7
CO2	Understand the concepts of immunological responses	2	PO3,PO4, PO7
CO3	Understand immunity with respect to disorders and infection	2	PO3,PO4, PO7
CO4	Understand the technological advances in immunology	2	PO3,PO4, PO7
CO5	Conduct various immunological assays and apply them to diagnostics	2	PO1,PO2,PO5

Syllabus

Module 1	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.
Module 2	**Immune response** Generation of immune response - Primary and Secondary immune responses. Structure, functions of antibody and BCR. Generation of Antibody diversity. TCR structure, δγTCR. MHC I and II gene, polymorphism. T helper, T cytotoxic cells. MHC peptide interaction. Antigen presentation, secondary signaling.
Module 3	**Immunological disorders** Immunological disorders; Hypersensitivity and autoimmune diseases. Immune response to viral and bacterial lymphatic infection. Kinetics of immune response. Techniques in humoral and cellular immunology.
Module 4	**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.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Immunology	Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne	6th Edition, Freeman	2002
2	Immunobiology	Janeway et al	4th Edition Current Biology publications	1999
3.	Clinical Immunology	Brostoff J, Seaddin JK, Male D, Roitt IM.,	6th Edition, Gower Medical Publishing	2002
4.	Fundamental of Immunology	Paul.W.E,	4th edition Lippencott Raven	1998

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignment	7	
	Skilling Continuous Evaluation	7	
In-Sem Summative	In Sem -1	15	38
	In Sem-2	15	
	Lab in sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End Sem Exam	16	

BIOREACTOR MODELING AND SIMULATION

COURSE CODE	23BT5101	MODE	R	LTPS	0-0-4-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the Fundamentals of Modeling and apply their principles in bioprocess.	3	PO1,PO3
CO2	Understand the Enzymes and growth kinetic models and Ability to apply their principles in bioprocess.	3	PO1,PO3
CO3	Understand batch and product formation kinetic models and ability to apply their principles in bioprocess.	3	PO1,PO3
CO4	Understand principles of biological systems and apply simulation principles for better biomass and product formation.	3	PO1,PO3

Syllabus

Module 1	**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)
Module 2	**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.
Module 3	**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
Module 4	**Case studies of simulations** Programme for simulation of Batch fermentation, continuous fermentation, steady state and fed batch fermentation.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Product recovery in bioprocess Technology	Butterworth - Heinemann		Biotechnology in Open Learning (BIOTOL), Elsevier India
2	Bio separations- Principles and Techniques	B. Sivasankar	2	PHI Learning Pvt. Ltd., (2009)

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignment	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In Sem -1	15	38
	In Sem-2	15	
	Practical In Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End Sem Exam	16	

BIOSEPERATIONS ENGINEERING

COURSE CODE	23BT5106	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Acquire the knowledge of primary separation and recovery processes	2	PO1, PO2/ PSO1
CO2	Apply the principles of solid removal unit operations and product enrichment operations	3	PO1, PO2/PSO1
CO3	Apply the principles of aqueous two-phase extraction process and product purification methods	3	PO2, PO5/ PSO2
CO4	Analyze the methods of alternative separation, product polishing and formulations	4	PO1, PO5/ PSO2
CO5	Evaluate the bioseparation methods for recovery, isolation and purification of various bioproducts	5	PO4, PSO1, PSO2

Syllabus

Module 1	**Primary Separation and Recovery Processes**: Characteristics of biological materials: pretreatment methods; Separation of cell mass: centrifugation, sedimentation, flocculation and filtration; Continuous operation. Mechanical approaches: sonication, bead mills, homogenizers; non-mechanical approaches: freeze/thaw, osmotic shock, chemical lysis, enzymatic lysis; measurement of cell disruption.
Module 2	**Product Enrichment Operations:** Filtration theory; Micro and ultrafiltration; Reverse osmosis; dialysis; electrodialysis, diafiltration; pervaporation; Multistage and continuous operation. Solvent extraction: phase equilibrium and distribution, counter-current operation, dissociative extraction, multiple stage analysis; Reciprocating-plate and centrifugal extractors; Reverse micellar extraction; Aqueous two-phase extraction, Supercritical fluid extraction.
Module 3	**Product Purification:** Adsorption equilibrium, Van Deemter equation; Chromatography: size, charge, polarity, shape, hydrophobic interactions; Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds). Principles & practices of Gel Filtration, Ion Exchange and Affinity chromatography. **Membrane based separations** – Filtration theory; Micro and ultrafiltration; Reverse osmosis; dialysis; electrodialysis, diafiltration; pervaporation; perstraction; Multistage and continuous operation. Membrane modules: Plate & Frame, hollow fiber, spiral wound, shell & tube, cross flow micro filtration.

Module 4	**Product Concentration and product design**: Precipitation: effect of size and charge, solvent effects, ionic strength effects, precipitate growth and aging models. Crystallization: nucleation and growth aspects; Drying: solvent removal aspects, dryers (vacuum, freeze, spray); Scale up aspects. Process synthesis: Identification and ordering of unit operations relevant for a case study. Analysis: comparison of different process synthesis steps. Case studies such as production and recovery of therapeutics, metabolites and antibodies.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Product recovery in bioprocess Technology	Butterworth - Heinmann	Wiley	Biotechnology in Open Learning (BIOTOL), Elsevier India
2	Bio separations- Principles and Techniques	B. Sivasankar	Oxford Publishers	PHI Learning Pvt. Ltd., (2009)

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignment	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In Sem -1	15	38
	In Sem-2	15	
	Practical In Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End Sem Exam	16	

ELECTIVES
ENZYME SCIENCE AND TECHNOLOGY

COURSE CODE	23BT51J3	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Acquire the knowledge of kinetics of enzyme catalyzed reaction in free and immobilized states. They will also able to organize the production of microbial enzymes and operate variables affecting the production process.	2	PO1,PSO1
CO2	To understand the various biological catalysts used in the enzyme engineering.	2	PO1,PSO1
CO3	To understand the enzyme immobilization and various applications in the field of bioprocessing.	2	PO1,PSO1
CO4	Apply principles of mass transfer in immobilized systems.	3	PO1, PO3

Syllabus

Module 1	**Introduction to enzyme technology:** Source of enzymes; Production, isolation and purification of enzymes; Characterization in terms of pH, temperature, ionic strength, substrate and product tolerance, effects of metal ions etc.; Various production methods for commercial enzymes; Large scale production of enzymes. Production of recombinant proteins (Insulin, Interleukin, Interferon); important commercial enzymes; Amylases; Proteases; Lipases; Cellulases
Module 2	**Enzyme Kinetics:** Michaelis-Menten equation, alterations and significance. General mechanisms of enzyme regulation, Types of inhibition; Irreversible inhibition (proteases), Reversible (glutamine synthase & phosphorylase), competitive inhibition, Non & Un-competitive, mixed inhibition, and substrate & product.inhibition; Allosteric enzymes, qualitative description of concerted & sequential models for allosteric enzymes. Allo-steric regulation of enzymes; Deactivation kinetics. Feed back inhibition and feed forward stimulation. Half site reactivity, Flipflop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamoylase. Protein-ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots
Module 3	. **Enzyme Engineering:** Enzymes as biological catalysts; Active site, Functional group, Enzyme substrate complex, Cofactors; Acidbase catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Chemical modification of active site groups. Random and rational approach of protein engineering; Directed evolution and its applications in the field of biocatalysis; various approaches of creating variant enzyme molecules; Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, lysozyme, carboxypeptidase and alcohol dehydrogenase.

Module 4	**Enzyme immobilization and applications:** Introduction to enzyme immobilization; various immobilization methods; physical and chemical techniques for enzyme immobilization – adsorption; Matrix entrapment, encapsulation; Cross-linking; Covalent binding; Medical and analytical applications of immobilized enzymes; Design of enzyme electrode & their application in clinical diagnostics. Role of enzymes in recombinant DNA technology; Enzymes for diagnostic and analytical purposes. Use of enzymes in analysis-types of sensing-gadgetry and methods. Case studies on application – chiral conversion, esterification.
Module 5	**Mass transfer effects in immobilized systems:** Analysis of Film and Pore Diffusion Effects on kinetics of Immobilized Enzyme Reactions; Calculations of diffusional resistances and Thiele's modulus; Multi step immobilized enzyme systems; Solutions of numerical problems; Application and future of immobilized enzyme technology. Concentration gradients and Reaction rates in solid catalysts; Internal mass transfer and reaction; Steady state Shell Mass balance; Formulation of dimensionless groups and calculation of Effectiveness factors.

Reference Books:

S.No	Title	Author(s)	Publisher	Year
1	Enzymes: Biochemistry, Biotechnology and Clinical Chemistry	Trevor Palmer	Wood head Publishing, UK.	2001
2	Fundamentals of Enzymology	Nicholas C. Price & Lewis Stevens	Oxford University Press, UK.	2002
3	Biochemistry	Lubert Stryer	Worth Publishers Inc.,	1999
4	Biochemistry	Donald Voet, Judith G. Voet	John Wiley & Sons	2001
5	Lehninger Principles of Biochemistry	David L. Nelson, Michael Cox	Macmillan Learning International Edition	2005

Global Certifications:

Mapped Global Certifications:						
Sl No	**Title**	**Certification Provider**	**Proctored (Y/N)**	**Format of the Exam**	**Exam Provider**	**URL of the Certification**
1	Not Applicable					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	3	22
	Home Assignments	7	
	Quiz	3	
	Case Studies	2	
	Lab Weekly Exercise	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

FOOD TECHNOLOGY

COURSE CODE	23BT51J2	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand microbiology of food production	2	PO1, PO2, PO3
CO2	Applications of enzymology in food production	3	PO1, PO2, PO3, PO5
CO3	Applications of food preservation technologies	3	PO1, PO2, PO3, PO5, PO6
CO4	Application of technologies for food storage and stability	3	PO1, PO2, PO3, PO5

Syllabus

Module 1	**Food Microbiology:** History of microorganisms in food, Foods as ecological niches for microbes. Types of microorganisms associated with food, its sources, types and behavior in foods. Role and significance of microorganisms in food. microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products Intrinsic and extrinsic parameters of foods that affect microbial growth. Genetic manipulations of microbes for food technology. Thermophiles and Radiation-resistant microorganisms, characteristics and growth of thermophilic microorganisms, Nature of Radiation resistance in microorganisms. Rheology of food production. single cell protein; probiotics and prebiotics.
Module 2	**Food processing, enzymes and fermentation technology:** Bioprocessing of meat, fisheries, vegetables, diary product, enzymes and chemicals used in food processing, biochemical engineering for flavour and food productions. Emerging processing and preservation technologies for milk and dairy products. Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes; interesterified fat; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucose oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing. Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria:
Module 3	**Food preservation:** Production and applications in 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.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Challenges for the flavour and food industries	Lidsay, Willis Biotechnology	Elsevier Applied Science	1988
2	Food Science and Food Biotechnology	F.F.G. Lopez & G.V. B. Canovas	CRC Press, Florida, USA	2003
3.	Basic Food Microbiology	. George J.B	CBS Publishers & Distributors	1987
4.	Food Biotechnology	Roger, A., Gordan B., and John T	CBS Publishers & Distributors	1989

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	Active Learning	3	22
	Home Assignments	7	
	Quiz	3	
	Case Study - Analysis	2	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

BIOREACTOR OPERATIONS

COURSE CODE	23BT51J1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Acquire the knowledge of bioreactor design, scale up and scale down processes.	3	PO1,PO3
CO2	Understand the basic operation of various bioreactors used in the animal and plant cells.	3	PO1,PO3
CO3	Understand the various facilities required for designing of bioreactor.	3	PO1,PO3
CO4	Apply principles of various heat and mass transfer principles on designing of bioreactor	3	PO1,PO3

Syllabus

Module 1	**Introduction to bioreactor design:** Introduction; General design information; Material and energy balance calculations; Process Flow, **Scale up and scale down processes:** Scale up and scale down issues: Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply; Bioreactor scaleup based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. **Scale-up of downstream processes:** Adsorption (LUB method); Chromatography (constant resolution etc.); Filtration (constant resistance etc.); Centrifugation (equivalent times etc.); Extractors (geometry based rules). Scale-down related aspects.
Module 2	**Basic bioreactor operations:** Spectrum of basic bioreactor operations: immobilized cell system, animal cells, plant cell cultures and waste management; Enzyme immobilization techniques; Bioconversion using immobilized enzyme preparation; Bioconversion in batch, Fed-batch and continuous bioreactors; Mass transfer in immobilized cell/enzyme reactor.
Module 3	**Bioreactor equipment:** Selection of bioprocess equipment (upstream and downstream); Specifications of bioprocess equipment; Mechanical design of reactors, heat transfer and mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment; Piping and instrumentation; Materials of construction for bioprocess plants.
Module 4	**Bioreactor facility design:** Facility design aspects; Utility supply aspects; Equipment cleaning aspects; Culture cell banks; cGMP guidelines; Validation; Safety; Process economics; Case studies.

Reference Books:

S.No	Title	Author(s)	Publisher	Year
1	Bioprocess Engineering	Michael L.Shuler Fikret Kargi	Pearson	2000
2	Principles of Fermentation Technology	Peter F Stanbury	ELSEVIER	1998
3	Biochemical Engineering.	F.C. Web	Wiley Blackwell	1997
4	Bioprocess Engineering Principles	Pauline M.Doran	ELSEVIER	1978
5	Introduction to Biochemical Engineering	D G Rao	Mc Graw Hill	1999

Global Certifications:

Mapped Global Certifications:						
Sl No	**Title**	**Certification Provider**	**Proctored (Y/N)**	**Format of the Exam**	**Exam Provider**	**URL of the Certification**
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	3	22
	Home Assignments	7	
	Quiz	3	
	Case Study – Analysis	2	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

ADVANCED BIOMATERIALS, BM

COURSE CODE	**23BT51B1**	**MODE**	**R**	**LTPS :2-0-2-0**	**PRE-REQUISITE**	**NIL**

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply the knowledge of Tissue engineering Traid in Therapies	3	PO3, PO5
CO2	Apply the knowledge of Tissue culture basics in maintaining cells	3	PO2, PO3, PO5
CO3	Apply the principles of 3D Tissue organization and angiogenesis	3	PO2, PO3
CO4	Apply the role TE components in Cell based Therapies with case studies	3	PO2,PO3, PO5, PO6
CO5	Apply the principles of TE Triad for up skilling on practical front	3	PO4, PO5,

Syllabus

Module 1	Tissue Engineering and Cell-Based Therapies, Biomaterials. Metals, ceramics, polymers (synthetic and natural). Biodegradable materials, native matrix
Module 2	Tissue culture basics: Primary cells vs. cell lines, sterile techniques, plastics, enzymes, reactors and cryopreservation. Principals of self-assembly, ECM.
Module 3	3D organization and angiogenesis. Natural Scaffold Materials, Synthetic Biomaterial Scaffolds, Scaffold Fabrication & Tailoring, Cell migration.Tissue Morphogenesis, Stem Cells and Lineages, Cell Isolation and Culture, Cell-Cell Communication, Graft Rejection/Material Biocompatibility, Cell Migration, Engineered Disease Models
Module 4	Stem Cell Therapies with case studies. Liver tissue engineering. Bio artificial liver (BAL) assist device, shear forces, oxygen transport, and plasma effects. Cardiovascular tissue engineering. Introduction, blood vessels structure, vascular grafts. Skin tissue engineering. Introduction, scar vs. regeneration, split skin graft
Module 5	Apply the principles of TE Triad for upskilling on practical front

Reference Books:

Book Sl No	Title	Author(s)	Publisher	Year
Book 1:	The Biomedical Engineering– Handbook	J. D. Bronzino	CRC	2009
Book 2:	Principles of tissue engineering	R. P. Lanza, R. LangerandW. L. Chick	Elsevier Academic press	2019
Book 3	Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues	W Mark Saltzman	Oxford University Press	2011
Book4	Tissue Engineering	John P Fisher, Antonios G Mikos, Joseph D Bronzino,	CRC Press	2022
Book 5	Tissue Engineering for Artificial Organs	Anwarul Hasan	John Wiley & Sons	2018

Global Certifications:

Mapped Global Certifications:						
Sl No	**Title**	**Certification Provider**	**Proctored (Y/N)**	**Format of the Exam**	**Exam Provider**	**URL of the Certification**
1	Biomaterials and Tissue Engineering Graduate Certificate	Colorado State University, USA	Y	MCQ	Colorado State University, USA	https://www.online.colostate.edu/certificates/biomaterials-tissue-engineering/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA	NA	NA

Evaluation Plan

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	8	
	Practical Continuous Evaluation	6	
In-Sem Summative	In-Sem 1	14	38
	In-Sem 2	14	
	Practical In-Sem	10	
End-Sem Summative	End-Sem Exam	24	40
	Lab End-Sem Exam	16	

ADVANCED STEM CELL TECHNOLOGY

COURSE CODE	23BT51B2	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Acquire the knowledge of stem cell technology	1	PO2
CO2	Understand stem cell characterization and tissue engineering	2	PO2
CO3	Illustrate various strategies involved in regulation and stem cell ethics.	2	PO3
CO4	Apply various principles involved in stem cell therapies.	3	PO1, PSO1

Syllabus

Module 1	**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
Module 2	**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
Module 3	**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.
Module 4	**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

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Essentials of Stem cell biology	Robert Lanza	Elsevier academic press	2015
2	Tissue engineering and artificial organs, Biomedical engineering hand book	Joseph D. Bronzino	CRC Press	2008
3	Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues	W Mark Saltzman	Oxford University Press	2004
4	Stem Cell Biology: A Practical Laboratory Manual	Dr. Indumathi Somasundaram (Author), Dr. Dhanasekaran Marappagounder (Author), Dr. Pankaj Kaingade (Author)	Evincepub Publishing	2020

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Stem Cell Technology Certification Course	Biotecnika	Y	Quiz	Biotecnika	https://stores.biotecnika.org/products/stem-cell-technology-certification-course

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA	NA	NA

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	24
	Practical Continuous Evaluation	8	
	Skill Continuous Evaluation	8	
In-Sem Summative	In-Sem 1	9	36
	In-Sem 2	9	
	Practical In-Sem	9	
	Skill In-Sem	9	
End-Sem Summative	End-Sem Exam	24	40
	Lab End-Sem Exam	8	
	Skill End-Sem Exam	8	

ADVANCED NANO BIOTECHNOLOGY

COURSE CODE	23BT51B3	MODE	Offline	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the significance of biotechnology in medical field	2	PO1, PO3
CO2	Understand the therapeutic methodologies against genetic disorders	2	PO8, PO9
CO3	Understand and identify potential stem cell technologies for medical application	2,3	PO3, PO8, PO9, PSO1
CO4	Apply the biotechnological tools in medical diagnosis and analyze the outcomes	3,4	PO3, PO8, PO9, PSO2

Syllabus

Module 1	**Introduction to medical technology** Introduction and applications of medical Biotechnology. Artificial organs– Methods and production principles. Production of Biotherapeutics: Therapeutic proteins (interferons, cytokinins, insulin), vaccine, antibodies (polyclonal and monoclonal) etc.
Module 2	**Gene transfer technology** Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy, Retro and adeno virus mediated gene transfer. Liposome and nanoparticles mediated gene delivery Cellular therapy, Ethics in gene therapy.
Module 3	**Stem cell technology** Stem cells: definition, properties and potency of stem cells; Stem cell niches; Cell cycles regulators in stem cells, embryonic and adult stem cells; Concept of tissue engineering; Scaffolds: properties, type and role; Growth factors and signaling cascade (BMP, Nodal, Wnt, Notch and Retenoid signaling); Clinical applications; Ethical issues.
Module 4	**Medical diagnosis** Biochemical diagnostics: inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, and glycogen storage disorders. Immunodiagnostic techniques: ELISA, RIA, Western blot and immunohistochemistry. PCR and Array based diagnostic techniques, DNA sequencing and diagnosis; Diagnostic imaging: CT, MRI, PET; Ethics in Molecular Diagnosis

Reference Books:

Book Sl No	**Title**	**Author(s)**	**Edition**	**Publisher**
Book 1:	Nanobiology: From Basic	Hélder A. Santos	1st Edition	CRC Press

	Research to Applications			
Book 2:	Nanobiology: Structures, Behavior, and Effects of Biomolecules at the Nanometer Scale	Michael M. Kozlov	1st Edition	Springer
Book 3	Nanobiology: The Science of Nanobiotechnology and Nanobiophotonics	Michael A. Stroscio and Mitra Dutta	1st Edition	Springer
Book 4	Nanobiology: Applications, Development, and Impact	David Goodsell and Arthur Olson	1st Edition	CRC Press
Book 5	Nanobiology: Concepts, Applications, and Perspectives	Christof M. Niemeyer and Chad A. Mirkin	1st Edition	Wiley-VCH
Book 6	Nanobiology: A Systems Approach	Chenzhong Li and Yanyi Huang	1st Edition	Wiley

Global Certifications:

Mapped Global Certifications:						
Sl No	**Title**	**Certification Provider**	**Proctored (Y/N)**	**Format of the Exam**	**Exam Provider**	**URL of the Certification**
1	**Certificate course on nanobiotechnology**	Biolim	Y	MCQ	Biolim	https://www.biolim.org/programmes/foundation-programmes/online/open/certificate-course-on-nanobiotechnology/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA	NA	NA

Evaluation plan

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	10	20
	Home Assignment and Book. (Min. 4 Assignments etc.)	10	
In-Sem Summative	In-Sem 1	20	40
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam	40	40

BIOMEDICAL INFORMATICS (BMI)

COURSE CODE	23BT51C1	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understand the basic definitions, key concepts, terminology, and historical context of Health Informatics	3	PO3
CO2	Understand fundamental characteristics of data, information, and knowledge in the Health Informatics domain	3	PO4
CO3	Develop understanding of population health and precision medicine	3	PO4
CO4	Develop understanding of various aspects of Health Information Technology standards	3	PO1
CO5	Apply IT aspects of clinical process modelling and health information systems	3	PO3,PO4

Syllabus

Module 1	Introduction to health informatics and its significance, Definitions and key concepts in health informatics, Background disciplines, historical overview, and future challenges, Introduction to knowledge hierarchy: Data, information, and knowledge, The definitions of healthcare data and information, Types of healthcare information (internal versus external data and information), The major purposes of maintain patient records, The content and uses of patient records and claim content
Module 2	History and evolution of healthcare information systems (HCIS), The major advances in information technology and significant federal initiatives that influenced the adoption, of healthcare information systems, The major types of administrative and clinical information systems used in healthcare, Current issues pertaining to the use HCIS
Module 3	Various ways to describe algorithms, such as flowchart, pseudo code, and conceptual graph, Introduction to medical algorithms, Algorithms in computer science, such as decision tree and regression, Calculation of measurements of classification performance—sensitivity and specificity
Module 4	Introduction to standards, The Need for Health Informatics Standards, The role of federal initiative and legislation that that have significant impact on the adoption of healthcare, information standards in the United States, Major types of healthcare information standards and the organization that develop or approve them, The importance of healthcare IT standards to the future of the US health care delivery system

Reference Books:

S.No	Title	Author(s)	Publisher	Year
1	Essential Bioinformatics	Jin Xiong	FIRST	Cambridge University Press

2	BIOINFORMATICS: METHODS AND APPLICATIONS - GENOMICS, PROTEOMICS AND DRUG DISCOVERY	RASTOGI, S.C., RASTOGI, PARAG, MENDIRATTA, NAMITA	FIFTH EDITION	PHI Learning Pvt. Ltd
3	Bioinformatics: Sequence and Genome Analysis	David W. Mount	FIRST	CSHL Press

Global Certifications:

Mapped Global Certifications:						
Sl No	**Title**	**Certification Provider**	**Proctored (Y/N)**	**Format of the Exam**	**Exam Provider**	**URL of the Certification**
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	**Tool Name**	**Parent Industry**	**Open Source/ Commercial**
1	Not Applicable		

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Lab Weekly Exercise	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

ADVANCED MOLECULAR MODELLING AND DRUG DESIGNING

COURSE CODE	23BT52C2	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Lays the foundations about molecular modeling and simulation; Basic knowledge and importance of biomacromolecules; Amino acids structures and properties, Bond length potential, Bond angle potential, Torsional potentials, Ramachandran Plot	1	PO1
CO2	Ability to analyze and develop the concepts of protein architecture; Protein databases; X-ray diffraction; 3D structure prediction	2	PO11
CO3	Ability to Design and interpret the knowledge on structure modeling: Energy based modeling and simulations	2	PO2
CO4	Ability to apply the above knowledge to Drug Discovery, designing and development against diseases	3	PO2

Syllabus

Module 1	**INTRODUCTION TO MOLECULAR MODELING**; History of molecular modelling, physical and computer models, different representation of computer models, databases, compilation of fragments libraries with standard geometrics, drawing of 2D structures using sketch.
Module 2	**PROTEIN STRUCTURE DETERMINATION & MODELLING**: Structure based modelling, comparative modelling of protein, ab initio modeling and fold recognition, transmembrane protein models, X-Ray and NMR based modeling, refinement of protein 3D structure and their complexes. Salvation effects, methods-ab initio method, semi empirical molecular orbital methods,
Module 3	**MOLECULAR DYNAMICS AND SIMULATIONS**; Energy based Modelling, generalization of potential energy surfaces, concepts of force fields, quantum and molecular mechanics force fields, geometry optimization and use of charges energy minimization, MD simulations, MC simulations, hybrid quantum and classic methods for computing, kinetic isotope effects of chemical reaction in solutions and in enzymes.
Module 4	**MOLECULAR MODELING APPLICATIONS IN DRUG DESIGNING**; identifying putative drug targets and potential drug leads: starting point of virtual screening and docking receptor, flexibility for large-scale Insilco ligand screens: chances and challenges, molecular docking.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Molecular modelling basic principles and applications	Hans-Dieter Holtje and Gerd Folkera,	Wiley.	2003
2	Molecular modelling of proteins	By Andreas Kukol	Humana Press	2008
3.	Molecular Modelling Principles and Applications	A. R. Leach	Longman	1996

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Essentials of Stem cell biology	Robert Lanza	Elsevier academic press	2015
2	Tissue engineering and artificial organs, Biomedical engineering hand book	Joseph D. Bronzino	CRC Press	2008
3	Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues	W Mark Saltzman	Oxford University Press	2004
4	Stem Cell Biology: A Practical Laboratory Manual	Dr. Indumathi Somasundaram (Author), Dr. Dhanasekaran Marappagounder (Author), Dr. Pankaj Kaingade (Author)	Evincepub Publishing	2020

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Stem Cell Technology Certification Course	Biotecnika	Y	Quiz	Biotecnika	https://stores.biotecnika.org/products/stem-cell-technology-certification-course

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA	NA	NA

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	24
	Practical Continuous Evaluation	8	
	Skill Continuous Evaluation	8	
In-Sem Summative	In-Sem 1	9	36
	In-Sem 2	9	
	Practical In-Sem	9	
	Skill In-Sem	9	
End-Sem Summative	End-Sem Exam	24	40
	Lab End-Sem Exam	8	
	Skill End-Sem Exam	8	

ADVANCED STRUCTURAL BIOLOGY (STB)

COURSE CODE	23BT51C3	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Acquire the knowledge on Structural biology of Nucleic Acids	3	PO3
CO2	Describe the Protein dynamics	3	PO4
CO3	Compare various techniques for structural biology	3	PO4
CO4	Conclude the principles involved in structure predictions and structural elucidation	3	PO3
CO5	Perform structure analysis using online tools	3	PO3,PO4

Syllabus

Module 1	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.
Module 2	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.
Module 3	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.
Module 4	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.

Reference Books:

S.No	Title	Author(s)	Publisher	Year
1	Introduction to Macromolecular Crystallography	McPherson	John Wiley Publication	2003
2	Introduction to Protein Science	Arthur M. Lesk	Oxford University Press, UK.	2000
3	Introduction to Protein Architecture	Arthur M. Lesk	Oxford University Press, UK.	2015

Global Certifications:

Mapped Global Certifications:						
Sl No	**Title**	**Certification Provider**	**Proctored (Y/N)**	**Format of the Exam**	**Exam Provider**	**URL of the Certification**
2		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Lab Weekly Exercise	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

ADVANCED MOLECULAR EXPRESSION TECHNOLOGY, (MET)

COURSE CODE	23BT52D1	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	MAPPED PO & PSOs
CO1	Compare gene expression in prokaryotic and eukaryotic system	3	PO1
CO2	Apply the role of expression in mammalian system	3	PO3
CO3	Develop various strategies of protein purification system	3	PO4
CO4	Apply strategies for maintaining protein stability	3	PO5
CO5	Analyse the expressed protein by analytical methods	4	PO4

Syllabus

Module 1	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
Module 2	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.
Module 3	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.
Module 4	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.

Reference Books:

S.No	Title	Author	Edition	Publisher
1	Gene Expression Technology	John N. Abelson	1st Academi	Academic Press

2	Molecular Biology of the Cell	Bruce Alberts	4th edition	Garland Science
3	Gene Expression	Fumiaki Uchiumi	2nd Edition	Intech Open
4	Gene Expression and Control	Fumiaki Uchiumi	3rd Edition	Intech Open

Global Certifications:

Mapped Global Certifications:						
Sl No	**Title**	**Certification Provider**	**Proctored (Y/N)**	**Format of the Exam**	**Exam Provider**	**URL of the Certification**
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	**Tool Name**	**Parent Industry**	**Open Source/ Commercial**
1	Not Applicable		

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

ADVANCED MOLECULAR MARKERS AND DIAGNOSTICS **(MMD)**

COURSE CODE	23BT52D2	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

Module 1	Diagnosis of Viral & Bacterial diseases: Host pathogen interactions in disease process; Protective immune response in Bacterial, Viral and Parasitic diseases; Cancer; Inappropriate Immune response; Disease pathology and clinical spectrum; Clinical diagnosis of diseases; Molecular Genetics of the host and the pathogen. Biochemical Disorders: Biochemical disorders; Immune, Genetic and Neurological disorders; Molecular techniques for analysis of these disorders; Assays for the Diagnosis of inherited diseases; Bioinformatics tools for molecular diagnosis.
Module 2	Immunodiagnostics: Antibody based diagnosis; Monoclonal antibodies as diagnostic reagents; Production of monoclonal antibodies with potential for diagnosis; Diagnosis of bacterial, viral and parasitic diseases by using; ELISA and Western blot.
Module 3	DNA based Diagnostics: Isolation of DNA; purification and analysis; DNA sequencing and diagnosis; PCR and Array based techniques in diagnosis; Single nucleotide polymorphism and disease association; Two dimensional gene scanning.
Module 4	Bio analytical Techniques for Diagnosis: Isolation of proteins and other molecules associated with disease; Process and their profiling for diagnosis; 2D analysis of such proteins by sequencing individual spots by Mass Spectrometry; Protein Micro array; Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS; Ethics in Molecular Diagnosis.

Reference Books:

S.No	**Title**	**Author(s)**	Edition	Publisher
1	Discovering Genomics, Proteomics and Bioinformatics	Campbell, M.A and Heyer L.J.	2nd Edition	CSHL Press, Pearson/Benzamin Cummings San Francisco
2	New Clinical Genetics	Andrew Read and Dian Donnai	1st Edition	Scion Publishing Ltd, Oxfordshire
3	Monoclonal antibodies: Principles and Practice	James W Goding	3rd Edition	Academic Press
4	Molecular Diagnostics	George Patrinos and Wilhelm Ansorage	1st Edition	Academic Press

Global Certifications:

Mapped Global Certifications:

Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
2		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	7	24
	Home Assignments	7	
	Lab Weekly Exercise	5	
	Project Conitnuous Evaluation	5	
In-Sem Summative	In-Sem 1	12	36
	In-Sem 2	12	
	Lab In-Semester Exam	6	
	Global Challenges - Leader board	6	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam+ Skill End-Sem Exam	8	
	Lab End-Sem Exam+ Skill End-Sem Exam	8	

ADVANCED MOLECULAR GENETICS AND FORENSICS

COURSE CODE	23BT52D3	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Acquire the knowledge of Genomes	3	PO1
CO2	Compare micro array analysis	3	PO2
CO3	Develop protein networks	5	PO3
CO4	Develop mapping strategies	5	PO3
CO5	Analyse protein structure	4	PO4

Syllabus

Module 1	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.
Module 2	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.
Module 3	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 Biomolecules, 2D-Gel Electrophoresis, MALDI-TOF, Protein-protein interaction networks: Topology, Network motifs, Protein Expression profiling and applications.
Module 4	Protein Networks and mapping-Yeast two hybrid, Co-Precipitation, Phage Display, Phylogenetic Profile, Domain fusion, Gene Neighbourhood, Gene Cluster, Mirror Tree, Analysis of genome wide Protein-Protein Interactions in yeast. Genome wide yeast two hybrid analysis of other organisms, Protein fragment complementation assays.

Reference Books:

S.No	Title	Author(s)	Edition	Publisher
1	Molecular Biology of the Cell	Alberts	5th Edition	Garland Science
2	Molecular Forensics	Ralph Rapley	4th Edition	John Wiley & Sons

3	Gene cloning and DNA analysis	T.A. Brown	4th Edition	John Wiley & Sons
4	Recombinant DNA	Watson	4th Edition	Freeman Press

Global Certifications:

Mapped Global Certifications:						
Sl No	**Title**	**Certification Provider**	**Proctored (Y/N)**	**Format of the Exam**	**Exam Provider**	**URL of the Certification**
2		Not Applicable				

Tools used in Practical / Skill:

Sl No	**Tool Name**	**Parent Industry**	**Open Source/ Commercial**
1	Not Applicable		

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

INDSTRIAL BIOTECHNOLOGY

COURSE CODE	23BT52R1M	MODE	M	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Acquire the knowledge of microbial technology.	3	PO1, PO2
CO2	Screen out medium and strain development	3	PO1
CO3	Develop various strategies to produce Primary and secondary Metabolites	3	PO1, PO2
CO4	Design various strategies for the production of enzymes, recombinant proteins, and other special bioproducts.	3	PO1

Syllabus

Module 1	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; Outline and integrated bioprocesses and various unit operations (upstream and downstream) involved in the bioprocesses. Generalized process flow sheets.
Module 2	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.
Module 3	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.
Module 4	Enzymes, Recombinant Proteins, Special bioproducts- Enzymes- Protease,; Concept of SSF, Advantages and disadvantages, Production of Recombinant Proteins- Insulin and Special Bioproducts- Biopesticides; Biofertilizers Natural Biopreservatives (Nisin); Biopolymers (Xanthan Gum); Single cell protein, High Fructose Corn Syrup; Process of bioleaching

Reference Books:

S.No	Title	Author(s)	Publisher	Year

1	Principles of Fermentation Technology,	Peter F Stanbury,	Elsevier	2019
2	Biochemical Engineering fundamentals	Bailey & Ollis,	Mcgraw Hill Higher Education	1988
3	Principles of fermentation technology. Elsevie.	Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall.	Elsevier	2013
4	"Industrial microbiology." Industrial microbiology.	Prescott, Samuel Cate, and Cecil Gordon Dunn.	Freeman Press	1949

Global Certifications:

Mapped Global Certifications:						
Sl No	**Title**	**Certification Provider**	**Proctored (Y/N)**	**Format of the Exam**	**Exam Provider**	**URL of the Certification**
2		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Review	10	20
	Viva-voce	10	
In-Sem Summative	Sem-In Exam	40	40
End-Sem Summative	End-Sem Exam (Online MCQ)	40	40

ADVANCED FERMENTATION TECHNOLOGY -FT

COURSE CODE	23BT52R2M	MODE	M	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply the principles of fermentation technology in monetering and controling aseptic condtions	3	PO1
CO2	Apply the priciples of media optimization in designing experiments in biological systems.	3	PO1
CO3	Apply the knowledge of modes of operation of bioprocesses in culturing and producing bioproducts	3	PO1
CO4	Apply the principles of mixing and sparging systems to optimize production of bioproducts	3	PO1

Syllabus

Module 1	Introduction to Fermentation: Different range of fermentation processes; Chronological development of fermentation industry; General requirements of fermentation processes; an overview of aerobic and anaerobic fermentation process, Monitoring and control of fermentation process. Ancillary fittings for reactors (sampling port); Aseptic transfer of spore suspension
Module 2	Medium Requirements and Optimization:Medium requirements for fermentation processes - Carbon, Nitrogen, Minerals, Vitamin sand Other Complex nutrients, Oxygen requirement. Introduction to medium optimization;Methods of media optimization (One factor method and Plackett – Burman design). Kinds of sterilization techniques; Thermal death kinetics of microorganisms, Batch and Continuous sterilization of liquid media,Filter sterilization.
Module 3	Classification of fermentation system (Batch, fed-batch, Continuous); Solid state fermentation, Submerged fermentation. Dual and multiple fermentations; Concept of Chemostat; Turbidostat. Industrial fermentation products-Penicillin, Alcohol production.
Module 4	Aeration and Agitation: Types of mixing mechanisms - bubble aeration & mechanical agitation; mixing equipment; Types of spargers and impellers in fermenters;Significance of oxygen transfer infermentations ;Factors affecting oxygen transfer rates. Scale - up of fermentation process;Principles;Theoretical considerations and techniques used; Scale down methods.
Module 5	From media to production

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Principles of Fermentation Technology, Elsevier	Peter F Stanbury,	Blackwell Publications	2000

2	Biochemical Engineering fundamentals Mcgraw Hill Higher Education (1988)	Bailey & Ollis,	Humana Publications	2015.

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1		Not Applicable				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Not Applicable		

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	Review	10	20
	Viva-voce	10	
In-Sem Summative	Sem-In Exam	40	40
End-Sem Summative	End-Sem Exam (Online MCQ)	40	40

ADVANCED BIOMINING

COURSE CODE	23BT52R3M	MODE	M	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To provide basic concept and history of biomining highlighting the microorganisms and reactors	1	PO1
CO2	Understand the concept and application of microorganisms in biomining of base metal sulfides	1	PO2
CO3	Understand the concept and application of microorganisms in biomining of nuclear and precious metals	2	PO1, PO2
CO4	Understand the role of microorganisms in pollution control and bioremediation	2	PO1, PO2

Syllabus

Module 1	**Basic concept and introduction to bioleaching: History of bioleaching, b**iogenesis of metals and minerals, microorganisms in biohydrometallurgy, reactor bioleaching and developments in bioleaching of concentrates, bioleaching mechanisms, bacterial attachment to minerals, metal toxicity in leaching bacteria, development of metal-tolerant Acidithiobacillus ferrooxidans.
Module 2	**Bioleaching of base metal sulfides:** Biohydrometallurgy of copper – general principles, mechanisms and microorganisms, biohydrometallurgy of copper – dump and heap leaching, biohydrometallurgy of copper – modern developments, bioleaching of nickel from sulfides and laterites, heap bioleaching technology for nickel, bioleaching of zinc sulfide ores and concentrates.
Module 3	**Bioleaching of nuclear and precious metals:** Biohydrometallurgy of uranium, Microorganisms and mechanisms, – Dump, heap and insitu leaching, industrial aspects and remediation, biotechnology for gold – biogenesis, microorganisms and gold nanobiotechnology, biooxidation of refractory sulfidic concentrates, recent developments, bioprocessing of industrial wastes
Module 4.	**Microbiological aspects of environmental pollution and control**: Acid mine drainage – mechanisms and control, bioremediation technologies in mining, industrial aspects and in situ remediation experimental determination of acid

	mine drainage, bioremediation using Sulfate – Reducing – Bacteria – Copper, iron, zinc and arsenic.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	an Introduction to Genetic Algorithms	Mitchell, M	Prentice-Hall.	1998
2	Neural Networks	Lau C., (Ed)	IEEE Press	1992
3.	Neural Networks: Algorithms, Applications and Programming Techniques	Freeman, J. and Skapura, D	Addison-Wesley	1991
4.	Uncertainty, and Information	Klir, G.J. and Folger, T.A.	PHI	1988

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	Review	10	20
	Viva-voce	10	
In-Sem Summative	Sem-In Exam	40	40
End-Sem Summative	End-Sem Exam (Online MCQ)	40	40

M.Tech - Construction Technology & Management

CONSTRUCTION PLANNING SCHEDULING AND CONTROL (CPSC)

COURSE CODE	**23CE5121**	MODE	6	LTPS	**2-0-2-4**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the concepts of project management for practical application	3	PO2, PO4, PO11, PSO1
CO2	Apply mathematical logic in the planning and scheduling of a project	5	PO2, PO4, PO11, PSO1
CO3	Apply concepts to estimate the project cost by using tools	5	PO2, PO4, PO11, PSO1
CO4	Apply concepts to maintain the construction documents in the project	2	PO2, PO4, PO11, PSO1
CO5	Plan, schedule, and control large-scale programs and individual projects by using Primavera/MS Project Tool	5	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**UNDERSTANDING PROJECT MANAGEMENT:** Project manager, organization structures, Organizing and staffing the project office and team, stages and phases involved in project management, techniques involved in project management
Module 2	**CONSTRUCTION PLANNING:** Project planning, milestone schedules, WBS, Network Techniques, critical path method, project evaluation review technique and Primavera, Resources leveling and smoothing.
Module 3	**CONSTRUCTION SCHEDULING** scheduling procedures, scheduling tools, construction activities in a project and their relationships, NETWORK ANALYSIS - Critical Path Method and Program Evaluation & Review Technique (PERT) and Range Estimating, The Role of the Scheduler in Construction Management, Technology Applications for Scheduling-Software Applications overview- primavera, MS Project Scheduling

Module 4	**COST CONTROL:** Introduction, Understanding Control, The Operating Cycle, Cost Account Codes, Budgets, The Earned Value Measurement System (EVMS) **PROJECT MANAGEMENT INFORMATION SYSTEM:** MIS reporting, Daily, Weekly and monthly reporting, Actual vs. Planned cost reports, Planning & Cost control document.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Construction Project Management: Planning, Scheduling and Control,	Chitkara, K.K.	Tata McGraw-Hill Publishing Company, New Delhi,	1998
2	Project Management	Harold Kerzner	CBS Publisers & Distributors 2nd Edition.	2005
3	Modern Construction Management	Frank Harris & Ronald McCaffer	Blackwell science 4th Edition.	2004
4	Principles of Construction Management	Roy Pilcher	McGraw Hill London.	005
5	Project Planning, Scheduling and Control in Construction: An Encyclopedia of terms and Applications.	Calin M. Popescu, ChotchaiCharoenngam,	Wiley, New York	1995
6	Project Management for Construction –Fundamental Concepts for Owners, Engineers, Architects and Builders	Chris Hendrickson and Tung Au	Prentice Hall, Pittsburgh.	2000
7	Scheduling Construction Projects	Willis, E. M	John Wiley & Sons,	1986
8	Financial and Cost Concepts for Construction Management	Halpin, D. W.	John Wiley & Sons, New York, 1985	1985

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	**Primavera/MS Project**	Microsoft	Open source
2			

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

Special Concrete and Admixtures

COURSE CODE	**23CE5104**	MODE	R	LTPS	**3-0-2-0**	PRE-REQUISITE	Nil

Course Outcomes

CO#	**CO Description**	**BTL**	**PO Mapping**
CO1	Understanding about Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design.	2	PO2, PO4, PO11, PSO1
CO2	Understanding about Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers	2	PO2, PO4, PO11, PSO1
CO3	Understanding about Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting	2	PO2, PO4, PO11, PSO1

CO4	Understanding about Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.	2	PO2, PO4, PO11, PSO1
CO5	To apply the knowledge on concrete to live situations	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	Understanding about Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design.
Module 2	Understanding about Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers
Module 3	Understanding about Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting
Module 4	Understanding about Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.
Module 5	To apply the knowledge on concrete to live situations

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Concrete Technology,	Santha kumar, A.R.	Oxford University press, New Delhi	2007
2	Concrete Technology	Gambhir, M.L.	Tata McGraw Hill Book Co. Ltd. Delhi,	2004
3	Properties of Concrete	Neville, A.M.	Longman,	1995

Evaluation Components:

Evaluation	Component	Weightage	Total

In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	32	40
	Lab End-Sem Exam	8	

PRE-ENGINEERING CONSTRUCTION AND TECHNOLOGY (PCT)

COURSE CODE	**23CE5123**	MODE	6	LTPS	**3-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the type of prefabricated elements and its importance	2	PO2, PO4, PO11, PSO1
CO2	Understand the precast construction procedure	2	PO2, PO4, PO11, PSO1
CO3	Understand the modular construction practices and its limitations and advantages	2	PO2, PO4, PO11, PSO1

CO4	Apply knowledge in the choice of production setup and manufacturing methods	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	Comparison with monolithic construction – Types of prefabrication – site and plant prefabrication - Economy of prefabrication – Modular coordination – Standardization – Planning for Components of prefabricated structures – Disuniting of structures – Design of simple rectangular beams and I beams – Handling and erection stresses – Elimination of erection stresses – Beams, columns – Symmetrical frames.
Module 2	**Precast Systems**: Design Principles- Large Panel System - Frame System- Slab-Column System with Shear Wall- Precast sandwich Panels, Prestressed concrete solid flat slabs, Hollow core slab/panels, Prestressed concrete Double “T”, Bridge, Precast segmental Box Girders, Specifications and Seismic considerations
Module 3	**Modular Construction Practices:** Introduction to Modular Construction, Modular coordination, Modular Standardization, Modular System Building, Limitation and Advantages of Modular Construction
Module 4	**Production and Hoisting Technology** Choice of production setup – manufacturing methods –stationary and mobile production – planning of production setup – storage of precast elements – dimensional tolerances – acceleration of concrete hardening. Equipment’s for hoisting and erection – techniques for erection of different types of members like beams, slabs, wall panels and columns – vacuum lifting pads

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Building materials and components	CBRI	Oxford University press, New Delhi,	1990
2	Knowledge based process planning for construction and manufacturing	Gerostiza C.Z., Hendrikson C. and Rehat D.R.,	Academic Press Inc.,	1994
3	Manual of precast concrete construction, Vols. I, II and III, 1971.	Koncz T.,	Bauverlag, GMBH,	1971

Global Certifications:

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

MECHANIZED CONSTRUCTION AND MACHINERY (MCM)

COURSE CODE	**23CE5224**	MODE	6	LTPS	**3-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding the basic concepts of Equipment Management and tools	2	PO2, PO4, PO11, PSO1
CO2	Understand various construction equipment and study the efficient utilization of the same using scientific principles	2	PO2, PO4, PO11, PSO1
CO3	Apply the knowledge for the selection of appropriate equipment	3	PO2, PO4, PO11, PSO1
CO4	Understand the operation of Earthwork and various functions of machinery used for Earth moving, compaction, etc.	2	PO2, PO4, PO11, PSO1
CO5	Write field report on machinery operation, cost and productivity by using project management tools like primavera/Candy/SAP etc	**3**	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Equipment Management:**Equipment Management, Costing, Optimum utilization and Equipment selection, depreciation, interest on capital, Manpower, Spare parts etc., Documentation, Logbooks, History Books, Periodical MIS Report
Module 2	**Construction Equipment:**Understanding basics, Capacity, Function & Efficiency of All Machinery, involving all machinery data, power use, fuel consumption and labor utilization. Special equipment, cost of owning and operating equipment, Work cycle time of any machine with corrective factors, depreciation of equipment, operative cost, inventory cost control, higher/rental- a) Average Investment value, b) Annual Ownership Cost, 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

Module 3	**Fundamentals of Earth Work Operations** - Earth Moving Operations-Types of Earthwork Equipment - Tractors, Motor Graders, Scrapers, Front end Loaders, Earth Movers – capacity calculations.
Module 4	**Equipment for compaction** - Types of pumps used in Construction - Equipment for Grouting - Pile Driving Equipment- Equipment of Erection and demolition.**Equipment for Earthmoving Machinery**, Concreting Equipment, Material Handling Equipment such as cranes, boom, lift and maintenance transportation Equipment's.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Construction planning, Equipments and methods.	R.L.Peurify	TMH	1996
2	Construction Planning, Equipment, and Methods	Robert L. Peurifoy, Clifford J. Schexnayder, and Aviad Shapira	McGraw-Hill Education	1991
3	Construction Equipment and its Planning and Applications",	Mahesh Varma,	Metropolitan Book Co.(P) Ltd., New Delhi. India.	2001
4	Construction Equipment Management for Engineers, Estimators, and Owner	Douglas D. Gransberg, Calin M. Popescu, and Richard C. Ryan	CRC Press	2004
5	Construction Equipment and Its Management	John E. Schaufelberger and Giovanni C. Migliaccio	Prentice Hall	2005

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

BUILDING INFORMATION MODELING AND COMPUTER APPLICATIONS (BIM)

COURSE CODE	**23CE5225**	MODE	6	LTPS	**2-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Become familiar with the trends, concepts of Building Information Modeling	2	PO2, PO4, PO11, PSO1
CO2	Learn about Project BIM Execution Planning	2	PO2, PO4, PO11, PSO1
CO3	Design the BIM execution process by creating process maps	4	PO2, PO4, PO11, PSO1
CO4	Develop BIM information exchanges	4	PO2, PO4, PO11, PSO1
CO5	Developing BIM Model using Revit Software and submission of project report	4	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Basics of BIM:** Fundamentals of Building Information Modeling, BIM, Project Delivery Methods & Trends BIM Adoption & Perceived ROI BIM for FM Concept BIM Proficiency Project Execution Planning
Module 2	**The Uses of BIM:** BIM use classification system and structure, the purposes and objectives of BIM, elaborating on the BIM use characteristics, level of development, selection of BIM uses
Module 3	**Project BIM Execution Planning:**Overview of the project execution planning procedure for BIM, identifying BIM goals and uses for a project, designing the BIM project execution process**Developing information exchanges :**Pulling the information through the project, information exchange worksheet.
Module 4	**Define supporting infrastructure for BIM implementation:**Project information, project BIM goals / BIM uses, organizational roles and staffing BIM and facility data requirements, delivery strategy / contract.**Implementing the BIM project execution planning procedure:**Meeting Structure for Developing a BIM Project Execution Plan, Planning Meeting Schedule, Monitoring Progress against the BIM Execution Plan

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors.	Eastman, C., Teicholz, P., Sacks, R., & Liston, C. (2011).	John Wiley & Sons.	2006
2	BIM and construction management: proven tools, methods, and workflows	Hardin, B., & McCool, D.	John Wiley & Sons.	2015
3	Green BIM: successful sustainable design with building information modeling. John Wiley & Sons.	giel, E., & Nies, B.	John Wiley & Sons.	2008
4	Building Information Modeling: Applications and Practices. American Society of Civil Engineers. •Teicholz, P. (Ed.). (2013).	Issa, R. R., & Olbina, S. (Eds.).	John Wiley & Sons.	2015
5	Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations .	Kymmell, W.	McGraw Hill Professional.	2007

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

MATERIAL PROCUREMENT MANAGEMENT

COURSE CODE	**23CE51E1**	MODE	6	LTPS	**2-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the significance of material management	2	PO2, PO4, PO11, PSO1
CO2	Integrate important materials functions to both products and services & use MRP, ERP,& PLM managing materials	3	PO2, PO4, PO11, PSO1
CO3	Apply various purchasing method and inventory controlling techniques into practice.	3	PO2, PO4, PO11, PSO1
CO4	Use the Material Management tools like TALLY, ERP, SAP in materials planning, procurement, inventory, control, cost control etc.	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Importance of Materials Management:** Importance of material management and its role in construction industry-scope, objectives and functions, Integrated approach to materials management, Role of materials manager
Module 2	**Codification and procurement:** Classification and Codification of materials of construction. ABC analysis-Procedure and its use, Standardization in materials and their management, Procurement, identification of sources of procurement, vendor analysis. Vendor analysis concept of (MRP) Material requirement planning, planning, purchase procedure, legal aspects.
Module 3	**Inventory and Stores Management:**Inventory Management – Inventory Control techniques. EOQ, Advantages and limitation of use of EOQ, Periodic ordering, order point control, safety stock, stock outs, application of AC analysis in inventory control, concept of (JIT)- Just in time management, Indices used for assessment of effectiveness of inventory management.
Module 4	Stores Management: Receipt and inspection, care and safety in handling, loss on storage, wastage, Bulk purchasing, site layout and site organization, scheduling of men, materials and equipment.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Purchasing and Inventory Control	K. S. Menon	Wheeler Publication.	2003

2	Materials Management	P.Gopalkrishnan	Prentice Hall.	1998
3	Handbook of materials management	P.Gopalkrishnan, Sundershan,	Prentice Hall.	2001
4	Inventory Management,	L.C.Jhamb,	Everest Publ.	2003

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

GREEN BUILDINGS (GB)

COURSE CODE	**23CE51E2**	MODE	6	LTPS	**2-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand Necessity and importance of Sustainable/ Green Buildings, Grasp the construction practices of a sustainable Buildings.	2	PO2, PO4, PO11, PSO1
CO2	Understanding the Green Building Rating Systems, Water & Energy efficiencies, Reduction in waste material during construction and Building Design	3	PO2, PO4, PO11, PSO1
CO3	Understanding Air Conditioning and HVAC system design, Salient features of CII Godrej Green Business Center	3	PO2, PO4, PO11, PSO1
CO4	Understanding Indoor Environment Quality and Occupational Health, Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels,	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction:**What is Green Building, why to go for Green Building, Benefits of Green Buildings, Green Building Materials and Equipment in India, What are key Requisites for Constructing a Green Building, Important Sustainable features for Green Building.
Module 2	**Green Building Concepts and Practices:**Indian Green Building Council, Green Building Moment in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation.**Green Building Opportunities and Benefits:** Opportunities of Green Building, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy Saving Approach in Buildings, LEED India Rating System and Energy Efficiency,
Module 3	**Green Building Design:**Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximize System Efficiency, Use of Renewable Energy Sources. Ecofriendly captive power generation for factory, Building requirement.**Air Conditioning:**Introduction, CII Godrej Green business center, Design philosophy, Design interventions, Energy modeling, HVAC System design, Chiller selection, pump selection, Selection of cooling towers, Selection of air handing units, Precooling of fresh air, Interior lighting system, Key feature of the building. Eco-friendly captive power generation for factory, Building requirement.

Module 4	**Material Conservation:**Handling of non-process waste, waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood, Rapidly renewable building materials and furniture;**Indoor Environment Quality and Occupational Health:** Air conditioning, Indore air quality, Sick building syndrome, Tobacco smoke control, Minimum fresh air requirements avoid use of asbestos in the building, improved fresh air ventilation, Measure of IAQ, Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels,

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Handbook on Green Practices	Indian Society of Heating Refrigerating and Air conditioning Engineers	Indian Society of Heating Refrigerating and Air conditioning Engineers	2009
2	Green Building Handbook.	Tomwoolley and Samkimings	Routledge	2009
3	Complete Guide to Green Buildings	Trish riley	Routledge	2008
4	Standard for the design for High Performance Green Buildings .	Kent Peterson	U.S. Green Building Council (USGBC)	2009

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

SUSTAINABLE ENGINEERING CONCEPTS AND LIFE CYCLE ANALYSIS (SECLCA)

COURSE CODE	**23CE51E3**	MODE	6	LTPS	**2-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding the Sustainable Engineering, Life Cycle Assessment	2	PO2, PO4, PO11, PSO1
CO2	Understanding the Sustainability Metrics and Indicators, Sustainable Design Principles	2	PO2, PO4, PO11, PSO1
CO3	Understanding the Sustainable Manufacturing and Operations, Sustainable Infrastructure:	2	PO2, PO4, PO11, PSO1
CO4	Understanding the Social and Ethical Considerations in Sustainable Engineering:	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction to Sustainable Engineering:** Definition and principles of sustainable engineering Environmental, social, and economic aspects of sustainability, Sustainable development goals and their relevance to engineering **Life Cycle Assessment (LCA):** Introduction to life cycle analysis, Phases of LCA: goal and scope definition, inventory analysis, impact assessment, interpretation, Life cycle thinking and its application in engineering projects, Data collection methods and databases for LCA
Module 2	**Sustainability Metrics and Indicators:** Key sustainability metrics and indicators used in engineering, Environmental footprint assessment, Social and economic indicators for sustainability analysis **Sustainable Design Principles:** Design for environment (DfE) principles, Eco-design and green product development, Design strategies for energy efficiency and renewable energy integration, Materials selection for sustainability
Module 3	**Sustainable Manufacturing and Operations:** Sustainable manufacturing processes and technologies, Resource and energy efficiency in manufacturing, Waste minimization and recycling strategies, Environmental management systems **Sustainable Infrastructure:** Sustainable urban planning and design, Green building design and certification systems (e.g., LEED, BREEAM), Transportation systems and sustainable mobility, Water and wastewater management
Module 4	**Social and Ethical Considerations in Sustainable Engineering:** Social equity and justice in engineering projects, Stakeholder engagement and participatory decision-making, Ethics of sustainable engineering practices

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Sustainable Engineering: Concepts, Design, and Case Studies	David T. Allen, David R. Shonnard, Subramanian Venkateswaran	Pearson	
2	Life Cycle Assessment: Theory and Practice	Michael Z. Hauschild, Ralph K. Rosenbaum, Stig Irving Olsen	Springer	
3	sustainable Engineering: Principles and Implementation	Susan Krumdieck	Routledge	
4	Life Cycle Assessment Handbook: A Guide for Environmentally Sustainable Products	Mary Ann Curran	Wiley	
5	Introduction to Life Cycle Analysis and Sustainable Engineering" by Publisher:	C.M. Eastman, M.M. Rymaszewski, B.B. LoBuglio	Prentice Hall	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

CONSTRUCTION PERSONNEL MANAGEMENT (CPM)

COURSE CODE	**23CE51F1**	MODE	6	LTPS	**2-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand Overview of manpower planning and roles of HR	**2**	PO2, PO4, PO11, PSO1
CO2	Understand Detail about the organizations and structure variance for organizations	**2**	PO2, PO4, PO11, PSO1
CO3	Understand human relations and organizational behavior for working in an organization	**2**	PO2, PO4, PO11, PSO1
CO4	Understand welfare measures and laws related to welfare measures and Detail overview of management and development methods	**2**	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**MANPOWER PLANNING :**Manpower Planning process, Organizing, Staffing, directing, and controlling – Estimation, manpower requirement – Factors influencing supply and demand of human resources – Role of HR manager – Personnel Principles.
Module 2	**ORGANISATION:**Requirement of Organisation – Organisation structure – Organisation Hierarchical charts – Staffing Plan - Development and Operation of human resources - Managerial Staffing – Recruitment – Selection strategies – Placement and Training.
Module 3	**HUMAN RELATIONS AND ORGANISATIONAL BEHAVIOUR:**Basic individual psychology – Approaches to job design and job redesign – Self managing work teams – Intergroup – Conflict in organizations – Leadership-Engineer as Manager – all aspects of decision making – Significance of human relation and organizational – Individual in organization – Motivation – personality and creativity – Group dynamics, Team working – Communication and negotiation skills.**WELFARE MEASURES :**Compensation – Safety and health – GPF – EPF – Group Insurance – Housing - Pension – Laws related to welfare measures.
Module 4	**MANAGEMENT AND DEVELOPMENT METHODS:**Wages and Salary, Employee benefits, Employee appraisal and assessment – Employee services – Safety and Health Management – Special Human resource problems – Productivity in human resources – Innovative approach to designing and managing organization – Managing New Technologies – Total Quality Management – Concept of quality of work life – Levels of change in the organizational Development – Requirements of organizational Development – System design and methods for automation and management of operations – Developing policies, practices and establishing process pattern – Competency up gradation and their assessment – New methods of training and development

	– Performance Management.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Complete Standard Handbook of Construction Personnel Management.	Carleton Counter II and Jill Justice Coutler	Prentice-Hall, Inc.,	1989
2	Management of Civil Engineer.	Charles D Pringle, Justin Gooderi Longenecter	Merril Publishing Co.	1981
3	Human Relations and OrganisationalBehaviour, 2005.	Dwivedi R.S	Macmillian India Ltd.,	2005
4	Handbook of Human Resources Administration.	Josy.J. Familaro,	McGraw-Hill International Edition,	1987
5	Personnel Management.	Memoria,C.B.,	Himalaya Publishing Co.,	1997

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

LEAN CONSTRUCTION PRACTICES (LCP)

COURSE CODE	**23CE51F2**	MODE	6	LTPS	**2-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the elements of traditional construction management	2	PO2, PO4, PO11, PSO1
CO2	Apply and analyse construction productivity measuring and improving techniques	4	PO2, PO4, PO11, PSO1
CO3	Implement lean principles in order to improve the customer value for sustainable project business	3	PO2, PO4, PO11, PSO1
CO4	Apply and analyse the lean practices	4	PO2, PO4, PO11, PSO1
CO5	Understand the integrated applications of various IT tools and case studies	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**TRADITIONAL CONSTRUCTION MANAGEMENT:**Project – Management – Project Management – Project vs. Process – Management: Art/Science? – Project objectives – Scientific way of managing project objectives – Project Stakeholders, Construction Project Organisation, Project Phases, Level of effort, Relative ability to influence cost – Project Execution phases (EPC and Fast Track) – Project Scheduling Levels – Need for productivity measurement systems.
Module 2	**CONSTRUCTION PRODUCTIVITY:**Productivity-basics – Levels of Productivity Models (economic, project, activity) – Productivity Measurement System – Planning control systems vs. Productivity measurement system – Framework for Productivity improvement – Productivity Analysis – Productivity Reporting – Productivity Assessment – Sources of lost time – Techniques for Measuring and Improving Productivity – work sampling (tour and crew-based), foreman delay survey, crew-balance charts, process chart
Module 3	**INTRODUCTION TO LEAN AND PRINCIPLES:**History of Management Science – Toyota’s 14 Management Principles – What is Lean – Core concept of Lean – Fundamental Lean Principles - Types of waste (Muda, Mura, and Muri) – Muda (8 waste) – Types of Muda – Mura and Muri – Tools to find waste (sampling, surveys) – Conventional Construction Management vs. Lean Construction – Lean Research groups, institutes and conferences.
Module 4	**LEAN PROJECT DELIVERY PRACTICES:**Flow – Craft vs. Mass vs. Lean Production - Push and Pull Mechanism – Airplane Game (illustrating flow-pull-waste), Behaviour of two systems – bottleneck, WIP, idle times, throughput, cycle time – Discussions – Last Planner System™ / Collaborative

	Planning System (master, look-ahead, weekly, daily front line plan, productivity measurement), PPC Variance and Root Cause Analysis – Discussions – Value stream mapping (definitions, typical value stream, procedure, symbols) – Example with discussions.**LEAN TOOLS AND CASE STUDIES:**Building Information Modeling (BIM) – Location-based Management System (LBMS) – Construction Supply Chain Management – Integrated Lean Project Delivery (ILPD) – Case studies.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Lean Construction – Core Concepts and New Frontiers .	Patricia Tzortzopoulos, Mike Kagioglou and Lauri Koskela	Routledge, Taylor & Francis Group, London and New York	2020
2	Lean Construction	Alarcon	A.A. Balkema Publishers, VT, USA	1997
3	The Toyota way Fieldbook	Liker and Meier	McGraw-Hill.	2006
4	Toyota Culture The Heart and Soul of the Toyota way.	Liker and Hoseus	McGraw-Hill.	2008
5	Advanced Project Management.	Fredrick Harrison and Dennis Lock	Gower Publishing Company, VT, USA.	2004

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	VisiLean	Microsoft	Open source
2	Excel	Microsoft	Open source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

INFRASTRUCTURE PLANNING AND MANAGEMENTS (IPM)

COURSE CODE	23CE51F3	MODE	6	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding the Introduction to Infrastructure Planning and Management, Infrastructure Systems and Components	2	PO2, PO4, PO11, PSO1
CO2	Understanding the Infrastructure Planning and Development Process, Infrastructure Asset Management	2	PO2, PO4, PO11, PSO1
CO3	Understanding the Infrastructure Financing and Funding, Infrastructure Policy and Regulation	2	PO2, PO4, PO11, PSO1
CO4	Understanding the Infrastructure Resilience and Risk Management, Case Studies and Best Practices	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction to Infrastructure Planning and Management:** Definition and scope of infrastructure, Importance of infrastructure in economic development, Challenges and complexities in infrastructure planning and management **Infrastructure Systems and Components:** Overview of different infrastructure systems (e.g., transportation, water supply, energy, telecommunications), Components and elements of infrastructure systems Interdependencies and interactions between infrastructure systems
Module 2	**Infrastructure Planning and Development Process:** Infrastructure planning frameworks and methodologies, Data collection and analysis for infrastructure planning, Feasibility studies and cost-benefit analysis, Stakeholder engagement and public participation in infrastructure planning **Infrastructure Asset Management:** Asset management principles and practices, Asset inventory and condition assessment Maintenance and rehabilitation strategies, Life cycle cost analysis and optimization

Module 3	**Infrastructure Financing and Funding:** Financing options for infrastructure projects (e.g., public-private partnerships, government funding, user fees), Project financing and risk assessment, Infrastructure investment planning and prioritization **Infrastructure Policy and Regulation:** Policy frameworks and regulatory frameworks for infrastructure planning and management, Environmental and sustainability considerations in infrastructure projects, Legal and institutional aspects of infrastructure governance
Module 4	**Infrastructure Resilience and Risk Management:** Resilience planning and strategies for infrastructure systems, Risk assessment and risk management in infrastructure projects, Emergency preparedness and response for infrastructure disruptions **Case Studies and Best Practices:** Analysis of real-world infrastructure projects and their planning and management approaches, Examination of best practices in infrastructure planning and management Lessons learned and challenges in infrastructure development

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Infrastructure Planning, Engineering, and Economics	George J. Sefa Dei, Allan McRobie	Cambridge University Press	
2	Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation, and Renovation	Rajib B. Mallick, Tahar El-Korchi	CRC Press	
3	Infrastructure Planning Handbook: Planning, Engineering, and Economics	A. A. Jha, W. H. Dilkes, T. C. Kavanagh	McGraw-Hill Education	
4	Infrastructure: A Guide to the Industrial Landscape	Brian Hayes	W. W. Norton & Company	
5	Infrastructure Finance: The Business of Infrastructure for a Sustainable Future	Neil Grigg	Wiley	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20

In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

STATISTICAL METHODS IN CONSTRUCTION

COURSE CODE	**23CE52G1**	MODE	6	LTPS	**3-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply discrete and continuous probability distribution including requirements mean and variance and making decisions	4	PO2, PO4, PO11, PSO1
CO2	Use the concepts of standard deviation, coefficient variance in different types samples and apply the tests	3	PO2, PO4, PO11, PSO1
CO3	Perform the correlation analysis in various civil engineering projects	4	PO2, PO4, PO11, PSO1
CO4	Apply simulation techniques for analysis and mitigation of construction project risks	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Probability:** Probability theory and its importance: Definition of probability, Rules of Probability, The Baye‘s theorem. Random variable. Probability distribution. Mean or Expectation of Random variable. Properties of Mean of Expectation.**Distributions:** Theoretical probability Distributions: Binomial Distribution, Poisson Distribution. Normal Distribution, Exponential Distribution, Beta, Gamma
Module 2	**Sampling:** Sampling and sampling distribution: Probability samples, Non-probability Samples, sample Random sampling, other sampling schemes, sampling distribution and Standard error, some Sampling and Quality control. Use of concepts of standard deviation, Coefficient of variance, range in quality control of concreting and similar such activities.
Module 3	**Testing:** Testing Hypothesis: Sampling of distribution – Test based on Normal Distribution, Students test, chi-square, K-S test for goodness of fit and distribution. Analysis of variance one Way & two way classification.**Correlation Analysis:** Correlation types, co-efficient. Bi-variate Frequency Distribution, Scatter Diagram, Correlation Analysis, Practical applications in civil engineering projects. Regression Analysis: Regression and Multivariate Analysis, Multiple Regression Analysis Nonlinear Regression. Use of regression analysis in Construction Projects.
Module 4	**Simulation:** Simulation – Types, case studies in construction using simulation Techniques, simulation software‘s used. Griffi‘s waiting line Method, Concept of Downtime Cost of Equipment, Cox and Nunally Model, Failure Cost Profile (FCP), LID.**Applications:** Use of mathematical models based on probabilistic and statistical methods, Simulation in risk identification, analysis and mitigation of project risks. EOQ in civil Engineering, Sensitivity analysis, ABC analysis.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Applied Statistics and Probability for Engineers.	Montgomery and Runger	Wiley,India.	2004
2	Probability and Statistics for Engineers.	Miller	Freund-Hall, Prentice India Ltd.	2009
3	Applied Mathematics for Engineers and Physiscists.	pipes and Harvill.	McGraw Hill International Edition	1970
4	Statistics-Concepts and Controversies.	David S. Moore	Freeman Company, New York.	2002
5	Reliability Principles and practices	Calabro	McGraw Hill Book Company	1963

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

PROJECT RISK MANAGEMENT (PRM)

COURSE CODE	**23CE52G2**	MODE	6	LTPS	**3-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Identify the stages involved in a project and analyze the obligatory services to be taken up while performing a construction activity	2	PO2, PO4, PO11, PSO1
CO2	Cultivate an idea on effective resource utilization and identify factors affecting job productivity	2	PO2, PO4, PO11, PSO1
CO3	Apply the professional skills acquired in managing a construction project.	3	PO2, PO4, PO11, PSO1
CO4	Gain the ability to attain an equilibrium among Innovation, Technology and Economic feasibility	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Risk analysis:**General – Importance of Risk, types of risks, quantifiable and un-quantified risks. Micro, market, project level risk analysis approach. Risk analysis and Management for projects (RAMP) – Identifying risk events. Probability distribution. Stages in Investment, life-cycle; determination of NPV and its standard deviation for perfectly co-related, moderately co-related and un-correlated cash flows. Dealing with uncertainties.
Module 2	Sensitivity analysis, scenario analysis simulation, decision tree analysis, risk profile method, certainly equivalent method; risk adjusted discount rate method, certainty index method, point estimated method.
Module 3	Use of risk prompts, use of Risk Assessment tables, details of RAMP process, utility of Grading of construction entities for reliable risk assessment. Risk Mitigation – by elimination, reducing, transferring, avoiding, absorbing or pooling. Residual risk, mitigation of un-quantified risk.
Module 4	Coverage of risk through CIDC's MOU with the Actuarial Society of India through risk premium such as (BIP) – Bidding Indemnity Policy (DIMO) – Delay in meeting obligation by client policy, (SOC) – Settlement of claims policy (LOP)-Loss of profit policy (TI). Transit Insurance policy (LOPCE) Loss of performance of construction equipment policy.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Project Risk Analysis And	John Bartlett	APM Publishing Limited	2004

	Management Guide.			
2	Industrial Engineering And Management Of Manufacturing Systems.	Dr.Surendra Kumar Satya Prakashan	Tata Mcgraw Hill Publ.	2003
3	RAMP Handbook	Institution Of Civil Engineers And The Faculty .	Institution Of Civil Engineers And The Faculty And Institute Of Actuariesthomas Telford Publishing, London.	2001
4	Construction Project Management..	K. K. Chitkara	Tata Mcgraw Hill Publ.	1999
5	Construction Management Practice.	Dr.V.K.Raina	Shroff Publ.	2003

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

CHARACTERIZATION OF CONSTRUCTION MATERIALS (CCM)

COURSE CODE	**23CE52G3**	MODE	6	LTPS	**3-0-2-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding the Introduction to Construction Materials, Physical Properties of Construction Materials, Chemical and Mineralogical Composition	2	PO2, PO4, PO11, PSO1
CO2	Understanding the Testing and Evaluation Methods, Concrete and Cementitious Materials	2	PO2, PO4, PO11, PSO1
CO3	Understanding the Asphalt and Bituminous Materials, Metals and Metal Alloys	2	PO2, PO4, PO11, PSO1
CO4	Understanding the Wood and Timber Products, Other Construction Materials	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction to Construction Materials:** Overview of construction materials used in civil engineering, Properties and characteristics of construction materials, Factors influencing material selection for specific applications **Physical Properties of Construction Materials:** Mechanical properties (e.g., strength, elasticity, toughness) of construction materials , Thermal properties (e.g., thermal conductivity, thermal expansion) of construction materials, Durability and weathering characteristics of construction materials **Chemical and Mineralogical Composition:** Chemical composition of construction materials (e.g., cement, aggregates), Mineralogical composition and its impact on material properties, Use of chemical tests and analysis techniques for material characterization
Module 2	**Testing and Evaluation Methods:** Sampling and specimen preparation for material testing, Mechanical testing methods (e.g., compression, tension, bending), Non-destructive testing techniques (e.g., ultrasonic testing, radiography), Chemical analysis and spectroscopic techniques for material characterization **Concrete and Cementitious Materials:** Properties and composition of concrete materials (e.g., cement, aggregates, admixtures), Concrete testing methods (e.g., slump test, compressive strength test), Microstructure analysis of concrete and cementitious materials
Module 3	**Asphalt and Bituminous Materials:** Properties and composition of asphalt and bituminous materials Asphalt mixture design and performance testing, Analysis of asphalt binder properties (e.g., penetration, viscosity, softening point) **Metals and Metal Alloys:** Properties and characteristics of metals used in construction (e.g., steel,

	aluminum), Metal testing methods (e.g., tensile test, hardness test), Microstructure analysis of metals and metal alloys
Module 4	**Wood and Timber Products:** Properties and characteristics of wood and timber, Wood moisture content and dimensional stability, Testing methods for wood strength and durability **Other Construction Materials:** Characterization of other construction materials such as polymers, composites, and ceramics, Properties, testing methods, and analysis techniques specific to these materials

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Characterization of Materials	E. M. Callister Jr. and D. G. Rethwisch	John Wiley & Sons	
2	Construction Materials: Their Nature and Behaviour	Peter Domone and J. M. Illston	Spon Press	
3	Characterization of Building Materials	Manfred A. Hirt and Reiner G. Schroff	John Wiley & Sons	
4	Concrete Microstructure, Properties, and Materials	P. Kumar Mehta and Paulo J. M. Monteiro	McGraw-Hill Education	
5	Introduction to Construction Materials	Adrian Cooper	Palgrave Macmillan	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignment	7	
	Practical Continues Evaluation	5	20
In-Sem Summative	In sem 1	16	
	In sem 2	16	
	Practical In sem	8	40
End-Sem Summative	End sem Exam (Paper Based)	32	
	Lab End sem Exam	8	40

EMERGING CONSTRUCTION TECHNOLOGIES (ECT)

COURSE CODE	**23CE52H1**	MODE	6	LTPS	**3-0-0-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the modern construction techniques used in the sub structure construction	2	PO2, PO4, PO11, PSO1
CO2	Understand the concepts used in the construction of special structures	2	PO2, PO4, PO11, PSO1
CO3	Apply mechanism/technique for strengthening and repair methods for different cases.	3	PO2, PO4, PO11, PSO1
CO4	Demonstrate knowledge and understanding of the principles and concepts relevant to super structure construction for buildings	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	GFRC Facade Panels System, Prefabricated Building, Vertical ICF Wall, Mechanical Concrete, Filterpave systems, FRP Rebar, FRP Deck: Rehabilitation of a Steel Truss Bridge, Concrete Lumber, Bone-shaped Short Fiber Composite, Slurry Infiltrated Mat Concrete, Alternative Material Dowel Bars for Rigid Pavement Joints, Snap Joint Technology for Composite Structures, Superpave System,
Module 2	Modular FRP Composite Bridge Deck, Composite Column Reinforcement, Rapid In situ Load Testing, Carbon Fiber Reinforced Polymer (CFRP), Polymer Concrete Pipes, Use of Composite Piping Offshore, Recycled Plastic Composite Railroad Ties. High Performance Steel (HPS), Embedded Galvanic Anodes, DIS Seismic Isolator, Hydraulic Vibratory Pile Driver, Soft Trencher, Deep Mixing Method for Ground Improvement, Mortar less Concrete Block System, Post-tensioned Steel Structure
Module 3	Attachment of Steel Decking using Mechanical Fasteners and Powder Actuated or Pneumatic Tools, Seismic Isolation Bearings, Bridge Lock-up Device System, Adjustable Steelwork Connectors, Precast Hybrid Moment Resistant Frames, Precast Concrete Beam to Column System (BSF).Low Temperature Concrete Admixture, Use of Recycled Tire Rubber in Concrete, Steel Free Concrete Bridge Deck, Rapid Repair Products, Concrete Restoration & Protection System, Precast Inverted T Beam,.
Module 4	Conductive Concrete, Smart Concrete.Rapid Drying Concrete, Rapid-1 Hardening Accelerator Concrete Admixture, Reactive Powder Concrete, Mellose non-dispersible Underwater Concrete, Segment Precast Floating Draw Span, Self-Placing Concrete, Shrinkage Reducing Admixture for Concrete, Corrosion Inhibitors for Reinforced Concrete, High Performance Concrete(HPC).

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Precast concrete - Materials, Manufacture Properties and Usage.	Levitt. M	Applied Science Publs	1982
2	Pre-cast concrete Production.	Richardson,J.G.	Cement and Concrete Association, London	1973
3	Modern Trends in Housing in Developing Countries,	MadhavaRao.A-G	Oxford & UBH Publishing co.,	1985
4	Building with Large Pre-fabrications.	Lewicki.B.	Elsevier Publishers.	2001
5	Large Panel Prefabricated Constructions	SERC	SERC, Madras.	2005

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	
	Home Assignment	10	
			20
In-Sem Summative	In sem 1	20	
	In sem 2	20	
			40
End-Sem Summative	End sem Exam (Paper Based)	40	
			40

RESOURCE MANAGEMENT AND CONTROL IN CONSTRUCTION (RMCC)

COURSE CODE	**23CE52H2**	MODE	6	LTPS	**3-0-0-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand overview of the resource planning and management of resources in construction	**2**	PO2, PO4, PO11, PSO1
CO2	Understand in detail about the labor management and optimization	**2**	PO2, PO4, PO11, PSO1
CO3	Understand equipment management and effective utilization of the material resources	**2**	PO2, PO4, PO11, PSO1
CO4	Understand detail about the allocation and levelling of resources with time management	**2**	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Resource Planning:** Resource Planning, Procurement, Identification, Personnel, Planning for material, Labor, time schedule and cost control, Types of resources, manpower, Equipment, Material, Money, Time.
Module 2	**Labor Management:** Systems approach, Characteristics of resources, Utilization, measurement of actual resources required, Tools for measurement of resources, Labor, Classes of Labor, Cost of Labor, Labor schedule, optimum use Labor.
Module 3	**Materials and Equipment:** Material: Time of purchase, quantity of material, sources, Transportation, Delivery and Distribution. Equipment: Planning and selecting by optimistic choice with respect to cost, Time, Source and handling.
Module 4	**Time Management, Resource Allocation and Leveling:** Personnel time, Management and planning, managing time on the project, forecasting the future, Critical path measuring the changes and their effects – Cash flow and cost control. Time-cost trade off, Computer application – Resource leveling, resource list, resource allocation, Resource loading, Cumulative cost – Value Management.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Hand Book of Engineering Management.	Andrew,D., Szilagg,	McGrew Hill	1982

2	Project Management using Micro Computers	Harvey, A., Levine	McGraw Hill C.A.Publishing Co., Inc. 1988.Industry, Granda Publishing Ltd.,	1980
3	Quantitative Methods in Construction Management, 1973.	James.A.,Adrain	American Elsevier Publishing Co., Inc.,	1973
4	Management Techniques applied to the Construction Industry	Oxley Rand Poslcit	Granda Publishing Ltd	2001
5	Hand Book of Engineering Management.	Andrew,D.Szilagg,	Elsevier Publishing	1982

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	
	Home Assignment	10	
			20
In-Sem Summative	In sem 1	20	
	In sem 2	20	
			40
End-Sem Summative	End sem Exam (Paper Based)	40	
			40

Principles of Construction Management (PCM)

COURSE CODE	23CE53H3	MODE	6	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding the Introduction to Construction Management, Construction Project Planning and Scheduling, Construction Cost Estimation and Budgeting	2	PO2, PO4, PO11, PSO1
CO2	Understanding the Construction Contracts and Legal Aspects, Construction Safety and Risk Management	2	PO2, PO4, PO11, PSO1
CO3	Understanding the Construction Quality Management, Construction Equipment and Methods, Construction Project Organization and Team Management	2	PO2, PO4, PO11, PSO1
CO4	Understanding the Construction Project Execution and Control, Sustainable Construction Practices, Case Studies and Project Management Software	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction to Construction Management:** Overview of the construction industry and its stakeholders, Roles and responsibilities of a construction manager, Construction management principles and processes **Construction Project Planning and Scheduling:** Project initiation and feasibility studies, Project planning techniques (e.g., Work Breakdown Structure, Critical Path Method), Construction project scheduling and resource allocation **Construction Cost Estimation and Budgeting:** Cost estimation methods for construction projects, Quantity takeoff and cost analysis, Construction project budgeting and cost control
Module 2	**Construction Contracts and Legal Aspects:** Types of construction contracts (e.g., lump sum, cost-plus, design-build), Contract documents and administration, Legal aspects and disputes in construction projects **Construction Safety and Risk Management:** Occupational safety and health in construction, Risk assessment and mitigation strategies, Insurance and bonding in construction projects
Module 3	**Construction Quality Management:** Quality standards and processes in construction, Quality control and assurance in construction projects, Quality management systems and continuous improvement **Construction Equipment and Methods:** Selection and procurement of construction equipment, Equipment productivity and cost analysis, Construction methods and techniques **Construction Project Organization and Team Management:**

	Organizational structure in construction projects, Roles and responsibilities of project team members, Communication and collaboration in construction project teams
Module 4	**Construction Project Execution and Control:** Construction project mobilization and site management, Construction progress monitoring and control, Change management and project documentation **Sustainable Construction Practices:** Principles of sustainable construction, Green building concepts and certifications, Integration of sustainability in construction management processes **Case Studies and Project Management Software:** Analysis of real-world construction projects, Use of project management software (e.g., Primavera, Microsoft Project), Application of principles and techniques learned in class

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Construction Management: Principles and Practice	Chris March and William J. Palmer	Wiley	
2	Construction Management: Subcontractor Scopes of Work	Jason G. Smith	CRC Press	
3	Construction Management JumpStart: The Best First Step Toward a Career in Construction Management	Barbara J. Jackson	Wiley	
4	Construction Management Fundamentals	Clifford J. Schexnayder, Richard Mayo, and R. Larry Reynolds	McGraw-Hill Education	
5	Modern Construction Management	Frank Harris and Ronald McCaffer	Wiley-Blackwell	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	
	Home Assignment	10	
			20
In-Sem Summative	In sem 1	20	
	In sem 2	20	
			40
End-Sem Summative	End sem Exam (Paper Based)	40	
			40

QUALITY MANAGEMENT AND SAFETY MANAGEMENT SYSTEMS IN CONSTRUCTION (QMSMSC)

COURSE CODE	**23CE52S1**	MODE	6	LTPS	**3-0-0-0**	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the concepts of quality management and the factors influencing construction quality	**2**	PO2, PO4, PO11, PSO1
CO2	Understand quality planning and programs in construction industry	**2**	PO2, PO4, PO11, PSO1
CO3	Acquire knowledge of quality management systems and ISO 9000 family of standards.	**2**	PO2, PO4, PO11, PSO1
CO4	Understand and analyses quality circle (QC) concepts for possible implementation to solve construction productivity and quality problems	**3**	PO2, PO4, PO11, PSO1
CO5	Understand and evaluate safety management principles in construction	**5**	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Quality Management:** Introduction – Definitions and objectives – Factors influencing construction quality –Responsibilities and authority – Quality plan – Quality Management Guidelines – Quality circles.**Quality Systems:** Introduction - Quality system standard – ISO 9000 family of standards – Requirements – Preparing Quality System Documents – Quality related training – Implementing a Quality system – Third party Certification.
Module 2	**Quality Planning:** Quality Policy, Objectives and methods in Construction industry - Consumers satisfaction, Ergonomics - Time of Completion - Statistical tolerance – Taguchi's concept of quality – Codes and Standards – Documents – Contract and construction programming – Inspection procedures -Processes and products – Total QA / QC programmed and cost implication.
Module 3	**Quality Assurance And Quality Improvement Techniques:** Objectives – Regularity agent, owner, design, contract and construction oriented objectives, methods – Techniques and needs of QA/QC – Different aspects of quality – Appraisals, Factors influencing construction quality – Critical, major failure aspects and failure mode analysis, –Stability methods and tools, optimum design – Reliability testing, Reliability coefficient and reliability prediction - Life cycle costing – Value engineering and value analysis. Quality Improvement Tools and Techniques.
Module 4	**Safety Management Systems:** Fundamental of safety management, construction safety, safety in scaffolding and working platform, welding and handling, excavation work, concreting and cementing work. Building construction, TAC and NBC rules, High rise building. Evolution of modern safety concept- Safety policy

	- Safety Organization. Safety survey, safety inspection, safety sampling, Safety Audit. Concept of an accident, Reportable and non reportable accidents, unsafe act and condition principles of accident prevention, Overall accident investigation process. Risk management

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	A Comprehensive Guide to Registration, Audit Guidelines and Successful Certification.	Hutchins.G	Viva Books Pvt. Ltd.	1994
2	Construction Inspection Handbook – Total Quality Management.	James, J.O' Brian	Van Nostrand	1997
3	The Management of Quality in Construction,	John L. Ashford	E &F.N.Spon.	1989
4	Quality Planning and Analysis.	Juran Frank, J.M. and Gryna, F.M.	McGraw Hill	2001
5	Fundamentals of Construction Management.	Kwaku.A., Tena, Jose, M. Guevara,	McGraw Hill	2001

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	
	Home Assignment	10	
			20
In-Sem Summative	In sem 1	20	
	In sem 2	20	
			40
End-Sem Summative	End sem Exam (Paper Based)	40	
			40

AI in Civil Engineering (AICE)

COURSE CODE	23CE52R2	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply the basic operations and data modifications in python	1,2,5	3
CO2	Apply the regression analysis on thegiven data	1,2,5	3
CO3	Apply some basic machine learningtechniques on given data	1,2,5	3
CO4	Understand the deep learning concepts	1,2,5	2

Syllabus

Module 1	**Python for AI-ML:** Python Basics, Datatypes and Operators, Conditional Statements, Loops, Standard Libraries, Built-in Functions, Scope of Variables, OOPS, Data Pre-processing, Data Manipulation, Data Visualization
Module 2	**Predictive Analytics:** Descriptive statistics and Inferential Statistics, exploratory data analysis, Linear & Non – Linear Regression, Logistic Regression, Multiple Linear Regression.
Module 3	**Machine Learning:** Introduction to Machine Learning, Supervised Learning - Decision Tree, Random Forest, Naive Bayes, KNN, SVM, Model Selection and Boosting. Unsupervised Learning, Dimensionality Reduction, Principal Component Analysis, Time Series Analysis.
Module 4	**Deep Learning**: Introduction to Deep Learning, Perceptron, Single Layer Perceptron, Multilayer Perceptron. Artificial Neural Networks, PNN, GA and Fuzzy neural networks

Reference Books:

Sl No	Title	Author(s)	Edition	Publisher
1	Machine Learning Using Python	Pradhan Manaranjan,		Wiley India Pvt. Ltd.

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	
	Home Assignments	10	20
In-Sem Summative	In-Sem 1	20	
	In-Sem 2	20	40
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

M.Tech - Structural Engineering

Structural Dynamics (SD)

COURSE CODE	**23CE5103**	MODE	R	LTPS	**2-0-2-4**	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Solve response of free and forced vibrations	3	PO2, PO4, PO11, PSO1
CO2	Solve response to Arbitrary, Step and Pulse Excitations (SDOF)	3	PO2, PO4, PO11, PSO1
CO3	Solve Earthquake Response of Linear Systems (SDOF)	3	PO2, PO4, PO11, PSO1
CO4	Build Generalized Single Degree of Freedom Systems	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Equation of Motions**, Problem Statement, Solution Methods of Single Degree of Freedom Systems (SDOF): Basic concepts of structural dynamics; single degree of freedom system, force displacement relationship, damping force, equation of motion, mass-spring-damper system, methods of solution of differential equation. Free Vibration (SDoF): Undamped free vibration, viscously damped free vibration, energy in free vibration. Response to Harmonic and Periodic Excitations (SDoF): Harmonic vibration of undamped systems, Harmonic vibration with viscous damping, response to vibration generator, natural frequency and damping from harmonic test, force transmission and vibration isolation, vibration measuring instruments, energy dissipated in viscous damping. Response to periodic force.
Module 2	Response to Arbitrary, Step and Pulse Excitations (SDoF): Response to unit impulse, response to arbitrary force, step force, ramp force, response to pulse excitations, solution methods, effects of viscous damping. Numerical Evaluation of Dynamic Response (SDoF): Time stepping methods, methods based on interpolation of excitation, central difference method, Newmark's method, stability and computational error, analysis of nonlinear response by Newmark's method.
Module 3	**Earthquake Response to Linear Systems (SDoF)** Earthquake excitation, equation of motion, response quantities, response history, response spectrum concept, deformation, pseudo-velocity and pseudo acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics, elastic design spectrum, comparison and distinction between design and response spectra. **Generalized Single Degree of Freedom Systems**: Generalized SDoF systems, rigid body assemblages, systems with distributed mass and elasticity, lumped

	mass system-shear building, natural vibration frequency by Rayleigh's method.
Module 4	**Multi -degree of freedom systems (MDoF):** Equation of motions: simple system-two storey shear building, general approach for linear systems, static condensation, and symmetric plan systems: ground motion. Multiple support excitation, methods of solving the equation of motions. Free Vibration (MDoF): Natural frequencies and modes: systems without damping, modal and spectral matrices, orthogonality of modes, normalization of modes. Solution of undamped free vibration systems, solution methods for eigenvalue problem.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Dynamics of structures	Anil K Chopra;	Prentice-Hall of India Limited, New Delhi	3rd edition 2006.
2	Dynamics of Structures	R.W. Clough and P.E. Penzien,	McGraw-Hill.	1st edition 1975
3	Structural Dynamics for Structural Engineers	G. C. Hart & K. Wang	John Wiley & Sons.	1st edition 1991
4	Structural Dynamics	Mario Paz,	CBS Publishers	1st edition 1991

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Special concretes and admixtures (ACT)

COURSE CODE	**23CE5104**	MODE	R	LTPS	**3-0-2-0**	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding about Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design.	2	PO2, PO4, PO11, PSO1
CO2	Understanding about Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers	2	PO2, PO4, PO11, PSO1
CO3	Understanding about Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting	2	PO2, PO4, PO11, PSO1
CO4	Understanding about Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.	2	PO2, PO4, PO11, PSO1
CO5	To apply the knowledge on concrete to live situations	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	Understanding about Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design.
Module 2	Understanding about Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers
Module 3	Understanding about Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting
Module 4	Understanding about Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.
Module 5	To apply the knowledge on concrete to live situations

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Concrete Technology,	Santha kumar, A.R.	Oxford University press, New Delhi	2007
2	Concrete Technology	Gambhir, M.L.	Tata McGraw Hill Book Co. Ltd. Delhi,	2004
3	Properties of Concrete	Neville, A.M.	Longman,	1995

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Advanced pre-stressed concrete (APC)

COURSE CODE	**23CE5105**	MODE	R	LTPS	**3-0-2-0**	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding about Fly Ash, Ground Granulated Blast Furnace Slag, Silica Fume, Metakaolin, Red mud, Bentonite, Concrete Mix Design.	2	PO2, PO4, PO11, PSO1
CO2	Understanding about Nano Materials in Concrete, Water Proofing, Chemical Admixture in Concrete (Super Plasticizers, Retarders, & Accelerators), Fibers, Polymers	2	PO2, PO4, PO11, PSO1
CO3	Understanding about Mass Concreting, Roller Compacted Concreting, Pumped Concreting, Sprayed Concreting, Self-Compacted Concreting, Re-Cycled Aggregate Concreting	2	PO2, PO4, PO11, PSO1
CO4	Understanding about Corrosion of Reinforcing Steel, Chloride Ion Penetration, Carbonation, Service Life of RC Structures, Sulphate Attack, Alkali Silica Reaction, Acid Attack.	2	PO2, PO4, PO11, PSO1
CO5	To apply the knowledge on concrete to live situations	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**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.
Module 2	**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 un-cracked 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.
Module 3	**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.
Module 4	**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.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Pre-stressed Concrete Structures"	Collins and Mitchell	Collins and Mitchell Prentice Hall	2015
2	"Pre-stressed Concrete Design to Eurocodes	Prab Bhatt and Thomas J. MacGinley	CRC Press	2015
3	Pre-stressed Concrete: Analysis and Design, Third Edition "	Antoine E. Naaman	Third Edition Taylor & Francis	2019
4	Design of Prestressed Concrete Structures	T.Y. Lin and Ned H. Burns	Wiley	2020
5	Pre-stressed Concrete Bridges: Design and Construction"	Nigel Hewson	ICE Publishing	2020
6	Pre-stressed Concrete: Basics and Applications	N.K. Bairagi and Alok Jakhmola	CRC Press	2020

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20

In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Finite Element Analysis for structural engineering (FEA)

COURSE CODE	**23CE5106**	MODE	R	LTPS	**3-0-2-0**	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the Basic Finite Element Concepts	2	PO2, PO4, PO11, PSO1
CO2	Analysis of Trusses, Beam Bending, Structural Frames and Column buckling using Finite Element Methods	3	PO2, PO4, PO11, PSO1
CO3	Analysis of Higher order elements for one dimensional problems and Isometric quadrilateral elements and triangular elements	3	PO2, PO4, PO11, PSO1
CO4	Analyse the applications based on general two-dimensional boundary value problem	3	PO2, PO4, PO11, PSO1
CO5	Demonstrate the ANSYS software to develop the models using Finite element method	4	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Basic Finite Element Concepts,** Approximate solution of boundary value problems- Methods of weighted residuals, Modified Galerkin method, Boundary conditions and general comments, Two dimensional example, Basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using modified Galerkin method, Application: Axial deformation of bars.
Module 2	**Analysis of Trusses, Beam Bending, Analysis of Structural Frames,** Two dimensional truss element, three dimensional space truss element, Governing differential equation for beam bending, two node beam element, exact solution of uniform beams subjected to distributed loads using superposition, Calculation of stresses in beams, Plane frame element, Thermal stresses in frames, three dimensional space frame element.
Module 3	**Higher order elements for one dimensional problems,** Shape functions for second order problems, Iso parametric mapping concept, Quadratic Iso parametric element for general one dimensional boundary value problem, one dimensional numerical integration, Two dimensional boundary value problems using triangular elements, A triangular element for general 2D BVP, Numerical Examples **Isometric quadrilateral elements and triangular elements,** Shape functions for rectangular elements, Iso parametric mapping for quadrilateral elements, and Numerical integration for quadrilateral elements, four node quadrilateral element for 2D BVP, and Eight node serendipity element for 2D BVP, Natural

	(or Area) coordinates for triangles, Numerical integration for triangles, Six node triangular element for general 2D BVP
Module 4	**Applications based on general two dimensional boundary value problem,** Torsion of 2 prismatic bars, Two dimensional elasticity, Governing differential equations, Constant strain triangular element, Four node quadrilateral element, Eight node Iso parametric element. Axisymmetric Solids, Three-Dimensional Solids

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Fundamental Finite Element Analysis and Applications: With Mathematica and MATLAB Computations,	Bhatti, M.A	John Wiley & Sons	2005
2	Finite Element Analysis	Abel and Desai,	New Age. Publishers	2007
3	Finite Element Analysis: Theory and Programming	C. S. Krishnamoorthy,	Tata McGraw-Hill,	2019
4	Finite Element Procedures in Engineering Analysis by K. J. Bathe, Prentice Hall Inc.,1996.	K. J. Bathe	Prentice Hall Inc.	1996
5	The Finite Element Method	by O.C. Zienkiewicz, and R.L.Taylor	McGraw – Hill	1987

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Bridge structural elements (BSE)

COURSE CODE	23CE5207	MODE	Regular	LTPS	2-0-2-0	PRE-REQUISITE	Nil

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understand the various types of bridges and their structural components.	2	PO2, PO4, PO11, PSO1
CO2	Apply the principles of statics and dynamics to the analysis of bridge structures.	3	PO2, PO4, PO11, PSO1
CO3	Analyse bridges to withstand the forces of gravity, wind, and traffic.	3	PO2, PO4, PO11, PSO1
CO4	Evaluate bridges to withstand the forces of gravity, wind, and traffic.	3	PO2, PO4, PO11, PSO1
CO5	Design bridges to withstand the forces of gravity, wind, and traffic.	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	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.
Module 2	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;
Module 3	Design of elastomeric pad bearing. Foundations For Bridges: scour at abutments and piers; Grip length; Types of foundations; Design of well foundation.
Module 4	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.

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Bridge Engineering	Ponnu Swamy	Tata McGraw-Hill	2008
2	Design of Bridge Structures	T. R Jagadeesh and M.A. Jayaram	Wiley	2009

3	Essentials of Bridge Engineering	Johanson Victor	Oxford & IBH Publishing Co. Pvt. Ltd.	2018
4	Bridge Engineering - Substructure Design	Wai-Fah Chen Lian Duan	CRC PR E S S	2003
5	Cable Supported Bridges: Concept and Design	Niels J. Gimsing, Christos T. Georgakis	Oxford & IBH Publishing Company	2009

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

PRE-ENGINEERED STRUCTURES (PS)

COURSE CODE	23CE51A1	MODE	Regular	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Introduction to PES	2	PO2, PO4, PO11, PSO1
CO2	Design Of Industrial Buildings And Shell Roofs	3	PO2, PO4, PO11, PSO1
CO3	Design Of Pre-Engineered Structures	3	PO2, PO4, PO11, PSO1
CO4	Applications & Practical Orientation	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction** Prefabricates classification, foundation, columns, beams, roof and floor panels, wall panels, clay units, box prefabricates, erection and assembly. Design of prefabricated elements, Lift points beams, slabs, columns, wall panels, footings, design of joints to transfer axial forces, moments and shear forces.
Module 2	**Design Of Industrial Buildings And Shell Roofs** Components of single-storey industrial sheds with crane gantry systems, Design of R.C. Roof Trusses, Roof Panels, Design of R.C. crane-gantry girders, corbels and columns, wind bracing design. Cylindrical, Folded plate and hyper-prefabricated shells, Erection and jointing, joint design, hand book based design
Module 3	**Design Of Pre-Engineered Structures** Introduction-section specification-Types of assemblies –analysis and design of pre-engineered structure connection details
Module 4	**Applications & Practical Orientation** Designing and detailing of precast unit for factory structures, purlins, principal rafters, roof trusses, lattice girders, gable frames, singe span single storied simple frames, single storied buildings, slabs, beams and columns

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Knowledge Based Process Planning for Construction and Manufacturing	Gerostiza. C.Z., Hendrikson, C., Rehat D.R.	Academic Press, Inc.	2002

2	Building with Large Prefabricates	Lewicki B	Elsevier Publishing Company, Amsterdam / London / Newyork, 1966.	1996
3	Manual of Precast Concrete Construction	Koncz.T.	Vol.I II, III and IV, Berlin	1971
4	Prefabricated Concrete for Industrial and Public Structures	Mokk L	Publishing house of Hungarian Academy of sciences, Budapest	2000

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Design of offshore Structures (DOS)

COURSE CODE	23CE51A2	MODE	Regular	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Analysis of Wave theories	3	PO2, PO4, PO11, PSO1
CO2	Analysis Forces of offshore structures	3	PO2, PO4, PO11, PSO1
CO3	Design of offshore structure & Analysis of offshore structures	3	PO2, PO4, PO11, PSO1
CO4	Design of offshore structures	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Wave Theories:** Wave generation process, small and finite amplitude wave theories.
Module 2	**Forces of Offshore Structures:** Wind forces, wave forces on vertical, inclined cylinders, structures - current forces and use of Morison equation.
Module 3	**Offshore Soil and Structure Modelling:** Different types of offshore structures, foundation modelling, structural modelling.
Module 4	**Analysis of Offshore Structures:** Static method of analysis, foundation analysis and dynamics of offshore structures. **Design of Offshore Structures:** Design of platforms, helipads, Jacket tower and mooring cables and pipelines

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Offshore Structural Engineering	Dawson.T.H.,	Prentice Hall Inc Englewood Cliffs, N.J.	1983
2	Hydrodynamics of Offshore Structures	Chakrabarti, S.K	Computational Mechanics Publications	1987
3	Dynamic Analysis of Offshore Structures	Brebia, C.A and Walker, S	New Butterworths,	2000

	.		U.K.	
4	“Offshore Structures”,	Reddy, D.V. and Arockiasamy, M.,	Vol.1 and Vol.2, Krieger Publishing Company, Florida	1991

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

THEORY OF PLATES AND SHELLS (TPS)

COURSE CODE	23CE51A3	MODE	Regular	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Derive the pure bending and curvature of plates	3	PO2, PO4, PO11, PSO1
CO2	Derive the differential equation for laterally loaded rectangular plates	3	PO2, PO4, PO11, PSO1
CO3	Derive the deformation of shells without bending	3	PO2, PO4, PO11, PSO1
CO4	Understand the general theory of Cylindrical shells	2	PO2, PO4, PO11, PSO1
CO5	Derive the pure bending and curvature of plates	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction:** Assumptions in the theory of thin plates – Pure bending of Plates – Relations between bending moments and curvature - Cases of pure bending of rectangular plates, Cylindrical bending - immovable simply supported edges – Synclastic bending and Anticlastic bending – Strain energy in pure bending of plates in Cartesian and polar co-ordinates – Limitations. **Laterally Loaded Circular Plates:** Differential equation of equilibrium – Uniformly loaded circular plates with simply supported and fixed boundary conditions – Annular plate with uniform moment and shear force along the boundaries.
Module 2	**Laterally Loaded Rectangular Plates:** Differential equation of plates – Boundary conditions – Navier solution for simply supported plates subjected to uniformly distributed load and point load – Levy's method of solution for plates having two opposite edges simply supported with various symmetrical boundary conditions along the other two edges loaded with u. d. l. – Simply supported plates with moments distributed along the edges - Approximate Methods. Effect of transverse shear deformation - plates of variable thickness – Anisotropic plates-thick plates-orthotropic plates and grids - Large Deflection theory.
Module 3	**Deformation of Shells without Bending:** Definitions and notation, shells in the form of a surface of revolution, displacements, unsymmetrical loading, spherical shell supported at isolated points, membrane theory of cylindrical shells, the use of stress function in calculating membrane forces of shells.
Module 4	**General Theory of Cylindrical Shells:** A circular cylindrical shell loaded symmetrically with respect to its axis, symmetrical deformation, pressure vessels, cylindrical tanks, thermal stresses, in extensional deformation, general case of

	deformation, cylindrical shells with supported edges, approximate investigation of the bending of cylindrical shells, the use of a strain and stress function, stress analysis of cylindrical roof shells.

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Theory of Plates and Shells	S.P Timoshenko and S.W Krieger	McGraw Hill.	1989
2	Theory and Analysis of Plates – Classical Numerical Methods	R. Szilard	Prentice Hall inc,	1974
3	Analysis of Shells and Plates,	P.L Gould	Springer-Verlag, New York	1988

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Design & Detailing of Structures (DDS)

COURSE CODE	23CE51B1	MODE	Regular	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Analysis, design and detailing of flat slab, grid slab	3	PO2, PO4, PO11, PSO1
CO2	Design and detailing of Elevated water tanks, cantilever and counterfort retaining walls	3	PO2, PO4, PO11, PSO1
CO3	Earthquake resistant design, Ductile detailing	3	PO2, PO4, PO11, PSO1
CO4	Analysis, design and detailing of flat slab, grid slab	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction:** Design and detailing of Continuous beam, slab, column and footing as per IS code provisions**.** Detailed design and drawing of portal frames, Design example for hinged and fixed frame.
Module 2	**Elevated water tanks:** Introduction, Analysis & Design and detailing of INTZ Tanks including staging and continuous deep beams.
Module 3	**Analysis, design and detailing** of flat slab, grid slab as per IS code provisions, cantilever and counterfort retaining walls as per IS code provisions.
Module 4	**Earthquake resistant design:** Concept of Earthquake resistant design, provisions of seismic code IS 1893 (Part-I), Design of buildings, Reinforcement detailing, Provisions of IS 13920 for ductile detailing

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Structural Concrete: Theory and Design	M. Nadim Hassoun and Akthem Al-Manaseer	Wiley	1998
2	Design of Concrete Structures	Arthur H. Nilson, David Darwin, and Charles W. Dolan	McGraw-Hill Education	2001
3	Design of Steel Structures	Edwin H. Gaylord, Charles N. Gaylord, and James E. Stallmeyer	McGraw-Hill Education	2000

4	Structural Analysis and Design of Tall Buildings: Steel and Composite Construction" by Bungale S. Taranath (CRC Press) "	Bungale S. Taranath	CRC Press	2000
5	Design of Prestressed Concrete Structures	T.Y. Lin and Ned H. Burns	Wiley	2002

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Repair and Rehabilitation of structures (RRS)

COURSE CODE	23CE51B2	MODE	Regular	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understand the concept of Deterioration of structures with aging, Need for rehabilitation	2	PO2, PO4, PO11, PSO1
CO2	Understand the damage level of structures affected due to seismic loads, Damage assessment and evaluation models	2	PO2, PO4, PO11, PSO1
CO3	Understand procedure of rehabilitation methods like Grouting; Detailing; Imbalance of structural stability	2	PO2, PO4, PO11, PSO1
CO4	Understand the retrofitting methodology and procedure	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction** Deterioration of structures with aging, need for rehabilitation, Distress in concrete and steel structures, Types of damages, Sources or causes for damages, effects of damages, case studies.
Module 2	**Damage assessment and evaluation models** Damage testing methods, Non-destructive testing methods, Semi-destructive testing methods.
Module 3	**Rehabilitation methods** Grouting; Detailing; Imbalance of structural stability; Case studies **Methods of Repair** Shot-creting, Grouting, Epoxy cement mortar injection; Crack ceiling
Module 4	**Seismic Retrofitting of reinforced concrete buildings** Introduction, Considerations in retrofitting of structures, Source of weakness in RC frame building – Structural damage due to discontinuous load path, Structural damage due to lack of deformation, Quality of workmanship and materials, Classification of retrofitting techniques, Retrofitting strategies for RC buildings – Structural level (global) retrofit methods; Member level (local) retrofit methods; Comparative analysis of methods of retrofitting

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Diagnosis and treatment of structures in distress	RN Raikar	R&D Centre of Structural Designers	1994

			& Consultants Pvt.Ltd., Mumbai	
2	Handbook on Repair and Rehabilitation of RCC buildings	-	CPWD, Delhi	2002
3	Earthquake resistant design of structures	Pankaj Agarwal and Manish Shrikhande	Prentice-Hall of India	2006

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Structural Reliability (SR)

COURSE CODE	23CE51B3	MODE	Regular	LTPS	2-0-2-0	PRE-REQUISITE	Nil

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understanding the Partial safety factor based approach of basic design variables	2	PO2, PO4, PO11, PSO1
CO2	Understanding the Checking safety and economy at some selected locations on the failure boundaries (i.e. limit states) considering uncertainties.	2	PO2, PO4, PO11, PSO1
CO3	Understanding the Exact assessment of safety based on detailed probabilistic analysis of the structural systems as a whole	2	PO2, PO4, PO11, PSO1
CO4	Understanding the Mathematical treatment of stability problems	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction to Structural Reliability:** Importance and concepts of structural reliability, Basic terminology and definitions, Objectives of structural reliability analysis **Probability and Statistics:** Fundamentals of probability theory, Probability distributions and their properties, Statistical analysis and parameter estimation
Module 2	**Load and Resistance Models:** Uncertainties in loads and load models, Uncertainties in material properties and resistance models, Statistical characterization of loads and resistance **Limit State Functions:** Introduction to limit state functions, Failure modes and limit state equations, Reliability index and failure probability **First-Order Reliability Methods (FORM):** Reliability analysis using FORM, Sensitivity analysis and importance measures, Reliability-based design optimization **Second-Order Reliability Methods (SORM):** Reliability analysis using SORM, Importance sampling and Monte Carlo simulation, Advanced methods for reliability analysis
Module 3	**System Reliability:** Reliability analysis of complex structural systems, Series and parallel systems, System redundancy and importance measures **Time-Dependent Reliability Analysis:** Modeling time-dependent factors in reliability analysis, Time-dependent failure modes and aging structures, Time-dependent reliability assessment methods

Module 4	**Reliability-Based Design Codes and Standards:** Overview of reliability-based design principles, Introduction to international design codes and standards, Reliability-based calibration of design codes **Applications and Case Studies:** Application of structural reliability analysis in engineering practice, Case studies on reliability analysis of various structural systems, Practical considerations and challenges in structural reliability analysis

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Structural Reliability Analysis and Prediction	Robert E. Melchers	Wiley	
2	Structural Reliability: Analysis and Prediction	A. H.-S. Ang and W. H. Tang	Wiley	
3	Structural Reliability Theory and Its Applications	Prasada Rao	CRC Press	
4	Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering	Alfredo H-S. Ang and Wilson H. Tang	Wiley	
5	Structural Reliability in Engineering Practice	P. Thoft-Christensen and J.D. Baker	CRC Press	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Fracture Mechanics (FM)

COURSE CODE	23CE51C1	MODE	Regular	LTPS	3-0-2-0	PRE-REQUISITE	Nil

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understanding the basic concepts of Fracture and Linear Elastic Fracture Mechanics (LEFM)	2	PO2, PO4, PO11, PSO1
CO2	Understanding the concept of Crack Tip Plasticity	2	PO2, PO4, PO11, PSO1
CO3	Understanding the concept Elastic Plastic Fracture Mechanics (EPFM)	2	PO2, PO4, PO11, PSO1
CO4	Understanding the concept of Fatigue Crack Growth and practical problems of fracture mechanics	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction to fracture mechanics** of concrete Structural failure based on material performance; Concepts of linear elastic fracture mechanics; Fracture mechanics of concrete **Principles of linear elastic fracture mechanics,** Airy stress functions for problems in elasticity; Complex stress function; Elastic stress and displacement fields at crack tip; Stress intensity factors and crack opening displacements for useful geometries; Superposition of stress intensity factors; Plastic zone at crack tip; Griffith's fracture theory; Strain energy release rate for crack propagation; Relationship between stress intensity factor and strain energy release rate; Design based on linear elastic fracture mechanics
Module 2	**Principles of non-linear fracture mechanics** energy principles for crack propagation in non-linear materials; J-integral for non- linear elastic materials; Fracture resistance (R curve); Crack tip opening displacement;
Module 3	**Structure and fracture process** of concrete constituents and microstructure of concrete; Fracture behaviour and strain localization of concrete; Fracture process zone and toughening mechanisms; Experimental determination of fracture zone; Influence of fracture process zone on fracture behaviour of concrete
Module 4	**Non-linear fracture mechanics** for Mode I Quasi-Brittle Fracture general description of quasi-brittle fracture; Fictitious approach – Energy dissipation for fictitious crack, Fictitious crack model by Bazant and Oh, Determination and influence of s (w) relationship, Some comments on fictitious crack approach; Effective elastic approach – Energy dissipation for effective-elastic crack, Two-parameter fracture model by Jenq and shah, Size effect model by Bazant and Kazemi, Effective crack model by Karihaloo and Nallathambi, Effective crack model by Refai and Swartz, Some comments on effective-elastic crack approach; Comparison between Fictitious and effective-elastic crack approaches; Finite

	element analysis – Discrete crack approach, Smeared crack approach.

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Fracture Mechanics of Concrete: Applications of Fracture Mechanics to Concrete, Rock and Other Quasi-Brittle Materials	Surendra P. Shah, Stuart E. Swartz, Chengsheng Ouyang,	Wiley	1995
2	Analysis of Concrete Structures by Fracture Mechanics	L. Elfgren,	Routledge	1990
3	Fracture mechanics – Applications to concrete	T.Victor C.Li and Z.P.Bazan	ACI SP118.	
4	Elements of fracture mechanics	Prashant Kumar	Wheeler Publishing	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Design of Tall Structures (DTS)

COURSE CODE	23CE51C2	MODE	Regular	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understanding the design criteria of Tall structures	2	PO2, PO4, PO11, PSO1
CO2	Understanding the Loadings On Tall Structures	2	PO2, PO4, PO11, PSO1
CO3	Understanding the behaviour of Rigid-Frame Structures and Shear Wall Structures	2	PO2, PO4, PO11, PSO1
CO4	Understanding the behaviour of Tubular Structures	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**INTRODUCTION**: Why Tall Buildings, Factors affecting growth, Height and structural form. The Tall Building Structure: Design process, Philosophy, scope and content. **DESIGN CRITERIA**: Design philosophy, Loading, Sequential loading, Strength and Stability, Stiffness and drift limitations, Human Comfort criteria, Creep, Shrinkage and temperature effects, Fire, Foundation settlement and soil structure interaction:
Module 2	**LOADING ON TALL STRUCTURES**: Gravity loading:-Methods of live load reduction, Impact gravity loading, Construction loading, Wind loading:-Simple static loading, Dynamic loading, Earthquake loading:-Equivalent lateral force procedure, Model analysis procedure, Combination of loading:-Working stress design, Limit Sate design. **STRUCTURAL FORM**: Structural form:-Braced frame structures, Rigid Frame structures, In filled-Frame structures, Flat plate- Flat slab structures, Shear wall structures, Wall frame structures, Framed tube structures, Suspended structures, Floor systems :-(Reinforced concrete):-One-way slabs on beams or walls, One-way pan joints and Beams, One-way slab on beams and girders, Two-way Flat plate, Two-way flat slab, Waffle flat slabs, Two-way slab and beam, Floor systems: - (Steel framing):-One-way beam system, Two-way beam system, Three way beam system, Composite Steel-Concrete floor system. **MODELING FOR ANALYSIS:** Approaches to analysis:-Preliminary analyses, Intermediate and final analysis, Assumptions:-

	Materials, Participating components, Floor slabs, Negligible stiffnesses, Negligible deformations, Cracking, High-Rise Behavior, Modeling for Approximate analyses:- Approximate Representation Bents, Approximate modeling of slabs, Modeling for continuum analyses, Modeling for Accurate analyses:-Plane frames, Plane shear walls, Three dimensional frame and wall structures, P-Delta effects, The assembled model.
Module 3	**BRACED FRAMES:** Types of bracings, Behavior of bracings, and Behavior of bracing bents, Methods of analysis:-member force analysis, Drift analysis, Worked example for calculating drift by approximate methods, use large scale bracing. **RIGID-FRAME STRUCTURES:** Rigid frame behavior, Approximate determination of member forces caused by Gravity loading:-Girder forces-Code recommended values, two cycle moment distribution, and Column forces, Approximate Analysis of member forces caused by horizontal loading:-Allocation of loading between bents, member force analysis by portal frame method, Approximate method by cantilever method, Approximate analysis of rigid frames with setbacks, Approximate analysis for drift:-Components of drift, correction of excessive drift, Effective shear rigidity (GA), Flat plate structures:-Analogues rigid frame, Worked examples, Computer analysis of rigid frames, Reduction of rigid frames for analysis:-Lumped girder frame, single- bay substite frame
Module 4	**SHEAR WALL STRUCTURES:** Behavior of shear wall structures, Analysis of proportionate wall systems:- Proportionate Non twisting structures, Proportionate twisting structures, Non Proportionate structures:- No proportionate Non twisting structures, Non proportionate twisting structures, Behavior of nonproportionate structures, Effects of discontinuities at base, Stress analysis of shear wall:-Membrane finite element analysis, Analogous frame analysis **TUBULAR STRUCTURES:** Structural behavior of tabular structures:-Framed- tube structures, Bundled Tube structures, Braced-Tube structures, General three dimensional structural analysis, Simplified Analytical models for symmetrical Tubular structures:-Reduction of three dimensional frame tube to an equivalent plane frame, Bundled-Tube structures, Diagonally braced frame tube structures **DYNAMIC ANALYSIS:** Dynamic Response to Wind Loading:-Sensivity of structures wind forces, Dynamic structural response due to wind forces, Along wind response, Cross wind response, worked examples, Dynamic response to Earthquake motions:-Response of Tall buildings to ground accelerations, response spectrum analysis, Empirical relations for fundamental natural frequency, Structural damping ratios, Comfort criteria: Human response to building motions:- Human perception of building motion, Perception thresholds,

	Use of comfort criteria in design

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Tall Building Structures Analysis and Design	Bryan Stafford Smith & Alex Coull	Wiley-Interscience Publications, Newyork	1991
2	Tall Building Structures on Elastic Subgrade and Research of Semi-Analytical.	Gong Yaoqing. Beijing	Tsinghua University	2006
3	ETAB,Three-Dimensional Analysis of Building Systems. Computers and Structures inc.,		Berkeley, California	1989

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	
	Home Assignments	7	
	Practical Continuous Evaluation	5	20
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Design Of Connections In Steel Structures (DCSS)

COURSE CODE	23CE51C3	MODE	Regular	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understand the fundamental mechanism of how different types of connections behave	3	PO2, PO4, PO11, PSO1
CO2	Analysis and design process accounts for the same	3	PO2, PO4, PO11, PSO1
CO3	solve examples of various types of steel connections	3	PO2, PO4, PO11, PSO1
CO4	simple connection, ordinary moment connections, ductile moment connections, connections in members subjected to axial forces, gusset plate design, etc.	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Introduction to Connections in Steel Structures:** Importance of connections in steel structures, Types of connections: bolted, welded, and combined connections, Behavior and design considerations for different connection types **Structural Steel Materials and Properties:** Properties of structural steel and their influence on connection design, Material selection and specification for steel connections, Bolt and weld materials and specifications
Module 2	**Bolts and Bolted Connections:** Types of bolts and their characteristics, Bolted connection behavior and design methods, Preloading, slip, and bearing resistance in bolted connections **Welded Connections:** Welding processes and techniques, Welded connection behavior and design considerations, Weld quality, strength, and fatigue considerations **Combined Connections:** Combined bolted and welded connections, Composite connections (steel-concrete), Behavior and design of composite connections
Module 3	**Connection Design Methods:** Design philosophies and codes for connection design, Limit states and design criteria for connections, Connection design in accordance with international design codes (e.g., AISC, Eurocode, etc.) **Connection Analysis and Load Transfer:** Analytical methods for connection analysis, Load transfer mechanisms in connections, Connection behavior under various loading conditions
Module 4	**Connection Design for Specific Steel Structures:** Connection design considerations for beams, columns, trusses, and bracing systems,

	Connection design in special structures (e.g., bridges, high-rise buildings, industrial structures, etc.) **Connection Testing and Quality Control:** Non-destructive testing of connections, Quality control and inspection of connections, Connection repair, retrofit, and strengthening techniques **Case Studies and Design Projects:** Analysis and design of practical connection problems, Case studies of real-world steel structures and their connection design

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Design of Steel Structures: Connections	Boris Androic and Darko Beg	Springer	
2	Design of Structural Connections: Eurocode 3: Design of Steel Structures - Part 1-8: Design of Joints	Jean-Pierre Jaspart, Klaus Weynand, and Jörg Lange	Wiley	
3	Structural Steelwork: Design to Limit State Theory	Dennis Lam, Thien Cheong Ang, and Sing-Ping Chiew	CRC Press	
4	Design of Bolted Steel Structures: Eurocode 3: Design of Steel Structures - Part 1-8: Design of Joints" by Alain Nussbaumer, Laurence Davaine, and Aurelio Ghersi (Wiley)	Alain Nussbaumer, Laurence Davaine, and Aurelio Ghersi	Wiley	
5	Designers' Guide to Eurocode 3: Design of Steel Buildings	Leroy Gardner, David A. Nethercot, and B. G. Neal	ICE Publishing	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	20
	Home Assignments	7	
	Practical Continuous Evaluation	5	
In-Sem Summative	In-Sem 1	16	40
	In-Sem 2	16	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	

Earthquake Resistant Design Of Structures (ERDS)

COURSE CODE	23CE51D 1	MODE	Regular	LTPS	3-0-0-0	PRE-REQUISITE	Nil

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understanding the designing of cable supported bridges.	2	PO2, PO4, PO11, PSO1
CO2	Understand the system of base isolation in structures for resistance towards earthquakes and general detailing requirements of ductile structure.	2	PO2, PO4, PO11, PSO1
CO3	Analyze a structure for earthquake forces onto the structure under static and dynamic behavior.	3	PO2, PO4, PO11, PSO1
CO4	Design the structure for earthquake forces on 2 – storey building	3	PO2, PO4, PO11, PSO1

Module 1	**Seismic-resistant buildings:** Introduction; 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, hyper stativity/redundancy,
Module 2	**Design forces for buildings:** Introduction, Equivalent static method; Mode superposition technique; Dynamic inelastic-time history analysis; Response Spectrum Analysis, Pushover analysis, advantages and disadvantages of these methods; Determination of lateral forces on an intermediate plane frame using Equivalent static method and Model analysis using response spectrum; Analysis of the intermediate frame for various load combinations as per IS1893(Part 1); Identification of design forces and moments in the members
Module 3	**Ductility considerations in earthquake resistant design of RCC buildings:** Introduction; Impact of ductility; Requirements for ductility; Assessment of ductility– Member/element ductility, Structural ductility; Factor affecting ductility; Ductility factors; Ductility considerations as per IS13920. Design and detailing of typical flexural member, typical column as per IS13920.
Module 4	**Shear Wall Design:** Introduction to Shear Walls, Types of shear walls, Design of shear wall for a Lateral Load resisting frame, Design of shear wall for multi storied structure. **Base isolation of structures:** Introduction; Considerations for seismic isolation; Basic elements of seismic isolation; seismic-isolation design principle; Feasibility of seismic isolation; Seismic-isolation configurations

Reference Books

S. No.	Title	Author(s)	Publisher	Year
1	Earthquake Resistant Design	Dr. Vinod Hosur	Wiley	2012

	of Building Structures .		Corporation	
2	Earthquake resistant design of structures	Pankaj Agarwal and Manish Shrikhande,	Prentice Hall of India	2006
3	Basics of structural dynamics and aseismic design	Damodaraswamy S.R and S. Kavitha	Prentice Hall India Learning Private Limited;	5th Edition (2009)
4	Seismic design of reinforced concrete and masonry buildings	T. Paulay and M.J.N. Priestley	John Wiley & Sons	1991

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	20
	Home Assignments	10	
In-Sem Summative	In-Sem 1	20	40
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

Stability of structures (SS)

COURSE CODE	23CE52D2	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Introduction to buckling of columns	2	PO2, PO4, PO11, PSO1
CO2	Analysis of lateral buckling of beams	3	PO2, PO4, PO11, PSO1
CO3	Analysis of lateral buckling of plates and shells	3	PO2, PO4, PO11, PSO1
CO4	Understanding the Mathematical treatment of stability problems	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	**Buckling of Columns:** Introduction; Methods of finding critical loads; Critical loads for straight columns with different end conditions and loading; Inelastic buckling of axially loaded columns; Energy methods; Prismatic and non-prismatic columns under discrete and distributed loading; General Principles of elastic 0stability of framed structures. **Buckling of thin walled members of open cross section:** Torsion of thin-walled bars; warping; Non-uniform torsion; Torsional buckling under axial loading; Combined bending and torsion buckling.
Module 2	**Lateral Buckling of Beams** Beams under pure bending; Cantilever and simply supported beams of rectangular and I- sections; Beams under transverse loading; Energy methods; Solution of simple problems.
Module 3	**Buckling of Rectangular Plates** Plates simply supported on all edges and subjected to constant compression in one or two directions; Plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides. **Buckling of Shells** Introduction to buckling of axially compressed cylindrical shells.

Module 4	**Mathematical treatment of stability problems** Discrete/Discontinuous systems; Eigen value problem; Converting continuous systems to discrete systems using the finite element method – Buckling of a column with sudden change in cross-section

Reference Books:

Sl No	Title	Author(s)	Publisher	Edition
1	Theory of elastic stability	Timoshenko & Gere	McGraw Hill	2000
2	Background to buckling by,.	Allen and Bulson	McGraw-Hill	1980
3	Elastic stability of structural elements by	N.G.R.Iyengar	Macmillan India Ltd	2007

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Leadership in Energy and Environmental Design (LEED)	U.S. Green Building Council (USGBC),	Y			
2	Building Research Establishment Environmental Assessment Method (BREEAM)	BREEAM is a widely adopted certification scheme originating in the United Kingdom	Y			

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Building Information Modeling (BIM):	architects, engineers, and construction professionals	
2	Energy Modeling Software		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	
	Home Assignments	10	20

In-Sem Summative	In-Sem 1	20	
	In-Sem 2	20	40
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

Soil Structure Interaction (SSI)

COURSE CODE	**23CE52D3**	**MODE**	**R**	**LTPS**	**3-0-0-0**	**PRE-REQUISITE**	**Nil**

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understand the different soil-structure interaction models for shallow foundation under various loading conditions and subgrade characteristics.	2	PO2, PO4, PO11, PSO1
CO2	Understand the Piles under uplift and lateral loading conditions will also be discussed.	2	PO2, PO4, PO11, PSO1
CO3	Understand the Beams and plates on elastic foundation problems & different foundation models and their solution	2	PO2, PO4, PO11, PSO1
CO4	Understand the Finite Difference Method (FDM) will be discussed. The application of foundation models in real life problems will also be discussed.	2	PO2, PO4, PO11, PSO1

Syllabus

Module 1	Bilonenko- Borodick, Pasternak; Elastic Continuum - plane strain, plane stress, Boussinesq's problem, line load strip load; Special models starting with elastic continuum - Vlazov, Reissner; Three parameter model - Kerr model; Evaluation of model parameters for different conditions.
Module 2	Beam on Winkler foundation: solutions for infinite and semi-infinite beams; Finite beams: method of initial parameters, method of superposition.
Module 3	Beams on Elastic continuum: Use of finite difference method, rigid and flexible beams, lift-off, nonhomogeneous soil, non-linear soil, plastic yielding of soil. Raft of Mat foundations: thin rectangular plates, approximate theory of plates, circular plates..
Module 4	Pile on Winkler foundation: Vertically loaded pile - rigid pile, evaluation of spring stiffness, non-homogeneous soil, compressible pile; Laterally loaded pile - rigid pile, Elastic pile, standard solutions for different end conditions; Pile on elastic continuum - vertically loaded piles - rigid pile

Reference Books:

Sl No	Title	Author(s)	**Publisher**	**Edition**
1	Analysis of Structures on Elastic Foundations. J. Ross Publishing	Tsudik, E.	Prentice Hall int.	2012
2	Dynamic soil-structure interaction.	Wolf, J. P.	Wiley.	1985
	Finite-element modelling of unbounded media. Chichester	Wolf, J. P., & Song, C.	Wiley.	1996
3	Geotechnical earthquake engineering (Vol. 80). Upper Saddle River, NJ	Kramer, S. L.	Prentice Hall.	1996

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Leadership in Energy and Environmental Design (LEED)	U.S. Green Building Council (USGBC),	Y			
2	Building Research Establishment Environmental Assessment Method (BREEAM)	BREEAM is a widely adopted certification scheme originating in the United Kingdom	Y			

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Building Information Modeling (BIM):	architects, engineers, and construction professionals	
2	Energy Modeling Software		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	
	Home Assignments	10	20
In-Sem	In-Sem 1	20	

Summative	In-Sem 2	20	40
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

Green Buildings (GB)

COURSE CODE	23CE52R1	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understand the environmental impact of building materials and systems and recommend sustainable alternatives.	2	PO2, PO4, PO11, PSO1
CO2	Apply principles of passive design and energy-efficient technologies to optimize building performance.	3	PO2, PO4, PO11, PSO1
CO3	Develop a comprehensive sustainability plan for a building project, incorporating site selection, energy efficiency, water conservation, and indoor environmental quality.	3	PO2, PO4, PO11, PSO1
CO4	Analyze the economic, social, and environmental benefits of green buildings and make a case for their adoption in various contexts.	3	PO2, PO4, PO11, PSO1

Syllabus

Module 1	Definition and principles of green building. History and evolution of green building, Benefits and challenges of green building, Global and regional green building rating systems
Module 2	Site selection and analysis. Sustainable site planning and design., Stormwater management and landscape design, Sustainable transportation and access.
Module 3	Passive design strategies. Energy-efficient HVAC systems, Building envelope and insulation, Renewable energy systems and technologies.
Module 4	Water conservation strategies and technologies. Indoor environmental quality and health, Daylighting and lighting design., Materials selection and indoor air quality.

Reference Books:

Sl No	Title	Author(s)	Edition	Publisher
1	Green Building: Principles and Practices in Residential and Commercial Construction	Adele Chang	1st Edition	CRC Press
2	Sustainable Construction: Green Building Design and Delivery	Charles J. Kibert	4th Edition	Wiley
3	Energy-Efficient Building Systems: Green Strategies for Operation and Maintenance	Liliana Beltran and William A. Rose	1st Edition	McGraw-Hill Education

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Leadership in Energy and Environmental Design (LEED)	U.S. Green Building Council (USGBC),	Y			
2	Building Research Establishment Environmental Assessment Method (BREEAM)	BREEAM is a widely adopted certification scheme originating in the United Kingdom	Y			

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Building Information Modeling (BIM):	architects, engineers, and construction professionals	
2	Energy Modeling Software		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	
	Home Assignments	10	20
In-Sem Summative	In-Sem 1	20	
	In-Sem 2	20	40

End-Sem Summative	End-Sem Exam (Paper Based)	40	40

AI in Civil Engineering (AICE)

COURSE CODE	**23CE52R2**	**MODE**	**R**	**LTPS**	**3-0-0-0**	**PRE-REQUISITE**	**Nil**

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply the basic operations and data modifications in python	1,2,5	3
CO2	Apply the regression analysis on thegiven data	1,2,5	3
CO3	Apply some basic machine learningtechniques on given data	1,2,5	3
CO4	Understand the deep learning concepts	1,2,5	2

Syllabus

Module 1	**Python for AI-ML:** Python Basics, Datatypes and Operators, Conditional Statements, Loops, Standard Libraries, Built-in Functions, Scope of Variables, OOPS, Data Pre-processing, Data Manipulation, Data Visualization
Module 2	**Predictive Analytics:** Descriptive statistics and Inferential Statistics, exploratory data analysis, Linear & Non – Linear Regression, Logistic Regression, Multiple Linear Regression.
Module 3	**Machine Learning:** Introduction to Machine Learning, Supervised Learning - Decision Tree, Random Forest, Naive Bayes, KNN, SVM, Model Selection and Boosting. Unsupervised Learning, Dimensionality Reduction, Principal Component Analysis, Time Series Analysis.
Module 4	**Deep Learning**: Introduction to Deep Learning, Perceptron, Single Layer Perceptron, Multilayer Perceptron.Artificial Neural Networks, PNN, GA and Fuzzy neural networks

Reference Books:

Sl No	Title	Author(s)	Edition	Publisher
1	Pradhan Manaranjan, Machine Learning Using Python, Wiley India Pvt. Ltd.			

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	
	Home Assignments	10	20
In-Sem Summative	In-Sem 1	20	
	In-Sem 2	20	40
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

M.Tech - Computer Science and Engineering

DISCRETE STRUCTURES AND MATRIX COMPUTATION

COURSE CODE	23MT5101	MODE	R	LTPS	2-2-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply Propositional logic and basic Relations and compare the Diagraphs and trigraphs	3	PO1
CO2	Analyse the Recurrence Relations, Posets and lattices	4	PO2
CO3	Analyse the Vector Multiplication, Elimination and positive defined Matrix	4	PO6, PO2
CO4	Apply the QR algorithm and Iterative Methods	4	PO2, PO6

Syllabus

Module 1	Basic Mathematical Structures-Sets, Functions, Relations, Matrices, Logic - Propositions and Logical Operations, Mathematical Induction, Relations and Digraphs-Paths in Relations and Digraphs, Computer Representation of Relations and Digraphs, Transitive Closure and Warshall's Algorithm.
Module 2	Recurrence Relations - Solving Recurrence Relations, Pigeon-hole problem, Posets-chains, anti-chains, topological sort, applications to (parallel) task scheduling, Lattices, Counting Techniques-, Principle, Graph Theory: Eulerian Graphs, Bipartite Graph, cliques and independent sets, Hall's Theorem and some applications.
Module 3	Matrix Computation Fundamentals: Flops, count Matrix vector Multiplication, Gaussian Elimination-Positive definite matrices, Cholesky factorization, sparsity. Error propagation in Gaussion elimination.
Module 4	Sensitivity and round off errors: Vector norms, Matrix norms, Rotators and reflectors, Eigenvalues and eigenvectors-Schur's theorem, normal matrices, tri-diagonal matrices, QR algorithm. Iterative Methods-Steepest descent, Conjugate Gradient.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Mathematics and its application.	Kenneth H.Rosen	McGrawhill	Eighth edition

2	Fundamentals of Matrix Computations.	David S.Watkins	Wiley-interscience	3rd editin, 2010
3	Introduction to Graph Theory	Douglas B. West		2nd edition
4	Discrete Mathematical Structures Third Edition Kokman,Busby and Ross.			
5	Gene H.Golub and Charles F.Van Loan ,Matrix computation,4h Edition,The hohns Hopkins university press,2013			

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1		NIL				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM (Quiz)	8	22
	Home Assignment and Book. (Min. 4 Assignments etc.)	7	
	Weekly exercise	7	
In-Sem Summative	In-Sem Exam-I (Paper Based & Closed Book Exam)	15	38
	In-Sem Exam-II (Paper Based & Closed Book Exam)	15	
	In Semester Exam (Paper Based & Closed Book Exam)	8	
End-Sem Summative	End Semester Exam (Paper Based & Closed Book Exam)	24	40
	End Exam (Paper Based & Closed Book Exam)	16	

Professional Core Courses

OBJECT ORIENTED PROGRAMMING (OOP)

COURSE CODE	23CS5101	MODE	R	LTPS	2-0-2-4	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand basic Concepts of OOP, fundamentals of Java and apply the concepts of classes and objects through Java language	2	PO1, PO2
CO2	Apply constructors, Overloading, parameter passing in Java Programming	3	PO1, PO2
CO3	Apply access control, Inheritance, Packages	3	PO1, PO2
CO4	Apply Interfaces, Exception Handling	3	PO1, PO2
CO5	Analyze object-oriented programming concepts to write programs	4	PO1, PO2

Syllabus:

Module 1	Object-Oriented Programming, OOP Principles, Encapsulation, Inheritance and Polymorphism Java as a OOPs & Internet Enabled language, The Byte code, Datatypes, Variables, Dynamic initialization, scope and lifetime of variables, Arrays, Operators, Control statements, Type Conversion and Casting, Compiling, and running of simple Java program
Module 2	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.
Module 3	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, String handling functions.
Module 4	Packages and Interfaces: Packages, Class path, Exception Handling: Exception Handling fundamentals, Collections Framework. JDBC - JDBC CRUD Operations

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Complete Reference Java	Herbert Schildt	Pearson	2008
2	Java – How to program	Deitel&Deitel	Pearson	2007

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	6	24
	Quiz	4	
	Practical Continuous Evaluation	5	
	Skill Continuous Evaluation	5	
	MOOCs Review	4	
In-Sem Summative	In-Sem 1	12	36
	In-Sem 2	12	
	Practical In-Sem	6	
	Skill In-Sem	6	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	8	
	Skill End-Sem Exam	8	

ECLECTIC DATABASE SYSTEMS (EDBS)

COURSE CODE	23CS5102	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the fundamentals of Data Modelling for ER Diagrams	2	PO1, PO2, PO3
CO2	Apply the Normalization techniques on Database	3	PO2, PO3, PO5
CO3	Analyse the OOP Approach in Database systems	4	PO3
CO4	Contrast the Multimedia databases to manage the Data	4	PO3
CO5	Choose advanced database Applications to increase the performance of Distributed Databases.	5	PO3, PO5
CO6	Evaluate the SQL & PL/SQL Queries of different databases.	5	PO1, PO3, PO5

Syllabus

Module 1	Database Fundamentals: DBMS Characteristics, Database Environment, Database Users, Database Architecture, Data Independence, Languages and tools. Data Modelling: ER Model, Constraint, Types, Relationships, ER data Model, EER Diagram. Relational Model: concepts, constraints, schemas, SQL & Relational Algebra.
Module 2	Normalization- Normal Forms, Multi value and join dependencies, Mongo DB: Introduction to NOSQL, CRUD-INDEXING, AGGREGATE. Distributed database: Replication, Shading, Performance analysis.
Module 3	Object Oriented database systems: Object DBMSs, Weakness of RDBMSs, Object Oriented Concepts, and 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, Comparison of ORDBMS and OODBMS. Overview of Transaction Management in distributed databases.
Module 4	Multimedia Databases: Multimedia databases, Multimedia Data, SQL and Multimedia-Manipulating Large objects, Querying Multimedia-Introduction, Manipulating Multimedia data. Multimedia modelling data, Multimedia Database Architecture and performance. Dealing with Multimedia text, image, and video.
Module 5	Introduction to Advanced Database Applications, Database Application Performance Optimization, Advanced Data Modeling, Advanced SQL Programming, NoSQL Databases, Data Warehousing and Business Intelligence, Big Data and Distributed Databases, Security and Privacy in Database Applications, Scalable Database Architectures, Cloud Databases and Database as a Service (DBaaS), Advanced Topics in Database Applications.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Multimedia Databases: An Object Relational Approach	Dunckley Lynne	Pearson Education	2019
2	Advanced database systems	Carlo Zaniolo, Stefano Ceri, Christos Faloutsos	Morgan Kaufmann	2008
3	Database Systems-Design, Implementation and Management	Peter Rob and Corlos coronel	Course Technology	2012
4	Database System Concepts	Abraham Silberschatz, Henry F. Korth, and S. Sudarshan	McGraw-Hill Education	2020
5	Database Management Systems	Raghu Ramakrishnan and Johannes Gehrke	McGraw-Hill Education	2020

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Mongo DB	Mongo DB University	YES	Multiple choice	MongoDB University	https://learn.mongodb.com/pages/certification-program
2	Azure Database Administrator Associate - Global Certification	Microsoft	YES	Multiple choice	Microsoft	https://learn.microsoft.com/en-us/certifications/azure-database-administrator-associate/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	PostgreSQL	PostgreSQL	Open Source
2	Mongo DB	Server Side Public License (SSPL)	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM (Quiz)	8	22
	Home Assignment and Book. (Min. 4 Assignments etc.)	7	
	Lab Weekly exercise	7	
In-Sem Summative	In-Sem Exam-I (Paper Based & Closed Book Exam)	15	38
	In-Sem Exam-II (Paper Based & Closed Book Exam)	15	
	Lab In Semester Exam (Paper Based & Closed Book Exam)	8	
End-Sem Summative	End Semester Exam (Paper Based & Closed Book Exam)	24	40
	Lab End Exam (Paper Based & Closed Book Exam)	16	

ADVANCED OPERATING SYSTEMS

COURSE CODE	23CS5103	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the design of multiprocessor and distributed Operating Systems. Analyze distributed file systems, Decentralization and Authentication.	4	PO1, PO3
CO2	Analyze the scheduling of Real time and Parallel Applications on Heterogeneous Distributed Systems. Analyze three basic approaches for implementing distributed mutual exclusion.	4	PO2,PO4,
CO3	Understand Replication. Analyze Deadlock detection, Check pointing and rollback recovery in distributed systems.	4	PO4
CO4	Analyze the algorithms for Consensus and agreement algorithms, and Failure detectors, Blockchain and Distributed ledgers	4	PO3,PO4
CO5	Implement the Concepts of multiprocessor Threads, distributed mutual exclusion, distributed scheduling, Distributed deadlocks, Distributed consensuses and Fault Handling.	4	PO5

Syllabus

Module 1	Introduction: Types of Advanced Operating Systems, Problem of Multiprocessor Systems, Solution with Master and Slave Processors, Solution with Semaphores. Distributed Unix Systems: Satellite Processors, The Newcastle Connection, Transparent Distributed File Systems.
Module 2	Scheduling: RTS, Reliability-Aware Fault-Tolerant Scheduling, Energy-Efficient Real-Time Scheduling, Scheduling Issues in load distributing, Components of load distributing algorithms, Selecting a suitable load sharing Algorithm. Synchronization: Physical and logical clocks, Distributed Mutual Exclusion: Introduction, Classification of Mutual Exclusion algorithms, Mutual Exclusion Algorithms.

Module 3	Distributed Deadlock: Introduction, deadlock handling strategies, Deadlock detection: Issues and resolution, Control Organizations, Centralized algorithms, Distributed algorithms, Hierarchical algorithms.
Module 4	Distributed Fault Handling: Agreement Protocol: System Model, Classification, Solution to Byzantine Agreement Problem, Partition tolerant consensus algorithms, e.g.: Paxos. Fault Recovery: Concepts, Classification of failures, Backward error recovery, Recovery in concurrent Systems, Consistent Check Points, Synchronous and Asynchronous check pointing and recovery. Fault tolerance: Issues, Atomic actions and committing, Commit Protocols, Non-blocking Commit protocols, Voting protocols and Dynamic Voting Protocols. Raft, ZAB, Replication: weak consistency model protocols, Replica synchronization: gossip and Merkle trees. Comparison of Distributed File systems, Distributed ledgers, Authentication in distributed systems, Blockchain, Decentralization, Symmetric and Public Key Cryptography, Hyperledger.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems.	Mukesh Singhal, Niranjan G. Shivaratri	MC Graw Hill education	
2	Distributed Computing: Principles, Algorithms, and Systems	A.D. Kshemkalyani, M. Singhal	Cambridge University Press	2011
3	Modern Systems Principles and Paradigms	Andrew S. Tanenbaum	PHI	
4	Distributed Operating System-Concepts and design.	Pradeep K. Sinha	PHI	
5	Distributed Operating System	Andrew S. Tanenbaum	Pearson education	2017
6	Real Time Systems	Jane W. S. Liu	Pearson education	
7	The design of the UNIX operating system	Maurice J. Bach	Prentice-Hall software series	
8	Distributed systems for fun and profit,	Mikito Takada	http://book.mixu.net/distsys/	

9	Mastering Blockchain - a deep dive into distributed ledgers, consensus protocols, smart contracts, Dapps, cryptocurrencies, Ethereum, and more.	Imran Bashir		2020
10	Concurrency Control in Distributed System Using Mutual Exclusion	Chaki, Nabendu_ Chattopadhyay, Samiran Kanrar, Sukhendu	Springer	2018
11	Scheduling Parallel Applications on Heterogeneous Distributed Systems (2019,)	GuoqiXie, Gang Zeng, Renfa Li, Keqin Li.	Springer Singapore	2019

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM (Quiz)	8	22
	Home Assignment and Book. (Min. 4 Assignments etc.)	7	
	Lab Weekly exercise	7	
In-Sem Summative	In-Sem Exam-I (Paper Based & Closed Book Exam)	15	38
	In-Sem Exam-II (Paper Based & Closed Book Exam)	15	
	Lab In Semester Exam (Paper Based & Closed Book Exam)	8	
End-Sem Summative	End Semester Exam (Paper Based & Closed Book Exam)	24	40
	Lab End Exam (Paper Based & Closed Book Exam)	16	

DATA STRUCTURES AND ALGORITHMS

COURSE CODE	23CS5204	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	DSMC

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply concepts of mathematics to find space and time complexities of various algorithms including string matching algorithms	3	PO1, PO2
CO2	Analyze the problems that can be solved by using Divide and Conquer and Greedy Method	4	PO2, PO5
CO3	Analyze the problems that can be solved by using Dynamic Programming and Backtracking	4	PO2, PO5
CO4	Analyze the problems that can be solved by using Branch and Bound and NP-Hard Graph problems	4	PO2, PO5
CO5	Analyze the various design techniques to solve any real-world problems.	3	PO2, PO5

Syllabus

Module 1	Introduction: Definition of an Algorithm- Algorithm Specification - Analysis of Algorithm. PRAM Algorithms: Merging- Sorting. String Algorithms: The Naive String Matching Algorithm, Robin – Karp Algorithm.
Module 2	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.
Module 3	Dynamic Programming: The General Method- Optimal Binary Search Tree- 0/1 Knapsack-Traveling Sales Person Problem. Ford Fulkerson. Backtracking: The Eight Queens Problem - Graph Coloring - Knapsack Problem.
Module 4	Branch and Bound: 0/I Knapsack Problem- Traveling Sales Person Problem. NP Hard and NP Complete Problems: Basic Concepts- Cook's Theorem-NP Hard Graph Problems- CDP, NCDP, AOG.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Fundamentals of Computer Algorithms	Ellis Horowitz, SartajSahni and Sanguthevar Rajasekaran	University Press, 2008	2008

2	Introduction to algorithms	Cormen, Leizerson &Rivest	Prentice-Hall, 2002	2002
3	Algorithm Design	Jon Kleinberg and Eva Tardos	Pearson Education, 2006	2006
4	Algorithms	Robert Sedgewick and Kevin wayne	Addison Wesley Prof., (2011)	2011
5	Introduction to Design and Analysis of Algorithms	Anny Levitin	Person Education Press. (2007)	2007

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	PCAP	OpenEDG Python Institute	Y	Single- and Multiple-select questions | Python 3.x	Pearson VUE	https://pythoninstitute.org/pcap
2	Certified Algorithms and Data Structures Specialist(CADSS)		Y	Single- and Multiple-select questions | Python 3.x	Single- and multiple-select questions | Python 3.x	https://www.iscb.org/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Code chef	Code chef	Open Source
2	Hacker Rank	Hacker Rank	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	MOOCS review		22
	Continuous Evaluation -Lab Exercise		

	Global Challenges		
In-Sem Summative	Semester in Exam-I		38
	Semester in Exam-II		
	Lab In Semester Exam		
End-Sem Summative	End Semester Exam		40
	Lab End Semester Exam		

AGILE BASED SOFTWARE ENGINEERING

COURSE CODE	23CS5205	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the fundamental concepts of principles and values of Agile methodologies, including iterative development, customer collaboration, and challenges.	3	PO1,PO2,PO3
CO2	Apply Agile project management techniques, including the creation of user stories, and managing product backlogs, sprint planning, sprint reviews, and retrospectives.	3	PO2,PO3,PO4
CO3	Apply various software methodologies of Scrum, Kanban, FDD and Lean software development Methodology for developing user friendly software and also they can able to analyse various software projects by Extreme Programming principles and values.	4	PO2,PO3,PO5
CO4	Analyze numerous testing methodologies for testing diverse software and analyze various TDD methodologies to assess the quality of the software. Apply various risk based testing methods in order to design and analyse any software project.	4	PO1,PO2,PO3
CO5	Analyze and compare various software projects by creating UML diagrams with the Star UML tool and JIRA for project monitoring	5	PO5,PO6

Syllabus

Module 1	Introduction: Need of Agile software development, agile context– Manifesto, Principles, Methods, Values, Roles, Artifacts, Stakeholders, and challenges. Business benefits of software agility.
Module 2	Project Planning: Recognizing the structure of an agile team– Programmers, Managers, Customers. User stories– Definition, Characteristics and content. Estimation– Planning poker, Prioritizing, and selecting user stories with the customer, projecting team velocity for releases and iterations.
Module 3	Project Design: Fundamentals, Design principles–Single responsibility, Open-closed, Liskov substitution, Dependency-inversion, Interface-segregation. Design Methodologies: Need of scrum, Scrum practices –Working of scrum, Project velocity, Burn down chart, Sprint backlog, Sprint planning and retrospective, Daily scrum, Scrum roles– Product Owner, Scrum Master, Scrum Team. Extreme Programming- Core principles, values and practices. Kanban, Feature-driven development, Lean software development.

Module 4	Testing: The Agile lifecycle and its impact on testing, Test driven development- Acceptance tests and verifying stories, writing a user acceptance test, Developing effective test suites, Continuous integration, Code refactoring. Risk based testing, Regression tests, Test automation.
Module 5	Case studies using Star UML, Project Monitoring Tool using JIRA, Working on the Projects through scrum model in GitHub

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Software Engineering - A Practitioner's Approach	Roger Pressman, 7th Edition	Mc Graw Hill,(2014)	
2	Software Engineering	Ian Sommerville, 10th Edition	Pearson Education, (2015)	
3	Agile Software Development Ecosystems	Jim Highsmith, 1st Edition	Addison Wesley	
4	"Software Engineering: A Practitioner's Approach"	Rajib Mall, 5th Edition	PHI Learning pvt ltd, Delhi	
5	"Software Engineering: Principles and Practices"	Deepak Jain, 1st Edition	Oxford	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	SCRUM	SCRUM ORGANIZATION	YES	OBJECTIVE	SCRUM ORGANIZATION	https://www.scrum.org/assessments/professional-scrum-master-i-certification
2	SAFe Certifications	Scaledagile.com	Yes	OBJECTIVE	Scaledagile.com	https://scaledagile.com/safe-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Star UML	IBM	Open Source
2	JIRA	ATLASIAN	Open Source
3	Github	Github	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	5	22
	Home Assignment	6	
	Practical Continuous Evaluation	6	
	MOOCs review	5	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

Professional Elective Courses
AI & DS
ARTIFICIAL NEURAL NETWORKS

COURSE CODE	23CS51A1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand and build basic network representations, topologies, and models	2	PO1, PO2
CO2	Apply various techniques for training and optimizing neural networks	3	PO1, PO2
CO3	Apply different techniques related to network stochastics	3	PO3, PO4
CO4	Analyse different techniques related to learning algorithms for neural networks and develop knowledge on emerging software, tools and technologies related to these algorithms	4	PO4, PO5
CO5	Evaluate different approaches and techniques for solving problems involving neural networks and their applications using python and develop knowledge on emerging software, tools and technologies related to these approaches	5	PO5, PO6

Syllabus

Module 1	Basics of Artificial Neural Networks: Historical perspective; Characteristics of Neural Networks; Artificial Neural Networks (ANN) terminology; Neuron Models; Topology; Basic learning laws, Activation dynamics models; Synaptic dynamics models; Learning methods; Stability and convergence; Recall;
Module 2	Feed forward Neural Networks: Analysis of Pattern association; pattern classification and pattern mapping by feed forward neural networks (FFNNs); Hebbian Rule; Perceptron learning; Delta rule; Back propagation Algorithm; Gradient descent and its variants, RBFN, Support Vector Machines for classification & regression.
Module 3	Feedback Neural Networks: Analysis of linear auto associative networks; Associative Memory, Exponential BAM Hopfield model for pattern storage; Stochastic networks and Simulated annealing; Restricted Boltzmann machine.
Module 4	Kohenen Self Organizing Maps - Learning Vector Quantization - Counter Propagation Networks, dynamically driven recurrent networks- RNN, Learning algorithms (BPTT, RTRL, Kalman Filter) Introduction to Generative Adversarial Networks (GANs) and its usage in for data augmentation privacy and anonymity, Convolutional neural networks, Applications of neural networks.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year

1	Artificial Neural Networks	B. Yegnanarayana	PHI	2006
2	Neural Networks Algorithms, Applications, and Programming Techniques	James A. Freeman David M. Skapura	Addison-Wesley Publishing Company	1991
3	Neural Networks: A Comprehensive Foundation	Simon Hayki	Pearson Prentice Hall	2008
4	Neural networks for Pattern Recognition	Christopher M Bishop	Oxford, Indian Edition	2010
5	Neural Networks: A Comprehensive Foundation	Simon Hayki	Pearson Prentice Hall	2008

Global Certification:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	TensorFlow Developer Certificate	Google	N	Online	Google	https://www.tensorflow.org/certificate
2	AWS Certified Machine Learning - Specialty	Amazon	Y	Online	Amazon	https://aws.amazon.com/certification/certified-machine-learning-specialty/

Tools used in Practical:

S.No	Tool Name	Parent Industry	Open Source/ Commercial
1	Anaconda Navigator		Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	5	22
	Home Assignment	6	
	Practical Continuous Evaluation	6	
	MOOCs review	5	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	

	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

BIG DATA OPTIMIZATION TECHNIQUES

COURSE CODE	23CS52A2	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	EDBS

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand optimization methods and analytics using R programming	2	PO2
CO2	Apply blind search and local search methods for solving optimization problems	3	PO2
CO3	Analyze and compare population-based search methods for solving real world problems	4	PO4
CO4	Analyze applications for genetic programming and identify problems that can be solved using multi-objective techniques	4	PO4
CO5	Implement optimization algorithms using R Programming	5	PO5

Syllabus

Module 1	Introduction: Motivation, Why R, Representation of a Solution, Evaluation Function, Constraints, Optimization Methods, Demonstrative Problems. R Basics: Introduction, Basic Objects and Functions, Data Structures
Module 2	Data structures: About usage, understanding data structures, functions, list, arrays, control structures, data manipulations, date and string manipulations. Blind Search: Introduction, Full Blind Search, Grid Search, Monte Carlo Search.
Module 3	Local Search: Introduction, Hill Climbing, Simulated Annealing, Tabu Search, Comparison of Local Search Methods. Population Based Search: Introduction, Genetic and Evolutionary Algorithms, Differential Evolution
Module 4	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.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Modern Optimization with R	Paulo Cortez	Springer	2014
2	Using R and R Studio for Data Management, Statistical Analysis, and Graphics, Second Edition	Nicholas J. Horton & Ken Klein man	CRC Press	2015
3	Advanced database systems	Carlo Zaniolo, Morgan Kaufmann	Elsevier	1997
4	Relational Database Design	Jan L Harrington	Elsevier	2009

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1		NIL				

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	5	22
	Home Assignment	6	
	Practical Continuous Evaluation	6	
	MOOCs review	5	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

COGNITIVE COMPUTING AND ANALYTICS

COURSE CODE	23CS52A3	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand what cognitive computing is, and how it differs from traditional approaches	2	PO1
CO2	Applying the primary tools associated with cognitive computing	3	PO1
CO3	Applying cognitive computing concepts	3	PO2
CO4	Applying Cognitive computing to business applications	3	PO2

Syllabus

Module 1	Introduction to Cognitive Systems and computation, Knowledge based AI: Cognitive systems. Artificial Intelligence as the Foundation of Cognitive Computing, Understanding Cognition, The Elements of a Cognitive System, Cognitive Applications. Design Principles for Cognitive Systems: Building the Corpus, Bringing Data into the Cognitive System, Machine Learning, Hypotheses Generation and Scoring, Presentation and Visualization Services.
Module 2	Cognitive Functioning: Learning, Memorising, Adaptation, Self Origination, Control, Thinking, Reasoning, Decision Making & Judgement. Natural Language Processing in Support of a Cognitive System: The Role of NLP in a Cognitive System Understanding Linguistics, Applying Natural Language Technologies to Business Problems .Representing Knowledge in Taxonomies and Ontologies: Developing a Cognitive System, Models for Knowledge Representation, Other Methods of Knowledge Representation. Mental States: Belief Desire Intention (BDI) emotion and feeling.
Module 3	Computation of Cognitive Functioning in machines: Applying Advanced Analytics to Cognitive Computing : Key Capabilities in Advanced Analytics, Using Machine Learning in the Analytics Process, Predictive Analytics Text Analytics, Image Analytics, Speech Analytics Using Advanced Analytics to Create Value. Business Implications: Advantages of New Disruptive Models, The Difference with a Cognitive Systems Approach
Module 4	IBM's Watson: Deep QA Architecture Robotics, Human-Robotics Interaction, Hepatic. Perception and sensing: Building Cognitive Applications: Defining the Objective, Defining the Domain, Defining Questions and Exploring Insights, Building a Cognitive Healthcare Application, Smarter Cities: Cognitive Computing in Government.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Cognitive Computing and Big Data Analytics	Hurwitz, Kaufman, and Bowles	Wiley, Indianapolis	2005
2	Speech and Language Processing	Jarafsky, D., and Martin, J.H.	Prentice Hall Series in Artificial Intelligence.	2008
3	A Brief Introduction to Neural Networks	David Kriesel	Elsevier	1997
4	Artificial Intelligence and Soft Computing: Behavioral and Cognitive Modeling of the Human Brain.	Amit Konar	CRC Press	2018
5	Artificial intelligence and tutoring systems: computational and cognitive approaches to the communication of knowledge	Etienne Wenger	Morgan Kaufmann, INC	2018
6	Foundations of Statistical Natural Language Processing	Manning, C. D., and Schuetze, H	MIT Press	2003
7	Natural Language Processing with Python	Bird, S., Klein, E., Loper, E.	O' Reilly Media	2009
8	Introduction to Natural Language Processing	Kibble, R	University of London	2013

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Cognitive Solutions and RPA Analytics	Coursera	N	MCQ		

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Python	NA	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	5	22
	Home Assignment	6	
	Practical Continuous Evaluation	6	
	MOOCs review	5	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

DEEP LEARNING

COURSE CODE	23CS52A4	MODE	R/M	LTPS	3-0-0-0	PRE-REQUISITE	ANN

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Able to understand apply optimization algorithms to solve neural networks	3	PO1, PO2
CO2	Able to apply CNN model and its variants to real time data like LeNet, AlexNet, ZF-Net, VGGNet models	3	PO2
CO3	Apply RNN,Long Short Term Memory (LSTM) and autoencoders	3	PO3
CO4	Able to construct the varaiational auto encoders and Generative Neural models	3	PO2, PO3
CO5	Abel to implement deeplearning techniques using keras	5	PO3, PO5

Syllabus

Module 1	Introduction to Deep learning, History of Deep Learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptron's, Perceptron Learning Algorithm and Convergence, Multilayer Perceptron's (MLPs), Representation Power of MLPs,Sigmoid Neurons, Feedforward Neural Networks, Backpropagation, Gradient Descent (GD), Momentum Based GD, Stochastic GD, Adam.
Module 2	Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Dropout, Greedy Layer wise Pre-training, Better activation functions, better weight initialization methods, Learning Vectorial Representations Of Words Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet Object Detection
Module 3	RCNN, Fast RCNN, Faster RCNN, YOLO. Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Recurrent Neural Networks, Backpropagation Through Time (BPTT),Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units (GRUs), Long Short TermMemory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs , Encoder Decoder Models:Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders
Module 4	Markov Networks. Using joint distributions for classification and sampling, Latent Variables, Restricted Boltzmann Machines, Unsupervised Learning, Motivation for Sampling, Markov Chains, Gibbs Sampling for training RBMs, Contrastive Divergence for training RBMs, Variational autoencoders, Autoregressive Models:NADE, MADE, Generative Adversarial Networks

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Deep Learning	Ian Goodfellow and Yoshua Bengio and Aaron Courville	MIT Press	2016
2	Grokking Deep Learning	Andrew Trask	Manning publications	2019
3	Deep Learning Book Deep Learning with Python	Francois Chollet	Manning publications	2018
4	Deep Learning with PyTorch: A practical approach to building neural network models using PyTorch	Vishnu Bramania	Packt Publishing Limited	2018

Global certification

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Tensorflow Developer Certificate	Google	N	Subjective/ practical	Tensorflow.org	https://www.tensorflow.org/certificate

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Python	python	opensource
2	Keras , tensorflow, pytorch	Google	opensource

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Moocs reviews	7	24
	Lab continuous evaluation	5	
	Skill continuous evaluation	5	
	Home assignment	7	
	Sem-In Exam-I	12	36

In-Sem Summative	Sem-In Exam-II	12	
	In-sem lab	6	
	In sem-skill	6	
End-Sem Summative	End sem theory	24	40
	End sem lab	8	
	End sem skill	8	

DATA VISUALIZATION TECHNIQUES

COURSE CODE	23CS61A5	MODE	M	LTPS	3-0-0-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the modelling of various types of data and the Visualization fundamentals	2	PO1
CO2	Apply methods and tools for Non-Spatial Data Visualization	3	PO2
CO3	Apply methods for Scientific/ Spatial Data Visualization and Web data visualization	3	PO5
CO4	Use Dashboard and its categories	4	PO5

Syllabus

Module 1	Data Modeling : Conceptual models, Spread sheet models, Relational Data Models, object-oriented models, semi structured data models, unstructured data models. Visualization Fundamentals, Design principles, The Process of Visualization, Data Abstraction, Visual Encodings, Use of Color, Perceptual Issues, Designing Views, Interacting with Visualizations, Filtering and Aggregation
Module 2	Design Studies Information / Non-Spatial Data Visualization, Tabular Data, Tree Data, Graph Data, Text Data, Flow Data, Time-Series Data, Topological Visualization, Uncertainty, Visual Analytics.
Module 3	Scientific / Spatial Data Visualization, Scalar Volumes, Iso-surfacing, Volume Rendering, Transfer Function Design, Vector Fields, Maps, Spatial Uncertainty Web data visualization: web structure data, web usage data ,web content data multimedia data visualization
Module 4	Information dashboard – categorizing dashboards – typical dashboard data – dashboard design issues and best practices. Visual perception – limits of short-term memory – visually encoding data – Gestalt principles – principles of visual perception for dashboard design Characteristics of dashboards – key goals in visual design process – dashboard display media – designing dashboards for usability – meaningful organization – maintaining consistency – aesthetics of dashboards – testing for usability – case studies: sales dashboard, CIO dashboard, Telesales dashboard, marketing analysis dashboard.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Visualizing Data	Fry	O'Reilly Media	2008
2	Visualization Analysis and Design	Munzner	CRC Press	2014
3	Information Visualization: Perception for Design	Ware, Morgan Kaufmann	Elsevier	2013
4	Data Visualization: A Practical Introduction	Kieran Healy	princeton university press	2018
5	Data Visualization: Principles and Practice	Alexandru C. Telea	CRC Ptress	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Data Visualization with Tableau Specialization (UC Davis)	UC Davis university		N		
2	Microsoft Certified: Azure Enterprise Data Analyst Associate	Microsoft		N		

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	20
	Home Assignments	10	
In-Sem Summative	In-Sem 1	20	40
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

CYBER SECURITY

CRYPT ANALYSIS AND CYBER DEFENCE

COURSE CODE	23CS51S1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the principles of cryptography by analyzing various attacks and apply different classic encryption techniques.	3	PO1
CO2	Understand the principles of block cipher and apply algorithms like DES, AES.	3	PO5
CO3	Understand and apply different algorithms of public key crypto system for ensuring secured communication and authentication.	3	PO5
CO4	Understand the concept of elliptic curve and its applications to cryptography. Apply hash algorithms for security.	3	PO5
CO5	Implement various cryptographic algorithms so as to analyze the achievability of security goals like Confidentiality, integrity, authentication and also Justify the possibility of cryptanalysis attack with each algorithm.	4	PO5

Syllabus

Module 1	Introduction to Security: Security Concepts, Security Attacks, Security Services and Mechanisms, A Security Model, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques. Block Ciphers and DES: Traditional Block Cipher Structure, DES, DES Example, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles.
Module 2	AES: Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Example, AES Implementation. Block Cipher Operation: Multiple Encryption and Triple DES, Modes of Operation
Module 3	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.
Module 4	Other Public-key Cryptosystems: Diffie-Hellman Key Exchange, ElGamal Cryptosystem, Elliptic Curve Arithmetic Elliptic Curve Cryptography. Cryptographic Hash Functions: Applications of Cryptographic Hash functions,

	Two Simple Hash Functions, Requirements and Security, Hash Functions based on Cipher Block Chaining, SHA.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Cryptography and Network Security Principles and Practice	William Stallings	Pearson, 5th edition	
2	Applied Cryptography: Protocols, Algorthms, and Source Code in C, Second Edition	Bruce Schneier	John Wiley & Sons, Inc	2015
3	Applied Cryptography for Cyber Security and Defense: Information Encryption and Cyphering	Hamid R. Nemati and Li Yang	IGI Global	2011
4	Cryptography and Network Security	Forouzon B	TMH	2010

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	5	22
	Home Assignment	6	
	Practical Continuous Evaluation	6	
	MOOCs review	5	
In-Sem Summative	In-Sem 1	15	38

	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

NETWORK AND INFRASTRUCTURE SECURITY

COURSE CODE	23CS52S2	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand security concepts, Infrastructure security techniques and securing enterprise networks. Understand router and switching security mechanism.	2	PO3,PO5
CO2	Understand hardware procedures for digital certificate and techniques of user authentication.	2	PO3,PO5
CO3	Appy the standardization schemes to maintain security in Web application and secured payment system. Identify security vulnerability in the system.	3	PO3,PO5
CO4	Apply security concepts in Email and Internet Protocol. Understand and apply security principles of firewall, Gateways and IDS.	3	PO5,PO3
CO5	Analyse various security concepts and their performance using networking tools.	4	PO1,PO3,PO5

Syllabus

Module 1	Introduction: Hardware, Software and Services, Hardware Protection, Intruders and Viruses, Network Management Security, Device security, Virtual Private Networks (VPNs), Data Centre and Enterprise Networks Security, Securing a Wireless LAN, LAN Switch Security- RootGuard, BPDUGuard, P and PE routers, Router Mechanisms for Security: Queuing and Scheduling Algorithms.
Module 2	Key management and distribution: Symmetric key distribution-Symmetric encryption, Asymmetric encryption, Public-Key Infrastructure, distribution of public keys, X.509 Certificates. User Authentication protocols: Remote User Authentication Principles, Remote User Authentication-Symmetric Encryption, Asymmetric Encryption, Kerberos.
Module 3	Web Security: Web security issues, Secure Socket Layer and Transport Layer Security, HTTPS, Secure Shell (SSH), Secure electronic transaction – Overview, dual signature, payment processing. Security vulnerabilities – Scanning techniques, Penetration testing. Electronic Mail Security: Pretty Good Privacy, S/MIME, Domain Keys Identified Mail.
Module 4	IP Security: IP Security Overview. IP Security Policy, Security Associations, Encapsulating Security Payload. Firewall and Gateway- Overview and working principles. Intrusion Detection System – Overview and working principles.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Cryptography and Network Security Principles and Practice	William Stallings	Pearson, 7th edition	2017
2	Cryptography And Network Security	Behrouz A. Forouzan ,Debdeep Mukhopadhyay	Tata McGraw Hill Education Private Limited, Fourth edition	2015
3	Network Security Essentials	William Stallings	Pearson Education, 7th Edition	2017
4	Network Security	Charlie Kaufman, Radia Perlman, Mike Speciner	Prentice Hall, 2nd edition	
5	Network Security Bible	Eric Cole, Ronald L. Krutz, James Conley	Wiley	2005

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	PCCET	Palo Alto networks	Y	MCQ	Pearson VUE	https://home.pearsonvue.com/paloaltonetworks
2	Certified Ethical Hacker	EC-COUNCIL	Y	MCQ	EC-COUNCIL	https://www.eccouncil.org/train-certify/certified-ethical-hacker-ceh/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	GNS3	GNS3	OPEN SOURCE
2	Nmap	Linux	OPEN SOURCE
3	Wireshark	The Wireshark Team	OPEN SOURCE
4	Metasploit	Rapid7	OPEN SOURCE

5	Snort	CISCO	OPEN SOURCE

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Home Assignments	7	22
	Quiz	8	
	Practical In Sem	7	
In-Sem Summative	In Sem 1	15	38
	In Sem 2	15	
	Practical In Sem	8	
End-Sem Summative	End Sem Exam	24	40
	Practical End Sem	16	

SECURITY GOVERNANCE AND MANAGEMENT

COURSE CODE	23CS52S3	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand basic security for the system.	2	PO1,PO2,PO3
CO2	Secure Design Principles and Patterns Secure Software Architecture	3	PO2
CO3	Secure Coding and Testing	3	PO3
CO4	Governance and Security	4	PO4
CO5	Penetration testing with security	5	PO5

Syllabus

Module 1	Security is a Software Issue – The Problem, Software Assurance and Software Security, Threats to Software Security, Sources of Software Insecurity, what makes Software Secure – Defining Properties of Secure Software, how to Assert and Specify Desired Security Properties, Secure Software Specifications and Requirements, Case Studies.
Module 2	Requirements Engineering for Secure Software – Misuse and Abuse Cases, Square Process Model, Requirements Elicitation and Prioritization, Secure Design Principles and Patterns Secure Software Architecture and Design – Architectural Risk Analysis
Module 3	Security Principles, Guidelines and Attack Patterns, Case Studies Secure Coding and Testing – Code Analysis, Practices, Testing and Consideration through the SDLC; Security and Complexity – Security Failures and Analysis, System Complexity, Case Studies.
Module 4	Governance and Security, governing for Enterprise Security, Defining an effective Enterprise security Program, Security Governance activities. Enterprise Software Security Framework, Security and Project Management.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year

1	Introduction to Security Governance	John Wiley & Sons, Inc		
2	Security Systems: Three Easy Pieces	Remzi H. Arpaci-Dusseau		

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	5	22
	Home Assignment	6	
	Practical Continuous Evaluation	6	
	MOOCs review	5	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

SECURITY FOR CLOUD SYSTEMS SERVICES

COURSE CODE	23CS52S4	MODE	R / M	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the principles of cryptography and Apply various cryptographic algorithms	3	PO2, PO3
CO2	Analyze various security issues and system vulnerabilities in virtualization	3	PO2, PO4
CO3	Analyze the technologies for virtualization based security enhancements	4	PO3,PO4
CO4	Analyze legal and Compliance issues and examine modern security standards	4	PO3, PO4

Syllabus

Module 1	Security Concepts: Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defense in depth, least privilege, the importance of security in the cloud, Importance in PaaS, IaaS and SaaS; Cryptographic Systems: Symmetric cryptography, stream ciphers, block ciphers, modes of operation, public-key cryptography, hashing, digital signatures, public-key infrastructures, key management, X.509 certificates, OpenSSL.
Module 2	Multi-tenancy Issues: Isolation of users/VMs from each other. Virtualization SystemSecurity Issues: e.g. ESX and ESXi Security, ESX file system security, storage considerations, backup, and recovery
Module 3	Virtualization System Vulnerabilities: Management console vulnerabilities, management server vulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisor vulnerabilities, hypervisor escape vulnerabilities, configuration issues, and malware (botnets, etc). Virtualization System-SpecificAttacks: Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyperjacking.
Module 4	Technologies for virtualization-Based Security Enhancement: IBM security virtual server protection, virtualization-based sandboxing; Storage Security: HIDPS, log management, Data Loss Prevention. Location of the Perimeter, Legal and Compliance Issues: Responsibility, ownership of data, right to penetration test. Local laws, examination of modern Security Standards (eg PCIDSS), Standards to deal with cloud services and virtualization, compliance for the cloud provider vs. compliance for the customer.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Cloud Security and Privacy: An EnterprisePerspective on Risks and Compliance	Tim Mather, Subra Kumaraswamy, Shahed Latif	O'Reilly Media Inc	2009
2	Cloud Security	Ronald L. Krutz, Russell Dean Vines	Wiley	2010
3	Cloud Computing	John Rittinghouse, James Ransome	CRC Press	2009
4	Securing the Cloud	J.R. ("Vic") Winkler	Elseiver	2011

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	AWS Certified Security - Specialty	AWS	Y	MCQ or Multiple Choice	AWS	https://aws.amazon.com/certification/certified-security-specialty/?trk=662aeb66-1ee5-4842-b706-60c6a1b4f187&sc_channel=ps&ef_id=CjwKCAjwge2iBhBBEiwAfXDBR222i27wciqwT-CCmDkSuheXUSCBc1x3gwHTH1_bgqivMtObNW5YbBoCimgQAvD_BwE:G:s&s_kwcid=AL!4422!3!467351734258!e!!g!!what%20is%20aws%20security%20certification!11138243483!106933367662

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Wireshark	NIS	Open Source
2	Aircrack	Thomas d'Otreppe de Bouvette	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Quiz	LMS / Paper Based	10
	MOOCs Review	LMS / Paper Based /Oral	10
In-Sem Summative	Global Challenges - Leaderboard	LMS	20
	MOOCs Exam	LMS / Paper Based	20
End-Sem Summative	MOOCs Exam	Open Book Exam / Closed Book Exam	40

INTRODUCTION TO BLOCKCHAIN AND CRYPTO CURRENCIES

COURSE CODE	23CS61S5	MODE	M	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the basic concepts of cryptography for blockchain	2	PO1, PO2
CO2	Understand the basics of blockchain and mining process	2	PO2, PO3
CO3	Apply about the different types of blockchain and consensus algorithms	3	PO4, PO5
CO4	Apply the different types of crypto currencies & its importance and Analyse blockchain applications	4	PO5, PO7

Syllabus

Module 1	Introduction to Cryptography: Structure of cryptosystem – symmetric key cryptography – asymmetric key cryptography – types of attacks – RSA algorithm – Elliptic Curve cryptography –authentication models – SHA-256 Hash algorithm
Module 2	Digital signature standards. Basics of Blockchain concepts: Architecture – Properties of Blockchain – Distributed ledger – Merkle tree – structure of a block – Smart contract – Crowd funding – Transaction – Double spending – Block propagation – Consensus – Proof of Work, Proof of Stack, Proof of Burn, Proof of Elapsed Time – Mining
Module 3	Types of Blockchain: Blockchain Components – Permissioned Blockchain – Permissionless Blockchain – Consortium Blockchain – Consensus Algorithms: PAXOS consensus Algorithm – RAFT consensus Algorithm – Byzantine general problem – Practical Byzantine fault tolerance Algorithm – Three phase commit Protocol.
Module 4	Cryptocurrencies: Cryptocurrencies applications using blockchain – Bitcoin: Bitcoin properties – Transaction life cycle – creation of coin – sending payments – double spending using blockchain – bitcoin anonymity – Ether: Ether coin properties – smart contract – Applications: Financial Services: Cross border payments, KYC, international trade – Health Care: Food safety.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Cryptography and Network Security: Principles and Practice”	William Stallings,	Pearson Education	2017
2	Blockchain Technology	Chandramouli Subramanian,	University Press (India)	2021

		Asha A George, Abhilash K A, Meena Karthikeyan	Private Limited	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Blockchain Security Professional (CBSP)	Blockchain Training Alliance	Y	Multiple-choice exam	Blockchain Training Alliance	https://blockchaintrainingalliance.com/products/cbsp
2	Certified Blockchain Architect (CBA)	Blockchain Council	Y	Multiple-choice exam	Blockchain Council	https://www.blockchain-council.org/exam/certified-blockchain-architect-cba-exam/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning – Quiz's, Case Study based learning, One-minute Paper.	10	20
	MOOCs Review	6	
	Home Assignment – Textbook	4	
In-Sem Summative	In-Sem 1	20	40
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam	40	40

MOOCs:

1. https://www.simplilearn.com/cryptocurrency-for-beginners-free-course-skillup?tag=blockchain
2. https://www.simplilearn.com/learn-blockchain-basics-skillup?tag=blockchain

3. https://www.udemy.com/course/eos-blockchain-and-bitcoin/
4. https://www.udemy.com/course/blockchain-revolution/
5. https://www.udemy.com/course/understanding-blockchain-technology/
6. https://www.udemy.com/course/blockchain-technology-for-beginners/
7. https://www.udemy.com/course/introduction-to-blockchain-applications-for-business/
8. https://www.udemy.com/course/blockchain-for-beginners/
9. https://www.udemy.com/course/blockchain-bitcoins-a-complete-package/
10. https://www.edx.org/course/introduction-to-blockchain?index=product&queryID=491d7d1b935eb381c1473ce3137efb16&position=1&results_level=first-level-results&term=blockchain&objectID=course-894bd8b1-7f01-4004-946e-b29f3a3bb282&campaign=Introduction+to+Blockchain&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
11. https://www.edx.org/course/mit-sloan-blockchain-technologies-business-innovation-and-application-online-program?index=product&queryID=e9b5b61adf15eb1984724fdfc8387fe9&position=1&results_level=first-level-results&term=blockchain&objectID=course-00176583-48ca-457f-abcd-0a9ccca1bd63&campaign=Blockchain+Technologies%3A+Business+Innovation+and+Application&source=2u&product_category=executive-education&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
12. https://www.edx.org/course/blockchain-understanding-its-uses-and-implications?index=product&queryID=491d7d1b935eb381c1473ce3137efb16&position=3&results_level=first-level-results&term=blockchain&objectID=course-0d30c44e-1ae3-4141-bf43-fa7bfc20d2c0&campaign=Blockchain%3A+Understanding+Its+Uses+and+Implications&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
13. https://www.edx.org/course/introduction-to-blockchain-and-web3?index=product&queryID=491d7d1b935eb381c1473ce3137efb16&position=2&results_level=first-level-results&term=blockchain&objectID=course-90c23fbb-64e6-46bd-b2ff-84c9c298b59c&campaign=Introduction+to+Blockchain+and+Web3&source=edX&product_category=course&placement_url=https%3A%2F%2Fwww.edx.org%2Fsearch
14. https://onlinecourses.swayam2.ac.in/aic21_ge01/preview
15. https://onlinecourses.nptel.ac.in/noc22_cs44/preview

CSE

WIRELESS AND MOBILE SECURITY

COURSE CODE	23CS51C1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To make the students aware of fundamental concepts related to Wireless communication	2	PSO1,PO7
CO2	To make the students aware of fundamental concepts related to Mobile communication	2	PSO1,PO7
CO3	Ability develop small wireless application for communicating between different embedded systems	2	PO7
CO4	Ability develop small mobile application for communicating between different embedded systems	2	PO7

Syllabus

Module 1	Introduction to wireless communication: Meaning of wireless communication, Wireless communication standards: OSI standards, layers, protocols and functions, Wireless communication protocols: Wi-Fi, Gigbee, Bluetooth, WiMAX.
Module 2	Wireless networks: peer to peer, Wireless LAN, Adhoc wireless network, Wireless gateways: wireless to cellular and Vice versa, wireless to router and wireless to optic fiber, PSTN to wireless and vice versa.
Module 3	Application development: Introduction to Wi-Fi related API included in python, developing Wi-Fi applications using python API. Introduction to mobile communication: Meaning of mobile communication. Mobile communication standards: OSI standards, layers, protocols and functions. Mobile communication protocols: Introduction to GSM, TDMA, FDMA AND CDMA, Random access data oriented networks, Short messaging service in GSM, Mobile application protocols.
Module 4	Mobile networks: peer to peer, Mobile LAN, Mobile Network gateways: wireless to Cellular and wired to mobile, wireless and vice versa. Mobility in Internet Applications, Cellular IP, IPv6 and Mobility Management. Mobile Application development: Introduction to Mobile communication related API within python, developing Mobile applications using python API.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Wireless Communications Principles and Practice second Edition	Theodore S. RappaPort,	Pearson Education, Inc, publishing as prentice Hall	2002
2	Principles of wireless network: a unified approach	Pahlavan,Kaveh and Prashanth Krishnamurthy	Prentice Hall	2001
3	802.11 Wireless Networks: the definitive guide, 2nd ed.	Gast, Mathew S	O'Reilly Media	2005
4	Wireless and Mobile Data Networks	Aftab Ahmad	Wiley	2005

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	5	22
	Home Assignment	6	
	Practical Continuous Evaluation	6	
	MOOCs review	5	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

CLOUD INFRASTRUCTURE AND SERVICES

COURSE CODE	23CS52C2	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply on-demand compute services. Understand IaaS Architectures and Implementation Guidelines.	3	PO1
CO2	Analyze applications and frameworks for data analysis and Content delivery in the cloud	4	PO1,PO3
CO3	Analyze Cloud Service Availability, Resiliency and dynamic scaling	4	PO1,PO3
CO4	Use Networking and Security Services. Automate cloud Infrastructure, Deployment, and Management	4	PO1,PO3
CO5	Hands-On Cloud Administration. Implement, monitor, and manage important cloud services and components including IaaS and PaaS	5	PO3, PO4

Syllabus

Module 1	Introduction to Cloud Technologies: Introduction to the Cloud Computing, History of cloud computing, Cloud Deployment models: IaaS, PaaS, and SaaS. Data as a Service, NoSQL as a Service, Identity as a Service, Desktop as a Service, Container as a Service (CaaS), cloud Architectures: NIST and ITU-T.
Module 2	Introduction to AWS: AWS history, AWS Infrastructure, AWS services, AWS ecosystem. Programming, management console and storage on AWS: Basic Understanding APIs-AWS Programming Interface, AWS URL naming, matching interfaces and services, Elastic block store – Simple storage service, Glacier - Content delivery platforms.
Module 3	Elastic cloud computer-Introduction to servers, Imaging Computers, Auto scaling, Elastic load balancing, AMIs, Selling on the marketplace’s, networking and databases: Virtual private clouds, Cloud models, Private DNS servers (Route 53), Relational database service –DynamoDB, Elastic ache, Redshift.
Module 4	Introducing Amazon API Gateway, Securing an API, Other AWS services and Management services: Analytics services, Application services, CloudWatch, Cloud Formation, Cloud Trail, and OpsWorks. AWS billing and Dealing with disaster: Managing costs, Bottom line impact, Geographic and other concerns, Failure plans, Examining logs.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Cloud Computing Bible	Barrie Sosinsky	John Wiley & Sons	
2	Cloud Computing Security: Foundations and Challenges	JOHN R. VACCA	CRC Press Taylor & Francis Group	2017
3	Learning Amazon Web Services (AWS)_ A Hands-On Guide to the Fundamentals of AWS Cloud	Mark Wilkins	Addison-Wesley Professional	2019
4	The Definitive Guide to AWS Infrastructure Automation _ Craft Infrastructure-as-Code Solutions	Bradley Campbell	Apress	2020
5	Hands-On Azure for Developers_ Implement rich Azure PaaS ecosystems using containers, serverless services, and storage solutions	Kamil Mrzygłód	Packt Publishing	2018
6	Practical Amazon EC2, SQS, Kinesis, and S3_ A Hands-On Approach to AWS	Sunil Gulabani	Apress	2017
7	AWS for System Administrators	Prashant Lakhera	Packt Publishing	2021
8	AWS SysOps cookbook _ practical recipes to build, automate, and manage your AWS-based cloud environments	Lucas Chan_ Rowan Udell_ Eric Z. Beard		2019
9	Practical Microsoft Azure IaaS	Shijimol Ambi Karthikeyan	Apress	2018

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	GCP	Google	Y	MCQs	PearsonVue	https://cloud.google.com/learn/certification?sjid=17308988494416668479-AP
2	AWS	Solutions Architect Associate	Y	65 MCQS	PearsonVue	https://aws.amazon.com/certification/certified-solutions-architect-associate/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	GCP	Google	Commercial
2	EUCALYPTUS, vSphere and vCenter	Dell Technologies	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Practical Continuous Evaluation	10	25
	Home Assignment and Text Books	10	
	ALM	5	
In-Sem Summative	In Sem-1	10	35
	In Sem-2	10	
	Practical In Exam	10	
	MOOCS Exam	5	
End-Sem Summative	End Semester Exam (Paper based)	30	40

CONTINUOUS DELIVERY AND DEVOPS

COURSE CODE	23CS52C3	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the DevOps Tools & Technologies used in devops to build an application.	3	PO1, PO2
CO2	Apply Continuous Integration and Continuous Deployment using Infrastructure as Code using Pipeline.	4	PO5, PO1
CO3	Analyze the need for Containerization in Devops and Examine the Kubernetes Pod Configuration.	4	PO1, PO5
CO4	Inspect about continuous monitoring and container orchestration process	4	PO3, PO5
CO5	Examine and Inspect the Design and Building of Web Based and Open Source Applications of DevOps Life Cycle on Windows and Ubuntu..	4	PO1, PO2, PO5

Syllabus

Module 1	Devops with the changing times, the waterfall model, The agile model, Build automation, Continuous integration Best practices, configuration management, Continuous delivery, Continuous monitoring, Continuous feedback, Code repositories -Git, Build tools -Maven, Continuous integration tools-jenkins, Configuration management tools- chef, Cloud service providers, Container technology-Docker, Monitoring tools-Zenoss, Nagios, Deployment orchestration/Continuous delivery-jenkins, an overview of a sample java EE application
Module 2	Installing Jenkins, The jenkins dashboard, Configuring java and Maven in Jenkins, Creating and configuration a build job for a java application with Maven, Configuring build job and Junit, Managing nodes, Sending e-mail notifications based on build status, Integrating jenkins and Sonar, Building the code and configuring the build pipeline-Creating a Groovy script to build a job, creating a build step to publish test reports, archiving build job artifacts, running a build steps of a build job, creating a pipeline for compiling and executing test units, Installing and Configuring Chef, Overview of hosted chef, Installing and configuring a chef workstation, converging a chef node using a chef workstation, installing software packages using cookbooks, Creating a role.

Module 3	Installing and configuring docker, Overview of docker containers, understanding the difference between virtual machines and containers, installing and configuring docker on CentOS, Creating your first docker container, understanding the client-server architecture of docker, managing containers, creating a docker image from docker file, Kubernetes, Cloud provisioning and Configuration management with chef, installing knife plugins for amazon web services and Microsoft azure, creating and configuring a virtual machine in amazon EC2, creating and configuring a virtual machine in Microsoft azure, docker containers, Deploying application in Docker containers, deploying application in AWS.
Module 4	Monitoring Infrastructure and Applications, Monitoring tools and techniques-Nagios, Monitoring AWS Elastic Beanstalk, Monitoring Microsoft Azure web app service, orchestrating application deployment, creating build jobs for end-to-end automation, configuring SSH authentication using a key, configuring the build pipeline for build job orchestration, executing the pipeline for application deployment automation,

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	DevOps for Web Development	Mitesh Soni	PACKT Publishing	2016
2	Beginning DevOps with Docker	Joseph Muli	PACKT Publishing	2018
3	DevOps With Kubernetes	Hideto Saito, Hui-Chuan Chloe Lee, Cheng-Yang	PACKT Publishing	2019

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	AWS Certified DevOps Engineer - Professional	Amazon	Y	75 Questions-300USD	Amazon	AWS Certified DevOps Engineer - Professional Certification | AWS Certification | AWS (amazon.com)
2	Microsoft Certified: DevOps Engineer Expert	Microsoft	Y	60 Questions	Microsoft	https://learn.microsoft.com/en-us/certifications/devops-engineer/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Jenkins	Jenkins	Jenkins
2	Chef	Chef	Chef Software DevOps Automation Solutions | Chef
3	Docker	Docker	Docker: Accelerated, Containerized Application Development
4	Nagios	Nagios	Nagios - The Industry Standard In IT Infrastructure Monitoring

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Home assignments	7	22
	Quiz	8	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem Exam-I	15	38
	In-Sem Exam-II	15	
	In Semester Lab Exam	8	
End-Sem Summative	End Semester Exam	24	40
	Lab End Exam	16	

IMAGE PROCESSING

COURSE CODE	23CS52C4	MODE	R / M	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the fundamental concepts of a digital image processing system and transformation techniques	2	PO1
CO2	Understand image enhancement techniques in spatial and frequency domains.	2	PO2
CO3	Understand image restoration and compression techniques.	2	PO3
CO4	Understand image segmentation, representations and description	2	PO1

Syllabus

Module 1	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, IMAGE TRANSFORMS – The Discrete Fourier Transform, The FFT, Walsh, Hadamard, Discrete Cosine Transform, The Haar Transform, And The Slant Transform.
Module 2	IMAGE ENHANCEMENT IN SPATIAL DOMAIN: Some basic Grey 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.
Module 3	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.
Module 4	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

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Digital Image Processing, Second Edition	Rafael C Gonzalez, Richard E Woods	Pearson Education Asia	2002
2	DSP Algorithms for Programmers	Jorg Arndt		
3	Digital Image Processing	Gonzalez. R & Woods B.E	Addison Wesley Longman Pearson Education	2000
4	Image Processing Analysis and Machine Vision	MilanSonka, Vaclav Hlavac and Roger Boyle	Thomson learning,Second Edition	2001
5	Digital Image Processing	William J Prati	John Wiley &sons	
6	Image Processing Principles and Applications Principles and Applications	TinkuAcharya, Ajoy K Ray	Wiley- Inter science	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Quiz	LMS / Paper Based	10
	MOOCs Review	LMS / Paper Based /Oral	10
In-Sem Summative	Global Challenges - Leaderboard	LMS	20
	MOOCs Exam	LMS / Paper Based	20

End-Sem Summative	MOOCs Exam	Open Book Exam / Closed Book Exam	40

AR AND VR APPLICATION DEVELOPMENT

COURSE CODE	23CS61C5	MODE	M	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To understand Basics of Augmented Reality and Interactions. Fundamentals of Augmented , Mixed Reality and its features	3	PO1
CO2	To understand Basics of Virtual Reality and Interactions. Fundamental Concept and Components of Virtual Reality	3	PO1,PO5
CO3	To understand Graphics Pipelines, Creating a sample augmented reality apps in android	3	PO1,PO5
CO4	To apply Unity development Environment, IDE Basics, Sprites, User Interfaces, Simple 3D animation Creation	3	PO5
CO5	Develop applications through Lab experiments	3	PO1,PO5

Syllabus

Module 1	Introduction: Introduction to Augmented Reality -Augmented Reality Interactions, Monitor Based Displays, Head mounted Displays, Ar Interaction, Ar Tracking , Augmented and Mixed Reality, Technology and features of augmented reality, Typical AR Experiences, Difference between AR, VR and MR, Challenges with AR, AR systems, Simultaneously Localize and Map Environment, Optical Tracking , AR Tracking and registration , Markers , Holography and Photography, AR System Evaluation approaches, Applying traditional evaluation, AR evaluation types and methods. Introduction to Virtual Reality.
Module 2	Historical development of VR Fundamental Concept and Components of Virtual Reality, Architecture of Virtual Reality, Primary Features and Present Development on Virtual Reality, Typical VR System, The three l's of virtual reality, commercial VR technology and the five classic components of a VR system, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement ,VR Content, Factors in Virtual Reality, Benefits of virtual reality, Typical System Delays, VR Graphics Architecture, Creating virtual reality 360 degree tour in cospaces, Application of virtual reality tour. The Graphics Pipeline VR– Panorama, Stereo Movie, Stereo Panorama , Mono Panoramas , Comparison: Mono and Stereo Panoramas, Spatial Audio for VR, Ambisonics, Motion Sickness.
Module 3	Spherical Harmonics ,Engines & Unity, VR Engines – Audio ,3D Audio, Physics , User Interface (UI), VR Engines – Content Creation, Latency, Post-rendering Warp, Eye Tracking, Filter Applications using SparkAR studio, Applications using lens studio. Introduction to Game Development - Unity development Environment, IDE Basics, Sprites, User Interfaces, Prefabs, Simple 3D animation Creation, Vuforia Engine, Wikitude, ARCore, ARKit, Vumarks

	Designer, Marker based AR with Vuforia and Unity, User Defined Target, Avengers on table using Vumarks, Multiple Image Targets and Vumarks with Vuforia and unity, adding shadow to Scene, Applications using Gdevelop and Flowlab , 3D environment using Blender n to Augmented Reality -Augmented Reality Interactions, Monitor Based Displays, Headmounted Displays, Ar Interaction, Ar Tracking , Augmented and Mixed Reality, Technology and features of augmented reality, Typical AR Experiences, Difference between AR, VR and MR, Challenges with AR, AR systems, Simultaneously Localize and Map Environment, Optical Tracking , AR Tracking and registration , Markers , Holography and Photography, AR System Evaluation.
Module 4	Introduction to Virtual Reality- Historical development of VR Fundamental Concept and Components of Virtual Reality, Architecture of Virtual Reality, Primary Features and Present Development on Virtual Reality, Typical VR System, The three l's of virtual reality, commercial VR technology and the five classic components of a VR system, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement ,VR Content, Factors in Virtual Reality, Benefits of virtual reality, Typical System Delays, VR Graphics Architecture. The Graphics Pipeline VR– Panorama, Stereo Movie, Stereo Panorama , Mono Panoramas , Comparison: Mono and Stereo Panoramas, Spatial Audio for VR, Ambisonics, Motion Sickness– Spherical Harmonics ,Engines & Unity, VR Engines – Audio ,3D Audio, Physics , User Interface (UI), VR Engines – Content Creation, Latency, Post-rendering Warp, Eye Tracking. Introduction to Game Development - Unity development Environment, IDE Basics, Sprites, User Interfaces, Prefabs, Simple 3D animation Creation, Vuforia Engine, Wikitude, ARCore, ARKit, Vumarks Designer, Marker based AR with Vuforia and Unity, User Defined Target, Avengers on table using Vumarks, Multiple Image Targets and Vumarks with Vuforia and unity, adding shadow to Scene.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Understanding Augmented Reality: Concepts and Applications	Alan B. Craig,	MK	2013
2	Understanding Virtua/Reality	William R. Sherman and Alan B. Craigm	Morgan Kaufmann Publishers	2018
3	Android Application development for java programmers	James C Sheusi	CENGAGE LEARNING	2013
4	Game Coding Complete	Mike Mc Shaffrfy and David Graham	CENGAGE LEARNING	2012
5	Virtual Reality	Brett S. Martin,	Norwood House Press	2017
6	Virtual Reality Systems	John Vince,	Pearson Education.	2007
7	Android apps for absolute Beginners	Wallace Jackson,	Apress	2017

8	Fundamentals of Game Design	Ernest Adams and Andrew Rolling,	2nd Edition Prentice Hall / New Riders	2009

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Quiz	LMS / Paper Based	10
	MOOCs Review	LMS / Paper Based /Oral	10
In-Sem Summative	Global Challenges - Leaderboard	LMS	20
	MOOCs Exam	LMS / Paper Based	20
End-Sem Summative	MOOCs Exam	Open Book Exam / Closed Book Exam	40

FULL STACK

ENTERPRISE DEVELOPMENT PROGRAMMING (EP)

COURSE CODE	23CS51F1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the concepts of XML, XSLT and JDBC	3	PO2
CO2	Develop Enterprise Application using Servlet and JSP	3	PO3
CO3	Create Enterprise Application using JSF and build Business Logic using EJB, JNDI and Session Beans	3	PO2
CO4	Implement the concept of JPA, JAX-RS and JMS to build Web -Services. Implement the concepts of XML, XSLT, Servlets, JSP, EJB, JPA, JAX-RS and JMS to build large scale and distributable applications	4	PO2
CO5	To experiment the concept of Enterprise Programming with real world problems	4	PO3

Syllabus

Module 1	XML Features and attributes - XML validation: DTD, XML Schema, XSD - XSLT - XSL Style Sheet to the XML Document - JDBC - JDBC CRUD Operations: Statement and PreparedStatement - Callable Statements - JDBC Transaction Management
Module 2	Servlets - Generic Servlet Class - HttpServlet - Config and Context - ServletRequest and Response Introduction to JSP - Scripting Elements - JSP Implicit Objects and Directives - Action Tags - JSP Exception - MVC - Pagination in JSP - CRUD Operations in JSP.
Module 3	Java EE Comparing Java EE and Java SE - Packaging and Deploying - Java Server Faces (JSF): Introduction, Tag Libraries, Input Validations, Page Navigation - Java Naming and Directory Interface (JNDI)

Module 4	Session Beans: EJB 3x Architecture - Session Beans: Introduction to EJB 3x Architecture - Converting a POJO to an EJB – Working with Stateless and Stateful Session Bean. Java Persistence API – Managing Entity Relationships - JAX-RS – Create and Consuming REST Service. Implement the Feature Rich Project with the Concepts - Hibernate, Spring, Spring Boot, Spring Cloud and Microservices

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	XML: The Complete Reference (Complete Reference Series)	Heather Williamson	McGraw Hill Education India	2^{nd} Edition
2	Java Server Programming Java EE7	Kogent Learning Solutions Inc.	Dreamtech Press	Reprint 2016
3	Advanced Java Programming	Uttam K. Roy	Oxford University Press	Reprint 2015

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	15	25
	Practical Continuous Evaluation	10	
In-Sem Summative	In Sem 1	7.5	35
	In Sem 2	7.5	
	Practical In Sem	10	
	MooC Certification	10	

End-Sem Summative	End-Sem Exam (Paper Based)	20	40
	Lab End Sem Exam	20	

JAVA FULL STACK DEVELOPMENT

COURSE CODE	23CS52F2	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the java full stack concepts on Hibernate, Spring DI, Spring IoC	3	PO3, PO5
CO2	Apply the java full stack concepts on Spring MVC, Spring JDBC and Hiberanate	3	PO3, PO5
CO3	Apply the java full stack concepts on Spring Boot MVC, google maps, 2 step verification, sending mail and sms, captcha generation	3	PO3, PO5
CO4	Apply the java full stack concepts on Spring Cloud and Spring Microservices.	3	PO3, PO5
CO5	Apply the Java Concepts and doing practicals on like Hibernate, Spring, Spring Boot, Spring Cloud and Microservices	3	PO3, PO5

Syllabus

Module 1	Introduction to Maven, JPA, Basic concepts of ORM and its advantages - JDBC Vs Hibernate. Hibernate Architecture - Hibernate Query Language (HQL) - Hibernate Criteria Query Language (HCQL) - Generator Classes in Hibernate - Hibernate Inheritance Mapping - Spring and its advantages. Spring Architecture and modules - Dependency Injection (Setter DI, Constructor DI and Interface DI) - DI with Primitive and Non Primitive Data types - Autowiring using Dependency Injection and IoC.
Module 2	Spring DAO with JDBC (Jdbc Template) - Spring DAO with Hibernate - Illustrate about MVC 2-Tier Architecture - Spring MVC based Web Application using Hibernate framework - Spring MVC Pagination.
Module 3	Spring Boot and Spring Boot Starter ProjectSending MAIL - Dependency Injection and Inversion of Control in Spring Boot - Spring Boot Web Application MVC - Spring Boot with Rest Controller - Spring Boot with DAO to perform CRUD Operations - Spring Boot with Restful Web Services - Sending SMS - Integrating Google Maps - Gmail based 2 way Verification - Captcha Generation and Authentication.
Module 4	Spring Cloud, Cloud Architecture. Features, Components and Its advantages - Spring Cloud Config. Setup version control repository. Integration with repository - Client-Side Load Balancer and Spring Cloud API Gateway - Microservice based application Architecture components and Patterns. - User Interfaces integration with Micro Services. Challenges in Micro Services implementation - Microservices with Spring Cloud - Spring security with JSON Web Token (JWT).

Module 5	Implement the practicals - Hibernate, Spring, Spring Boot, Spring Cloud and Microservices

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Web Technologies: Concepts, Methodologies, Tools, and Applications	Arthur Tatnall	Information Science Reference	4th edition
2	Microservices with Spring Boot and Spring Cloud: Build resilient and scalable microservices using Spring Cloud	Istio and Kubernetes	Packet Publishing LTD	2nd Edition
3	Spring and Hibernate	Santosh Kumar k	Tata McGraw-Hill Education	2009
4	Beginning Spring Boot 2 Applications and Microservices with the Spring Framework	K. Siva Prasad Reddy	Apress	1st edition
5	Java EE 8 Application Development	David R.	Heffelfinger.	1st edition

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Nil					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Eclipse IDE for Enterprise Java Developers - Eclipse IDE 2023-06 – For CO1 and CO3	Eclipse - https://www.eclipse.org/downloads/packages/release/2020-12/r/eclipse-ide-enterprise-java-developers	Open Source
2	STS 4 – For CO2 and CO3	Spring.io - https://spring.io/tools	Open Source
3	MySQL – for Database	Oracle - https://dev.mysql.com/downloads/installer/	Open Source

4	MySQL Workbench – Tool to work with MySQL	Oracle - https://dev.mysql.com/downloads/workbench/	Open Source
5	JDK 20 – For Java Application Development	Oracle - https://www.oracle.com/in/java/technologies/downloads/#jdk20-windows	Open Source
6	JRE 1.8 – For Java Application Runtime Environment	Oracle - https://www.java.com/en/download/manual.jsp	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	15	25
	Practical Continuous Evaluation	10	
In-Sem Summative	In Sem 1	7.5	35
	In Sem 2	7.5	
	Practical In Sem	10	
	MooC Certification	10	
End-Sem Summative	End-Sem Exam (Paper Based)	20	40
	Lab End Sem Exam	20	

PROBLEM-SOLVING USING PYTHON PROGRAMMING

COURSE CODE	23CS61F5	MODE	M	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding the fundamental concepts like Flow control and conditions, File handling, OOPs, and Python modules.	2	PO2,PO5
CO2	Apply various conditional, loop, logical and bitwise operations on different Applications	3	PO2,PO5
CO3	Analyse different techniques related to Modules and packages for creating applications for real world Problems	4	PO2,PO5
CO4	Analyse Object-Oriented Approach, Exceptions and files to handle real world Applications	4	PO2,PO5

Syllabus

Module 1	Introduction to Python, Data Types, Variables, Basic Input-Output Operations, Basic Operators, Boolean Values,
Module 2	Conditional Execution, Loops, Lists and List Processing, Logical and Bitwise Operations, Functions, Tuples, Dictionaries, and Data Processing,
Module 3	Modules, Packages, String and List Methods, and Exceptions.
Module 4	The Object-Oriented Approach: Classes, Methods, Objects, and the Standard Objective Features; Exception Handling, and Working with Files.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Powerful Object-Oriented Programming	Mark Lutz	O'Reilly	
2	Head First Python: A Brain-Friendly Guide	Paul Barry	O'Reilly	2nd Edition

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification

1	PCAP: Programming Essentials in Python	Cisco Net Academy	Y	Multiple Choce	Cisco	https://pythoninstitute.org/pcap

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Pycharm	Jetbrains	Open source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	MOOCs Review	7	
In-Sem Summative	In-Sem 1	19	38
	In-Sem 2	19	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	End-Sem Exam (MCQ based)	16	

PRI
ESSENTIALS OF RESEARCH DESIGN

COURSE CODE	23IE5201	MODE	R	LTPS	1-1-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Illustrate Research objects, steps involved in research and articulate appropriate Research Questions	3	PO1
CO2	Perform Literature Review in a Scholarly style and apply appropriate methods for Data collection	3	PO2
CO3	Represent the data in tabular/Graphical form and prepare data for analysis	3	PO2
CO4	Perform statistical modelling and analysis to optimize the data, prepare the data for publishing.	4	PO2

Syllabus

Module 1	Definition and objectives of Research-Types of research, Various Steps in Research process, Applied Mathematical tools for analysis, developing a research question- Choice of a problem, Literature review, Surveying, Synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.
Module 2	Literature Review (LR)-Meaning and its Types-Narrative and Systematic, LR using Web of Science, Google and Google Scholar, Citations-Types, referencing in academic writing, Citation vs Referencing Vs Bibliography, Citation tools-Zotero, Qualitative Research and its methods, Quantitative Research, and its Methods. Data Collection-Primary data collection using Questionnaire, Google forms, survey monkey, Testing the validity and Reliability of Questionnaire using Factor Analysis and Cronbach's Alpha respectively, Secondary data-sources.
Module 3	Diagrammatic and graphical presentation of data: Diagrams and Graphs of frequency data of one variable- histogram, barcharts-simple, sub-divided and multiple; line charts, Diagrams and Graphs of frequency data of two variables -scatter plot, preparing data for analysis. Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Error Analysis.
Module 4	Analyzing data using one-dimensional statistics, two-dimensional statistics and multidimensional statistics. Technical Writing and Publishing, Conference presentations, Poster Presentations, Plagiarism-check and tools, Self-Plagiarism. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, Design Thinking for Contextualized Problem-Solving and Empathetic Research

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Research Methods for Engineers	C.R. Kothari		
2	Engineering Research Methodology	y Krishnan Nallaperumal		
3	Engineering Research Methodology -A Practical Insight for Researchers	Dipankar Deb and Balas		

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NIL					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	8
	Home Assignments	8	8
	Tutorial Continuous Evaluation	8	8
In-Sem Summative	In-Sem 1	18	18
	In-Sem 2	18	18
End-Sem Summative	End Exam	40	40

AUC

PROFESSIONAL COMMUNICATION SKILLS (CRS)

COURSE CODE	23UC5201	MODE	R / M	LTPS	0-0-4-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To develop and demonstrate principles of listening, speaking, reading and writing in various functional contexts	3	PO 5
CO2	To demonstrate different types of personal and professional skills and apply them for growth in professional zone.	3	PO 5
CO3	Apply the concepts of Mathematical Principles to solve problems on Arithmetic , Algebra & Geometry to improve problem solving ability.	3	PO5
CO4	Apply the concepts and using Logical thinking to solve problems on verbal & Non-Verbal Reasoning to develop Logical thinking skills.	3	PO5

Syllabus

Module 1	A)Vocabulary: Synonyms, Antonyms and One-word substitutes, (B)Reading comprehension, Critical reading, (C) Writing skills: Email writing, report writing and paragraph writing (D) Listening/Speaking Skills: listen & speak, Functional grammar
Module 2	(A) Personal Skills: Intra & Interpersonal skills (B) Assertiveness (C) Group Discussion (D) Resume writing (E) Video resumes (F) Interview skills
Module 3	Simple Equations, Ratio & Partnership, Averages, Percentages, Profit & Loss, Simple & Compound Interest, Numbers, Quadratic Equations & Inequalities, Time & Work, Time, Speed & Distance, Permutations & Combinations, Probability, Mensuration, Data Interpretation.
Module 4	Syllogism, Logical Venn Diagrams, Cubes & Dice, Number& letter series, Number, letter & word Analogy, Odd Man Out, Coding & Decoding, Blood Relations, Directions, clocks, calendars, Number, ranking & Time sequence test, Seating Arrangements, Data Sufficiency.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Business Student's Handbook: Skills for Study and Employment	Fisher, Julie and Bailey, Peter	Cengage Learning	2017
2	The Complete Guide to mastering soft skills for workplace success	Adams, John	Adams media	2019
3	Writing Tools: 55 Essential Strategies for Every Writer	Roy Peter Clark	Little, Brown and Company	2006
4	Quantitative Aptitude	R. S. Agarwal	SCHAND	
5	A Modern Approach to Verbal Reasoning	R. S. Agarwal	SCHAND	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Lingua Skills	Cambridge University	Yes	Online	Cambridge	https://www.cambridgeenglish.org/exams-and-tests/qualifications/business/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NIL		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	8
	Home Assignments	8	8
	Tutorial Continuous Evaluation	8	8
In-Sem Summative	In-Sem 1	18	18
	In-Sem 2	18	18
End-Sem Summative	End Exam	40	40

Y23 M.TECH VLSI SYLLABUS

TRANSFORMATION TECHNIQUES, RANDOM VARIABLES & STOCHASTIC PROCESSES

COURSE CODE	23VL5001	MODE	Offline	LTPS	2-2-0-0	PRE-REQUISITE	

Course Outcomes

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

Syllabus

Module 1	Introduction, Review of Probability Theory, Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete, Continuous and Mixed Random Variables, Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Conditional Distribution, Conditional Density, Properties. Vector Random Variables, Joint Distribution Function, Properties of Joint Distribution, Marginal Distribution Functions, Conditional Distribution and Density, Statistical Independence, Sum of Two Random Variables, Sum of Several Random Variables, Central Limit Theorem: Unequal Distribution, Equal Distributions. OPERATION ON ONE AND MULTIPLT RANDOM VARIABLE-EXPECTATIONS
Module 2	Introduction, Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Chebychev's Inequality, Characteristic Function, Moment Generating Function, Transformations of a Random Variable: Monotonic Transformations for a Continuous Random Variable, Nonmonotonic Transformations of Continuous Random Variable. OPERATIONS ON MULTIPLE RANDOM VARIABLES: Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two Random Variables case, N Random Variables case, Properties, Transformations of Multiple Random Variables, Linear Transformations of Gaussian Random Variables. RANDOM PROCESSES – TEMPORAL CHARACTERISTICS
Module 3	The Random Process Concept, Classification of Processes, Deterministic and Non deterministic Processes, Distribution and Density Functions, Concept of Stationarity and Statistical Independence. First-Order Stationary Processes, Second-order and Wide-Sense Stationarity, Nth-order and Strict- Sense Stationarity, Time Averages and Ergodicity, Autocorrelation Function and its Properties, Cross-Correlation Function and its Properties, Covariance Functions, Gaussian Random Processes, Poisson Random Process. RANDOM PROCESSES -SPECTRAL CHARACTERISTICS

Module 4	The Power Density Spectrum: Properties, Relationship between Power Density Spectrum and Auto correlation Function, The Cross-Power Density Spectrum, Properties. Random Signal Response of Linear Systems: System Response – Convolution, Mean and Mean-squared Value of System Response, Auto correlation Function of Response, Cross-Correlation Functions of Input and Output.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Probability, Random Variables & Random Signal Principles	Peyton Z.Peebles	TMH	2001
2	Probability, Random Variables and Stochastic Processes	Athanasios Papoulis and S.Unnikrisha	PHI	2002
3	Probability and Random Processes with Applications to Signal Processing	Henry Starkand John W.Woods	Pearson	2001

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	6	6
	Home assignments	15	15
	Tutorial	5	5
In-Sem Summative	Sem in 1	17	17
	Sem in 2	17	17
End-Sem Summative	End Semester Exam	40	40

MOS CIRCUIT DESIGN

COURSE CODE	23VL5101	MODE	Offline	LTPS	3-0-2-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply basic concepts of VLSI design flow, Design styles,IC fabrication ,layout design rules for CMOS circuits. and MOS transistor and circuit modeling.	3	PO1,PO3
CO2	Explain and Analyze MOS static characteristics and interconnect effects.	2	PO2, PO1
CO3	Demonstrate the design concepts of Combinational and Sequential MOS logic Circuits.	2	PO1, PO2
CO4	Apply Combinational and Sequential MOS logic Circuits to build different Dynamic logic circuits	3	PO1, PO3
CO5	Construct of Various CMOS Circuits using EDA Tools.	3	PO5

Syllabus

Module 1	Introduction: Classification of CMOS digital circuits and Circuit design, Overview of VLSIdesign methodologies, VLSI design flow, Design hierarchy and concepts, VLSI design styles, Designquality, Packing technology, CAD technology, Fabrication process flow, CMOS n-well process, layoutdesign rules. MOS Transistor and Circuit Modeling: MOS structure, MOS system under external bias,structure and operation of MOS transistor, MOSFET current-voltage characteristics, MOSFET scaling andsmall-geometry effects, MOSFET capacitances, Modeling of MOS transistor using SPICE.
Module 2	MOS Inverterstatic characteristics and Interconnect Effects: Introduction, Resistive-Load Inverter, Inverter with n-typeMOSFET load, CMOS Inverter, Delay-Time Definitions, Calculation of Delay Times, Inverter Design withDelay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, SwitchingPower Dissipation of CMOS Inverters.
Module 3	Combinational and Sequential MOS logic Circuits: Introduction,MOS logic circuits with depletion nMOS loads, CMOS logic Circuits, Complex logic circuits, CMOStransmission gates (Pass gates), Behavior of bistable elements, SR latch circuit, clocked latch and flip-flopcircuits, CMOS D-latch and Edge-triggered flip-flop.
Module 4	Dynamic logic Circuits: Basic principles of passtransistor circuits, voltage bootstrapping, synchronous dynamic circuit techniques, Dynamic CMOS circuittechniques, High-performance dynamic CMOS circuits.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	CMOS Digital Integrated Circuits	Sung-Mo Kang, Yusuf Leblebici	TMH	2003
2	CMOS VLSI Design	Neil H.E. Weste and David. Harris Ayan Banerjee	Pearson	2002
3	Digital IntegratedCircuits	Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic	Pearson	2003

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	8
	Home assignments	6	6
	Lab Weekly Exercise	10	10
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab in Sem Exam	8	8
End-Sem Summative	End Semester Exam	24	24
	Lab End Semester Exam	16	16

DIGITAL VLSI DESIGN

COURSE CODE	23VL5102	MODE	Offline	LTPS	3-0-2-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand and apply the Verilog HDL concepts for combinational logic.	3	PO4, PO5
CO2	Understand and apply the Verilog HDL concepts for sequential logics	3	PO4, PO5
CO3	Apply the synchronous design and ASM techniques in design of digital systems	3	PO4, PO5
CO4	Analyze the reliabilty of digital systems by applying testing techniques	4	PO4, PO5
CO5	Design of various digital systems by using EDA tools	5	PO5, PO3, PO2

Syllabus

Module 1	Digital System Design Automation with Verilog: Digital Design Flow, Verilog HDL, RTL Design with Verilog, Verilog Language Concepts. Combinational Circuit Description: Module Wires, Gate Level Logic, Hierarchical Structures, Assign Statements, Behavioral and combinational Synthesis.
Module 2	Sequential Circuit Description: Sequential Model Basic Memory Components, Functional Registers, State Machine Coding, Sequential Synthesis, Component Test and Verification: Testbench, Testbench Techniques, Design Verification, Assertion Verification.
Module 3	Synchronous Sequential Circuits: Basic Steps, State Assignment Problem, Mealy State Model, Design of FSM, State Minimization Algorithmic State Machine (ASM): ASM Chart, Timing Considerations, Control Implementation, Design with Multiplexers, PLA Control.
Module 4	Asynchronous Sequential Circuits: Asynchronous behavior, Analysis and synthesis of Asynchronous circuits, State Reduction, State Assignment, Hazards. Testing of Logic Circuits: Fault Models, Complexity of test, Path sensitizing, Random Tests, Testing of sequential Circuits, Built-in-self-test.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	A Verilog Synthesis: A Practical Primer	J. Bhasker	Star Galaxy	1998
2	Fundamentals of Digital Logic with Verilog Design"	Stephen Brown and Zvonko Vranesic	TMH	2003
3	Digital Logic and Computer Design	M. Morris Mano	Pearson	2003

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	8
	Home assignments	6	6
	Lab Weekly Exercise	10	10
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab in Sem Exam	8	8
End-Sem Summative	End Semester Exam	24	24
	Lab End Semester Exam	16	16

ANALOG IC DESIGN

COURSE CODE	23VL5103	MODE	Offline	LTPS	3-0-2-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Application of the MOS transistors for the design of single stage amplifiers.	3	PO1, PO3
CO2	Analysis and design of active & passive current Mirrors and the differential amplifiers with qualitative and quantative analysis.	4	PO1, PO3
CO3	Analyze the CMOS Op Amps, and various types of Op Amps with qualitative and quantative approaches.	4	PO1, PO3
CO4	Analyze the high frequency response of CS, CG and CD amplifiers and noise analysis of various amplifiers and analysis of non-linear analog circuits like switched capacitor circuits, PLL, ADC and DAC.	4	PO1, PO3, PO5
CO5	Design and analysis of various MOS analog circuits using Cadence/ LT-SPICE environment for real time applications.	5	PO5,PO7,PO1,PO3

Syllabus

Module 1	The preamble to Analog VLSI: Basic MOS Device physics: MOSFET operation, Drain current equation, MOSFET large and small signal models, second order effects. Single Stage Amplifiers: Introduction, Common source stage - Source follower- Common gate stage - Cascode stage. Single Stage Amplifiers: Common source stage, Source follower, Common gate stage- cascode stage. The single-ended and differential operation, Common mode response, differential pair with MOS loads, Gilbert Cell.
Module 2	Biasing Circuits: Basic current mirrors, cascode current mirrors, - voltage references, supply independent biasing - temperature independent references-PTAT current generation- Constant-Gm Biasing. Basic differential pair- Differential pair with MOS loads and active current mirrors.

Module 3	Operational amplifier stability and Frequency compensation: General Considerations, One and Two Stage Op Amps, Gain Boosting, Comparison, Common mode feedback, Input range limitations, Slew rate, Power Supply Rejection, Noise in Op Amps, General consideration of stability and frequency compensation, Multipole system: Phase margin, Frequency compensation, Compensation of two-stage op Amps, Other compensation techniques.
Module 4	Frequency response of amplifiers and Noise: General considerations, Miller Effect and Association of Poles with Nodes, Common source stage, Source followers, Common gate stage, Cascode stage, Differential pair. Noise: Statistical characteristics of noise, Types of noise, Representation of noise in circuits, Noise in single-stage amplifiers, Noise in differential pairs, and Noise Bandwidth. Feedback: General Consideration of feedback circuits, Feedback topologies, the effect of loading, and the effect of feedback on Noise. Nonlinear Analog circuits & other applications: Precision rectification, phased locked loops, Sampling Switches, switched capacitor integrator, oscillators, ADC, DAC.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	CMOS Analog Circuit Design‖	Phillip Allen and Douglas Holmberg	Oxford University Press	2004
2	Analysis and Design of Analog Integrated Circuits	Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer,	Wiley	2009
3	Bipolar and MOS Analog Integrated circuit desig	Grebene,	Wiley	2009

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	8
	Home assignments	6	6
	Lab Weekly Exercise	10	10
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab in Sem Exam	8	8
End-Sem Summative	End Semester Exam	24	24
	Lab End Semester Exam	16	16

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

COURSE CODE	23EC5101	MODE	Offline	LTPS	2-0-2-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the possibilities offered by AI in finding solutions to domain-independent engineering problems and examine the fundamental blocks for building AI-based computer searches.	3	PO1, PO3
CO2	Analyze machine learning approaches for clustering and classification by demonstrating architecture formulations, learning algorithms, and performance measurements.	4	PO1, PO3
CO3	Analyze and reconfigure the dimensionality of datasets for training and interpret numerically.	4	PO1, PO3
CO4	Apply optimization algorithms and estimate unknown phenomena.	4	PO1, PO3
CO5	Experiment and design AI models on multiple datasets by providing discriminative analysis of the evaluation metrics.	5	PO1, PO3, PO5

Syllabus

Module 1	Introduction and Overview of AI: Meaning of AI, The AI Problems, Task Domains. Problems, Problem Spaces & Search: Defining the Problem as a State Space Search, Production Systems – BFS, DFS, Heuristic Search, Problem & Production System Characteristics, Issues in the Design of Search Programs, Common AI Problems. Knowledge Representation using Rules: Procedural vs Declarative Knowledge, Logic Programming, Forward vs Backward Reasoning, Matching & Control Knowledge.
Module 2	I nt roduct ion to art ificial neur al net works (ANN) PDP m odels: Interactive and competition (IAC) and Constraint Satisfaction (CS) models. Analysis of Feedforward Neural Networks (FFNN): Overview, linear associative networks, perceptron network, multilayer perceptron, gradient descent meth - ods. Analysis of Feedback Neural Networks (FBNN): Overview, Hopfield model, Boltzmann-Gibbs L aw, simulated annealing, Boltzmann machine.
Module 3	Introduction to Machine Learning, Unsupervised & Semi-Supervised Learning: Clustering (K-means, GMMS), Factor Analysis (PCA, LDA). Super- vised Learning: K-Nearest Neighbour, Naive Bayes, Linear Regression, Logistic Regression, Support Vector Machines, Neural Networks and Gaussian Mixture Models Introduction to R Programming.
Module 4	Introduction to Fuzzy logic, Genetic Algorithms: Concept of ”Ge - netics” and ”Evolution” and its application to probabilistic search techniques. Natural Language processing, applications to Computer Vision and Biometrics.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Neural networks and learning machines	Simon Haykin	Pearson	2016

2	Artificial Neural Networks	B Yegnanarayana,	Prentice-Hall	1999
3	Machine Learning	Mitchell, Tom	TMH	2001

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	8
	Home assignments	6	6
	Lab Weekly Exercise	10	10
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab in Sem Exam	8	8
End-Sem Summative	End Semester Exam	24	24
	Lab End Semester Exam	16	16

TERM PAPER

COURSE CODE	23IE5149	MODE	Offline	LTPS	0-0-8-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	The term paper has to be taken up by the MTech Second Semester students. It is based on independent research in one of the areas opted by the student. In a term paper, a student should demonstrate his/her ability in finding out the relevant sources, selection, an illustration of logic, and in organizing the information on the topic, gathering the data, processing, analyzing, and summarizing.	3	PO4

Syllabus

Module 1	The term paper has to be taken up by the MTech First Semester students. It is based on independent research in one of the areas opted by the student. In a term paper, a student should demonstrate his/her ability in finding out the relevant sources, selection, an illustration of logic, and in organizing the information on the topic, gathering the data, processing, analyzing, and summarizing.

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Continuous Evaluation -Project	60	60
In-Sem Summative			
End-Sem Summative	Exam – Report	40	40

ALGORITHMS FOR VLSI DESIGN AUTOMATION

COURSE CODE	23UC5202	MODE	Offline/Moocs	LTPS	0-0-4-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the Algorithmic Graph Theory for the shortest path identification of the graph.	3	PO1, PO3
CO2	Apply and analyze Placement, Floor planning and Routing with suitable algorithms	4	PO1, PO3
CO3	Apply and realize the Physical Design cycle for FPGA's partitioning and routing for segmented and staggered models	4	PO1, PO3

Syllabus

Module 1	Introduction to Design Methodologies: Design Automation tools, Algorithmic Graph Theory, Computational Complexity, Tractable and Intractable Problems
Module 2	Compaction, Placement, Floor planning and Routing Problems, Concepts and Algorithms Modeling: Gate Level Modeling and Simulation, Switch level modeling and simulation, Basic issues and Terminology, Binary- Decision diagram, Two Level Logic Synthesis.
Module 3	Internal representation of the input algorithm, Allocation, Assignment and Scheduling, Some Scheduling Algorithms, Some aspects of Assignment problem, High-level Transformations.
Module 4	Physical Design cycle for FPGA's partitioning and routing for segmented and staggered models. MCM technologies, MCM physical design cycle, Partitioning, Placement-Chip array based and full custom approaches, Routing –Maze routing, Multiple stage routing, Topologic routing, Integrated Pin – Distribution and routing, routing and programmable MCM's.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Algorithms for VLSI Design Automation	S.H.Gerez	John Wiley	1999
2	Algorithms for VLSI Physical Design Automation	Naveed Sherwani	Springer	2003
3	Modern VLSI Design: Systems on silicon	Wayne Wolf	Pearson	2001

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Lab Weekly Exercise	40	40
In-Sem Summative			
End-Sem Summative	Lab End Semester Exam	60	60

LOW POWER VLSI SYSTEM DESIGN

COURSE CODE	22VL5103	MODE	Offline	LTPS	3-0-2-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the physics of power in CMOS circuits	2	PO1, PO3
CO2	Analyses probabilistic power analysis and apply low power techniques at circuit level for CMOS circuits	3	PO1, PO3
CO3	Apply low power techniques at gate level, architecture level and system levels	3	PO1, PO3
CO4	Realize essential tasks in algorithm and architecture level low power design environments and Apply low powerclock tree distribution techniques to create low power devices	3	PO1, PO3
CO5	Experiment and design VLSI circuits with various low power techniques using Cadence VLSI design suite.	5	PO1, PO3, PO5

Syllabus

Module 1	Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. Device & Tech- nology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & De- vice innovation. Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation.
Module 2	Probabilistic power analysis: Random logic signals, probability & fre - quency, probabilistic power analysis techniques, signal entropy. Low Power Circuit's: Transistor and gate sizing, network restructuring and Reorganiza - tion. Special Flip Flops & L atches design, high capacitance nodes, low power digital cells library.
Module 3	Logic level: Gate reorganization, signal gating, logic encoding, state ma- chine encoding, pre-computation logic. Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel archi - tecture with voltage reduction, flow graph transformation, low power arithmetic components.
Module 4	Low power Clock Distribution: Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & packag e co design of clock network. Special Techniques: Power Reduction in Clock net- works, CMOS Floating Node, Low Power Bus Delay balancing, and Low Power Techniques for SRAM.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year

1	Pr actical Low Power Digital VLSI Design	Gar y K. Yeap	KAP	2002
2	Low Power Design Methodologies	Rabaey, Pedram,	Kluwer Academic	2001
3	L ow-Power CMOS VL SI Cir cuit Design	Kaushik Roy, Shar at Pr asad	Wiley	2001

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	8
	Home assignments	6	6
	Lab Weekly Exercise	10	10
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab in Sem Exam	8	8
End-Sem Summative	End Semester Exam	24	24
	Lab End Semester Exam	16	16

ASIC AND FPGA DESIGN

COURSE CODE	22VL5103	MODE	Offline	LTPS	2-0-2-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the physics of power in CMOS circuits	2	PO1, PO3
CO2	Analyses probabilistic power analysis and apply low power techniques at the circuit level for CMOS circuits	3	PO1, PO3
CO3	Apply low power techniques at gate level, architecture level and system levels	3	PO1, PO3
CO4	Realize essential tasks in algorithm and architecture level low power design environments and Apply low power clock tree distribution techniques to create low power devices	3	PO1, PO3
CO5	Experiment and design VLSI circuits with various low-power techniques using Cadence VLSI design suite.	5	PO1, PO3, PO5

Syllabus

Module 1	Introduction t o ASICs: Types of ASICs, Design flow, Economic s o f A S IC s , ASIC cell libr ar ies – CMOS logic cell- data path logic cells – I/O cells – c e ll compiler s. Pr ogr ammable ASICs: The Antifuse, Static RAM, EPROM and EEPROM. MOS Pr ogrammable L ogic Device (PLD);
Module 2	Digit al Syst em Design Aut om at ion wit h VHDL : Entity Declar ation, Architecture Body, Configuration and Package Declaration, Basic Language el- ements, Behavior al, Dataflow and Str uctural Modeling.
Module 3	Programmable Logic t o ASI Cs: PROM, PL As, PAL s, Mas k ed Ga t e A r - r ay ASICs, CPL Ds and FPGAs. Complex Pr ogrammable L ogic Devices: CPLD Ar chitecture, Function Block, I/O Blocks, Clock Dr ivers, Inter Connect, Em- bedded Devices. Field Programmable Gate Arrays: FPGA Architecure, Config - urable Logic Block, Configurable I/O Block, Embedded Devices, Programmable Interconnect, Clock circuitry, SRAM Vs Antifuse Programming. Programmable ASIC L ogic Cells: Actel ACT, Xilinx L CA, Alter a FL EX, Alter a MAX.
Module 4	ASI C Construction: Physical Design FPGA partitioning, Partitioning Methods. Floor Planning & Placement: Floor Planning Goals and Objectives, Measurement of Delay in floor planning, Floor planning tools, I/O and Power planning, Clock planning, Placement terms and definitions, Placement Algo - rithms. Routing: Global routing, Detailed routing, special routing.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Application specific Integrated Circuits	J.S. Smith, Addison Wesley	Addison Wesley	1997

2	A VHDL Pr immer	Jayar am Bhaskar,	Kluwer Academic	2001
3	L ow-Power CMOS VL SI Cir cuit Design	Kaushik Roy, Shar at Pr asad	Wiley	2001

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	8
	Home assignments	6	6
	Lab Weekly Exercise	10	10
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab in Sem Exam	8	8
End-Sem Summative	End Semester Exam	24	24
	Lab End Semester Exam	16	16

NANO EL ECTRONICS

COURSE CODE	22VL5503	MODE	Offline	LTPS	3-0-0-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand nanoelectronics and shrink-down approach	2	PO1
CO2	Interpret the concept behind nano MOSFET and nanodevices	3	PO1
CO3	Apply and Analyze the Schrodinger equation for different types of potentials in one dimension	3	PO1, PO2
CO4	Understand the process of nanofabrication and characterization facilities	2	PO1

Syllabus

Module 1	Introduction: Recent past, the present and its challenges, Future, Overview of basic Nano electronics. Nano electronics & Nanocomputer architectures: Introduction to Nanocomputers, Nanocomputer Architecture, Quantum DOT cellular Automata (QCA), QCA circuits, Single electron circuits, molecular cir - cuits, Logic switches – Interface engineering – Properties (Self-organization, Size-dependent) – Limitations.
Module 2	Nanoelectronic Architectures: Nanofabrication – Nanopatterning of Metal-lic/Semiconducting nanostructures (e-beam/X-ray, Optical lithography, STM/AFM-SEM & Soft-lithography) – Nano phase materials – Self-assembled Inorganic/Organic layers.
Module 3	Spintronics: Introduction, Overview, History & Background, Generation of Spin Polarization Theories of spin Injection, spin relaxation and spin dephasing, Spintronic devices and applications, spin filters, spin diodes, spin transistors.
Module 4	Memory Devices And Sensors: Memory devices and sensors – Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design –ferroelectric thin film properties and integration – calorimetric -sensors – electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases – semiconductor sensor array

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Nanoelectronics & Nanosystems: From Transistor to Molecular & Quan- tum Devices	Karl Goser, JanDienstuhl	Springer	2003
3	Nano Electronics and Information Technology	Rainer Waser	Wiley	2012

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	15	15
	Home assignments	10	10
In-Sem Summative	Sem in 1	17.5	17.5
	Sem in 2	17.5	17.5
End-Sem Summative	End Semester Exam	40	40

TESTING OF VLSI CIRCUITS

COURSE CODE	23VL5401	MODE	Offline	LTPS	3-0-2-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the Testing Strategies of Digital Circuits and Fault Modeling Analysis.	2	PO1
CO2	Interpret the Test Pattern for Testable Combinational & Sequential Circuits	3	PO1
CO3	Apply Adhoc DFT Techniques, Scan Chain Design Rules and test pattern generation for BIST Architectures	3	PO1
CO4	Apply the Faults in Digital Circuits and Memory Architectures	3	PO1
CO5	Design and Analyze a Digital Circuit using testing methods	4	PO1, PO2

Syllabus

Module 1	Role of testing VLSI circuits, VLSI trends affecting testing, Test process and ATE, Fault Modeling: Functional Testing, Structural Testing, Types of Fault Models, Stuck-at Faults, Bridging Faults, cross point faults, Fault detection, Fault location, Fault Equivalence, Fault Dominance, Modeling Levels and Types of Simulators, True value simulation algorithm-Compiled-Code, Event-Driven; Fault Simulation Algorithm-Serial, Parallel, Deductive and Concurrent Fault Simulation.
Module 2	Test generation algorithms-Fault Table -path sensitization-Kohavi-Boolean difference, Test Generation for Combinational and Sequential Circuits, Testability Measures-Test generation for combinational and sequential logic circuits, Testable combinational and sequential logic circuit design.
Module 3	Ad-hoc design, Generic scan-based design, Classical scan-based design-System level DFT approaches, Memory test. Introduction to BIST concepts: Built-In Self-Test: Test pattern generation for BIST, Circular BIST, BIST Architectures
Module 4	Testable Memory Design, Test algorithms, Test generation for Embedded RAMs. Fault Diagnosis Logic: Diagnosis by UUT reduction, Fault Diagnosis for Combinational Circuits, Self-checking design, System Level Diagnosis.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Digital Systems and Testable Design	M. Abramovici, M.A. Breuer and A.D. Friedman	Jaico Publishing House	2003

2	Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits	M.L. Bushnell and V.D. Agrawal	Kluwer Academic Publishers	2002
3	Logic Design Theory	Nripendra N. Biswas	Prentice Hall Publisher	2003

Y23 M.TECH ROBOTICS AND AUTOMATION SYLLABUS

Course Title: Non-Linear Systems and Control Optimization for Robotics

COURSE CODE	23RA5141	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Introduce the need and concept of nonlinear system and optimizations for robotics	2	PO1, PO2
CO2	Impart knowledge about different strategies adopted in the of nonlinear systems for robotics engineering	3	PO2, PO3
CO3	Apply constrained optimization to various physical systems. Implement optimal control algorithms to track the response of the system through a predefined trajectory	3	PO2, PO3
CO4	Familiarize with the design of different types of nonlinear Robotics controllers	3	PO2, PO3

Course Syllabus	
Module	Syllabus
Module 1:	Introduction: Components of Robotics Automatic control systems- Open loop and closed loop systems - Examples - Transfer function Time Domain analysis: Linear, Nonlinear- P, PI and PID modes of feedback control. Overview of robotic dynamics-Forward and inverse dynamics Properties of the dynamic model and case studies- Nonlinear systems and control schemes System stability and types of stability Nonlinear control schemes-Observer based on acceleration, velocity, and position feedback- Numerical simulations using software packages namely MATLAB/MATHEMATICA.
Module 2:	State-space representation of dynamic systems, phase-portraits of second order systems, types of equilibrium points: stable/unstable node, stable/unstable focus, saddle- Existence and uniqueness of solutions: Lipschitz continuity, Picard's iteration method, proof of existence and uniqueness theorem, continuous dependence of solutions on initial conditions; Features of nonlinear dynamical systems: multiple disjoint equilibrium points, limit cycles, Bendixson criterion, Poincare Bendixson criterion- Hamilton-Jacobi-Bellman equation-Pontryagin Maximum Principle
Module 3:	System Stability: Concept of stability – stability & location of the poles in S-plane - Characteristic equation, Routh-Hurwitz stability criterion, Root Locus concepts-Construction of root locus – Nyquist stability - Nyquist stability criterion - Linearization: linearization around an equilibrium point, validity of linearization: hyperbolic equilibrium points, linearization around a solution; Stability analysis: Lyapunov stability of autonomous systems, Lyapunov theorem of stability, converse theorems of Lyapunov theorem, construction of Lyapunov functions:

	Krasovskii method and variable gradient method, LaSalle invariance principle, region of attraction, input/output stability of nonautonomous systems, L-stability
Module 4:	Control of nonlinear systems: describing functions method, passivity theorem, small gain theorem, Kalman-Yakubovich-Popov lemma, Aizermann conjecture, circle/Popov criteria, methods of integral quadratic constraints and quadratic differential forms for designing stabilizing linear controllers, multiplier techniques.

Reference Books:				
Book Sl No	Title	Author(s)	Publisher	Year
Book 1:	Nonlinear systems	H. K. Khalil	Prentice Hall	2002
Book 2:	Nonlinear systems analysis	M. Vidyasagar	Society of Industrial and Applied Mathematics	2002
Book 3	Nonlinear Control Systems: Analysis and Design	H. Marquez	Wiley	2003
Book 4	Nonlinear Control Systems	A. Isidori	Springer	1995
Book 5	Nonlinear Differential Equations and Dynamical Systems	F. Verhulst	Springer	1990

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Solving Nonlinear Equations with MATLAB	Mathworks	N	Online	Math works	https://matlabacademy.mathworks.com/details/solving-nonlinear-equations-with-matlab/rootfinding

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	6	106 6
	Home assignments	5	5
	Tutorial	15	15
In-Sem Summative	Sem in 1	17	17
	Sem in 2	17	17
End-Sem Summative	End-Sem Summative	40	40

Course Title: Robotics: Cyber Physical Systems

COURSE CODE	22RA5142	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Ability to understand cyber-physical systems are and highlight the main challenges they currently face.	2	PO1, PO2
CO2	Ability to Enumerates several fields where cyber-physical systems are widely used.	2	PO2, PO3
CO3	Gain a knowledge Ability to use and develop robotics algorithms and cyber physical systems	3	PO2, PO3
CO4	Creates wider design analysis on RCPS and fabricate engineering systems that interact with humans and the environment and create sustainable solutions	4	PO3, PO4

Course Syllabus	
Module	Syllabus
Module 1:	**Structure and Functions of Cyber Physical Systems**: Key Features of Cyber-Physical Systems-Synchronous Model-Safety Requirements-Asynchronous Model-Liveness Requirements-Dynamical Systems-Timed Model-Real-Time Scheduling
Module 2:	**Advanced Modeling and Simulation of Robotics cyber physical systems(RCPS):**Modeling Physical Systems-Hybrid Systems -Control Theory-Modeling Computational Systems -Coordinate Transformation (Robot Arm)-Game Theory: The Role of Game Theory in CPS Design-Sensing and Actuation based on CPS-Design project
Module 3:	**Drones as Cyber-Physical Systems**: Introduction to the Fourth Industrial Revolution-Drone Flight Ready-Cyber Systems:Drone CyberSystems as CPS Components-Drone Assembly-radio control transmitterradio communication-software-sensors in CPS-Location Sensor-image sensors-Valuing Cyber-Physical Bridging Intensity of Drone - Futurology and Future Prospect of Drone CPS
Module 4:	**Practical Introduction to Human-in-the-Loop Cyber-Physical Systems**: Humans as Elements of Cyber-Physical Systems- Evolution of HiTL Technologies- Theory of HiTLCPSs- Human-in-the-Loop: HandsOn- Future of Human-In-the-Loop Cyber-Physical Systems Case Study Cooperative and Autonomous Systems with cyber-physical systems Teamwork: Design a Robotics cyber-physical system verify with robotics software’s.

Reference Books:

Book Sl No	Title	Author(s)	Publisher	Year
Book 1:	Principles of Cyber-Physical Systems	Rajeev Alur	The MIT Press	2015
Book 2:	Drones as Cyber-Physical Systems_ Concepts and Applications f or the Fourth Industrial Revolution	Jung-Sup Um	Springer Singapore	2019
Book 3	Cyber-Physical Systems_ A Model-Based Approach	Walid M. Taha, Abd-Elhamid M. Taha, Johan Thunberg	Springer International	2020
Book 4	A practical introduction to human-in-the-loop cyber-physical systems	Boavida, Fernando_ Nunes, David_ Silva, Jorge Sá	John Wiley & Sons	2017

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Simscape Onramp	Mathworks	N	Online	Mathworks	https://matlabacademy.mathworks.com/details/simscape-onramp/simscape

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10
	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: IIoT4.0 for Automation and Robotic Systems

COURSE CODE	22RA5143	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Describe IOT, IIOT	2	PO1, PO2
CO2	Understand the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits	3	PO2, PO3
CO3	Understand, design, and develop the real life IoT applications using off the shelf hardware and software	3	PO2, PO3
CO4	Understand the concepts of Design Thinking	3	PO2, PO3

Course Syllabus	
Module	Syllabus
Module 1:	**Overview of Robotic and automation Industrial IoT (IIoT) 4.0**: Industry 4.0 and 5.0 Basic terms – Ecosystem IOT and IIOT -History of IIOT 4.0-Components of IIOT-Robotics Industry IoT 5.0 sensing and process systems -Business Models and Reference Architecture of IIoT-Challenges & Benefits in implementing IIOT 4.0- Business Models and Reference Architecture of IIoT -Service Level Agreement of IIOT 4.0-Characteristics of robotics and automation industry 4.0 IOT.
Module 2:	**Robotic Industry IOT Devices**: IIOT based Sensors and Actuators, Categories, Functionality, and characteristics- Industrial Data Transmission: Foundation Fieldbus, profibus, HART, Interbus, Bitbus, DigitalSTROM, CAN, DeviceNet, LoRaandLoRaWAN. **Industrial Data Acquisition:** Distributed Control System-PLC-SCADA – Factory **IIoT Analytics**: Sentinel forIndustrial Robots IoT 5.0-Categorization of analytics: IIoT and Industry 4.0 context-Mapping of analytics with the IIRA architecture-Discovering OPC
Module 3:	**Cognitive Sensors and IoT4.0**:Introduction to Cognition in IoT-InformationCentric Sensor Networks-for Cognitive IoT- Cognitive-Node Architecture and aDeployment Strategy for the Future Sensor Networks- A Data Delivery Framework forCognitive Information-Centric Sensor Networks in Smart Outdoor MonitoringCognitive Routing Protocol for Disaster-Inspired WSNs on the Internetof ThingsFog-Based Caching and Learningfor Information-Centric Networks-M2M To IOT - M2M Vs IOT – A vision from M2M to IOT – Case Study

Module 4:	Collaborative Man and Machine Workforce (IIoT 4.0):Technological Architecture Collaborative Robots in Industry 5.0-Robotics Modeling and Design:Mathematical Model of a Swarm Robotic-System with Wireless Bidirectional-Energy Transfer -Machine Learning and Deep Learning in Industries IOT 5.0-Pareto Optimal Solutions and Their-Application in Designing Robots-and Robotic Systems. Collaborative Robotics IOT 5.0:Control and Ergonomic Problems of Collaborative Robotics-Human-Robot Interaction Efficiency and Human-Robot Collaboration - Human-Robot Cooperation in Technological Wall Climbing Robot-Features of Human-Exoskeleton Interaction System-Analysis of Dynamics in Human Exoskeleton Collaborative System-Design studies on Siemens Melds Mendix with MindSphere to Boost IIoT Development

Reference Books:				
Book Sl No	Title	Author(s)	Publisher	Year
Book 1:	Hands on Industrial Internet of Things	GiacomoVeneri and Antonio Capasso	Packt publisher	2018
Book 2:	Cognitive Sensors and IoT_ Architecture, Deployment, and Data Delivery	Fadi Al-Turjman	CRC Press	2017
Book 3	Introduction to Industrial Internet of Things and Industry 4. 0	Anandarup Mukherjee, Chandana Roy, and Sudip Misra	Alasdair Gilchrist	2020
Book 4	Robotics_ Industry 4.0 Issues &_ New Intelligent Control Paradigms	Alla G. Kravets	Springer International	1995
Book 5	The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics	Bartodziej, Christoph Jan	Springer	1990
Book 6	Embedded System: Architecture, Programming and Design	Rajkamal	TMH3	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Machine Learning with MATLAB	Mathworks	N	Online	Math works	https://matlabacademy.mathworks.com /details/machine-learning-with-matlab/mlml

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total

In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10
	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: Algorithms for Robotics Sensor Fusion

COURSE CODE	22RA5247	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	The concepts and techniques used in sensor data fusion	3	PO1, PO2
CO2	develop and apply data fusion algorithms	3	PO2, PO3
CO3	The state of the art in multi sensor CO3 / source integration, target tracking and identification	3	PO2, PO3
CO4	Fusion Algorithms for Robotics Sensor Fusion	3	PO3, PO4

Course Syllabus	
Module	Syllabus
Module 1:	Introduction, sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data f usion, Mathematical tools used: Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta - heuristics.
Module 2:	Taxonomy of algorithms for multisensory data fusion. Data association. Identity declaration Estimation: Kalman filtering, practical aspects of Kalman filtering, extended Kalman filters. Decision levels identify fusion. Knowledge based approaches
Module 3:	information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion.
Module 4:	Structures: Tessellated, trees, graphs, and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems within dependability bounds. Implementing data fusion system-3D Sensing and Sensor Fusion: Introduction to Lidar and Point Clouds- Point Cloud Segmentation-Clustering Obstacles Camera Based 2D Feature Tracking- Track an Object in 3D Space - Combining Camera and Lidar- Radar Target Generation and Detection Teamwork: Design studies and Unscented Kalman Filter Highway Project based on Machine Learning, Deep Neural networks sensor fusion algorithms

Reference Books:				
Book Sl No	Title	Author(s)	Publisher	Year
Book 1:	Mathematical techniques in Multisensor data fusion	McMullen	Artech House, Boston	2004
Book 2:	Multisensor Fusion: Fundamentals and Applications with Software	R.R. Brooks and S.S.Iyengar	Prentice Hall	1998
Book 3	Multi sensor data fusion with MATLAB	Jitendra R.Raol	CRC Press	2010
Book 4	Processing: The Model Based Approach	McGraw	Hill Book Company	1987

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Image Processing with MATLAB	Mathworks	N	Online	Math works	https://matlabacademy.mathworks.com/details/image-processing-with-matlab/mlip

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10
	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: Artificial Intelligence and Machine Learning

COURSE CODE	22EC3304	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	To understand the concepts of Artificial Intelligence	2	PO1, PO2
CO2	To understand the concepts of neural networks	2	PO2, PO3
CO3	To elaborate machine learning methods	2	PO2, PO3
CO4	To understand the concepts of Fuzzy logic	2	PO3, PO4

Course Syllabus	
Module	Syllabus
Module 1:	Introduction and Overview of AI: Meaning of AI, The AI Problems, Task Domains. Problems, Problem Spaces & Search: DefiningThe Problem as a State Space Search, Production Systems – BFS, DFS, Heuristic Search, Problem & Production System Characteristics, Issues in the Design of Search Programs, Common AI Problems. Knowledge Representation using Rules: Procedural vs Declarative Knowledge, Logic Programming, Forward vs Backward Reasoning, Matching & Control Knowledge.
Module 2:	Introduction to artificial neural networks (ANN) PDP models: Interactive and competition (IAC) and Constraint Satisfaction (CS) models. Analysis of Feedforward Neural Networks (FFNN): Overview, linear associative networks, perceptron network, multilayer perceptron, gradient descent methods. Analysis of Feedback Neural Networks (FBNN): Overview, Hopfield model, Boltzmann-Gibbs Law, simulated annealing, Boltzmann machine.
Module 3:	Introduction to Machine Learning, Unsupervised & Semi-Supervised Learning: Clustering (K-means, GMMS), Factor Analysis (PCA, LDA). Supervised Learning: K-Nearest Neighbour, Naive Bayes, Linear Regression, Logistic Regression, Support Vector Machines, Neural Networks and Gaussian Mixture Models Introduction to R Programming.
Module 4:	Introduction to Fuzzy logic, Genetic Algorithms: Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques. Natural Language processing, applicationsto Computer Vision and Biometrics

Reference Books:				
Book Sl No	Title	Author(s)	Publisher	Year
Book 1:	Neural networks and learning machines	Simon Haykin	Pearson Education	2016
Book 2:	Artificial Neural Networks	B Yegnanarayana	Prentice-Hall of India	1999
Book 3	Machine Learning	Mitchell, Tom	NY: McGraw-Hill	1997
Book 4	Information Theory, Inference, and Learning Algorithms.	MacKay, David	UK: Cambridge University Press	2003

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Deep Learning with MATLAB	Mathworks	N	Online	Mathworks	https://matlabacademy.mathworks.com/details/deep-learning-with-matlab/mldl

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10
	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: Advanced Robotic Wireless Sensor Networks

COURSE CODE	22RA5244	MODE	R	LTPS	3-0-0-2	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	To know the Basic Robots Advancements and terminologies	3	PO1, PO2
CO2	To impart knowledge in Advances in Robotic Kinematics	3	PO2, PO3
CO3	Examining the Varieties of Robots & Advanced Robotics Heterogeneity (ARH)	3	PO2, PO3
CO4	Understanding the Robotic Wireless Sensor Networks and Design project on various robots	3	PO3, PO4

Course Syllabus	
Module	Syllabus
Module 1:	Basic Robots Advancement: Anatomy of Robot-principles and Laws- brief history-Advancement in Degrees of Freedom (DoF): 6DOF,16DOF-Actuators and Drives-ControlComponents- Kinematics-Differential Motion-Statics, Energy Method-Hybrid Position-force Control-Compliance, End-effecter Design-Non-holonomic Systems-Legged Robots, Multi-fingered HandsDynamics-Computed Torque Control-Computer Vision- NavigationTele-robotics and Virtual Reality.
Module 2:	Advances in Robotic Kinematics: Facts and thoughts-Forward Kinematics 4-1CableDriven Parallel Robot-Inverse KinematicsConvergingPaths Algorithm-1DoF 7-R Closed Loop-Linkage as a Building Block of Nanorobots- Bennett Based Balanced Butterfly LinkAge-CooperativeObject-Manipulation Through a Heterogeneous Mobile-Multi-robot System-Robust Trajectory Planning of UnderActuated-Cable-Driven Parallel Robot with 3 Cables-Kinematic Synthesis Modified Jansen LegMechanism-Kinematics and Orientation Workspace3-DOF Parallel Robotic Wrist-Actuated Spherical Four-Bar Linkages-Real-Time Motion-Planning DynamicEnvironments via EnhancedVelocity Obstacle-Design Project verification on robot simulator CoppeliaSim
Module 3:	Varieties of Robots & Advanced Robotics Heterogeneity (ARH)Design Studies on Boston Dynamics Products: Cheetah, Atlas, SpotMini, Legged Robots, Wheeled Robots, Mobile Robots, Telerobots, Service Robots; Design considerations On: Large Robots, Miniature Robot(Swarm robotics), Auto-bots, Swarm-Robotics, Micro-bots, wheeled mobile robots, bipeds,KUKA Collaborative Robot Serie, autonomous Underwater Vehicle, Unmanned Aerial Vehicle; Reactor Pressure Vessel (RPV) Measuring Robots, Introduction to Autonomous Electric Vehicles(AEVs)- Design Project verification on robot simulator CoppeliaSim.

Module 4:	Robotic Wireless Sensor Networks: Basic terms of RWSN-Architecture -working principles of RWSN-robotics Router- RSSI Models, Measurements, and RF mapping- RWSN Systems Components Communication Aware Robot Positioning and Movement Control RWSN Network Stack Layer Analysis IoT and Wireless Sensor Network based Autonomous Farming Robot

Reference Books:				
Book Sl No	Title	Author(s)	Publisher	Year
Book 1:	Robot Analysis and Control	Asada, H., and J. J. Slotine	NY: Wiley	1986
Book 2:	Advances in Robot Kinematics 2020	JadranLenarcic, Bruno Siciliano	Springer International Publishing	2022
Book 3	Approaches to Probabilistic Model Learning for Mobile Manipulation Robots	Jürgen Sturm	Springer-Verlag Berlin Heidelberg	2013
Book 4	Indoor robot localization based on wireless sensor networks	Cheng, Long, Cheng-Dong Wu, and Yun-Zhou Zhang.	IEEE Transactions on Consumer Electronics 57.3	2011
Book 5	Advanced Technologies in Robotics and Intelligent Systems_ Proceedings	Sergey Yu. Misyurin, Vigen Arakelian, Arutyun I. Avetisyan	ITR 2019	2005
Book 6	Probabilistic Robotics	Sergey Yu. Misyurin, Vigen Arakelian, Arutyun I. Avetisyan	August 2005	2020

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Wireless Communications Onramp	Mathworks	N	Online	Math works	https://matlabacademy.mathworks.com/details/wireless-communications-onramp/wireless

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10
	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: Autonomous mobile robots and Automotive Electronics

COURSE CODE	22RA5245	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Understand the basics of Autonomous Mobile Robots dynamics and design electronics to complement those features.	3	PO1, PO2
CO2	Understand Mobile robot kinematics and dynamics, Motion Control	3	PO2, PO3
CO3	Examining the autonomous mobile robot Perceptions with algorithms.	3	PO2, PO3
CO4	Design studies on embedded to Automotive Electronics protocols vehicle testing, vibration.	3	PO3, PO4

Course Syllabus	
Module	Syllabus
Module 1:	Introduction: Outdoor Mobile Robots-Mechanism Robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability. Mobile robot kinematics and dynamics: Forward and inverse kinematics, holonomic and nonholonomic constraints,kinematic models of simple car and legged robots, dynamics simulation of mobile robots. Motion Control: Cooperative Motion control land sensing Architecturekinematic Motion Control Sensory System: basic terms-relative position sensor-first tier data fusion-second tier data fusion-static testing of the RPS-Testing of the RPS and data fusion
Module 2:	Robust Motion Control: kinematic and dynamic models-single axle nonlinear damping control design-multi axle distributed control design - controller evaluation Perception: Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors formobile robots like global positioning system (GPS), Doppler effect-based sensors, vision-based sensors, uncertaintyin sensing, filtering
Module 3:	Localization: Terrain inclination based localization and mapping - Odometric position estimation, belief representation, probabilistic mapping, Markov localization,Bayesian localization, Kalman localization, positioning beacon systems;Introduction to planning and navigation: path planning algorithms based on A-star, Dijkstra, Voronoi diagrams,probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP),stochastic dynamic programming (SDP);Planning and Cloud based localization architecture in large scale environments: basics-cloud based outsourcing localization architecture-cloud based localization algorithms-Design project

Module 4:	Embedded to Automotive Electronics and autonomous Vehicles Fundamentals of Automotive Electronics (FAE)-Advanced driver assistance systems-Controlled Area Network (CAN)-Local Interconnect Network (LIN) -FlexRay Consortium -Media Oriented Systems Transport (MOST)- Vehicle Area Network (VAN)-Integrated to Automotive Electronic Protocols: EBD, Electronics stability programs (ESP)- OPC, Remotely Piloted Vehicles (RPVs)-UAV-Vehicle Networking & Diagnostics Stacks; Automotive Functional Testing: The Process Flow-diagram. HIL Testing, MIL Testing, SIL Testing. Navigation Robotics Design Project: Students will work on a semester long project consisting of design, fabrication, and programming a mobile robotic platform

Reference Books:				
Book Sl No	Title	Author(s)	Publisher	Year
Book 1:	Autonomous mobile robots in unknown outdoor environment	Xiaorui Zhu_ Youngshik Kim_ Mark A Mino	CRC Press	2018
Book 2:	Introduction to Autonomous Mobile Robots	R. Siegwart, I. R. Nourbakhsh,	The MIT Press	2011
Book 3	Planning Algorithms	S. M. LaValle	Cambridge University Press	2006
Book 4	Intelligent Robotics and Autonomous Agents	Roland Siegwart_ Illah Reza Nourbakhsh_ Davide Scaramuzza	MIT Press	2011
Book 5	Probabilistic Robotics	Thrun, S., Burgard,W., and Fox, D	MIT Press	2005
Book 6	Arduino and Kinect Projects: Design, Build, Blow Their Minds	Melgar, E. R., Diez, C. C.	CRC	2012

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Stateflow Onramp	Mathworks	N	Online	Mathworks	https://matlabacademy.mathworks.com/details/stateflow-onramp/stateflow

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10
	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: Robotics: Design of Sensors, Drives and Actuators

COURSE CODE	23RA51A1	MODE	A	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Acquire knowledge about the fundamental principles, Robot Sensors, and implementation strategies of Internal Sensors and Inertial Sensors	2	PO1, PO2
CO2	Provide solutions for Ultrasonic Sensors in Home, industry, Vision, Stereo Vision, and Proximity Sensors	2	PO2, PO3
CO3	Apply the knowledge on Robot Actuators and Industrial Robots, cooperative robotics Electrical actuators to form an automated kitchen	3	PO2, PO3
CO4	Apply the fundamentals of Motors, DC Motors, and Functionality of the Harmonic Drive to design a simple robot	3	PO2, PO3

Course Syllabus	
Module	Syllabus
Module 1:	Introduction to Robot Sensors -Definition, types, merits, and Internal Sensors and External Sensors, and operations-Optical Encoder-Basic elements of Other position sensor: Potentiometer, -Levels of Velocity Measurement - Process, Inertial Sensors, Applications of Gyroscopes, -An overview of Accelerometer, - Fundamentals of Force Sensors, Torque Sensor, Range Sensors, IR Range Sensors, Limitations of Infrared Sensors, Time of Flight Range Sensors.
Module 2:	Ultrasonic Sensors: Introduction Ultrasonic Sensors; Determining Limitations of Ultrasonic Sensors; Laser Ranger Finder: Example (Laser Range Finder), Vision, Stereo Vision, and Proximity Sensors, Infrared (IR) Detector, Touch Sensors, Tactile Sensors
Module 3:	Robot Actuators and Industrial Robots: Study of Basic Functionality of Robot Actuators, Operations of Electrical actuators; Robotics Hydraulic actuators in Advanced Automation; Pneumatic actuators in conveyor Belts operations, robots in industry real time embedded systems, Industrial Robots: Approach Manipulators by Using Visual; Tracking Over a Distributed System; Baggage Collection Automation Applications for Human Safety: Dangerous domains for humans, (Mine Detection), Hazardous domains for humans (chemical fumes etc.), Nuclear Biological Chemical warfare, dangerous exploratory missions UAVs, unmanned Rockets, Mars Mission, Chandrayaan.
Module 4:	Introduction to Motors and Drives: Fundamentals of Motors, T DC Motors; Stepping Motors, Principles of Servo Motors, Working Definition of Motion Transmission, Gear Ratio, Functionality of the Harmonic Drive, feature and

	limitation drive; Axis drive arrangements, ball screw, timing belts and couplings, Analog and digital drives. AC&DC servomotors, DC and AC servo drives for axis motors, servo tuning. Stepper motors and drives, spindle motors & drives DC &AC. Selection criteria, drive optimization and protection.

Reference Books:				
Sl No	Title	Author(s)	Publisher	Year
1	Robotics and Control	R K Mittal and I J Nagrath	Tata McGraw Hill	2003
2	Performance Modeling of Automated Manufacturing Syetms	N.Viswanadham and Y.Narahari	Printice Hall India Pvt. Ltd	1999
3	Mechatronics	R K Mittal	Tata McGraw Hill	1998
4	Production Systems, and computer integrated Manufacturing	Mikell P Groover	Prentice Hall	2001
5	Robotics Technology and Flexible Automation‖	Deb S R.and DebS	Tata McGraw Hill	2010

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Simulink Fundamentals	Mathworks	N	Online	Mathworks	https://matlabacademy.mathworks.com/details/simulink-fundamentals/slbe

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10
	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: Robotics: Autonomous mobile robot systems

COURSE CODE	22RA51A2	MODE	A	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Apply the basic mechanical and electrical systems concerning robots' locomotion and manipulation.	3	PO1, PSO1
CO2	Apply the mathematical models and computational and motion control methods to mobile robotic systems.	3	PO1, PSO1
CO3	Apply the sensor systems related to state measurements, navigation, and localization.	3	PO1, PO3, PSO1
CO4	Analyse the A-star, Dijkstra algorithm for planning the required path.	4	PO1, PO2, PO4, PO12, PSO1

Course Syllabus	
Module	Syllabus
Module 1:	Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion. Types of mobile robots: ground robots (wheeled and legged robots), aerial robots, underwater robots, and water surface robots. Robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots, stability, manoeuvrability, controllability; mobile robots.
Module 2:	Mobile robot kinematics and dynamics: Kinematics of wheeled mobile robot, degree of freedom, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots. Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots; Dynamics of mobile robot: Lagrange-Euler and Newton-Euler methods. Computer based dynamic (numerical) simulation of different wheeled mobile robots.
Module 3:	Perception: Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots magnetic and optical position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual and motion sensing systems. Doppler effect-based sensors, vision-based sensors, uncertainty in sensing, filtering.
Module 4:	Path planning and navigation: Robot navigation: Localization, Error propagation model, Probabilistic map-based localisation, Autonomous map building, Simultaneous localization, and mapping (SLAM). path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP).

Reference Books:				
Sl No	Title	Author(s)	Publisher	Year
1.	Introduction to Autonomous Mobile Robots	R. Siegwart, I. R. Nourbakhsh	MIT Press	2011
2.	Robotics, Vision, and Control: Fundamental Algorithms in MATLAB	Peter Corke	Springer	2011
3.	Planning Algorithms	S. M. LaValle	Cambridge University Press	2006
4.	On-Road Intelligent Vehicles: Motion Planning for Intelligent Transportation Systems	Rahul Kala	Butterworth-Heinemann	2016
5.	Probabilistic Robotics	Thrun, S., Burgard,W., and Fox, D.	MIT Press	2005
6.	Autonomous Vehicles Volume 1: Using Machine Intelligence	Romil Rawat	Wiley	2022
7.	Introduction to Mobile Robot Control	SG Tzafestas	Elsevier	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Computer Vision Onramp	Mathworks	N	Online	Mathworks	https://matlabacademy.mathworks.com/details/computer-vision-onramp/orcv

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10
	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: Swarm Robotics Control Systems

COURSE CODE	23RA51A4	MODE	A	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Apply the principles and various Swam Robotics Control Systems for direction study	3	PO1, PO3, PSO2
CO2	Apply multi-agent systems, parallel, scalable, stable for different types of tasks	3	PO1, PO3, PO4, PSO2
CO3	Apply concepts of Swam Robotics Control Systems and Creating Advanced behavior module.	3	PO1, PO3, PO12, PSO2
CO4	Apply the Cooperative algorithms, earlier progress of swarm robotics algorithms, Features of swarm robotics algorithm for navigate and control swarm movements effectively	3	PO3, PO4, PO12, PSO1, PSO2

Course Syllabus	
Module	Syllabus
Module 1:	Swarm and robotics, several aspects. Definition swarm robotics, Characteristics of nature swarms, nature swarm, special features of the swarm robotics, single robot and other multi-individual systems, nature swarm to swarm intelligence, Advantages of swarm robotics
Module 2:	Scalable, Stable, Economical, Energy efficient, Different multi-agent systems: Tasks cover large area robot, Tasks dangerous to robot, scaling population and redundancy, Swarm robotics system in real life. Modelling swarm robotics, General model of swarm robotics, Information exchange module, Direct communication, Communication through environment- Sensing, Basic behaviour module.
Module 3:	Swarm robotics. Sensor-based modelling, microscopic modelling, Macroscopic modelling, Modelling swarm intelligence algorithms, Cooperation schemes between robots, Architecture of swarm, Locating, Physical connections, Self-organization and self-assembly, Entity projects and simulations.
Module 4:	Earlier progress of swarm robotics algorithms, Features of swarm robotics algorithm, Simple, Scalable, Decentralization, Local, Parallel, Fundamental tasks of swarm robotics, Formation, Potential field functions, Positioning and navigation, Navigation, Obstacle avoidance, Swarm robotics searching algorithms, inspired from swarm intelligence algorithms, Optimizing the parameters, Modelling the individual behaviours, Mixing and Inspired methods. Processes (MDP), stochastic dynamic programming (SDP).

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1.	Swarm Robotics: A Formal Approach	Elhadi Shakshuki	Springer	2019
2.	Swarm Robotics: Synchronization and Control	Alejandro Ribeiro and Pramod Varshney	Wiley	2018
3.	Swarm Robotics: A Comprehensive Guide	Sabine Hauert, Vito Trianni, and Elio Tuci	CRC Press	2018
4.	Principles of Robot Motion: Theory, Algorithms, and Implementations	Howie Choset, Kevin M. Lynch, et al.	The MIT Press	2005
5.	Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies	Dario Floreano and Claudio Mattiussi	The MIT Press	2008

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	MATLAB for Data Processing and Visualization	Mathworks	N	Online	Math works	https://matlabacademy.mathworks.com/details/matlab-for-data-processing-and-visualization/mlvi

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	10	10
	Home assignments	10	10
In-Sem Summative	Sem in 1	20	20
	Sem in 2	20	20
End-Sem Summative	End-Sem Summative	40	40

Course Title: Human Machine Interface & Brain Machine Interface (HMI&BMI)

COURSE CODE	23RA51B2	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Apply the basics of HMI: Asimov's Laws, GUI Design, Aesthetic for the Developments in Bio-Chips	3	PO1, PO2
CO2	Apply the HMI Technologies such as GMOS Models, CMN-GOMS, Fitts Laws, Hick Hyman Laws and Norman's 7 Principles for effective human machine interface.	3	PO2, PO3
CO3	Apply the concept of Brainwaves & BMI in ARMA Model	3	PO2, PO3
CO4	Appy Humanoids & HMI/BMI for the Applications: Hierarchical Task Analysis, Dialog Design, Use of FEM	3	PO3, PO4

Course Syllabus	
Module	Syllabus
Module 1:	Intro. to HMI: Asimov's Laws, GUI Design, Aesthetics, Developments in Bio-Chips, Heuristics Introduction to the course and to HMI/HCI, HMI/HCI Its history Relation to Ergonomics and Human Factors Problems and challenges Recurrent HMI Themes, Historical evolution of the field, Concept of usability - definition and elaboration, HCI an d software engineering, GUI design and aesthetics, Prototyping techniques.
Module 2:	Design rules Authority vs. generality Principles, introduction to different types of models, GOMS family of models (KLM and CMN-GOMS, Fitts' law and Hick-Hyman's law, Guidelines in HCI: Norman's seven principles, Norman's model of interaction, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough
Module 3:	Brainwaves & BMI: Alpha, Beta, Theta, Gamma wave, Brain-Control Interface, ARMA Model -Introduction to Brain Control Interface Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, Non-invasive, and Partially invasive BCI Brain signal acquisition, Experiment design and data analysis (with explanation of one-way ANOVA), ARMA Model MEMS Simulators-Team-Design studies on MEMS based Sensors and Actuators: Using COMSOL Multiphysics
Module 4:	Humanoids & HMI/BMI Applications: Hierarchical Task] Analysis, Dialog Design, Use of FSM] Task modelling and analysis through Hierarchical task analysis (HTA), GUI design for a mobile phone based Matrimonial application, Employment Information System for unorganized construction workers on a Mobile Phone. Dialog Design using FSM (finite state machines), Cognitive architecture, Object Oriented Modelling of User Interface Design

Reference Books:				
Sl No	Title	Author(s)	Publisher	Year
Book 1:	Human Computer Interaction	Dix A., Finlay J., Abowd G. D., and Beale R.	Pearson Education	2005
Book 2:	Human Computer Interaction	Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T	Addison-Wesley	1994
Book 3	Designing the User Interface	B. Schneiderman	Indian Reprint	2000
Book 4	Brain Computer Interfaces: Principles and practice	Jonathan Wolpaw, Elizabeth Winter Wolpaw	Oxford University Press	2012

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Deep Learning with MATLAB	Mathworks	N	Online	Mathworks	https://matlabacademy.mathworks.com/details/deep-learning-with-matlab/mldl

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10
	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: Computer Vision & Applications

COURSE CODE	23EC51B3	MODE	A	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Apply the fundamental concepts of signal processing to computer vision	3	PO1, PSO1
CO2	Apply different methodologies of feature extraction, pattern analysis and visual geometric modelling to stochastic optimization problems	3	PO1, PO5, PSO1
CO3	Apply various Boundary and Edge Detection techniques in 3D signal (Video).	3	PO1, PO5, PSO1
CO4	Analyze the classifiers in different applications such as Biometrics, Medical diagnosis, document processing, mining of visual content, surveillance, and advanced rendering.	4	PO1, PO2, PO5, PSO1

Course Syllabus	
Module	Syllabus
Module 1:	Introduction to Computer Vision (CV) Basic Block Diagram Computer Vision; Principle of Computer Vision; Perception of 2 Dimensional & 3Dimensional Transformation (2 DCVT &3DCT); 3D Rotation; Histogram, Texture Analysis; Image formation, Geometric Primitives and transformations, Geometric Primitives, 3 D to 2D Projections, Lens distortions, Color, Compositing and matting, Point, Pixel transforms, Histogram equalization, Application: Tonal adjustment, 4D to 11D Transformation on CV.
Module 2:	Optical Features Extraction (OFE) Overview of Feature Extraction on Computer Vision ; Edges, HOG, SIFT, SURF, DTW, Gabor Filter, Scale Space Analysis; Analysis Edges, Edge detection , Edge linking , Application: Edge editing and enhancement ,A comparative study of CFs, LBP, HOG, SIFT, SURF, and BRIEF for security and face recognition , Gabor filter for image processing and computer vision
Module 3:	Video Features & CV Methods Optical Flow, Optical Flowrate, Elastic Band, Boundary Detection. Optical Flow-Rate, Optical Flow Estimation, Elastic Band, Selection of Terminal Point of the Line, Texture Segmentation, Edge Flow and Anisotropic Diffusion, Edge Flow Definition, Edge Flow Intensity, Edge Flow Texture, Edge Flow, Edge Flow Based on Gabor Phase, Edge Flow Integration, Edge Flow Propagation and Boundary Detection.
Module 4:	Pattern Analysis-Dimension Reduction VQ, ICA, KNN, PCA, LDA, Classifiers: GMM, SVM, CNN, DNN, Gaussian Mixture Model and Deep Neural Network Recognizing f aces with PCA and ICA, K-nearest Neighbors (KNN) ,Classification ModelLDA in Python for Computer Vision

	,LDA in Python for Computer Vision, Deep Learning for Computer Vision, Support Vector Machines (SVM), Image Processing with the Computer Vision APIvision field, LDA in Python for Computer Vision, Robust Principal Component Analysis for Computer Vision, Diagnosis and Treatment of Computer Vision Syndrome, Image Classifier using CNN

Reference Books:				
Sl No	Title	Author(s)	Publisher	Year
1	Computer Vision: Algorithms and Applications	Richard Szeliski	Springer	2010
2	Computer Vision: Models, Learning, and Inference	Simon J. D. Prince	Cambridge University Press	2012
3	Deep Learning for Computer Vision: Expert techniques to train advanced neural networks using TensorFlow and Keras	Rajalingappaa Shanmugamani	Packt Publishing	2018
4	Computer Vision: A Modern Approach	David A. Forsyth and Jean Ponce	Prentice Hall	2002

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Computer Vision Onramp	Mathworks	N	Online	Mathworks	https://matlabacademy.mathworks.com/details/computer-vision-onramp/orcv

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	106 8
	Home assignments	10	10

	Lab Weekly exercise	6	6
In-Sem Summative	Sem in 1	14	14
	Sem in 2	14	14
	Lab In Semester Exam	8	8
End-Sem Summative	End-Sem Summative	24	24
	Lab End Semester Exam	16	16

Course Title: Signal Processing for Robotics

COURSE CODE	23RA51C3	MODE	A	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Apply signal processing techniques to solve problems related to perception and control in robotics	3	PO1, PO2, PSO2
CO2	Apply different signal processing algorithms and their applicability to specific robotic system	3	PO2, PO3, PSO2
CO3	Apply mathematical and programming skills to implement signal processing algorithms in robotics.	3	PO2, PO3, PSO2
CO4	Apply and analysis Programming Language: Mobile robots, walking devices. Robot reasoning	4	PO3, PO4, PSO2

Course Syllabus	
Module	Syllabus
Module 1:	Introduction to Signal Processing and Robotics: Overview of signal processing in robotics, Role of signal processing in perception and control, Introduction to robot sensors and data acquisition; Continuous and Discrete Signals: Continuous-time and discrete-time signals, Sampling and quantization, Signal representation and analysis
Module 2:	Signal Filtering: Basics of filtering and noise removal, FIR and IIR filters, Design, and implementation of filters; Fourier Analysis: Fourier series and transform, Frequency domain representation, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT); Time-Frequency Analysis: Short-Time Fourier Transform (STFT), Spectrogram analysis, Wavelet transforms
Module 3:	Image Processing for Robotics: Image acquisition and preprocessing, Image enhancement and restoration, Feature extraction and object recognition; Sensor Fusion: Sensor fusion concepts and techniques, Kalman filters and extended Kalman filters, Multisensor data fusion
Module 4:	Applications of Signal Processing in Robotics: Speech and audio processing for human-robot interaction, Vision-based navigation and mapping, Signal processing in robotic control systems; Hands-on exercises and projects using signal processing libraries, Machine learning in signal processing for robotics, Emerging trends in signal processing and robotics

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Robotics, Vision, and Control: Fundamental Algorithms in MATLAB	Peter Corke	Springer	2017
2	Signal Processing and Performance Analysis for Imaging Systems	Cédric Vonesch and Pierre Vandergheynst	CRC Press	2015
3	Introduction to Random Signals and Applied Kalman Filtering with MATLAB Exercises	Robert Grover Brown and Patrick Y.C. Hwang	Wiley-IEEE Press	2012
4	Digital Image Processing	Rafael C. Gonzalez and Richard E. Woods	Pearson	2018

Global Certifications:

Mapped Global Certifications:

Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Signal Processing with MATLAB	Mathworks	N	Online	Math works	https://matlabacademy.mathworks.com/details/signal-processing-with-matlab/mlsg

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs		10
	Home assignments	10	10
In-Sem Summative	Sem in 1	20	20
	Sem in 2	20	20
End-Sem Summative Evaluation	End-Sem Summative	40	40

Course Title: Automotive Electronics & Avionics

COURSE CODE	22RA51D2	MODE	A	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Apply the basic principles of automotive electronics and avionics in robotics	3	PO1, PO3, PSO1
CO2	Apply vehicle electrical systems, sensors, and electronic control units and Explore communication protocols used in automotive and avionics systems	3	PO1, PO3, PSO1
CO3	Apply the integration of electronic systems in automobiles and aircraft	3	PO1, PO3, PO12, PSO1
CO4	Apply safety and reliability considerations in automotive electronics and avionics and gain an awareness of emerging trends and future developments in the field	3	PO1, PO3, PO4, PO12, PSO1

Course Syllabus	
Module	Syllabus
Module 1:	Introduction to Automotive Electronics and Avionics: Overview of automotive electronics and avionics systems, Evolution and trends in the field, Safety and reliability considerations; Vehicle Electrical Systems: Basics of vehicle electrical systems, Battery, alternator, and electrical wiring, Power distribution and grounding; Electronic Control Units (ECUs): Introduction to ECUs and their functions, Architecture of automotive and avionics ECUs, ECU programming and calibration
Module 2:	Sensors in Automotive Electronics: Introduction to sensors used in vehicles, Engine sensors, temperature sensors, pressure sensors, etc., Sensor characteristics and selection criteria; Communication Protocols: Overview of communication protocols used in automotive and avionics systems, CAN (Controller Area Network), LIN (Local Interconnect Network), FlexRay, ARINC 429, etc., Message formats, bus systems, and diagnostics
Module 3:	Human-Machine Interface (HMI): HMI design considerations for automotive and avionics applications, Displays, controls, and user interaction, Ergonomics, and safety considerations; Automotive Electronics Integration: Integration of electronic systems in vehicles, Wiring harness design and layout, Electromagnetic compatibility (EMC) considerations
Module 4:	Avionics Systems: Introduction to avionics systems in aircraft, Flight control systems, navigation systems, communication systems, etc., Safety-critical considerations in avionics design; Avionics Integration: Integration of avionics systems in aircraft, Certification and regulatory requirements, Maintenance and troubleshooting procedures; Emerging trends in automotive electronics and avionics, Electric and autonomous vehicles

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Automotive Electronics Handbook	Ronald K. Jurgen and Jürgen Leohold	CRC Press	2019
2	Avionics: Elements, Software and Functions	Albert Helfrick and Len Buckwalter	Springer	2017
3	Introduction to Automotive Electronic Systems	Andrew F. Zorowitz and Robert Bosch GmbH	Delmar Cengage Learning	2012
4	Avionics: Development and Implementation	Cary R. Spitzer	Wiley	2016

Global Certifications:

Mapped Global Certifications:

Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Circuit Simulation Onramp	Mathworks	N	Online	Mathworks	https://matlabacademy.mathworks.com/details/circuit-simulation-onramp/circuits

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs		10
	Home assignments	10	10
In-Sem Summative	Sem in 1	20	20
	Sem in 2	20	20
End-Sem Summative Evaluation	End-Sem Summative	40	40

Course Title: Design of Automation Systems and Assistive Robotic Systems

COURSE CODE	22RA51D4	MODE	A	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes:			
CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Understand the fundamental concepts and principles of automation systems and assistive robotic systems	2	PO1, PO3, PSO1
CO2	Apply sensors, actuators, and control systems used in automation and robotics	3	PO1, PO3, PSO1
CO3	Apply human-robot interaction and safety considerations in the design process	3	PO1, PO3, PO12, PSO2
CO4	Apply automation and robotic technologies to solve real-world problems in different domains	3	PO1, PO3, PO4, PO12, PSO2

Course Syllabus	
Module	Syllabus
Module 1:	Introduction to Automation Systems and Robotics: Definition and scope of automation and robotics, Historical overview and current trends, Applications in industry, healthcare, and assistive technologies; Sensors and Actuators for Automation Systems: Classification of sensors and actuators, Selection criteria and performance characteristics, Integration, and interfacing with control systems
Module 2:	Modelling and Control of Automation Systems: Mathematical modelling of dynamic systems, Control system design techniques, PID control and advanced control algorithms; System Integration and Architecture: System components and their interconnections, Communication protocols and networking, Integration of subsystems and software development
Module 3:	Human-Robot Interaction: User-centered design principles, Interface design and usability considerations, Collaborative and cooperative interaction; Safety Considerations in Automation and Robotics: Risk assessment and hazard analysis, Safety standards and regulations, Protective measures and emergency stop systems
Module 4:	Application of Automation and Robotics: Manufacturing automation and robotics, Assistive technologies for individuals with disabilities, Robotics in healthcare and rehabilitation, Analysis of case studies showcasing successful applications, Advanced robotics technologies

Reference Books:				
Sl No	Title	Author(s)	Publisher	Year

1	Industrial Automation: Hands-On	Frank Lamb	McGraw-Hill Education	2013
2	Robotics: Modelling, Planning and Control	Bruno Siciliano and Lorenzo Sciavicco	Springer	2010
3	Introduction to Autonomous Robots: Kinematics, Perception, Localization and Planning	Nikolaus Correll and Bradley Hayes	CRC Press	2019
4	Assistive Robotics: Principles and Practice	Chen-Hua Yeow and Marcelo H. Ang Jr.	World Scientific Publishing Co.	2016

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Image Processing with MATLAB	Mathworks	N	Online	Math works	https://matlabacademy.mathworks.com/details/image-processing-with-matlab/mlip

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	MathWorks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs		10
	Home assignments	10	10
In-Sem Summative	Sem in 1	20	20
	Sem in 2	20	20
End-Sem Summative Evaluation	End-Sem Summative	40	40

DEPARTMENT OF MECHANICAL ENGINEERING

Y23 M.TECH MACHINE DESIGN SYLLABUS

i. COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION (CTEO)

COURSE CODE	23MT5102	MODE	R	LTPS	2-2-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the fundamental concepts of optimization, including types of problems, mathematical formulation, and programming implementation.	2	PO1, PO2, PO3
CO2	Apply mathematical optimization techniques, both unconstrained and constrained, to solve engineering problems using programming languages like Matlab/Python/R.	3	PO1, PO4, PO5
CO3	Analyze and solve multi-objective optimization problems, considering trade-offs and conflicting objectives, using appropriate algorithms and methodologies.	4	PO1, PO4, PO5
CO4	Apply optimization techniques to solve application-specific problems in Machine Design and Thermal Engineering domains, demonstrating domain-specific knowledge and skills.	3	PO1, PO4, PO5

Syllabus

Module 1	Introduction to Engineering Optimization: Basics of optimization, mathematical formulations, and algorithms. Applications in mechanical and machine design.
Module 2	Unconstrained Optimization Techniques: Newton's method, gradient descent, conjugate gradient. Implementation in MATLAB/Python.
Module 3	Constrained Optimization Techniques: Linear and nonlinear constraints, Lagrange multipliers, penalty and barrier methods. Application in mechanical design.
Module 4	Multi-objective Optimization: Pareto optimality, weighted sum, epsilon-constraint methods. Implementing multi-objective optimization using Python.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Engineering Optimization: Methods and Applications"	Ravindran, R., Ragsdell, K. M., & Reklaitis, G. V.	Wiley	2006
2	"Introduction to Optimization"	Chong, E. K. P., & Zak, S. H.	Wiley	2013
3	"Optimization Concepts and Applications in Engineering"	Belegundu, A. D., & Chandrupatla, T. R.	Pearson	2011
4	"Optimization in Practice with MATLAB®: For Engineering Students and Professionals"	Achanta, S., & Darby-Dowman, K.	Cambridge University Press	2015

5	"Applied Optimization: Formulation and Algorithms for Engineering Systems"	Ross, I. J.	Cambridge University Press	1999

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Optimization Engineer (COE)	INFORMS	Y	Online	INFORMS	COE Certification
2	Professional Engineering Optimization Certification	Optimization Firm	Y	Online	Optimization Firm	PE Optimization Certification

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	Software	Commercial
2	Python with NumPy/SciPy	Software	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	24
	Tutorial	8	
	Home Assignment and Book. (Min. 4 Assignments etc.)	8	
In-Sem Summative	In-Sem Exam-I	18	36
	In-Sem Exam-II	18	
End-Sem Summative	End Semester Exam	40	40

ii. Design of experiments (DOE)

COURSE CODE	23MD5101	MODE	R	LTPS	0 0 4 0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the basics of Design of Experiments (DoE) and understand the principles, advantages, and applications in engineering.	3	PO1, PO2, PO4
CO2	Plan and design experiments using various techniques such as factorial designs, response surface methodology, and analysis.	5	PO1, PO3, PO5

Syllabus

Module 1	Introduction to Design of Experiments (DoE): Basics of DoE, principles, advantages, and applications in engineering.

Module 2	Planning and Designing Experiments: Experimental design techniques, factorial designs, response surface methodology, and statistical analysis of data.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives"	Chris Mi, M. Abul Masrur	Wiley	2018
2	"Design of Alternative Energy Systems: Second Edition"	Mohammad Rasul	McGraw-Hill Education	2016
3	"Fundamentals of Electric Vehicle Drives"	Saeed Book Bank	CRC Press	2017
4	"Hybrid and Electric Vehicles: Principles and Applications"	Chris Mi	CRC Press	2013
5	"Advanced Electric Drive Vehicles"	Ali Emadi	CRC Press	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Hybrid Vehicle Design Engineer (CHVDE)	Society of Automotive Engineers (SAE)	Yes	Online Exam	SAE	https://www.sae.org/standards/content/j2882/
2	Electric Vehicle Certified Technician (EVT)	Automotive Service Excellence (ASE)	Yes	Computer-Based Test (CBT)	ASE	https://www.ase.com/Tests/ASE-Certification-Tests

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Minitab	Statistical	Commercial
2	Design-Expert Software	Engineering	Commercial

Evaluation Components:

Evaluation	Component		Weightage	Total
In-Sem Formative	Lab Weekly exercise / Continuous evaluation		12.5	25
	Project Continuous evaluation		12.5	
In-Sem Summative	In Semester Exam-I		17.5	35
	In Semester Exam-II		17.5	
End-Sem Summative	Lab End Sem Exam	Viva	7	40
		Exercise	20	
		Report	5	
	External Review		8	

iii. MODELLING AND ANALYSIS OF MECHANICAL ELEMENTS (MAME)

COURSE CODE	22ME5102	MODE	R	LTPS	2-0-2-4	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	To understand various evaluation criteria's for CAD/CAM system and need of graphics standard.	3	PO4
CO2	To represent different curves and surfaces of geometric models mathematically.	3	PO1,PO2
CO3	To represent solid models using different solid represent schemes	3	PO1,PO2
CO4	To recognize and apply various data exchange formats in geometric modelingand also will be able to apply finite element modeling and mechanical assembly concepts in design applications	3	PO1,PO3
CO5	Build the 3D models		

Syllabus

Module 1	CADTOOLS:Definition of CAD Tools, Types of System, CAD/CAM system evaluation criteria, brieftreatment of input an output devices. Graphics standards, functional areas of CAD, ModelingandViewing, Softwaredocumentation efficient useofCADSoftware.GEOMETRICMODELING:Types of Mathematical representation of curves, wire frame models, wire frame entities,parametric representation of synthetic curves hermit cubic splines, Bezier curves, B-Splinesrationalcurves.
Module 2	SURFACEMODELING:Mathematical representation surfaces, surface model, surface entities, surfacerepresentation,parametricrepresentationofsurfaces,planesurface,rulesurface,surfaceofrevolution,tabularcylinder.PARAMETRICREPRESENTATIONOFSYNTHETICSURFACES:Hermit Bi-Cubic surface, Bezier curve surface, B-Spline surface, COONs, Blending Surface,Sculptured surface, Surface Manipulation- Displaying, segmentation, trimming, intersection,Transformations(2D and3D).
Module 3	GEOMETRICMODELING3D:Solidmodeling, solid representation, Boundary Representation (B-Rep), Constructive SolidGeometry.CAD/CAMDATAEXCHANGE:Evaluationofdata–Exchangeformat,IGESDatarepresentationsandstructure,STEPArchitecture,Implementation, ACIS and DXF.
Module 4	DESIGNAPPLICATIONS:FiniteElementModelingandAnalysisandMechanicalAssembly.COLLABORATIVEENGINEERING:CollaborativeDesign,Principles,Approaches,tools,designssystem.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	CAD/CAM Theory and Practice	Ibrahim Zeid	McGrawHill	1991
2	CAD/CAM	PN Rao	TMH	2002

3	CAD/CAM Principles, Practice and Manufacturing Management	Chris Mc.Mohan, Jimmie Browne	Pearson	
4	Concurrent Engineering Fundamentals: Integrated Product Development	E. Paul DeGarmo, J. Temple Black, Ronald A. Kohser	CRC Press	1991
5	Successful implementation of concurrent Product and Process	Sammy G Sinha	Wiley John and Sons Inc.	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Autodesk Certified Professional: AutoCAD	Autodesk	Yes	Online	Autodesk	AutoCAD Certification
2	ertified SolidWorks Professional (CSWP)	Dassault Systèmes	Yes	Online	Dassault Systèmes	CSWP Certification

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	CNC Train Simulation Software	MTAB	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

iv. Robotics: Manipulator Design and Analysis (RMDA)

COURSE CODE	23MD5102	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Apply homogeneous transformations and DH parameters	Understand	PO1, PO3, PO4
CO2	Apply forward and inverse kinematics to Robots	Apply	PO1, PO2, PO3, PO4
CO3	Apply rigid body dynamics and dynamic modelling to Robots	Apply	PO1, PO2, PO3, PO4
CO4	Design mechanical systems for robot manipulators	Analyse	PO1, PO2, PO3, PO4
CO5	Apply configuration space and motion planning	Apply	PO1, PO2, PO3, PO4

Syllabus

Module 1	1. Introduction to Robotics • Definition of Robotics, Classification of Robots, Robot Components and Architecture 2. Robot Kinematics • Homogeneous Transformations, Denavit-Hartenberg (DH) Parameters
Module 2	1. Forward Kinematics, Inverse Kinematics 2. Robot Dynamics • Rigid Body Dynamics, Lagrange's Equation, Newton-Euler Equations,
Module 3	1. Dynamic Modeling of Manipulators 2. Robot Motion Planning • Configuration Space, Path Planning 3. Motion Planning Algorithms Robot Control • Proportional-Integral-Derivative (PID) Control, Computed-Torque Control
Module 4	1. Robot Manipulator Design • Mechanical Design Considerations 2. Actuators and Drive Systems Robot Sensors and Perception (3 hours) • Sensor Types and Selection, Sensing Techniques for Robotics

Note: During Practical sessions, Robot Programming and Simulation tools will be studied.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Robotics: Modelling, Planning and Control	Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo	Springer	-
2	Introduction to Robotics: Mechanics and Control	John J. Craig	Pearson	-
3	Robot Dynamics and Control	Mark W. Spong, Seth Hutchinson, M. Vidyasagar	Wiley	-

4	Robot Modeling and Control	Mark W. Spong, Seth Hutchinson, M. Vidyasagar	Wiley	-
5	Introduction to Autonomous Robots: Kinematics, Perception, Localization, and Planning	Nikolaus Correll	CRC Press	-
6	Robotics: Control, Sensing, Vision, and Intelligence	K.S. Fu, R.C. Gonzalez, C.S.G. Lee	McGraw-Hill	-

Global Certifications:

Mapped Global Certifications:						
Sl. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Any MBD tool – MSC Adams	MSC Hexagon	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

v. Mechanical Behaviour of Materials><(MBM)>

COURSE CODE	23MD5103	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the significance of compatibility and equilibrium equations. Evaluation of factor of safety against yielding in multi- axial stress state.	4	PO1
CO2	Solve 2-D elasticity problems in Cartesian and Polar coordinate systems	4	PO2
CO3	Analyze the bending of cantilever beams having rectangular and circular cross-sections; Axisymmetric stress and deformation in a solid of revolution ; and simple 3-D stress analysis problems	4	PO1

CO4	Understand the plastic deformation and plastic yielding. Solving problems using the characteristic methods and engineering methods.	4	PO1

Syllabus

Module 1	ELASTICITY: Two dimensional stress analysis - Plane stress - Plane strain – Equations of compatibility - Stress function - Boundary conditions. PROBLEMS IN RECTANGULAR COORDINATES - Solution by polynomials - Saint Venent's principles - Determination of displacement - Simple beam problems.
Module 2	PROBLEMS IN POLAR COORDINATES - General equations in polar coordinates – Stress distribution symmetrical about axis – Strain components in polar coordinates - Simple and symmetric problems.
Module 3	ANALYSIS OF STRESS AND STRAIN IN THREE DIMENSIONS: Principle stresses - Homogeneous deformations - Strain spherical and deviatoric stress - Hydrostatic strain. General theorems: Differential equations of equilibrium and compatibility - Displacement -Uniqueness of solution - Reciprocal theorem.
Module 4	BENDING OF PRISMATIC BARS: Stress function - Bending of cantilever beam - Beam of rectangular cross- section - Beams of circular cross-section. PLASTICITY: Plastic deformation of metals - Structure of metals -Deformation – Creep stress relaxation of deformation - Strain rate condition of constant maximum shear stress - Condition of constant strain energy - Approximate equation of plasticity. METHODS OF SOLVING PRACTICAL PROBLEMS: The characteristic method – Engineering method - Compression of metal under press -Theoretical and experimental data drawing.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Theory of Elasticity	Timoshenko S.P. and Goodier J.N.	McGraw-Hill Education	1970
2	An Engineering Theory of Plasticity	E.P. Unksov	Butterworths	1961
3	Applied Elasticity	C.T. Wang	McGraw-Hill	1953
4	Theory of Plasticity for Engineers	Hoffman and Sacks	McGraw-Hill	1953
5	Theory of Elasticity and Plasticity	Sadhu Singh	Khanna Publishers	1988
6	Theory of Elasticity and Plasticity	Harold Malcolm Westergaard	Dover Publications	1964

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification

1	Understanding Solid Mechanics: Stress analysis approach Stress Analysis Approaches	NAFEMS	Y	MCQS	NAFEMS - Professional Simulation Engineer	https://www.nafems.org/professional-development/certification/
2	Nonlinear FEA	NAFEMS	Y	MCQS	NAFEMS - Professional Simulation Engineer	https://www.nafems.org/professional-development/certification/

Tools used in Practical / Skill:

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	100
	Tutorial	8	100
	Home Assignment and Text Book	8	40
	Skill Continuous Evaluation	NA	NA
In-Sem Summative	Semester in Exam-I	18	50
	Semester in Exam-II	18	50
	Skill in-sem	NA	NA
End-Sem Summative	End Semester Exam	40	100
	Skill end sem exam	NA	NA

vi. ESSENTIALS OF RESEARCH DESIGN> <(ERD)>

COURSE CODE	23IE5201	MODE	R	LTPS	1-1-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Illustrate Research objects, steps involved in research and articulate appropriate Research Questions	3	PO4,PSO1
CO2	Perform Literature Review in a Scholarly style and apply appropriate methods for Data collection	3	PO4,PSO1

CO3	Represent the data in tabular/Graphical form and prepare data for analysis	3	PO1,PSO1
CO4	Perform statistical modelling and analysis to optimize the data, prepare the data for publishing.	4	PO1,PSO1

Syllabus

Module 1	Definition and objectives of Research-Types of research, Various Steps in Research process, Applied Mathematical tools for analysis, developing a research question-Choice of a problem, Literature review, Surveying, Synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.
Module 2	Literature Review (LR)-Meaning and its Types-Narrative and Systematic, LR using Web of Science, Google and Google Scholar, Citations-Types, referencing in academic writing, Citation vs Referencing Vs Bibliography, Citation tools- Zotero, Qualitative Research and its methods, Quantitative Research, and its Methods. Data Collection-Primary data collection using Questionnaire, Google forms, survey monkey, Testing the validity and Reliability of Questionnaire using Factor Analysis and Cronbach's Alpha respectively, Secondary data-sources
Module 3	Diagrammatic and graphical presentation of data: Diagrams and Graphs of frequency data of one variable- histogram, barcharts-simple, sub-divided and multiple; line charts, Diagrams and Graphs of frequency data of two variables -scatter plot, preparing data for analysis. Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Error Analysis.
Module 4	Analyzing data using one-dimensional statistics, two-dimensional statistics and multi-dimensional statistics. Technical Writing and Publishing, Conference presentations, Poster Presentations, Plagiarism-check and tools, Self-Plagiarism. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, Design Thinking for Contextualized Problem-Solving and Empathetic Research.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Research Methodology Methods and Techniques	C.R. Kothari	New Age International	2019
2	Business Research Methods,	Donald R.Cooper, Pamela S. Schhindler	TMH	2018
3	Research Methods for Engineers	David V Thiel	Cambridge University Press	2015
4	Engineering Research Methodology	Krishnan Nallaperumal	Manonmaniam Sundaranar University.	2013
5	Business Research Methods	William G Zikmund	South West Cengage Learning	2013

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification

1	Research Design and Methodology Certification	Global Association of Research Methodology Education and Training (GARMET)	Proctored	Online Multiple Choice Questions	GARMET	https://www.garment.org/certifications/research-design-methodology
2	Certified Research Methodologist (CRM)	International Institute for Applied Knowledge Sciences (IIAKS)	Proctored	Online Exam	IIAKS	https://www.iiaks.org/certifications/certified-research-methodologist

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	24
	HOME ASSIGNMENT AND TEXT BOOK	8	
	TUTORIALS	8	
In-Sem Summative	IN SEM EXAMINATION-I	18	36
	IN SEM EXAMINATION-II	18	
End-Sem Summative	END SEMESTER EXAM	40	40

vii. Advanced Strength of Materials (ASM)

COURSE CODE	23MD5204	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Analyse the stresses and deflections in the beams under unsymmetrical bending and determination of shear centre.	4	PO2
CO2	Analyse the stresses induced in curved beams subjected to loading.	4	PO1, PO2
CO3	Analyse the torsional stresses in beams and determine the contact stresses.	4	PO1, PO2
CO4	Apply principles of elasticity to determine stresses in two-dimensional and three dimensional problems.	4	PO2
CO5	Simulate the structural members using ANSYS software and validate the results with analytical methods	4	PO1, PO2

Syllabus

Module 1	UNSYMMETRICAL BENDING: Bending stress in beams subjected to non-symmetrical bending, deflection of straight beams due to non symmetrical bending. SHEARCENTER:

	Bending axis and shear center-shear center of axisymmetric and unsymmetrical sections.
Module 2	CURVED BEAM THEORY: Winkler Bach formula for circumferential stress- limitation – correct factors- radial stress in curved beams– closed ring subjected to concentrated and uniform loads-stress in chain links. Torsion: Linear elastic solution, Pradtl elastic membrane (Soap-Film) Analogue, Narrow rectangular cross-section, Hollow thin wall torsion members, multiply connected cross-section.
Module 3	CONTACT STRESS: Introduction, problem of determining contact stresses, assumptions on which a solution for contact stresses is based, expression for principle stresses, method of computing contact stresses, deflections of bodies in point contact, stresses for two bodies in contact over narrow rectangular area (Line of contact). Loads normal to area, stressed for two bodies in line contact normal and tangent to contacts area.
Module 4	TWO DIMENSIONAL ELASTICITY PROBLEMS: Plane stress and plain strain – problems in rectangular Coordinates bending of cantilever beam loaded at the end, bending of a beam by uniform load. In polar coordinates, general equations in polar coordinates, stress distribution symmetrical about the axis, pure bending of curved bars, and displacements for symmetrical stress distributions, rotating discs. INTRODUCTION TO THREE DIMENSIONAL PROBLEMS: Uniform stress stretching of a prismatic bar by its own weight, twist o circular shafts of constant cross section, pure bending of plates.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced Mechanics of materials	A.P.Boresi and O.M.Side bottom	Wiely International	2009
2	Theory of Elasticity	Timoschenko S.P. and Goodier J.N	Mc Graw hill Publishers.	1951
3	Advanced strength of materials	Den Hortog J.P.	Dover Publications	2014
4	Theory of plates and shells	S.Timoshenko	McGraw-Hill	1959
5	Strength of Materials and Theory of Structures	B.C Punmai	Laxmi Publications Pvt Limited	2004

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Ansys-Structural analysis	ANSYS	Y	MCQs	Mindbox-ARK Info solutions	https://certifications.ansys.com/associate-certifications/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial

1	ANSYS	ANSYS Inc.	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

viii. Mechanical Vibrations> <(MV)>

COURSE CODE	23MD5205	MODE	Regular	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyse free vibrations of single degree freedom systems	4	PO1,PO2,PSO1
CO2	Analyse harmonically excited vibrations of single degree freedom systems	4	PO1,PO2,PSO1
CO3	Analyse the mode shapes of two degree and multi degree vibration systems	4	PO1,PO2,PSO1
CO4	Identify the means to control and measure the vibration response of the system	4	PO1,PO2,PSO1
CO5	Analyse the vibrations of the system using analysis software	4	PO1,PO4,PSO1

Syllabus

Module 1	Classification of vibrations, Vibration analysis procedure, spring elements, damping elements, Inertia elements, harmonic motion and analysis, free vibration of undamped and damped translational and torsional systems.
Module 2	Response of an undamped and damped systems under harmonic excitation, Response of damped system under harmonic force of the base, Response of damped system under rotating unbalance, Transfer function approach, solution using frequency transfer function.
Module 3	Free vibration analysis of undamped 2DOF systems, coordinate coupling and Principal coordinates, forced vibration analysis, semidefinite system, solutions using Laplace Transform, Modelling of continuous system as multi degree of freedom systems
Module 4	Vibration control and Isolation, Vibration measurement: Transducers, Vibration pickups, frequency measuring instruments, vibration exciters, signal analysis, dynamic testing of machinery and structures, machine condition monitoring and diagnosis.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Mechanical vibrations	S.S.Rao	Pearson	6^{th} edition 2018
2	"Vibration Analysis and Control in Mechanical Systems"	C. M. Harris	CRC Press	2nd Edition, 2001
3	"Mechanical Vibrations: Theory and Applications"	S. Graham Kelly	Cengage Learning	1st Edition, 2012
4	"Vibration Analysis for Electronic Equipment"	Dave S. Steinberg	Wiley-IEEE Press	3rd Edition, 2000
5	"Mechanical Vibrations and Noise Engineering"	A. G. Ambekar	Pearson	1st Edition, 2011

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	"Certified Vibration Analyst Category I"	Vibration Institute	Proctored	Multiple Choice Questions	Vibration Institute	Certified Vibration Analyst Category I
2	"ISO 18436-2 Vibration Analyst Category I"	Mobius Institute	Proctored	Multiple Choice Questions	Mobius Institute	ISO 18436-2 Vibration Analyst Category I

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MAT LAB	MAT LAB	Commercial
2	Msc Adams	Hexagon	Commercial
3	PYTHON	PYTHON	Python

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	CONTINUOUS LAB weekly EXERCISE	7	
	HOME ASSIGNMENT AND TEXT BOOK	7	
In-Sem Summative	IN SEM EXAMINATION-I	15	38
	IN SEM EXAMINATION-II	15	
	LAB IN SEM EXAM	8	
End-Sem Summative	END SEMESTER EXAM	24	40
	LAB End SEM EXAM	16	

ix. Lean Manufacturing> <(LM)>

COURSE CODE	23MD51A1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply Lean principles: Understand and apply the principles of Lean Manufacturing, including waste elimination, standardized work, value stream mapping, and continuous improvement.	2	PO1, PSO1
CO2	Optimize processes: Analyze and optimize manufacturing processes to identify and eliminate waste, reduce variability, and improve efficiency.	2	PO1, PSO1
CO3	Implement visual management: Develop skills to implement visual cues, metrics, and displays to enhance communication, transparency, and problem-solving.	3	PO1, PSO1
CO4	Foster continuous improvement: Create a culture of continuous learning, problem-solving, and improvement using methodologies like PDCA and Kaizen.	3	PO1, PSO1
CO5	Apply Lean Manufacturing principles and tools in a hands-on laboratory setting to optimize manufacturing processes.	3	PO1, PSO1
CO6	<CO for Skill – can be deleted otherwise>		

Syllabus

Module 1	Introduction to Lean Manufacturing – • History and evolution of Lean Manufacturing • Principles and philosophy of Lean, including the Toyota Production System • Lean culture and mindset • Key concepts such as customer value, waste, and continuous improvement
Module 2	Waste Elimination and Value Stream Mapping • Identifying the eight types of waste (TIMWOODS) • Value stream mapping to analyze and improve the flow of materials and information • Techniques for waste elimination, such as 5S, visual management, and error-proofing (Poka-Yoke) • Implementing continuous improvement methodologies like Kaizen events
Module 3	Standardized Work and Just-in-Time Production • Establishing standardized processes, work instructions, and procedures for consistency and quality • Implementing just-in-time production to meet customer demand with minimal inventory and lead times • Kanban systems and pull production techniques • Balancing workloads and leveling production
Module 4	Continuous Improvement and Lean Tools • Creating a culture of continuous improvement and problem-solving • Applying the PDCA (Plan-Do-Check-Act) cycle and other improvement methodologies

	• Exploring additional Lean tools and techniques like SMED, TPM, and Six Sigma • Data analysis and measurement techniques for performance monitoring and decision-making

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer"	Jeffrey Liker	McGraw-Hill,	2004
2	Lean Thinking: Banish Waste and Create Wealth in Your Corporation	Jmes P. Womack and Daniel T. Jones	Free Press,	2003
3	Lean Thinking: Banish Waste and Create Wealth in Your Corporation	Pascal Dennis	Productivity Press,	2007
4	The Lean Six Sigma Pocket Toolbook: A Quick Reference Guide to 100 Tools for Improving Quality and Speed" by Michael L. George, John Maxey, David T. Rowlands, and Malcolm Upton	Michael L. George, John Maxey, David T. Rowlands, and Malcolm Upton	McGraw-Hill Education,	2004
5	Lean Manufacturing for the Small Shop	Gary Conner	Society of Manufacturing Engineers (SME),	2001

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Lean Six Sigma Green Belt Certification Certification Provider	International Association for Six Sigma Certification (IASSC)	Y	Multiple -choice questions	IASSC	https://www.iassc.org/six-sigma-certification/green-belt-certification/
2	Lean Six Sigma Black Belt Certification Certification	American Society for Quality (ASQ)	Y	Multiple -choice questions	ASQ	https://asq.org/cert/six-sigma-black-belt

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	5S Methodology	Manufacturing, Services, Healthcare, etc	Manufacturing, Services, Healthcare, etc
2	Manufacturing, Services, Healthcare, etc	Any Industry	Both (Various methodologies, templates, and software available)

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	Assignment	7	
	Lab Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End Sem Exam	16	

x. PRECISION AND QUALITY ENGINEERING (PQE)

COURSE CODE	23MD51A2	MODE	R	LTPS	2 0 2 0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the principles and techniques of precision engineering for enhancing product quality.	BTL-2	PO1, PO3, PO4
CO2	Analyze and apply statistical methods for quality control and process improvement in manufacturing.	BTL-4	PO2, PO3, PO4
CO3	Explore the concepts of tolerance analysis and its significance in the design and assembly of products.	BTL-3	PO1, PO2, PO3
CO4	Comprehend the principles of metrology and apply measurement techniques to ensure product accuracy.	BTL-4	PO2, PO3, PO5
CO5	Apply precision engineering and quality control techniques through practical exercises and projects.	BTL-5	PO1, PO2, PO3, PO4, PO5, PO11 (where applicable)

Syllabus

Module 1	Introduction to Precision Engineering: Principles, applications, and role in enhancing product quality.
Module 2	Geometric Dimensioning and Tolerancing (GD&T): Standards, symbols, and techniques for design and inspection.
Module 3	Metrology and Measurement Systems: Principles, calibration, and analysis of measurement uncertainties.
Module 4	Statistical Process Control (SPC): Techniques for monitoring and improving process stability and quality.
Module 5	Practical Component: Hands-on experience with precision measurement tools, GD&T application, and SPC software.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year

1	Design for Manufacturability Handbook	James G. Bralla	McGraw-Hill Education	2011
2	Design for Manufacturability and Statistical Design	Scott K. Johnson	CRC Press	2019
3	Design for Manufacturing: A Structured Approach	Corrado Poli	Springer	2018
4	Design for Manufacturing and Assembly	Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight	Marcel Dekker Inc.	2002
5	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Ian Gibson, David W. Rosen, Brent Stucker	Springer	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Quality Engineer (CQE)	American Society for Quality (ASQ)	Y	Multiple-Choice Questions	ASQ	Link
2	Six Sigma Green Belt Certification	International Association for Six Sigma Certification (IASSC)	Y	Multiple-Choice Questions	IASSC	Link

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Coordinate Measuring Machine (CMM)	Manufacturing	Commercial
2	Statistical Process Control (SPC) Software	Quality Assurance	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Lab Weekly exercise	7	22
	ALM (LTC, in-class Quiz, etc.)	8	
	Home Assignment and Book. (Min. 4 Assignments etc.)	7	
In-Sem Summative	In Semester Exam	8	38
	In-Sem Exam-I	15	
	In-Sem Exam-II	15	
End-Sem Summative	End Semester Exam	24	40
	Lab End Exam	16	

xi. Behaviour of Composite Materials> <(BCM)>

COURSE CODE	23MD51A3	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Composite materials, Classifications and Manufacturing Processes	3	PO1, PSO1
CO2	Identify the behavior of composite Lamina at micro level	3	PO1, PO2, PSO1
CO3	Identify the behavior of composite Lamina at macro level	3	PO1, PO2, PSO1
CO4	Apply Failure theories to calculate stresses in composite materials	3	PO1, PO2, PSO1

Syllabus

Module 1	Introduction to composite materials, Geometric definitions, Classification of composites, Types of fibers, Types of the matrix, Hybrid composite, Scale of analysis- micro and macro mechanics approaches, Degree of Anisotropy. Manufacturing methods of the composites, Autoclave molding, Filament winding, and Resin transfer molding.
Module 2	Elastic behavior of composite lamina (Micro-mechanics), Micro-mechanics methods, Geometric aspects and elastic symmetry, Longitudinal elastic properties (Continuous fibers), Transverse elastic properties, In-plane shear properties (Continuous fibers), Longitudinal properties (short fibers)
Module 3	Elastic behavior of composite lamina (Macro mechanics approach), Stress-Strain relations: General anisotropic material, Specially orthotropic material, Transversely isotropic material, Orthotropic material under plane stress, Isotropic material.
Module 4	Standard sizes of the specimen for tensile and compressive, Fatigue tests, and Impact tests of uni-directional composites. Experimental methods for characterization and testing of composite materials. Failure of the composite materials: fiber failures, matrix failure, interface failure. Failure Theories: Tsai-Wu, Tsai-Hill, Puck criterion, Maximum stress, maximum strain.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Engineering Mechanics of Composite Materials	Issac Daniel & Ori Ishai	OUPublisher, USA	2005
2	Mechanics of Composite Materials	Autar K. Kaw	Taylor & Francis	2005
3	Mechanics of Composite Materials	R.M.Jones	Taylor & Francis	1998
4	Composite Materials	N. Chawla and K.K. Chawla	Springer	2006
5	Mechanics of Composite Materials & Structures	Madhujit Mukhopadhyay	University Press	2022

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Ansys-Structral Analysis	ANSYS	Y	MCQs	Mindbox-ARK Info solutions	https://certifications.ansys.com/associate-certifications/
2	Fusion 360	Autodesk	Y	MCQs	Autodesk	https://www.autodesk.com/certification/overview

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA		
2	NA		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	Home Assignments and text book	10	
In-Sem Summative	In sem-1	20	20
	In Sem-2	20	
End-Sem Summative	End Sem Exam	40	40

xii. DESIGN FOR MANUFACTURING (DFM)

COURSE CODE	23MD52C1	MODE	R	LTPS	2 0 2 0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the principles and methodologies of Design for Manufacturing (DFM) and its impact on manufacturing processes.	BTL-2	PO1, PO2, PO3
CO2	Apply design techniques for optimizing part geometry, tolerances, and surface finish to improve manufacturability in machining processes.	BTL-3	PO2, PO3, PO4
CO3	Analyze and incorporate design considerations for casting, forging, and sheet metal forming processes.	BTL-3	PO2, PO3, PO4
CO4	Evaluate the design constraints and opportunities of Additive Manufacturing (AM) techniques in product development.	BTL-6	PO1, PO2, PO3

CO5	Apply DFM principles through case studies, hands-on exercises, and software simulations to optimize manufacturing processes.	BTL-3	PO2, PO4, PO5

Syllabus

Module 1	Introduction to Design for Manufacturing (DFM) principles and methodologies. Understanding the impact of design decisions on manufacturing processes.
Module 2	Design for Machining: Optimizing part geometry, tolerances, and surface finish requirements to improve manufacturability using machining processes.
Module 3	Design for Casting and Forming: Considerations for designing parts for casting, forging, and sheet metal forming processes.
Module 4	Design for Additive Manufacturing (AM): Exploring the design constraints and opportunities for utilizing AM techniques in product development.
Module 5	Practical Component: Application of DFM principles through case studies, hands-on exercises, and software simulations for manufacturing process optimization.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Design for Manufacturability Handbook	James G. Bralla	McGraw-Hill Education	2011
2	Design for Manufacturability and Statistical Design	Scott K. Johnson	CRC Press	2019
3	Design for Manufacturing: A Structured Approach	Corrado Poli	Springer	2018
4	Design for Manufacturing and Assembly	Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight	Marcel Dekker Inc.	2002
5	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Ian Gibson, David W. Rosen, Brent Stucker	Springer	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Manufacturing Technologist (CMfgT)	Society of Manufacturing Engineers (SME)	Yes	Online Proctored	SME	https://www.sme.org/certification/certified-manufacturing-technologist/
2	Certified SolidWorks Associate (CSWA)	Dassault Systèmes	Yes	Online Proctored	Dassault Systèmes	https://www.solidworks.com/sw/support/mcad-certification-programs.htm

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Computer-Aided Design (CAD) Software	Design	Commercial
2	Design for Manufacturing (DFM) Software	Manufacturing	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Lab Weekly exercise	7	22
	ALM (LTC, in-class Quiz, etc.)	8	
	Home Assignment and Book. (Min. 4 Assignments etc.)	7	
In-Sem Summative	In Semester Exam	8	38
	In-Sem Exam-I	15	
	In-Sem Exam-II	15	
End-Sem Summative	End Semester Exam	24	40
	Lab End Exam	16	

xiii. Design for Sustainability (DFS)

COURSE CODE	23MD52B1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	Mapped PO & PSOs
CO1	Understanding the Principles and Importance of Sustainability	Understand	PO5, PO6
CO2	Applying Life Cycle Assessment and Environmental Impact Assessment in Design	Apply	PO1, PO2
CO3	Implementing Sustainable Design Strategies and Principles	Apply	PO1, PO2
CO4	apply Sustainable Manufacturing, Supply Chain, and Assessment Tools	Apply	PO5, PO6, PO7
CO5	apply principles of sustainability in engineering design and develop sustainable solutions	Apply	PO5, PO6, PO7

Syllabus

Module 1	Introduction to Sustainability: Definition and Principles of Sustainability, Importance of Sustainable Design, Environmental, Social, and Economic Dimensions Life Cycle Assessment: Introduction to Life Cycle Assessment (LCA), Life Cycle Thinking and Stages of LCA, Environmental Impact Assessment in Design, Interpretation and Limitations of LCA Results.
Module 2	Sustainable Design Strategies: Design for Disassembly and End-of-Life Management, Material Selection and Substitution, Energy Efficiency and Renewable Energy Integration, Water Conservation and Waste Reduction, Design for Recyclability and Upcycling Sustainable Product Design:

	Design Principles for Sustainable Products, Eco-design and Design Guidelines, Cradle-to-Cradle Design Concepts, Sustainable Packaging Design
Module 3	Sustainable Manufacturing and Supply Chain Lean Manufacturing and Waste Reduction, Green Supply Chain Management, Closed-Loop Systems and Circular Economy, Social and Ethical Considerations in Manufacturing
Module 4	Sustainable Design Assessment Tools Sustainable Design Standards and Certifications (e.g., LEED, BREEAM), Environmental Product Declarations (EPDs), Carbon Footprint Analysis, Social Life Cycle Assessment
Module 5	apply principles of sustainability in engineering design

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Sustainable Design: A Critical Guide	David Bergman	Bloomsbury	-
2	Cradle to Cradle: Remaking the Way We Make Things	William McDonough, Michael Braungart	North Point Press	2002
3	The Upcycle: Beyond Sustainability—Designing for Abundance	William McDonough, Michael Braungart	North Point Press	2013
4	Sustainability in Engineering Design	Ramachandran S.	CRC Press	2019
5	Design for Sustainable Change	Stephen Lehmann, Roberta Tassi	Bloomsbury	2019
6	Engineering Design	G. E. Dieter	McGraw-Hill	-

Global Certifications:

Mapped Global Certifications:						
Sl. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Sustainability Excellence Associate*	International Society of Sustainability Professionals	Y	75 objective questions	International Society of Sustainability Professionals - online	https://sustainability-excellence.gbci.org/sea

- Global certification is only optional for this course

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Any modelling tool like- Solidworks, Fusion 360	Dassault Systemes, Autodesk	Commercial
2	Any stress Analysis tool – Ansys, Hyperworks, Nastran	Ansys, Altair, MSC-Hexagon	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	

	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

xiv. CONCURRENT MANUFACTURING> <(CM)>

COURSE CODE	23MD52B2	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the principles and concepts of concurrent manufacturing	2	PO2,PSO1
CO2	Apply concurrent engineering techniques in product development	3	PO1,PSO1
CO3	Examine Collaborate effectively in cross-functional teams and observe the benefits and challenges of concurrent manufacturing	3	PO1,PSO1
CO4	Analyze and optimize manufacturing processes for efficiency	4	PO1,PSO1
CO5	Demonstrate proficiency in using concurrent engineering tools	4	PO4,PSO1

Syllabus

Module 1	Introduction to concurrent manufacturing: principles and concepts - Overview of concurrent engineering and its importance in product development - Role of concurrent manufacturing in reducing time-to-market and enhancing product quality - Integration of design, manufacturing, and other functions for concurrent manufacturing
Module 2	- Concurrent engineering techniques in product development - Simultaneous engineering and its application in concurrent manufacturing - Design for manufacturability and design for assembly principles - Use of computer-aided design (CAD) and computer-aided engineering (CAE) tools for concurrent design
Module 3	- Collaboration in cross-functional teams for concurrent manufacturing - Team dynamics and communication strategies for effective collaboration - Cross-functional team roles and responsibilities in concurrent manufacturing - Conflict resolution techniques and decision-making in cross-functional teams
Module 4	- Analysis of manufacturing processes for efficiency - Value stream mapping and process flow analysis - Identification of bottlenecks and waste in manufacturing processes - Lean manufacturing principles and their application in concurrent manufacturing

Module 5	- Concurrent engineering tools and software - Overview of concurrent engineering software tools and their functionalities - CAD/CAM integration and data exchange for concurrent manufacturing - Simulation tools for process optimization and validation - Hands-on practice with concurrent engineering software tools

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Concurrent Engineering: Contemporary Issues and Modern Design	Fathi, Madjid	CRC Press	2nd Edition, 2021
2	Concurrent Engineering: Automation, Tools, and Techniques	William D. Herrold	Wiley-IEEE Press	1st Edition, 2018
3	Design for Manufacturability and Concurrent Engineering	David M. Anderson	CRC Press	1st Edition, 2014
4	Collaboration Engineering: Designing Concurrent Systems	B. Sena, R. De Guio, et al.	Springer	1st Edition, 2013
5	Lean Manufacturing: Tools, Techniques, and How to Use Them	William M. Feld	CRC Press	2nd Edition, 2017

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Concurrent Manufacturing Professional (CCMP)	International Society of Manufacturing Engineers (ISME)	Yes	Online Proctored	ISME	https://www.isme.org/certification/ccmp-certification
2	Certified Lean Manufacturing Practitioner (CLMP)	Lean Manufacturing Institute (LMI)	Yes	Online Proctored	LMI	https://www.lean.org/Workshops/WorkshopDescription.cfm?WorkshopId=90

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	HOME ASSIGNMENT AND TEXT BOOK	7	
	LAB WEEKLY EXERCISE	7	
	IN SEM EXAMINATION-I	15	38

In-Sem Summative	IN SEM EXAMINATION-II	15	
	LAB IN SEM EXAM	8	
End-Sem Summative	END SEMESTER EXAM	40	40

xv. Advanced Finite Element Analysis (AFEA)

COURSE CODE	23MD52C1	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply finite element method to solve two dimensional structural problems	PO3	3
CO2	Apply finite element method to solve problems in Bending of plates and shells and Conforming and Non-Conforming elements.	PO3, PO4	3
CO3	Formulate and solve the Non Linear problems in - Elasto Plasticity and Large displacement formulation.	PO3, PO5	4
CO4	Formulate the Dynamic Problems problems in free, transient and forced vibration.	PO1	4
CO5	Gain hands on experience in converting a given structure into desired shape and size by applying suitable ANSYS APDL software.	PO6	4

Syllabus

Module 1	**Two Dimensional Problems:** Basic concepts of plane stress and plane strain, stiffness matrix of CST element, finite element solution of plane stress problems.
Module 2	**BENDING OF PLATES AND SHELLS**: Review of Elasticity equation – Bending of plates and shells – Finite Element formulation of plates and shell elements – Conforming and Non-Conforming elements- C_0 and C_1 Continuity elements– application and examples.
Module 3	**NON-LINEAR PROBLEM:** Introduction- Iterative Techniques – Material Non- Linearity – Elasto Plasticity – Plasticity –Viscos Plasticity – Geometric Non linearity –Large displacement formulation– application in metal forming process and contact problems.
Module 4	**DYNAMIC PROBLEMS**: Direct formulation-free, transient and forced response– Solution procedures- Subspace iterative Techniques– Houbot, Wilson, Newmark– Methods – Examples.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Finite Element Method	Zienkiewicz,O.C. and Taylor,R.L.	Mc Graw Hill International Edition	1991
2	Concept and Applications of Finite Element Analysis	Cook R.D	John Wiely and Sons Inc	1989

3	Finite Element Procedure in Engineering Analysis	BatheK.J.,	PrenticeHall	1990

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Ansys-Structural analysis	ANSYS	Y	MCQs	Mindbox-ARK Info solutions	https://certifications.ansys.com/associate-certifications/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	ANSYS	ANSYS Inc.	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

xvi. Fracture Mechanics><(FM)>

COURSE CODE	23MD52C2	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand Crack growth and fracture mechanics	4	P02
CO2	Development of stress field equations in fracture mechanics	4	P01
CO3	Know the various methods for evaluating stress intensity factors	4	P01
CO4	Understand how to perform fracture toughness testing and crack growth phenomenon	4	P02
CO5	Evaluate the behaviour of fracture in mechanical structure/components	4	PO2

Syllabus

Module 1	**ELEMENTS OF SOLID MECHANICS**: The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation –limit analysis. **STATIONARY CRACK UNDER STATIC LOADING**: Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdale model – J integral and its relation to crack opening displacement.
Module 2	**ENERGY BALANCE AND CRACK GROWTH**: Griffith analysis–Linear Fracture Mechanics-Crack Opening displacement–Dynamic energy balance–crack arrest.
Module 3	**FATIGUE CRACK GROWTH CURVE**: Empirical Relation describing crack growth by fatigue – Life calculations for a given load amplitude– effects of changing the load spectrum– Effects of Environment.
Module 4	**ELEMENTS OF APPLIED FRACTURE MECHANICS**: Examples of crack-growth Analysis for cyclic loading - leak before break – crack Initiation under large scale yielding – Thickness as a Design parameter – crack instability in Thermal or Residual – stress fields.
Module 5	**EVALUATION OF BEHAVIOUR OF FRACTURE**: Crack initiation, Crack growth, Fatigue lifecycle measurement.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Elementary Engineering Fracture Mechanics	David Broek	Fifthoff and Noerdhoff International Publisher	1978
2	Introduction of Fracture Mechanics	Kare Hellan	McGraw-Hill Book Company	1985
3	Elements of Fracture Mechanics	Preshant Kumar	Wheeler Publishing	1999

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Fatigue & Fracture Mechanics Professional	NAFEMS	Y	MCQS	NAFEMS-Professional Simulation Engineer	https://www.nafems.org/professional-development/certification/

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	8	22
	Home Assignments	7	
	Practical Continuous Evaluation	7	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	8	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

xvii. Tribological System Design> <(TSD)>

COURSE CODE	23MD52C3	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the surface wear and its treatment.	2	PO2
CO2	Analyze the lubricant flow and delivery in different bearings.	3	PO2
CO3	Analyze the mechanism of rolling bearings and its failure criterion.	3	PO2
CO4	Understand the tools to measure the bearing performance.	3	PO2

Syllabus

Module 1	Topography of Surfaces – Surface features – Surface interaction – Theory of Friction – Sliding and Rolling Friction, Friction properties of metallic and non-metallic materials – friction in extreme conditions – wear, types of wear – mechanism of wear – wear resistance materials– surface treatment – Surface modifications– surface coatings.
Module 2	Lubricants and their physical properties, lubricants standards–Lubrication Regimes Hydrodynamic lubrication – Reynolds Equation, Thermal, inertia and turbulent effects –Elasto hydrodynamic and plasto hydrodynamic and magneto hydrodynamic lubrication–Hydrostatic lubrication– Gas lubrication.
Module 3	Design and performance analysis of thrust and journal bearings – Full, partial, fixed and pivoted journal bearings design – lubricant flow and delivery–power loss, Heat and temperature, rotating loads and dynamic loads in journal bearings– special bearings– Hydrostatic Bearing design. **ROLLING ELEMENT BEARINGS**: Geometry and kinematics– Materials and manufacturing processes– contact stresses– Hertzian stress equation– Load divisions– Stresses and deflection–Axial loads and rotational effects, Bearing life capacity and variable loads –ISO standards– Oil films and their effects – Rolling Bearings Failures.
Module 4	**TRIBOMEASUREMENT INSTRUMENTATION**: Surface Topography measurements– Electron-microscope and friction and wear measurements– Laser method– instrumentation-International standards– bearings performance measurements– bearing vibration measurement.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Tribology: Friction and Wear of Engineering Materials	Ian M. Hutchings	Butterworth-Heinemann	2017
2	Fundamentals of Tribology	Basim Al-Najjar	CRC Press	2019
3	Introduction to Tribology	J. Halling	Wykeham Publications	2016
4	Introduction to Tribology	B.C. Majumdar	New Age	2006
5	Tribology: Principles and Design Applications	P. Sahoo	PHI	2012

Mapped Global Certifications:

Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Lubrication Specialist	STLE	Y	MCQs	STLE	https://www.stle.org/files/Certifications/About_Certification.aspx

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	Home Assignments and text book	10	
In-Sem Summative	In sem-1	20	20
	In Sem-2	20	
End-Sem Summative	End Sem Exam	40	40

xviii. Design of pressure Vessels and Plates> <(DPVP)>

COURSE CODE	23MD52D1	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the methods to determine stresses in cylindrical shells	4	PO1,PO2,PSO1
CO2	Analyze the stresses in pressure vessel with various closure heads	4	PO1,PO2,PSO1
CO3	Formulate basic equations for bending of rectangular plate	4	PO1,PO2,PSO1
CO4	Analyze bending stresses in circular plate	4	PO1,PO2,PSO1

Syllabus

Module 1	Methods for determining stresses, Factors affecting the design of vessels, Design approach, Terminology and ligament efficiency.Problems on strins,stresses and Ligament efficiency.
Module 2	General theory of Membrane stresses in vessels under internal pressure, Torus under Internal pressure, Thick cylinder ,Thermal stresses and their significance, Graphical determination of thermal stress in a cylindrical vessel for any thermal gradient. Bending of a pate in one and two perpendicular directions.
Module 3	Introduction-assumptions-slopes and curvatures of bent plate-strain curvature relations- moment curvature relations-equilibrium equations-rectangular plate, -rectangular plate, circular plate-summery of basic equations-basic equations in Cartesian coordinate system Method of superposition for the analysis of rectangular plates with arbitrary boundary conditions.
Module 4	Basic equations in polar co-ordinate system. Pure bending and cylindrical bending of rectangular plates Navier solution for an all-round simply supported rectangular plate-levy solution for rectangular plates-. Circular plates subjected to an arbitrary load- Symmetric bending of circular plates, circular plate subjected to asymmetric load. circular plate-boundary conditions

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Theory and Design of Pressure Vessels	John F. Harvey	CBS Publishers and Distributors	1987
2	Theory of plates	K Chandrashekara	University Press	2001
3	Approximate Methods in the Design and Analysis of Pressure Vessels and Piping	Stanley, M. Wales,	Pre ASME Pressure Vessels and Piping Conference	1997
4	Theory of elasticity	Timoshenko S.P. and Goodier J.N	McGraw-Hill Publishers	1987
5	Theory Of Plates And Shells	Timoshenko S	McGraw-Hill Publishers	1988

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	"ASME Section VIII Division 2 Design Engineer"	American Society of Mechanical	Proctored	Multiple Choice Questions	ASME	ASME Section VIII Division 2 Design Engineer

		Engineers (ASME)				
2	"API 510 Pressure Vessel Inspector Certification"	American Petroleum Institute (API)	Proctored	Multiple Choice Questions	API	API 510 Pressure Vessel Inspector Certification

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	HOME ASSIGNMENT AND TEXT BOOK	10	
In-Sem Summative	IN SEM EXAMINATION-I	20	40
	IN SEM EXAMINATION-II	20	
End-Sem Summative	END SEMESTER EXAM	40	40

xix. ENGINEERING FAILURE ANALYSIS AND PREVENTION (EFAP)

COURSE CODE	23MD52D2	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	Mapped PO & PSOs
CO1	**Understand the principles and importance of engineering failure analysis**	Understand	PO1, PO2, PO6
CO2	**Identify different failure modes and their associated mechanisms**	Apply	PO1, PO2
CO3	**Apply material selection techniques for failure prevention**	Apply	PO1, PO2, PO3
CO4	**Analyze failure cases, conduct risk assessment, and propose mitigation strategies**	Analyse	PO1, PO2, PO5

Syllabus

Module 1	Introduction to Failure Analysis and Failure Modes • Introduction to Engineering Failure Analysis • Case studies of prominent engineering failures • Mechanical failure modes: fracture, fatigue, wear, corrosion, etc. • Failure mechanisms: brittle fracture, ductile fracture, creep, etc. • Factors influencing failure modes and mechanisms
Module 2	Material Selection and Design Considerations • Material properties and their impact on failure • Selection criteria for materials in different applications • Material testing and characterization techniques • Design principles for robustness and reliability • Stress analysis and failure prediction • Safety factors and design codes • Failure prevention in critical components

Module 3	Non-Destructive Testing, Inspection, and Maintenance • Introduction to non-destructive testing (NDT) methods • Visual inspection, ultrasonic testing, radiography, etc. • NDT applications in failure analysis and preventive maintenance • Preventive maintenance and condition monitoring • Failure data analysis and reliability-centered maintenance • Maintenance planning and scheduling
Module 4	Case Studies, Risk Assessment, and Mitigation • Analysis of real-world failure cases • Root cause investigation and failure reconstruction • Lessons learned and recommendations for prevention • Risk assessment techniques: FMEA, FMECA, fault tree analysis • Risk management strategies and decision-making • Failure mitigation measures and their implementation

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Failure Analysis of Engineering Structures: Methodology and Case Histories	V. Ramachandran and T. R. Chandrupatla	CRC Press	
2	Introduction to the Design and Behavior of Bolted Joints	John H. Bickford	CRC Press	
3	Engineering Fracture Mechanics	David Broek	CRC Press	
4	Mechanical Behavior of Materials	Marc André Meyers and Krishan Kumar Chawla	Cambridge University Press	
5	Practical Engineering Failure Analysis	David H. H. Sheppard	CRC Press	
6	Root Cause Failure Analysis	R. Keith Mobley	Butterworth-Heinemann	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	22
	Home Assignments	10	
In-Sem Summative	In-Sem 1	20	38
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

XX.

COURSE CODE	23MD52D3	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Build mathematical models of mechatronic systems such as mechanical, electrical, fluid, thermal.	3	PO1, PO2

CO2	Build mathematical models of electro-mechanical systems and representation of systems using transfer function.	3	PO1, PO2
CO3	Representation of systems using state space approach and system identification techniques to synthesize system models	3	PO1, PO4
CO4	Evaluate time response and frequency of systems.	4	PO1, PO4

Syllabus

Module 1	Physical Modelling: Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams
Module 2	mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling.
Module 3	Simulation Techniques: Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis
Module 4	design of identification experiments, choice of model structure, scaling, numeric methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL)
Module 5	Rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Modeling of Dynamical Systems	L. Ljung, T. Glad	Prentice Hall Inc	2001
2	System Dynamics: A Unified Approach	D.C. Karnopp, D.L. Margolis and R.C. Rosenberg	Wiley-Interscience	1995
3	System Simulation	G. Gordon	PHI Learning	
4	Micromechatronics, Modeling, Analysis, and Design with MATLAB	V. Giurgiutiu and S. E. Lyshevski	CRC Press	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified LabVIEW Associate Developer (CLAD)	National Instruments	Yes	Online	National Instruments	CLAD Certification

2	Certified SolidWorks Associate (CSWA)	Dassault Systèmes	Yes	Online	Dassault Systèmes	CSWA Certification

Tools used in Practical / Skill :NA

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	CNC Train Simulation Software	MTAB	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	20
	Home Assignments	10	
In-Sem Summative	In-Sem 1	20	40
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

xxi. DESIGN OF HYBRID VEHICLES(DHV)

COURSE CODE	23MD53E1	MODE		LTPS	3 0 0 0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply theoretical knowledge and engineering principles to design and analyze hybrid vehicles.	4	PO1, PO2, PO3
CO2	Demonstrate proficiency in using industry-standard software for hybrid vehicle design and simulation.	5	PO2, PO4, PO5
CO3	Develop critical thinking and problem-solving skills related to hybrid vehicle design.	6	PO3, PO4, PO5
CO4	Apply engineering ethics and sustainability principles in the design of hybrid vehicles.	3	PO6, PO7, PO9

Syllabus

Module 1	Introduction to Hybrid Vehicles: Hybridization principles, hybrid vehicle architectures, energy management strategies, and the role of hybridization in sustainable transportation.
Module 2	Hybrid Powertrain Technologies: Study of internal combustion engines, electric motors, batteries, power electronics, and control systems used in hybrid vehicle propulsion systems.
Module 3	Hybrid Vehicle Design: Design considerations for hybrid vehicle components, including powertrain, regenerative braking systems, energy storage, and system integration.
Module 4	Hybrid Vehicle Control Systems: Control strategies for hybrid vehicles, optimization techniques, energy management algorithms, and vehicle performance analysis.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives"	Chris Mi, M. Abul Masrur	Wiley	2018
2	"Design of Alternative Energy Systems: Second Edition"	Mohammad Rasul	McGraw-Hill Education	2016
3	"Fundamentals of Electric Vehicle Drives"	Saeed Book Bank	CRC Press	2017
4	"Hybrid and Electric Vehicles: Principles and Applications"	Chris Mi	CRC Press	2013
5	"Advanced Electric Drive Vehicles"	Ali Emadi	CRC Press	2014

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Hybrid Vehicle Design Engineer (CHVDE)	Society of Automotive Engineers (SAE)	Yes	Online Exam	SAE	https://www.sae.org/standards/content/j2882/
2	Electric Vehicle Certified Technician (EVT)	Automotive Service Excellence (ASE)	Yes	Computer-Based Test (CBT)	ASE	https://www.ase.com/Tests/ASE-Certification-Tests

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB/Simulink	Software	Commercial
2	Finite Element Analysis	Engineering	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	10	20
	Home Assignment and Book. (Min. 4 Assignments etc.)	10	
In-Sem Summative	In-Sem Exam-I	20	40
	In-Sem Exam-II	20	
End-Sem Summative	End Semester Exam	40	40

xxii. Enterprise Resources Planning for Mechanical Engineers> <(ERP)>

COURSE CODE	23MD52O5	MODE	R	LTPS	3-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping

CO1	Understand the concept of Enterprise Resource Planning (ERP) and its significance in modern organizations	2	PO3
CO2	Understand the different modules of ERP systems, including Finance, Plant Maintenance, Quality Management, and Materials Management	2	PO3
CO3	Understand ERP Implementation Lifecycle and ERP Case studies	2	PO3
CO4	Understand E-Business Architecture and the role of ERP in e-governance.	2	PO3

Syllabus

Module 1	Introduction to ERP: Enterprise – An Overview, Integrated Management Information, Business Modeling, Integrated Data Model ERP and Related Technologies Business Processing Reengineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management (SCM),Customer Relationship Management(CRM), MIS - Management Information System, DSS - Decision Support System, EIS - Executive Information System.
Module 2	ERP Manufacturing Prospective: MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP - Distributed Requirement Planning, PDM - Product Data Management ERP Modules Finance, Plant Maintenance, Quality Management, Materials Management Benefits of ERP Reduction of Lead-Time, On-time Shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Supplier Performance, Increased Flexibility, Reduced Quality Costs, Improved Information Accuracy and Design-making Capability
Module 3	ERP Implementation Lifecycle Pre-evaluation Screening, Package Evaluation, Project Planning Phase, Gap Analysis, Reengineering, Configuration, Implementation Team Training, Testing, Going Live, End-user Training, Post-implementation (Maintenance mode) ERP Case studies E-Commerce to E-business E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techo enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications
Module 4	E-Business Architecture Enterprise resource planning the E-business Backbone Enterprise architecture planning, ERP usage in Real world, ERP implementation, Future of ERP applications ,memo to CEOE Procurement, E-Governance, Developing the E-Business Design Introduction to ERP tools JDEdwards-Enterprise One, Microsoft Dynamic CRm-Module

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Introduction to Enterprise Resource Planning Systems	Bret Wagner, Ellen Monk	Cengage Learning	2022
2	ERP: Making It Happen - The Implementers' Guide to Success with Enterprise Resource Planning	Thomas F. Wallace, Michael H. Kremzar	Wiley	2023
3	Enterprise Architecture Planning: Developing a Blueprint for Data, Applications, and Technology	Steven H. Spewak	Wiley	2022
4	Enterprise Resource Planning: Concepts and Practice	V. K. Garg, N. K. Venkitakrishnan	PHI Learning Pvt. Ltd.	2023
5	Enterprise Resource Planning: Concepts and Practice	Vinod Kumar Garg, N.K. Venkitakrishnan	PHI Learning Pvt. Ltd.	2021

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	20
	Home Assignments	10	
In-Sem Summative	In-Sem Exam-I	20	40
	In-Sem Exam-II	20	
End-Sem Summative	End Semester Exam	40	40

xxiii. INTERNET OF THINGS IN INDUSTRIES (IOTI)

COURSE CODE	23MD52E2	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand architecture of IIoT and IIOT Components	2	PO1, PO2
CO2	Understand communication Technologies of IIoT	2	PO1, PO2
CO3	Apply Visualization concepts of IIoT to design a IIoT system	3	PO1, PO2
CO4	Apply IIoT technology to design a robotic system	3	PO1, PO2

Syllabus

Module 1	Introduction to IIoT, the difference between IoT and IIoT, Architecture of IIoT, IOT node, Challenges of IIOT. Fundamentals of Control System, introductions, components, closed loop & open loop system. Introduction to Sensors, Types of sensors, working principle of basic Sensors -Ultrasonic Sensor, IR sensor, MQ2, Temperature and Humidity Sensors.
Module 2	Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID. Industry standards communication technology (LoRAWAN, OPC UA, MQTT), connecting into existing Modbus and Profibus technology, wireless network communication.

Module 3	Front-end EDGE devices, Enterprise data for IIoT, Emerging descriptive data standards for IIoT, Cloud data base, could computing, Fog or Edge computing. Extraction from Web: Grabbing the content from a web page, Sending data on the web, Types of IoT interaction, Machine to Machine interaction (M2M).
Module 4	Programmable logic controller (PLC), Real-time control system, Supervisory Control & Data Acquisition (SCADA). HMI in an automation process, ERP & MES. Case study: Health monitoring, Iot smart city, Smart irrigation, Robot surveillance.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Internet of Things in the Industrial Sector	Zaigham Mahmood	Springer	2019
2	Industrial Internet of Things: Cybermanufacturing System	Sabina Jeschke	Springer	2016
3	Industrial IoT: Challenges, Design Principles, Applications, and Security	Ismail Butun	Springer	2020
4	INTRODUCTION TO INDUSTRIAL INTERNET OF THINGS AND INDUSTRY 4.0	Sudip Misra	CRC Press	2020
5	Industrial Internet of Things (IIoT)	R. Anandan	Wiley-Scrivener	2022

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	Home Assignment and Textbook	10	
In-Sem Summative	Semester in Exam-I	20	40
	Semester in Exam-II	20	
End-Sem Summative	End Semester Exam	40	40

M.TECH THERMAL ENGINEERING

COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION (CTEO)

COURSE CODE	23MT5102	MODE	R	LTPS	2-2-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the fundamental concepts of optimization, including types of problems, mathematical formulation, and programming implementation.	2	PO1, PO2, PO3
CO2	Apply mathematical optimization techniques, both unconstrained and constrained, to solve engineering problems using programming languages like Matlab/Python/R.	3	PO1, PO4, PO5
CO3	Analyze and solve multi-objective optimization problems, considering trade-offs and conflicting objectives, using appropriate algorithms and methodologies.	4	PO1, PO4, PO5
CO4	Apply optimization techniques to solve application-specific problems in Machine Design and Thermal Engineering domains, demonstrating domain-specific knowledge and skills.	3	PO1, PO4, PO5

Syllabus

Module 1	Introduction to Engineering Optimization: Basics of optimization, mathematical formulations, and algorithms. Applications in mechanical and machine design.
Module 2	Unconstrained Optimization Techniques: Newton's method, gradient descent, conjugate gradient. Implementation in MATLAB/Python.
Module 3	Constrained Optimization Techniques: Linear and nonlinear constraints, Lagrange multipliers, penalty and barrier methods. Application in mechanical design.
Module 4	Multi-objective Optimization: Pareto optimality, weighted sum, epsilon-constraint methods. Implementing multi-objective optimization using Python.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Engineering Optimization: Methods and Applications"	Ravindran, R., Ragsdell, K. M., & Reklaitis, G. V.	Wiley	2006
2	"Introduction to Optimization"	Chong, E. K. P., & Zak, S. H.	Wiley	2013
3	"Optimization Concepts and Applications in Engineering"	Belegundu, A. D., & Chandrupatla, T. R.	Pearson	2011
4	"Optimization in Practice with MATLAB®: For Engineering Students and Professionals"	Achanta, S., & Darby-Dowman, K.	Cambridge University Press	2015
5	"Applied Optimization: Formulation and Algorithms for Engineering Systems"	Ross, I. J.	Cambridge University Press	1999

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Optimization Engineer (COE)	INFORMS	Y	Online	INFORMS	COE Certification
2	Professional Engineering Optimization Certification	Optimization Firm	Y	Online	Optimization Firm	PE Optimization Certification

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	Software	Commercial
2	Python with NumPy/SciPy	Software	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	24
	Tutorial	8	
	Home Assignment and Book. (Min. 4 Assignments etc.)	8	
In-Sem Summative	In-Sem Exam-I	18	36
	In-Sem Exam-II	18	
End-Sem Summative	End Semester Exam	40	40

SIMULATION OF ENERGY MANAGEMENT SYSTEM (SEMS)

COURSE CODE	23TE5101	MODE	R	LTPS	0-0-4-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Design of renewable energy power plants by optimum sizing of components	6	PO1,PO2
CO2	Perform financial analysis of different RE technologies	3	PO1, PO2

Syllabus

Module 1	RET Screen (i) Design and sizing RET Projects (ii) Greenhouse Gas (GHG) Emission Reduction Analysis (ii) Financial Analysis for various case studies listed below a. Photovoltaic Project Model for on-grid (central-grid and micro- grid PV systems); off-grid (stand-alone (PV-battery) and hybrid (PV-battery-genset) systems; and water pumping applications
Module 2	b. Solar Water Heating Project Model for domestic hot water, industrial process heat and swimming pools, ranging in size from small residential systems to large scale commercial, institutional and industrial systems.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Clean Energy Project Analysis: RETScreen Engineering & Cases Textbook-Photovoltaic Project Analysis	Leng, G., Meloche, N., Monarque, A., Painchaud, G., Thevenard, D., Ross, M., & Hosette, P.	*CANMET Energy Technology Center*	2004
2	PVSYST user's manual	Mermoud, A., & Wittmer, B.	*Switzerland.*	2014
3	U.S. Department of Energy	EnergyPlus Documentation https://energyplus.net/documentation		2017

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA	NA	NA	NA	NA	NA

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial

1	RetScreen Software	Government of Canada	Commercial

Evaluation Components:

<table>
<tr><td>Evaluation</td><td colspan="2">Component</td><td>Weightage</td><td>Total</td></tr>
<tr><td rowspan="2">In-Sem Formative</td><td colspan="2">Lab Weekly Exercise/continuous evaluation</td><td>12.5</td><td rowspan="2">25</td></tr>
<tr><td colspan="2">Project continuous evaluation</td><td>12.5</td></tr>
<tr><td rowspan="2">In-Sem Summative</td><td colspan="2">Sem in 1</td><td>17.5</td><td rowspan="2">35</td></tr>
<tr><td colspan="2">Sem in 2</td><td>17.5</td></tr>
<tr><td rowspan="4">End-Sem Summative</td><td rowspan="3">Lab End sem Exam</td><td>Viva</td><td>7</td><td rowspan="4">40</td></tr>
<tr><td>Exercise</td><td>20</td></tr>
<tr><td>Report</td><td>5</td></tr>
<tr><td colspan="2">External Review</td><td>8</td></tr>
</table>

DESIGN OF THERMAL SYSTEMS> <(DTS)>

COURSE CODE	23TE5102	MODE	R	LTPS	2-0-2-4	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the modelling concepts to the design of thermal systems	3	PO1,PO2,PSO1
CO2	Analyse the design of thermal systems by considering its economic viability	4	PO1,PO2,PSO1
CO3	Analyse about the problem formulation for optimization and its search methods and understanding Lagrange multiplier	4	PO1,PO2,PSO1
CO4	Analyse about the Geometric, linear and dynamic Programming and modelling of thermal equipment	4	PO1,PO2,PSO1

Syllabus

Module 1	Modeling of Thermal Systems: types of models, mathematical modelling, curve fitting, linear algebraic systems, numerical model for a system, system simulation, methods for numericalsimulation;Acceptable Design of thermal System: initial design, designstrategies,designofsystemsfromdifferentapplicationareas,additionalconsiderationsforlargepracticalsystem
Module 2	Economic Considerations: calculation of interest, worth of money as a function of time, series of payments, raising capital, taxes, economic factor in design, application to thermal systems;
Module 3	Problem Formulation for Optimization: optimization methods, optimization of thermal systems, practical aspects in optimal design, Lagrange multipliers, optimization of constrained and unconstrained problems, applicability to thermal systems; search methods: single-variable problem, multivariable constrained optimization, examples of thermal systems; geometric, linear, and dynami cprogramming and other methods for optimization, knowledge-baseddesign and additional considerations, professional ethics.
Module 4	Optimization, Objective function formulation, Constrainte quations, Mathematicalformulation,Calculusmethod,Dynamicprogramming,Geometricprogramming,linearprogrammingmethods, solution procedures. Equation fitting, Empirical equation, best fit method, method of leastsquares. Modelingofthermalequipmentssuchasturbines, compressors,pumps,heatexchangers, evaporatorsandcondensers

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Thermal Design and Optimization	Bejan,G.Tsatsaronis, M.J.Moran	Wiley	
2	N.V.Suryanarayana	Design&SimulationofThermalSystems	MGH	
3	Developments in the Design of Thermal Systems	R.F.Boehm	CambridgeUniversityPress.	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA	NA	NA	NA	NA	NA

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MAT LAB	MAT LAB	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	CONTINUOUS LAB EXERCISE	7	
	HOME ASSIGNMENT AND TEXT BOOK	7	
In-Sem Summative	IN SEM EXAMINATION-I	15	38
	IN SEM EXAMINATION-II	15	
	LAB IN SEM EXAM	8	
End-Sem Summative	END SEMESTER EXAM	24	40
	LAB IN ENDEXAM	16	

ADVANCED THERMODYNAMICS<(ATD)>

COURSE CODE	22TE5103	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply thermodynamics concepts for various applications like availability analysis and thermodynamic relations.	3	PO1, PSO1
CO2	Analyze Phase transition, types of equilibrium and stability, multi-component and multi-phase systems.	4	PO2, PSO1
CO3	Analyze the basic concepts of Statistical and Irreversible thermodynamics.	4	PO2, PSO1
CO4	Analyze the behaviour of real gas behaviour, availability analysis, statistical and irreversible thermodynamics	4	PO2, PSO1
CO5	Practice the case study problems solve the with help of learned concepts.	4	PO2, PSO1

Syllabus

Module 1	Review of first and second law of thermodynamics, Maxwell equations, Joule-Thompson experiment, irreversibility and availability, exergy analysis, phase transition, types of equilibrium and stability, multi-component and multi-phase systems, equations of state, chemical thermodynamics, combustion. Third law of thermodynamics.
Module 2	Kinetic theory of gases introduction, basic assumption, molecular flux, equation of state for an ideal gas, collisions with a moving wall, principle of equi-partition of energy, classical theory of specific heat capacity. Transport phenomena-intermolecular forces, The Vander Waals equation of state, collision cross section, mean free path.
Module 3	Statistical thermodynamics- introduction, energy states and energy levels, macro and micro-scales, thermodynamic probability, Bose-Einstein, Fermi-Dirac, Maxwell-Boltzmann statistics.
Module 4	distribution function, partition energy, statistical interpretation of entropy, application of statistics to gases-mono-atomic ideal gas.
Module 5	Practice the case study problems in Simulation.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced Thermodynamics for Engineers	Kenneth Wark	McGraw-Hill	
2	Thermodynamics, Kinetic theory, and Statistical thermodynamics.	F. W. Searsand G. L. Salinger	Narosa Publishing House	1998
3	Fundamentals of Engineering thermodynamics	M. J. Moron, and H. N. Shapiro	JohnWiley& Sons.	
4	Heat and thermodynamics	M. W. Zemansky, and R. H. Dittman	McGraw Hill International	2007

5	Advanced Engineering Thermodynamics	A. Bejan	Wiley and sons	2006
6	Thermodynamics	J. P. Holman	McGraw-Hill Inc.	1998

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Advanced Thermodynamics	yes		Objective	yes	https://nptel.ac.in/courses/112/103/112103016/
2	Advanced Engineering Thermodynamics	yes		objective	yes	https://booksonweb.files.wordpress.com/2011/09/2-advanced-thermodynamics-engineering.pdf

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys	Simulation	Open Source
2	MATLAB	SimBiology	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	**ALM**	8	22
	LAB WEEKLY EXERCISE	7	
	Home Assignment and Textbook	7	
In-Sem Summative	**Semester in Exam-I**	15	38
	Semester in Exam-II	15	
	IN SEM LAB EXAM	8	

COMPUTATIONAL FLUID DYNAMICS <(CFD)>

COURSE CODE	23TE5104	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Derive Governing equations of fluid flow and heat transfer and apply finite difference formulation to discretize the governing equations	3	PO1,PO3
CO2	Analyze heat transfer characteristics in case of steady diffusion problems using finite volume discretization technique.	4	PO1,PO3
CO3	Analyze fluid flow and heat transfer characteristics in case of steady advection diffusion	4	PO1,PO3
CO4	Formulate explicit and implicit algorithms to solve N-S Equations and to understand the turbulence modelling	4	PO1,PO3
CO5	Analyze various fluid flow and heat transfer characteristics using a simulation software (Ansys-Fluent)>	4	PO2,PO3,PO4

Syllabus

Module 1	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
Module 2	Finite Volume Technique: Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods, Methods of Solution: Solution of finite difference equations; matrix inversion methods
Module 3	central, upwind and hybrid formulations and comparison for convection-diffusion problem, Solution of finite difference equations – Iterative methods
Module 4	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.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	An Introduction to Computational Fluid Dynamics	H. K. Versteeg & W. Malalasekera	Longman Scientific & Technical	2005
2	Computational Fluid Mechanics and Heat Transfer	J. C. Anderson, D. A. Tannehil and R. H. Pletcher,	Taylor & Francis publications	
3	Computational Methods for Fluid Dynamics	J. H. Ferziger and M. Peric	Springer	
4	Fundamentals of CFD	T. K. Sengupta	Universities Press	

Global Certifications:

Mapped Global Certifications:						
S. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Basics of Fluid Dynamics	Ansys	Yes	Online	Ansys	https://certifications.ansys.com/courses/basics-of-fluid-dynamics-associate-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys - Fluent	Ansys	Commercial

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	ALMs	8	22
	Home assignments	7	
	Continuous Evaluation - Lab Exercise	7	
In-Sem Summative	Sem in 1	15	38
	Sem in 2	15	
	Lab In Semester Exam	8	
End-Sem Summative	End Semester Exam	24	40
	Lab End Semester Exam	16	

ADVANCED HEAT AND MASS TRANSFER <(AHMT)>

COURSE CODE	23TE5205	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyze 1D steady and unsteady state state heat conduction in various heat transfer applications	4	PO1, PO2
CO2	Analyze Multidimensional and transient heat conduction and heat transfer characteristics in various various heat transfer applications	4	PO1, PO2
CO3	Design heat exchangers by applying the basic heat transfer principles and analyze the radiation heat transfer characteristics	4	PO1, PO2
CO4	Analyze the Diffusion and convective mass transfer in plate and pipes	4	PO1, PO2
CO5	Analyze various the heat transfer characteristics in fins and heat exchangers using Ansys software	4	PO2,PO3,PO4

Syllabus

Module 1	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)
Module 2	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
Module 3	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
Module 4	Diffusion and Convective Mass Transfer - Combined Heat andMass Transfer from Plates and in Pipes.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year

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
3	Heat Transfer	P.S.Ghoshdatidar	Oxford University Press	
4	Heat Transfer – A practical approach	Y. A. Cengel	Tata McGraw-Hill	2002

Global Certifications:

Mapped Global Certifications:						
S. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Basics of Fluid Dynamics	Ansys	Yes	Online	Ansys	https://certifications.ansys.com/courses/basics-of-fluid-dynamics-associate-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys - Fluent	Ansys	Commercial

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	ALMs	8	22
	Home assignments	7	
	Continuous Evaluation - Lab Exercise	7	
In-Sem Summative	Sem in 1	15	38
	Sem in 2	15	
	Lab In Semester Exam	8	
End-Sem Summative	End Semester Exam	24	40
	Lab End Semester Exam	16	

MEASUREMENTS IN THERMAL ENGINEERING > <(MTE)>

COURSE CODE	23TE5206	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply scientific and engineering methods for the measurement of field and derived quantities	3	PO1, PSO1
CO2	Analyze principles of presentation, estimation and data analysis	4	PO2, PSO1
CO3	Apply various experimental measurement techniques for the measurement of field quantities with probe and non-instructive techniques	3	PO1, PSO1
CO4	Evaluate the measurement of derived quantities and analytical methods and design and conduct the experiments, as well as to organize, analyze and interpret data to produce meaningful conclusions and recommendations	4	PO3, PSO1

Syllabus

Module 1	Introduction to measurements for scientific and engineering applications- need and goal - broad category of methods for measuring field and derived quantities
Module 2	Principlesofmeasurement-parameterestimation-regressionanalysis-correlations-errorestimation and data presentation - analysis of data;
Module 3	Measurement of field quantities -thermometry-heat flux measurement-measurement of force, pressure, flowrate, velocity, humidity, noise, vibration- measurement of the above by probe and nonintrusive techniques
Module 4	Measurement of derived quantities-torque,power,thermo-physical properties - radiation and surface properties; Analytical methods and pollutionmonitoring-massspectrometry-chromatography-spectroscopy.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Fluid mechanics and measurements	,R.J.Goldstein	Taylor Francis	
2	Hand book of experimental fluid mechanics	C.Tropea,Y.Alexander,J.F.Foss	SPRINGER	
3	Thermal and flow measurements	,T.W.Lee,	CRCPress.	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA	NA	NA	NA	NA	NA

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA (For practical, instruments available in the laboratory will be used)	NA	NA

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	CONTINUOUS LAB EXERCISE	7	
	HOME ASSIGNMENT AND TEXT BOOK	7	
In-Sem Summative	IN SEM EXAMINATION-I	15	38
	IN SEM EXAMINATION-II	15	
	LAB IN SEM EXAM	8	
End-Sem Summative	END SEMESTER EXAM	24	40
	LAB IN END EXAM	16	

ESSENTIALS OF RESEARCH DESIGN> <(ERD)>

COURSE CODE	23IE5201	MODE	R	LTPS	1-1-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Illustrate Research objects, steps involved in research and articulate appropriate Research Questions	3	PO4,PSO1
CO2	Perform Literature Review in a Scholarly style and apply appropriate methods for Data collection	3	PO4,PSO1
CO3	Represent the data in tabular/Graphical form and prepare data for analysis	3	PO1,PSO1
CO4	Perform statistical modelling and analysis to optimize the data, prepare the data for publishing.	4	PO1,PSO1

Syllabus

Module 1	Definition and objectives of Research-Types of research, Various Steps in Research process, Applied Mathematical tools for analysis, developing a research question-Choice of a problem, Literature review, Surveying, Synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.
Module 2	Literature Review (LR)-Meaning and its Types-Narrative and Systematic, LR using Web of Science, Google and Google Scholar, Citations-Types, referencing in academic writing, Citation vs Referencing Vs Bibliography, Citation tools- Zotero, Qualitative Research and its methods, Quantitative Research, and its Methods. Data Collection-Primary data collection using Questionnaire, Google forms, survey monkey, Testing the validity and Reliability of Questionnaire using Factor Analysis and Cronbach's Alpha respectively, Secondary data-sources
Module 3	Diagrammatic and graphical presentation of data: Diagrams and Graphs of frequency data of one variable- histogram, barcharts-simple, sub-divided and multiple; line charts, Diagrams and Graphs of frequency data of two variables -scatter plot, preparing data for analysis. Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Error Analysis.
Module 4	Analyzing data using one-dimensional statistics, two-dimensional statistics and multi-dimensional statistics. Technical Writing and Publishing, Conference presentations, Poster Presentations, Plagiarism-check and tools, Self-Plagiarism. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, Design Thinking for Contextualized Problem-Solving and Empathetic Research.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Research Methodology Methods and Techniques	C.R. Kothari	New Age International	2019
2	Business Research Methods,	Donald R.Cooper, Pamela S. Schhindler	TMH	2018

3	Research Methods for Engineers	David V Thiel	Cambridge University Press	2015
4	Engineering Research Methodology	Krishnan Nallaperumal	Manonmaniam Sundaranar University.	2013
5	Business Research Methods	William G Zikmund	South West Cengage Learning	2013

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Research Design and Methodology Certification	Global Association of Research Methodology Education and Training (GARMET)	Proctored	Online Multiple Choice Questions	GARMET	https://www.garment.org/certifications/research-design-methodology
2	Certified Research Methodologist (CRM)	International Institute for Applied Knowledge Sciences (IIAKS)	Proctored	Online Exam	IIAKS	https://www.iiaks.org/certifications/certified-research-methodologist

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	24
	HOME ASSIGNMENT AND TEXT BOOK	8	
	TUTORIALS	8	
In-Sem Summative	IN SEM EXAMINATION-I	18	36
	IN SEM EXAMINATION-II	18	
End-Sem Summative	END SEMESTER EXAM	40	40

GAS TURBINE ENGINEERING > <(GTE)>

COURSE CODE	23TE51A1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the concepts of air standard cycle to analyse the performance of ideal and actual gas turbine cycles	3	PO1, PSO1
CO2	Apply gas turbine theory to jet propulsion and understand fabrication techniques of components	3	PO1, PSO1
CO3	Analyze the Performance of compressors and combustion chambers.	4	PO2, PSO1
CO4	Analyze the Performance of gas turbine and cogeneration systems.	4	PO2, PSO1

Syllabus

Module 1	Thermodynamicsofgasturbines:Cycleanalysis;GasTurbineComponents:compressor,combustor,heatexchangers,turbine-description:analyticalconsiderations, performance
Module 2	Matching of compressor and turbine: cooling of turbine blades. Compressor and turbine impeller construction, blade fixing details, sealing; Material selection for components
Module 3	, Protective coating for hot turbine parts, Components fabrication techniques, Gas turbine turbocharger, gas turbine power generation, turbo expander, gas turbine application, Closed cycle gas turbines
Module 4	Co-generation-Introduction, Thermodynamics of co-generation, Criteria for component performance, Some practical schemes.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Aircraft Propulsion and Gas Turbine Engines;	AhmedF.El-Sayed	CRCpress,2008.	
2	Turbine, Compressors and Fans	Turbine, Compressors and Fan		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

ELECTRIC VEHICLE ENGINEERING<(EVE)>

COURSE CODE	23TE51A2	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand Hybrid /EV Vehicles and study of vehicle dynamics	3	PO1, PO2
CO2	Apply Architecture of Hybrid/EV Vehicles, components and Battery EV	3	PO1, PO2, PO3
CO3	Apply and analyse Fuel Cell, DC/AC Drives and SRM	3	PO1, PO3, PO4
CO4	Apply EV Controls, Controller, and control strategies	4	PO1, PO2, PO4
CO5	Analyze and apply theoretical concepts to develop mathematical models and simulate the Combustion and EV Vehicles	5	PO2, PO3, PO5

Syllabus

Module 1	Introduction: Electric Vehicle History, Components of Electric Vehicle, Comparison with Internal combustion, Engine: Technology, Comparison with Internal combustion Engine: Benefits and Challenges, EV classification and their electrification levels, EV Terminology Motor Torque Calculations for Electric Vehicle: Calculating the Rolling Resistance, calculating the grade resistance, Calculating the Acceleration Force, Finding the Total Tractive Effort, Torque Required On The Drive Wheel.
Module 2	Electric Vehicle Architecture Design: Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV),
Module 3	Plug-in hybrid vehicle(PHEV), Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles.
Module 4	Electric Drive and controller: Types of Motors, Selection and sizing of Motor, RPM and Torque calculation of motor, Motor Controllers, Component sizing, Physical locations, Mechanical connection of motor, Electrical connection of motor.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	1. Electric and Hybrid Vehicles: Design Fundamentals.	Iqbal Husain	CRC Press	
2	Modern Electric Hybrid Electric and Fuel Vehicles	Mehrdad Ehsani, Yimin Gao, Stefane Longo, Kambiz Ebrahimi.	CRC Press, 3rd Edition	

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Mat Lab, Diesel RK		Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

ENERGY CONSERVATION & AUDIT<(ECA)>

COURSE CODE	23TE51A3	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyze the present energy scenario and understand the need of energy conservation	PO2	4
CO2	Apply various instruments in energy audit	PO1	3
CO3	Apply various measures of energy conservation and financial implications for various thermal utilities.	PO1	3
CO4	Audit the power plants, the various measures for energy conservation and financial implications for various thermal utilities.	PO1	4
CO5	Analyse the energy performance of power plants numerically using MAT lab	PO2	4

Syllabus

Module 1	Energy Scenario - Basics of Energy and its various forms - Energy Management and - Audit - Material and Energy Balance - Energy Action Planning - Financial Management –Project Management - Energy Monitoring and Targeting - Global Environmental Concerns
Module 2	Energy Efficiency in Thermal Utilities - Fuels and Combustion – Boilers - Steam System - Furnaces - Insulation and Refractory - FBC Boilers -Cogeneration - Waste heat recovery. Energy Efficiency in Electrical Utilities - Electrical Systems - Electric Motors - Compressed Air System - HVAC and Refrigeration System - Fans and Blowers - Pumps and Pumping System - Cooling Tower - Lighting System - Diesel Generating System - Energy Efficient Technologies in Electrical Systems.
Module 3	. Energy Performance Assessment for Equipment and Utility systems – Boilers – Furnaces - Cogeneration, Turbines (Gas, Steam) - Heat Exchangers - Electric Motors andVariable Speed Drives - Fans and Blowers - Water Pumps – Compressors
Module 4	HVACSystems - Lighting Systems - Performing Financial Analysis - Applications of Non - Conventional and Renewable Energy Sources - Waste Minimization and Resource Conservation

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Energy Management Principles	CB Smith	Pergamon Press, NewYork	1981
2	Energy Auditing and Conservation; Methods, Measurements,Management & Case study	Hamies	Hemisphere, Washington	1980

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MAT Lab		Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

ADVANCED ENERGY STORAGE TECHNOLOGIES > <(AEST)>

COURSE CODE	23TE52B1	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand various thermal storage systems and storage materials	2	PO1
CO2	Analyse the sensible and latent heat concepts and develop a heat storage units	4	PO2
CO3	Apply the basics of storage systems to understand the various thermal storage systems	3	PO1
CO4	Apply the principles of heat storage systems on regenerators and its applications	3	PO1

Syllabus

Module 1	Necessity of thermal storage – types-energy storage devices – comparison of energy storage technologies - seasonal thermal energy storage - storage
Module 2	Basic concepts and modelling of heat storage units - modelling of simple water and rock bed storage system – use of TRNSYS – pressurized water storage system for power plant applications
Module 3	Modelling of phase change problems – temperature based model - enthalpy model – porous medium approach - conduction dominated phase change – convection dominated phase change
Module 4	Specific areas of application of energy storage – food preservation – waste heat recovery – solar energy storage – green house heating – power plant applications – drying and heating for process industries.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Energy Production and Storage	Crabtree R.H	Wiley	2010
2	Energy Storage Fundamentals, Materials and Applications	Huggins & Robert	Springer	2016
3	Thermal Energy Storage Systems and Applications	Ibrahim Dincer and Mark A. Rosen	Wiley & Sons	2002

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

FOOD PROCESSING PRESERVATION AND TRANSPORT > <(FPPT)>

COURSE CODE	23TE52B2	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply food preservation methods and understand the factors effecting food deterioration	3	PO1, PSO1
CO2	Analyse the different types of drying and food concentration methods	4	PO1, PSO1
CO3	Analyse the role of natural, chemical preservatives and recent preservation techniques	4	PO2, PSO1
CO4	Analyse the effect of molecules in transport mechanisms	4	PO2, PSO1

Syllabus

Module 1	Food and its preservation Food preservation - Need, importance, principals and methods. Perishable and non perishable foods, concept of shelf life- definition and factors affecting water activity in food and its significance in food preservation, factors affecting food deterioration – physical factors, chemical factors and microbiological factors.
Module 2	Drying- Theory and Mechansim, drying characteristics of materials, preliminary processing, Sun drying vs dehydration, Driers - Air convection driers and types, Drum /Roller Drier, Vacuum drier, Belt drier, tunnel drier, spray drier, rotary drier, fluidized bed drier, Freeze drying and microwave drying. Food Concentration- purpose, methods of concentration, changes during concentration, Intermediate moisture foods (IMF).
Module 3	Use of high temperature- principle and equipments: Methods - pasteurization, blanching, sterilization , canning- procedure, canning of acid foods and nonacid foods, aseptic canning nutritive value of canned foods, types of spoilage in canned foods, storage of canned foods, influence of canning on the quality of food,.
Module 4	Introduction to transport phenomena – Molecular transport mechanism, transport properties and their proportionality constants in momentum, energy and mass transfer. Mass transfer -- Fick's law of diffusion, diffusion of gases and liquids through solids, equimodal diffusion, isothermal evaporation of water into air, mass transfer coefficients

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Food Microbiology	William C Frazier & Dennis C Westhoff	Tata McGraw Hill Publications	2013
2	Food Scienc	Norman N Potter Joseph H Hotchkiss	CBS Publishers	2005
3	The Technology of Food Preservation	Norman W Desrosier James N Desrosier	CBS Publishers	2006
4	Food Processing and Preservation	B. Sivasankar P	PHI Learning Pvt Ltd	2002

5	Introduction to Food Science and Technology	Stewart GP and Amerine MA	Elsevier	2012

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

CONVECTION AND TWO PHASE FLOW <(CTPF)>

COURSE CODE	23TE52B3	MODE	R	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the basics of two phase flow, Interfacial phenomena and Phase transitions	2	PO1
CO2	Apply mathematical models to understand hydrodynamics of two phase flows without phase change.	3	PO1,PO3
CO3	Derive and apply various correlations to analyse boiling and condensation phenomena	3	PO1,PO3
CO4	Apply two phase flows for thermal management of electronic components	3	PO1,PO3
CO5	Analyze various two phase flows (with and without phase change) using a commercial software Ansys-Fluent	4	PO2,PO3,PO4

Syllabus

Module 1	Introduction to two-phase flow and heat transfer technology, Liquid-vapor phase change phenomena, Interfacial tension, Wetting phenomenon, Contact angles, Transport effects, Dynamic behaviour of interfaces, Phase stability and nucleation
Module 2	Two- phase flow fundamentals, Flow patterns and map representation, Development of homogeneous, separated flow and drift flux models, Flooding mechanisms
Module 3	Boiling Fundamentals, Homogeneous and heterogeneous nucleation, Pool boiling and convective flow boiling, Heat transfer and CFH mechanisms, Enhancement techniques, Condensation fundamentals, External and internal condensation, Film condensation theory, Drop-wise condensation theory, Enhancement techniques
Module 4	Application of two- phase flow and heat transfer, Electronics thermal management, Latent heat storage devices, Gravity assisted thermo-siphons/Vapor chambers, Theory and operation of Conventional heat pipes, Micro heat pipes, Pulsating heat pipes, Capillary pumped loops/ Loop heat pipes, Micro two-phase heat exchangers

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Liquid Vapor Phase Change Phenomena	Van P. Carey	Taylor & Francis	2005
2	Two-phase Flow and Heat Transfer	P. B. Whalley	Oxford Engineering Science	

3	One Dimensional Two-Phase Flow	G. B. Wallis	McGraw Hill	
4	Convective Boiling And Condensation	Collier John	Oxford Engineering Science	

Global Certifications:

Mapped Global Certifications:						
S. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Basics of Fluid Dynamics	Ansys	Yes	Online	Ansys	https://certifications.ansys.com/courses/basics-of-fluid-dynamics-associate-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys - Fluent	Ansys	Commercial

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	ALMs	8	22
	Home assignments	7	
	Continuous Evaluation - Lab Exercise	7	
In-Sem Summative	Sem in 1	15	38
	Sem in 2	15	
	Lab In Semester Exam	8	
End-Sem Summative	End Semester Exam	24	40
	Lab End Semester Exam	16	

Renewable Energy Sources and Technology> <(REST)>

COURSE CODE	23TE52C1	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand concept of various forms of Non-renewable and renewable energy	4	PO1, PSO1
CO2	outline division aspects and utilization of renewable energy sources for both domestics and industrial applications	3	PO1, PSO1
CO3	study the environmental and cost economics of using renewable energy sources compared to fossil fuels	3	PO1, PSO1
CO4	Understand the commercial energy and renewable energy sources. Know the working principle of various energy systems	4	PO1, PSO1
CO5	Apply RET Screen software in feasibility analysis for the installation of Solar PV and water heater	4	PO1, PSO1

Syllabus

Module 1	Renewable Energy Sources in India - Potential sites, availability. Solar Energy:Measurement and collection, flat plate collectors, concentrating collectors, solar ponds
Module 2	photovoltaic conversion, Thermal energy storage. Ocean Energy: Principles of OTEC; wave energy, tidal energy, energy conversion systems. Wind Energy: Principle, potential and status; Wind Characteristics; National Wind Atlas; Theory of wind turbine blades; Types of wind turbines and their characteristics.
Module 3	Biofuels: Sources and potential, properties and characterization; Biogas generation through aerobic and anaerobic digestion; Thermochemical methods of biofuel utilization: Combustion and gasification; Status of biofuel technology
Module 4	Geothermal Energy-Nature, types and utilization. Applications: Applications of renewable energy sources-Typical examples.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Renewable Energy Resources	Twidell &Wier	CRC Press	2000
2	Renewable Energy, Power for a Sustainable Future,	Godfrey Boyle,	Oxford University Press	2000
3	Wind Energy Conversion systems	L.L.Freris	Prentice Hall	1990
4	Renewable energy resources	Tiwari and Ghosal	Narosa	2002

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Wind Turbine Technician Certification	Pinnacle career institute		Online		https://www.pcitraining.edu/wind-turbine-technician

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	RET Screen software		Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	08	22
	Home Assignments	07	
	Practical Continuous Evaluation	07	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	08	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

Principles of Turbo Machinery (PTM)

COURSE CODE	22TE52C2	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyse the design principles of turbomachinery to improve and optimize its performance	4	PO2, PSO1
CO2	Design the performance of Turbo machines for engineering applications	5	PO3, PSO1
CO3	Analyse the energy transfer process in Turbomachines and governing equations of various forms.	4	PO2, PSO1
CO4	Design various Turbomachines for power plant and aircraft applications	5	PO3, PSO1
CO5	Design and Maintain Turbomachinery Using Ansys Simulation Solutions	5	PO3, PSO1

Syllabus

Module 1	Classification - Specific work - Representation of specific work in T-s and h-s diagrams - Internal and external losses
Module 2	Euler's equation of turbo-machinery - Ideal and actual velocity triangles-Slip and its estimation-Impulse and reaction type machines
Module 3	Degree of reaction - Effect of outlet blade angle on blade shape - Model laws, specific speed and shape number-Special features of hydro, steam and gas turbines
Module 4	Performance characteristics of turbo-machines-Cavitation, Surge and Stall-Thin aerofoil theory - Cascade mechanics. Use of CFD for Turbo-machinery analysis and design.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Fundamentals of Turbomachinery	WilliamW.Peng	JohnWiley&Sons	
2	Principles of turbomachinery	D.G.Shepherd	Macmilan	1969
3	Aircraft Propulsion and Gas Turbine Engines	AhmedF.El-Sayed	CRCpress	2008
4	Hydraulic and Compressible Flow Turbo machines	A.T.Sayers	Mc-GrawHill	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	08	22
	Home Assignments	07	
	Practical Continuous Evaluation	07	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	08	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

Heat Exchanger Design (HED)

COURSE CODE	23TE52C3	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Classify heat exchangers and understand thermo-hydraulic fundamentals of the exchangers.	PO1	2
CO2	Apply LMTD and ε-NTU methods for the design of different types of shell and tube heat exchangers.	PO3	3
CO3	Apply different methods in the design of shell and tube heat exchangers	PO3	3
CO4	Design of Compact heat exchangers and study of fouling control techniques	PO3	3
CO5	Design and analyse various heat exchangers using Ansys Fluent	PO3, PSO1	5

Syllabus

Module 1	Heat Exchangers: Introduction, Classification, and Selection. Heat Exchanger: Thermo-Hydraulic Fundamentals. Heat Exchanger Design. Compact Heat Exchangers
Module 2	Shell and Tube Heat Exchanger Design. Regenerators. Plate Heat Exchangers and Spiral Plate Heat Exchangers. Heat-Transfer Augmentation
Module 3	Fouling; Flow-Induced Vibration of Shell and Tube Heat Exchangers. Mechanical Design of Shell and Tube Heat Exchangers.
Module 4	Corrosion; Material Selection and Fabrication. Quality Control and Quality Assurance and Non-destructive Testing. Heat Exchanger Fabrication

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Heat Exchangers: Selection, Design and Construction	E. A. Saunders	Longman Scientific and Technical	1988
2	Fundamentals of Heat Exchanger Design	Ramesh K. Shah, Dusan P. Sekulic,	Wiley	2002

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	ALMs	8	22
	Home assignments	7	
	Continuous Evaluation - Lab Exercise	7	
In-Sem Summative	Sem in 1	15	38
	Sem in 2	15	
	Lab In Semester Exam	8	
End-Sem Summative	End Semester Exam	24	40
	Lab End Semester Exam	16	

REFRIGERATION AND CRYOGENICS<(R & C)>

COURSE CODE	23TE52D1	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply basic thermodynamic principles to produce low temperatures and to the liquefaction systems.	3	PO2
CO2	Analyse different types of cryogenic refrigerators and insulation and their applications.	4	PO2
CO3	Examine the properties of matter at low temperature and their measurement.	2	PO3
CO4	Understand the principle of superconductivity, adiabatic demagnetization, and dilution refrigeration etc. to produce low temperatures	2	PO2

Syllabus

Module 1	Review of Basic Thermodynamics, Properties of Cryogenic fluids, First and Second Law approaches to the study of thermodynamic cycles, Isothermal, Adiabatic, and Isenthal pic processes. Production of Low Temperatures: Liquefaction systems, ideal, Cascade, Linde Hampson, and Claude cycles and their derivatives; Refrigerators: Stirling, Gifford-McMahoncycles and their derivatives.
Module 2	Cryogenic Insulations: Foam, Fibre, powder, and Multi-layer. Applications of Cryogenics in Industry, Space Technology, Nuclear Technology, Biology, and Medicine. The matter at low temperatures: specific heat, thermal conductivity, electrical conductivity, magnetic and mechanical properties.
Module 3	Properties of liquid 4He and 3He; and their measurements. Review of a free electron and band theory of solids: Basic properties of Superconductors; outlines of Ginzbarg Landau and Bardeen-Cooper-Schrieffer theories of superconductivity.
Module 4	superconducting tunnelling phenomena; Introduction to type IIsuperconductivity including flux flow and critical current density: High-temperature superconductivity. Production of very low temperatures by adiabatic demagnetization, dilution refrigeration, and nuclear demagnetization.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	A Textbook of Cryogenics	V V Kostionk	Discovery Publishing house	2003
2	Cryogenic Fundamentals	Haselden.G.G	Academic Press-Newyork	
3	Principles of Refrigeration	Dossat Thomas	J.Horan Books	
4	Refrigeration and Air conditioning	Stoecker and Jones	McGraw Hill	

5	Cryogenic Systems	RFBarron	Oxford University press	1985
6	Cryogenics-Theory, Process, and applications	Allyson E Hayes	Nova science Incorporated	2010

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Cryogenic Engineering	yes		objective	nptel	https://nptel.ac.in/courses/112101004/
2	Cryogenic Engineering	yes		objective	nptel	https://nptel.ac.in/courses/112101004/

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	HOME ASSIGNMENT AND TEXT BOOKS	10	
In-Sem Summative	IN SEM EXAMINATIONS-1	20	40
	IN SEM EXAMINATION-II	20	
End-Sem Summative	END SEMESTER EXAM	40	40

AIR CONDITIONING SYSTEMS > <(ACS)>

COURSE CODE	23TE52D2	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply Psychrometric process in air conditioning equipment.	3	PO1, PSO1
CO2	Analyse the effect of cooling and dehumidification.	4	PO1, PSO1
CO3	Analyse air conditioning processes in various seasons.	4	PO2, PSO1
CO4	Analyse the factors governing optimum effective temperature, Design consideration in comfort air conditioning systems.	4	PO2, PSO1

Syllabus

Module 1	PSYCHROMETRY: Properties of moist air. Important Psychrometry properties, Dry bulb temperature, Humidity ratio, degree of saturation, Dew point temperature and Enthalpy, Psychometric chart and ASHRAE chart. Psychrometric process in air conditioning equipment, Bypass factor and sensible heat factor
Module 2	APPLIED PSYCHROMETRY: Use of Effective and grand sensible heat factor, Selection of air conditioning equipment for cooling and dehumidification. High latent cooling load applications, All outdoor air applications.
Module 3	AIR CONDITIONING PROCESSES: Mixing process- Summer, winter and year round air Conditioning system, Hot and dry outdoor conditions. Hot and humid outdoor conditions. Winter air conditioning system. Year round air conditioning system.
Module 4	COMFORT AIR CONDITIONING: Thermodynamics of human body. Body regulation process against heat and cold. Comfort & Comfort chart, Effective temperature, Factors governing optimum effective temperature, Design consideration. Selection of outside and inside design conditions, Air conditioning control systems, basic elements of the control system, Temperature, Humidity & Pressure controls, Refrigeration, Room thermostat.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Refrigeration & Air Conditioning	CP Arora	Tata McGraw Hill Publications	2013
2	Refrigeration & Air Conditioning	Arora and Domkundwar	Dhanpat Rai &Co	2005
3	Refrigeration & Air Conditioning	RC Arora	PHI Learning Pvt Ltd	2012
4	Refrigeration & Air Conditioning	SC Jain	Chand & Co	2002
5	Hand Book of Air Conditioning System Design	Carrier	Carrier	2012

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	HOME ASSIGNMENT AND TEXT BOOK	10	
In-Sem Summative	IN SEM EXAMINATION-I	20	40
	IN SEM EXAMINATION-II	20	
End-Sem Summative	END SEMESTER EXAM	40	40

SOLAR ENERGY & SYSTEMS> <SES)>

COURSE CODE	23TE52D3	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Expose to Solar energy and its applications,	4	PO1, PSO1
CO2	Demonstrate the importance of renewable energy source and various applications of solar energy systems	3	PO1, PSO1
CO3	Do the preliminary analysis related to solar energy systems and design of solar PV and solar thermal systems	3	PO1, PSO1
CO4	Identify the power electronic converters for solar PV energy systems	4	PO1, PSO1

Syllabus

Module 1	Availability - Measurement and Estimation - Isotropic and an Isotropic Models – Introduction to Solar Collectors (Liquid Flat - Plate Collector, Air Heater and Concentrating Collector) and Thermal Storage - Steady State Transient Analysis - SolarPond - Solar Refrigeration
Module 2	**Modeling of Solar Thermal Systems and Simulations in Process Design:** Design of Active Systems by f-chart and Utilizability Methods – Water Heating Systems-Active and Passive-Passive Heating and Cooling of Buildings-Solar Distillation-Solar Drying
Module 3	**Photo voltaic Solar Cell** P-N Junction-Metal-Schottky Junction, Electrolyte - Semiconductor Junction, Types of Solar Cells – their Applications
Module 4	Experimental Techniques to determine the Characteristics of Solar Cells -Photovoltaic Hybrid Systems Photovoltaic Thermal Systems – Storage Battery - SolarArrayandtheirCharacteristicsEvaluation-SolarChargeableBattery

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Solar Energy: principles of Thermal Collection and Storage,	S.P.Sukhatme	Tata McGraw-Hill	
2	Solar Energy Handbook	J.F.Kreider and F.Kreith	McGraw-Hill	2016

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	
	Home Assignment and Book	10	20
In-Sem Summative	Sem -1	20	
	Sem -2	20	40
End-Sem Summative	End sem exam	40	40

HYDROGEN AND FUEL CELLS <HFC)>

COURSE CODE	23TE53E1	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand various properties of hydrogen and various production methods	2	PO1, PO2 & PSO2
CO2	Understand hydrogen storage methods and employing hydrogen as fuel for IC engine	2	PO1, PO2 & PSO2
CO3	Apply fuel cell basics and Fuel cell thermodynamics	3	PO1, PO2 & PSO2
CO4	Apply fuel cell reaction kinetics	3	PO1, PO2 & PSO2

Syllabus

Module 1	Hydrogen basics and Production methods: Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water
Module 2	Hydrogen storage methods: Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons. Safety and management of hydrogen, Transportation of hydrogen. Applications of Hydrogen. Hydrogen as a fuel for automobiles – Combustive properties of Hydrogen, Problems caused by hydrogen by employing fuel for automobiles, Design modifications required for the engine, Performance parameters of hydrogen fuelled IC engines
Module 3	Fuel cell: Overview of Fuel Cells, low and high temperature fuel cells. Fuel Cell performance, Polymer electrolyte fuel cells, Alkaline fuel cells, Phosphoric fuel cells, Molten carbonate fuel cells, Solid oxide fuel cells, Fuel cell systems and Sample calculations. Fuel cell thermodynamics - heat, work potentials, prediction of reversible voltage, fuel cell efficiency.
Module 4	Fuel cell reaction kinetics - electrode kinetics, over voltages, Tafel equation, charge transfer reaction, exchange currents, electro catalyses - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Hydrogen and Fuel Cells: A Comprehensive Guide	Rebecca L. and Busby	2005	Penn WellCorporation, Oklahoma
2	Fuel Cell Handbook	Mark C. Williams and H. Quedenfeld	2004	EG&GTechnical Services, Inc
3	Fuel Cells – Principles andApplications	Viswanathan, B and M Aulice Scibioh	2006	Universities Press

4	Non Conventional Energy Sources	G.D Rai	2017	Khanna Publishers

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Improving Fuel Cell Designs for FCEVs Using Simulation	Ansys	Y	Online		https://www.ansys.com/en-in/resource-center/webinar/improving-fuel-cell-designs-for-fcevs-using-simulation

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	COMSOL multiphysics Software		Commercial
2	Ansys		Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	
	Home Assignment and Book	10	20
In-Sem Summative	Sem -1	20	
	Sem -2	20	40
End-Sem Summative	End sem exam	40	40

AIRCRAFT & JET PROPULSION SYSTEMS > <AJPS)>

COURSE CODE	23TE52E2	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyze the Air craft and jet propulsion systems and its applications,	4	PO1, PSO1
CO2	Applying the One Dimensional Flows and shock waves	3	PO1, PSO1
CO3	Applying the Propulsive Engines For Aircraft	3	PO1, PSO1
CO4	Analyze the Shaft Power and Gas Turbine Cycles	4	PO1, PSO1

Syllabus

Module 1	Basic Principles of Propulsion, Historical background, how the jet engines make thrust: conceptual basis; Jet engine: Turbo-jet, Turbo-fans, Turbo prop, Turbo-shaft, Ramjet. Scramjets
Module 2	Compressible flow; Quasi One dimensional flow, Normal shock, Oblique shock, , Air intake, Nozzle flow, Boundary layer flow, Rayleigh flow, Fanno flow, Effect of frictional duct length in subsonic flow and supersonic flow, numerical problems in 1D flow
Module 3	The Otto cycles; IC engines for aircraft application Reciprocating engine performance; Supercharging and Performance enhancement Propeller fundamentals & Theories.
Module 4	Reheat cycle, cycle with heat and heat exchange, Methods of accounting for components losses, stagnation properties, compressor and turbine efficiencies, isentropic and polytropic, pressure losses, heat exchanger effectiveness, Mechanical losses, bleed flows, design point calculations, comparative performance of practical cycles.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Elements of Gas Turbine Propulsion”,	Mattingly J.D	”, McGraw Hill	
2	Aerothermodynamics of Aircraft Engine Components	G.C (r) Oates,	AIAA	

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	
	Home Assignment and Book	10	20
In-Sem Summative	Sem -1	20	
	Sem -2	20	40
End-Sem Summative	End sem exam	40	40

BATTERY AND THERMAL MANAGEMENT SYSTEMS> <BTMS>

COURSE CODE	23TE52E3	MODE	MOOCS	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the construction and fabrication methods of various kinds of batteries	2	PO1, PSO1
CO2	Apply laws of thermodynamics to analyze battery performance	4	PO1,PO2, PSO1
CO3	Analyze various battery thermal management systems	4	PO1,PO2, PSO1
CO4	Simulate and analyze liquid cooled and air cooled battery pack	4	PO1,PO2, PSO1

Syllabus

Module 1	Introduction to Battery Technology and Electrochemical Modelling – working of electrochemical cell, li ion cell make up, manufacturing of electrodes, Assembling the cell, Failure modes.
Module 2	Equivalent Circuit Modelling of Cell and Thermodynamic of Cell - Open Circuit Voltage (OCV), SOC, OCV Testing, Coulombic Efficiency, Thermal Logic and Algorithms, Li-ion Aging, Butler Volmer Model
Module 3	Battery Thermal Management - Air Cooling and Heating, Liquid Cooling and Heating, PCM, Thermoelectric Module, Heat Pipe
Module 4	Thermal and Flow Modelling of Battery Pack - Pressure Drop Study, 3D Modelling of Liquid-cooled Thermal Systems using Fluent, 3D Thermal Modelling of an Air-cooled Battery Pack

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Thermal Management of Electric Vehicle Battery Systems	Ibrahim Dinçer, Halil S. Hamut, Nader Javani	John Wiley & Sons	2017
2	Handbook of Thermal Management Systems	Fethi Aloui, Edwin Geo Varuvel, Ankit Sonthalia	Elsevier	2023

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Ansys Associate certification	Ansys	Y	MCQs	Ansys	https://certifications.ansys.com/courses/basics-of-fluid-dynamics-associate-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys Fluent	Ansys	Commercial
2	Matlab	Mathworks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	12	22
	Home Assignments	10	
In-Sem Summative	In Sem -1	19	38
	In Sem-2	19	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40