KCG COLLEGE OF TECHNOLOGY

AFFILIATED TO ANNA UNIVERSITY | AUTONOMOUS

REGULATIONS - 2023

CURRICULUM AND SYLLABI

(2023-2024)

B.E. MECHANICAL ENGINEERING

KCG COLLEGE OF TECHNOLOGY
AFFILIATED TO ANNA UNIVERSITY | AUTONOMOUS

KCG College of Technology was founded in 1998 to fulfill the Founder-Chairman, Dr. KCG Verghese's vision of **"To Make Every Man a Success and No Man a Failure".** It is a Christian minority institution, affiliated to Anna University (Autonomous), Chennai and approved by AICTE, New Delhi.

VISION OF THE INSTITUTION

KCG College of Technology aspires to become a globally recognized centre of excellence for science, technology & engineering education, committed to quality teaching, learning and research while ensuring for every student a unique educational experience which will promote leadership, job creation, social commitment and service to nation building.

MISSION OF THE INSTITUTION

- Disseminate knowledge in a rigorous and intellectually stimulating environment.
- Facilitate socially responsive research, innovation and entrepreneurship.
- Foster holistic development and professional competency.
- Nurture the virtue of service and an ethical value system in the young minds.

VISION OF THE DEPARTMENT

The department aspires to become a globally recognized centre of excellence by producing competent professionals in Mechanical Engineering to serve as a valuable resource for industry and society.

MISSION OF THE DEPARTMENT

- Impart intellectually rigorous and holistic education to the students in the field of Mechanical Engineering.
- Establish state of-the-art facilities for research and consultancy work.
- Enhance the knowledge and skills of the faculty with the latest advancements in the mechanical engineering domain.
- Mentor the students to develop research and entrepreneurial capabilities.
- Inculcate a high degree of professionalism and contribute to the needs of industry and society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

After 5 years of completion of B.E (Mechanical Engineering), the Graduates will be able to

PEO 1	Excel as competent professional or entrepreneur or researcher in related fields of Mechanical Engineering.
PEO 2	Analyze, design/develop innovative solutions for real world engineering problems using appropriate modern tools.
PEO 3	Exhibit professionalism, ethical attitude and adapt to the changes in the industry and society supporting sustainable development.
PEO 4	Lead and manage teams for effective execution of projects.

PROGRAM OUTCOMES (POs)

The Graduates of B.E (Mechanical Engineering) will be able to

PO 01	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 02	Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 03	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 04	Use research based knowledge and methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 05	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 06	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 07	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 08	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 09	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadcast context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 01	Model, analyze, design and realize physical systems, components or process by applying principles of three core streams of Mechanical Engineering, i.e., Design, Manufacturing, Thermal and Fluid Engineering.
PSO 02	Ideate innovative concepts, develop prototypes and implement sustainable systems to meet societal needs both individually and as a team
PSO 03	Engage in lifelong learning and follow ethics, codes and standards of professional practices.

INDEX

KCG COLLEGE OF TECHNOLOGY
AUTONOMOUS
REGULATIONS 2023
BE - MECHANICAL ENGINEERING
CHOICE BASED CREDIT SYSTEM
CURRICULA FOR SEMESTERS I TO VIII

SEMESTER–I

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
	23IP101	Induction Programme		-	-	-	-	-
THEORY								
1	23HS101	Essential Communication	HSMC	3	0	0	3	3
2	23MA101	Matrices and Calculus	BSC	3	0	0	3	3
3	23AD101	Programming in Python	ESC	3	0	0	3	3
4	23HS102	Heritage of Tamils	HSMC	1	0	0	1	1
THEORY AND PRACTICALS								
5	23PH111	Engineering Physics	BSC	3	0	2	5	4
6	23CY111	Engineering Chemistry	BSC	3	0	2	5	4
PRACTICALS								
7	23AD121	Python Programming Laboratory	ESC	0	0	4	4	2
8	23HS121	Communication Skills Laboratory	HSMC	0	0	2	2	1
9	23HS122	General Clubs / Technical Clubs / NCC / NSS / Extension Activities	HSMC	0	0	2	2	1*
TOTAL				16	0	12	28	21

*** The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA**

SEMESTER –II

Sl. No.	Course code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	23HS201/ 23HS202	Professional English/ Foreign language	HSMC	3	0	0	3	3
2	23MA203	Statistics and Numerical Methods	BSC	3	1	0	4	4
3	23PH206	Materials Science	BSC	3	0	0	3	3
4	23ME201	Applied Mechanics	PCC	3	0	0	3	3
5	23HS203	Tamils and Technology	HSMC	1	0	0	1	1
THEORY AND PRACTICALS								
6	23EE281	Basic Electrical and Electronics Engineering	ESC	2	0	2	4	3
7	23ME211	Engineering Graphics	ESC	3	0	2	5	4
PRACTICALS								
8	23ME221	Engineering Practices Laboratory	PCC	0	0	4	4	2
9	23ME222	Applied Mechanics Laboratory	PCC	0	0	4	4	2
10	23HS221	Soft Skills	EEC	0	0	2	2	1*
TOTAL				18	1	14	34	25

*** The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA**

SEMESTER- III

Sl. No.	Course code	Course Title	Category	Periods Per Week L	T	P	Total Contact Periods	Credits
THEORY								
1	23MA302	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2	23ME301	Engineering Thermodynamics	PCC	3	0	0	3	3
3	23ME302	Engineering Materials and Metallurgy	PCC	3	0	0	3	3
4	23HS301	Universal Human Values and Ethics	HSMC	3	0	0	3	3
THEORY AND PRACTICALS								
5	23ME311	Manufacturing Processes	PCC	3	0	2	5	4
6	23ME312	Fluid Mechanics and Hydraulic Machinery	PCC	3	0	2	5	4
PRACTICALS								
7	23ME321	Computer Aided Machine Drawing Laboratory	PCC	0	0	4	4	2
8	23ES391	Presentation Skills	EEC	0	0	2	2	1*
TOTAL				18	1	10	29	23

*** The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA**

SEMESTER-IV

Sl. No.	Course code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	23MA401	Optimization Techniques	BSC	3	1	0	4	4
2	23ME401	Thermal Engineering	PCC	3	0	0	3	3
3	23ME402	Theory of Machines	PCC	3	1	0	4	4
4		Department Elective 1	DEC	3	0	0	3	3
5		Department Elective 2	DEC	3	0	0	3	3
THEORY AND PRACTICALS								
6	23CE412	Strength of Materials	PCC	3	0	2	5	4
PRACTICALS								
7	23ME421	Thermal Engineering Laboratory	PCC	0	0	4	4	2
8	23ME422	Kinematics and Dynamics Laboratory	PCC	0	0	4	4	2
9	23ES491	Aptitude and Logical Reasoning – 1	EEC	0	0	2	2	1*
10	23ME423/ 23ME424	Mini Project -1/ In-Plant Training - 1	EEC	0	0	2	2	1
TOTAL				18	1	14	33	26

*** The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA**

SEMESTER-V

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	23RE501	Research Methodology and Intellectual Property Rights	ESC	2	0	0	2	2
2	23ME501	Design of Machine Elements	PCC	3	0	0	3	3
3	23ME502	Heat and Mass Transfer	PCC	3	0	0	3	3
4		Department Elective 3	DEC	3	0	0	3	3
5		Open Elective - 1 (Emerging Technology)	OEC	3	0	0	3	3
THEORY AND PRACTICALS								
6	23ME511	Engineering Metrology and Measurements	PCC	3	0	2	5	4
PRACTICALS								
7	23ME521	Heat Transfer Laboratory	PCC	0	0	4	4	2
8	23ME522/ 23ME523	Mini Project - 2/ In-Plant Training - 2	EEC	0	0	4	4	2
9	23ES591	Aptitude and Logical Reasoning – 2	EEC	0	0	2	2	1*
TOTAL				17	0	12	29	22

*** The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA**

SEMESTER VI

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	credits
				L	T	P		
THEORY								
1		Department Elective – 4	DEC	3	0	0	3	3
2		Department Elective – 5	DEC	3	0	0	3	3
3		Open Elective – 2 (Management / Safety Courses)	OEC	3	0	0	3	3
THEORY AND PRACTICALS								
4	23CE611	Environmental Science and Engineering	ESC	3	0	2	5	4
5	23ME611	CAD/CAM	PCC	3	0	2	5	4
6	23ME612	Finite Element Analysis	PCC	3	0	2	5	4
PRACTICALS								
7	23ME621	Project Work - Phase 1	EEC	0	0	4	4	2
8	23ME624	Technical Training	EEC	0	0	2	2	1
9	23ME623	Technical Seminar - 1	ESC	0	0	2	2	1
TOTAL				18	0	14	32	25

SEMESTER -VII

Sl. No.	Course Code	Course Title	Cate Gory	periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1		Department Elective – 6	OEC	3	0	0	3	3
2		Open Elective - 3 (Management Courses)	DEC	3	0	0	3	3
3	23ME701	Fluid Power Automation	PCC	3	0	0	3	3
4	23ME702	Comprehension	EEC	2	0	0	2	2
THEORY AND PRACTICALS								
5	23ME711	Mechatronics and IOT	PCC	3	0	2	5	4
PRACTICALS								
6	23ME721	Project Work – Phase 2	EEC	0	0	6	6	3
7	23ME722	Technical Seminar – 2	ESC	0	0	4	4	2
TOTAL				14	0	12	26	20

SEMESTER -VIII

Sl. No.	Course code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
PRACTICALS								
1	23ME821/ 23ME822	Capstone Project / Internship cum project	EEC	0	0	20	20	10
TOTAL				0	0	20	20	10

TOTALCREDITS: 172

DEPARTMENT ELECTIVE COURSES: VERTICALS

VERTICAL 1: MANUFACTURING ENGINEERING

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23ME031	Additive Manufacturing	DEC	3	0	0	3	3
2	23ME032	Digital Manufacturing and IoT	DEC	3	0	0	3	3
3	23ME033	Surface Engineering	DEC	3	0	0	3	3
4	23ME034	Non-Traditional Machining Processes	DEC	3	0	0	3	3
5	23ME035	Process Planning and Cost Estimation	DEC	3	0	0	3	3
6	23ME036	Non-Destructive Testing and Evaluation	DEC	3	0	0	3	3
7	23ME037	Design for Manufacturing and Assembly	DEC	3	0	0	3	3
8	23ME038	Quality Control and Reliability Engineering	DEC	3	0	0	3	3

VERTICAL 2: COMPUTATIONAL ENGINEERING

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23ME039	Design Concepts in Engineering	DEC	3	0	0	3	3
2	23ME040	Design of Transmission Systems	DEC	3	0	0	3	3
3	23ME041	Product Design and Development	DEC	3	0	0	3	3
4	23ME042	Computational Fluid Dynamics and Heat Transfer	DEC	3	0	0	3	3
5	23ME043	Mechanical System Design	DEC	3	0	0	3	3
6	23ME044	Computational Bio-Mechanics	DEC	3	0	0	3	3
7	23ME045	Ergonomics in Design	DEC	3	0	0	3	3
8	23MT055	Machine Learning for Intelligent Systems	DEC	3	0	0	3	3

VERTICAL 3: THERMAL SCIENCES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23ME046	Power Plant Engineering	DEC	3	0	0	3	3
2	23ME047	Refrigeration and Air-Conditioning	DEC	3	0	0	3	3
3	23ME048	Non-conventional Energy sources	DEC	3	0	0	3	3
4	23ME049	Bioenergy Conversion Technologies	DEC	3	0	0	3	3
5	23ME050	Thermal Management of Batteries and Fuel Cells	DEC	3	0	0	3	3
6	23ME051	Energy Storage Devices	DEC	3	0	0	3	3
7	23ME052	Energy Conservation in Industries	DEC	3	0	0	3	3
8	23MT047	Automobile Engineering	DEC	3	0	0	3	3

VERTICAL 4: MODERN MOBILITY SYSTEMS

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23AU064	Automotive Control Systems	DEC	3	0	0	3	3
2	23AU701	Intelligent Vehicle Technology	DEC	3	0	0	3	3
3	23ME053	Hybrid and Electric Vehicle Technology	DEC	3	0	0	3	3
4	23ME054	Energy Storage and Management System for Electric Vehicles	DEC	3	0	0	3	3
5	23ME055	Electric Vehicle Design	DEC	3	0	0	3	3
6	23ME056	Vehicle Health Monitoring, Maintenance and Safety	DEC	3	0	0	3	3
7	23ME057	Conventional and Futuristic Vehicle Technology	DEC	3	0	0	3	3
8	23ME058	Automotive Materials, Components, Design and Testing	DEC	3	0	0	3	3

VERTICAL 5: ROBOTICS AND AUTOMATION

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23AE069	Drone Technologies	DEC	3	0	0	3	3
2	23ME059	Electrical Drives and Automotive Actuators	DEC	3	0	0	3	3
3	23ME060	Introduction to Robotics	DEC	3	0	0	3	3
4	23ME061	Digital Twin and Industry 5.0	DEC	3	0	0	3	3
5	23MT031	Robots and Systems in Smart Manufacturing	DEC	3	0	0	3	3
6	23MT033	Agricultural Robotics and Automation	DEC	3	0	0	3	3
7	23MT065	Total Integrated Automation	DEC	3	0	0	3	3
8	23MT401	Sensors and Instrumentation	DEC	3	0	0	3	3

OPEN ELECTIVE – EMERGING TECHNOLOGIES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact periods	Credits
				L	T	P		
1	23OAD971	Artificial Intelligence and Machine Learning Fundamentals	OEC	3	0	0	3	3
2	23OAD972	Foundation of Big Data Analytics	OEC	3	0	0	3	3
3	23OCS971	Augmented Reality and Virtual Reality	OEC	3	0	0	3	3
4	23OCS972	Data Science and Fundamentals	OEC	3	0	0	3	3
5	23OEC971	IoT Concepts and Applications	OEC	3	0	0	3	3
6	23OIT971	Blockchain Technology	OEC	3	0	0	3	3
7	23OPH971	Quantum Technology	OEC	3	0	0	3	3

OPEN ELECTIVE – MANAGEMENT COURSES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23OMG971	Total Quality Management	OEC	3	0	0	3	3
2	23OMG972	Engineering Economics and Financial Accounting	OEC	3	0	0	3	3
3	23OMG973	Engineering Management and Law	OEC	3	0	0	3	3
4	23OMG974	Knowledge Management	OEC	3	0	0	3	3
5	23OMG975	Industrial Management	OEC	3	0	0	3	3
6	23OMG976	Entrepreneurship and Business Opportunities	OEC	3	0	0	3	3
7	23OMG977	Modern Business Administration and Financing	OEC	3	0	0	3	3
8	23OMG978	Essentials of Management	OEC	3	0	0	3	3

OPEN ELECTIVE – SAFETY RELATED COURSES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23OAU981	Automotive Safety	OEC	3	0	0	3	3
2	23OCE981	Disaster Management	OEC	3	0	0	3	3
3	23OME981	Industrial Safety	OEC	3	0	0	3	3

SEMESTER-WISE CREDIT DISTRIBUTION

SEMESTER	HSMC	BSC	ESC	PCC	DEC	OEC	EEC	Total
Semester I	5	11	5	-	-	-	-	**21**
Semester II	4	7	9	5	-	-	-	**25**
Semester III	3	4	-	16	-	-	-	**23**
Semester IV	-	4	-	15	6	-	1	**26**
Semester V	-	-	2	12	3	3	2	**22**
Semester VI	-	-	5	8	6	3	3	**25**
Semester VII	-	-	2	7	3	3	5	**20**
Semester VIII	-	-	-	-	-	-	10	**10**
Total	**12**	**26**	**23**	**63**	**18**	9	21	**172**

SEMESTER –I

23IP101	INDUCTION PROGRAMME	L	T	P	C
		-	-	-	0

COURSE OBJECTIVES:

- This is a mandatory 2 weeks Programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.
- The induction Programme has been introduced by AICTE with the following objectives
- Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.
- One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character
- Hence, the purpose of this Programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and

students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature • **Physical Activity** This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc., • **Life skills** Every student would choose one skill related to daily needs such as stitching, accounting, finance management, etc.,
Universal human values
This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through dos and don'ts, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real-life activities rather than lecturing.
Club Activity
Students will be introduced to more than 20 Clubs available in the college-both technical and non-technical. The student can choose as to which club the student will enroll in.
Value Based Communication
This module will focus on improving the communication skills of students
Lectures by Alumni
Lectures by alumni are arranged to bring in a sense of belonging to the student towards the institution and also to inspire them to perform better
Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged
Familiarization to Dept./Branch and Innovations
They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops and other facilities
Address by different heads
Heads of Placement, Training, Student affairs, counsellor, etc would be interacting with the students to introduce them to various measures taken in the institution for the betterment of students.
Induction Programme is totally an activity-based Programme and therefore there shall be no tests / assessments during this Programme.
REFERENCES:
Guide to Induction program from AICTE

23HS101	ESSENTIAL COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To help learners extract information from short and simple correspondence
- To familiarize learners with different text structures by engaging them in reading, writing and grammar learning activities
- To help learners write coherent, short paragraphs and essays
- To enable learners to use language efficiently while expressing their opinions via various media.

UNIT I	FORMATION OF SENTENCES	9

Reading- Read pictures-notices- short comprehension passages and recognize main ideas and specific details. Writing- framing simple and compound sentences, completing sentences, developing hints, writing text messages. Language development- Parts of Speech, Wh- Questions, yes or no questions, direct and indirect questions. Vocabulary development– prefixes- suffixes- articles – countable and uncountable nouns

UNIT II	NARRATION AND DESCRIPTION	9

Reading – Read short narratives and descriptions from newspapers, dialogues and conversations. Reading strategies and practices. Language development – Tenses- simple present, present continuous, present perfect, simple past, past continuous, past perfect, simple future, future continuous, past participle, pronouns. Vocabulary development- guessing meanings of words in context. Writing – Write short narrative paragraphs, biographies of friends/relatives - writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested

vocabulary and structures.		
UNIT III	**COMPARING AND CONTRASTING**	**9**
Reading- short texts and long texts -understanding different types of text structures, -coherence-jumbled sentences. Language development- degrees of comparison, concord- Vocabulary development – single word substitutes- discourse markers- use of reference words Writing - comparative and contrast paragraphs writing- topic sentence- main idea, free writing, compare and contrast using some suggested vocabulary and structures.		
UNIT IV	**SOCIAL MEDIA COMMUNICATION**	**9**
Reading- Reading blogs, social media reviews, posts, comments, process description, Language development - relative clause, Vocabulary development- social media terms-words, abbreviations and acronyms Writing- -e-mail writing-conventions of personal email, descriptions for simple processes, critical online reviews, blog, website posts, commenting to posts.		
UNIT V	**ESSAY WRITING**	**9**
Reading- Close reading non-technical longer texts Language development - modal verbs, phrasal verbs- Vocabulary development - collocation. Writing- Writing short essays- brainstorming – developing an outline- identifying main and subordinate ideas.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to		
CO1	Summarize simple, level-appropriate texts of around 300 words recognizing main ideas and specific details.	
CO2	Demonstrate the understanding of more complex grammatical structures and diction while reading and writing.	

CO3	Use appropriate expressions to describe, compare and contrast people, things, situations etc., in writing.
CO4	Establish the ability to communicate effectively through emails.
CO5	Determine the language use appropriate for different social media platforms.
CO6	Use appropriate expressions for narrative descriptions and process descriptions.
TEXT BOOKS:	
1	Susan Proctor, Jack C. Richards, Jonathan Hull. Interchange Level 2. Cambridge University Press and Assessment
2	Susan Proctor, Jack C. Richards, Jonathan Hull. Interchange Level 3. Cambridge University Press and Assessment
REFERENCES:	
1	Dutt P. Kiranmai and Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013
2	Means,L. Thomas and Elaine Langlois. English and Communication for Colleges. Cengage Learning , USA: 2007

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
3	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
4	-	-	-	-	-	-	-	-	-	3	-	2	-	-	-
5	-	-	-	-	-	1	1	-	3	3	-	2	-	-	-
6	-	-	-	-	-	1	1	-	3	3	-	2	-	-	-
Overall Correlation	-	-	-	-	-	**1**	**1**	-	**3**	**3**	-	**2**	-	-	-

Recommended by Board of Studies	**28-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23MA101	MATRICES AND CALCULUS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications

UNIT I	MATRICES	9

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.

UNIT II	DIFFERENTIAL CALCULUS	9

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

UNIT III	FUNCTIONS OF SEVERAL VARIABLES	9

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multiplier.

UNIT IV	INTEGRAL CALCULUS	9

Definite and Indefinite integrals - Substitution rule - Techniques of

Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.		
UNIT V	**MULTIPLE INTEGRALS**	**9**
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1	Apply the matrix algebra techniques and applications in Engineering Problems.
CO2	Make use of the concept of limits and rules of differentiation to differentiate functions
CO3	Find the derivative of functions of several variables
CO4	Examine the application of partial derivatives
CO5	Compute integrals by different techniques of Integration.
CO6	Apply the concept of integration to compute multiple integrals.
TEXT BOOKS:	
1	Kreyszig. E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2	James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015.
REFERENCES:	
1	Dr.P.Sivaramakrishnadas, Dr.C.Vijayakumari., — Matrices and Calculus‖ Pearson Publications Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2	Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016

3	Bali. N., Goyal. M. and Watkins. C., ―Advanced Engineering Mathematics‖, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.														
4	Narayanan. S. and Manicavachagom Pillai.T. K., ―Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.														
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Recommended by Board of Studies	**02-08-2023**														
Approved	**1st ACM**			**Date**			**09-09-2023**								

23AD101	PROGRAMMING IN PYTHON	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To know the basics of Programming.
- To convert an algorithm into a Python program.
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions.
- To use Python data structures-lists, tuples, dictionaries and files.

UNIT I	COMPUTATIONAL THINKING	9

Introduction to Computing and Problem Solving: Fundamentals of Computing –Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).

UNIT II	INTRODUCTION TO PYTHON	9

Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, type () Function and Is Operator, Dynamic and Strongly Typed Language. Control Flow Statements: if, if…else, if…elif…else Decision Control Statements, Nested if Statement, while Loop, for Loop, continue and break Statements.

UNIT III	FUNCTIONS AND STRINGS	9

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments. Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

UNIT IV	LISTS, TUPLES, DICTIONARIES AND FILES	9
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list Parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension. Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages.		
UNIT V	**OBJECT-ORIENTED AND FUNCTIONAL PROGRAMMING**	**9**
Object-Oriented Programming: Classes and Objects, Creating Classes in Python,Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance, Polymorphism. Functional Programming: Lambda. Iterators, Generators, List Comprehensions.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Develop algorithmic solutions to simple computational problems.
CO2	Develop and execute simple Python programs using Control Statements
CO3	Develop simple Python programs for solving problems using Functions and Strings
CO4	Build a Python program using lists, tuples, dictionaries and files.
CO5	Construct a code related to Object-Oriented Programming Concept
CO6	Construct a code related to Functional Programming.
TEXT BOOKS:	
1	Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/).

2	Karl Beecher, “Computational Thinking: A Beginnerand#39;s Guide to Problem Solving and Programming”, 1st Edition, BCS Learning andamp; Development Limited, 2017.
REFERENCES:	
1	Learning To Program with Python. Richard L. Halterman. Copyright © 2011
2	Python for Everybody, Exploring Data Using Python 3. Dr. Charles R. Severance. 2016.
3	Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
4	G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
5	John V Guttag, andquot;Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data‘‘, Third Edition, MIT Press , 2021
6	Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
7	https://www.python.org/
8	Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	-	-	-	-	1	3	1	-
2	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
3	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
4	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
5	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
6	3	2	1	1	1	-	-	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

Recommended by Board of Studies	**28-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

<table>
<tr><td rowspan="2">23HS102</td><td rowspan="2">HERITAGE OF TAMILS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• Explain the classical literature of Tamil and highlight notable Tamil poets.
• Explain the creation of traditional Tamil musical instruments.
• Explain the sports and games associated with Tamil heritage.
• Explore the education and literacy practices during the Sangam period.
• Explain the contributions of Tamils to the Indian freedom struggle.
• Explain the development and history of printing in Tamil Nadu.</td></tr>
<tr><td>UNIT I</td><td colspan="4">LANGUAGE AND LITERATURE</td><td>3</td></tr>
<tr><td colspan="6">Language Families in India – Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature – Management Principles in Thirukural – Tamil Epics and Impact of Buddhism and Jainism in Tamil Land – Bakthi Literature Azhwars and Nayanmars – Forms of minor Poetry – Development of Modern literature in Tamil – Contribution of Bharathiyar and Bharathidhasan.</td></tr>
<tr><td>UNIT II</td><td colspan="4">HERITAGE – ROCK ART PAINTINGS TO MODERN ART – SCULPTURE</td><td>3</td></tr>
<tr><td colspan="6">Hero stone to modern sculpture – Bronze icons – Tribes and their handicrafts – Art of temple car making – – Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments – Mridhangam, Parai, Veenai, Yazh and Nadhaswaram – Role of Temples in Social and Economic Life of Tamils.</td></tr>
</table>

UNIT III	**FOLK AND MARTIAL ARTS**	**3**
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance – Sports and Games of Tamils.		
UNIT IV	**THINAI CONCEPT OF TAMILS**	**3**
Flora and Fauna of Tamils and Aham and Puram Concept from Tholkappiyam and Sangam Literature – Aram Concept of Tamils – Education and Literacy during Sangam Age – Ancient Cities and Ports of Sangam Age – Export and Import during Sangam Age – Overseas Conquest of Cholas		
UNIT V	**CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**	**3**
Contribution of Tamils to Indian Freedom Struggle – The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement – Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions and Manuscripts – Print History of Tamil Books.		
		TOTAL: 15 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the evolution of Tamil language and literature, focusing on its cultural, ethical, and secular themes.
CO2	Outline the making of musical instruments related to Tamil heritage.
CO3	Discuss the sports and games of Tamils
CO4	Explain the education and literacy during Sangam age.
CO5	Express the importance and contribution of Tamils to Indian Freedom Struggle
CO6	Outline the print history of books in Tamil Nadu

TEXT BOOKS:	
1	தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்). தமிழக வரலாறு-மக்களும் பண்பாடும்-கே.கேபிள்ளை (வெளியீடு:
2	கணினித்தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்).

REFERENCES:	
1	**கீழடி- வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம்** (**தொல்லியல் துறை வெளியீடு)**
2	பொருனை- ஆற்றங்கரை **நாகரிகம்** (**தொல்லியல் துறை வெளியீடு)**

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
2	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
4	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
5	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
6	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
Overall Correlation		-	-	-	-	2	2	-	-	-	-	-	-	-	-

Recommended by Board of Studies	28-07-2023		
Approved	1st ACM	Date	09-09-2023

<table>
<tr><td rowspan="2">23PH111</td><td rowspan="2">ENGINEERING PHYSICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• To make the students effectively achieve an understanding of mechanics.
• To enable the students to gain knowledge of electromagnetic waves and its applications.
• To introduce the basics of optics and lasers.
• To equip the students successfully understand the importance of quantum physics.
• To motivate the students towards the applications of quantum mechanics.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">MECHANICS</td><td>9</td></tr>
<tr><td colspan="6">Types of stress, Stress-strain diagram and its uses- factors affecting elastic modulus- tensile strength- Bending of beams, bending moment – theory and experiment: Uniform and non-uniform bending, Center of mass (CM) – CM of continuous bodies –rod, motion of the CM. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M.I –moment of inertia of rod, disc, solid sphere – M.I of a diatomic molecule - torque -rotational energy state of a rigid diatomic molecule – M.I of disc by torsional pendulum</td></tr>
<tr><td>UNIT II</td><td colspan="4">ELECTROMAGNETIC WAVES</td><td>9</td></tr>
<tr><td colspan="6">Concept of field-introduction to gradient, divergence and curl of field – Stokes theorem (No proof)-Gauss divergence theorem (No proof) - The Maxwell's equations in integral form and differential form - wave equation; Plane electromagnetic waves in vacuum - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - Energy and momentum in EM waves-Poynting's vector - Cell-phone reception.</td></tr>
<tr><td>UNIT III</td><td colspan="4">OPTICS AND LASERS</td><td>9</td></tr>
<tr><td colspan="6">Reflection and refraction of light waves - total internal reflection –</td></tr>
</table>

types of optical fiber, Numerical Aperture and acceptance angle - interference –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients(Qualitative) - population inversion - CO2 laser, semiconductor laser (Homo junction) - Applications of lasers in industry.		
UNIT IV	**BASIC QUANTUM MECHANICS**	**9**
Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization – Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.		
UNIT V	**ADVANCED QUANTUM MECHANICS**	**9**
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.		
		TOTAL: 45 PERIODS
PRACTICAL EXERCISES: (Any Seven Experiments)		

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects
2. Simple harmonic oscillations of cantilever
3. Non-uniform bending- Determination of Young's modulus
4. Uniform bending–Determination of Young's modulus
5. Laser-Determination of the wavelength of the laser using grating
6. Air wedge- Determination of thickness of a thin sheet /wire

7. a) Optical fibre-Determination of Numerical Aperture and acceptance angle b) Compact disc-Determination of width of the groove using laser. 8. Acoustic grating-Determination of velocity of ultrasonic waves in liquids. 9. Ultrasonic interferometer–determination of the velocity of sound and compressibility of liquids 10. Post office box-Determination of Band gap of a semiconductor. 11. Photoelectric effect 12. Michelson Interferometer. 13. Melde's string experiment 14. Experiment with lattice dynamics kit.	
TOTAL: 30 PERIODS	
COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Determine the mechanical properties of materials.
CO2	Apply the principles of electromagnetic waves to real world system.
CO3	Determine the thickness of thin wire and the characteristic parameter of an optical fiber.
CO4	Apply the principles of lasers to real world application.
CO5	Organize the quantum mechanical properties of particles and waves.
CO6	Utilize the quantum mechanical principles towards the formation of energy bands.
TEXT BOOKS:	
1	D.Kleppner and R.Kolenkow, "An Introduction to Mechanics", McGraw Hill Education (Indian Edition), 2017.
2	Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, "Concepts of Modern Physics", McGraw-Hill (Indian Edition), 2017.

REFERENCES:	
1	R.Wolfson," Essential University Physics", Volume 1 and 2. Pearson Education (Indian Edition), 2009.
2	Paul A. Tipler, "Physic – Volume 1 and 2", CBS, (Indian Edition), 2004.
3	K.Thyagarajan and A.Ghatak,"Lasers: Fundamentals and Applications," Laxmi Publications, (Indian Edition), 2019.
4	D.Halliday, R.Resnick and J.Walker, "Principles of Physics", Wiley (Indian Edition), 2015.
5	N.Garcia, A.Damask and S.Schwarz, "Physics for Computer Science Students",Springer Verlag, 2016.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**28-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23CY111	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage batteries.

UNIT I	WATER AND ITS TREATMENT	9

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, flouride and arsenic. Sewage treatment primary treatment and disinfection (UV, Ozonation, break-point chlorination). Hardness-Estimation of Hardness of water by EDTA-numerical Problems-Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming andfoaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process

UNIT II	NANOCHEMISTRY	9

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials (Metal oxide and Metal) Synthesis and Characterization of nanomaterials: sol-gel, solvothermal, laser ablation, chemical

vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, energy, sensor , electronics and catalysis.		
UNIT III	**PHASE RULE AND COMPOSITES**	**9**
Phase rule: Introduction, definition of terms with examples. One component system – water system; CO_2 system; Reduced phase rule; Two component system: lead-silver system – Pattinson process. Composites: Definition and Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites – definition and examples.		
UNIT IV	**FUELS AND COMBUSTION**	**9**
Fuels: Fossil Fuels, Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking – octane number, diesel oil – cetane number; Power alcohol and biodiesel. Combustion of fuels: Introduction: Calorific value – higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis – ORSAT Method. CO_2 emission and carbon sequestration, Green Hydrogen.		
UNIT V	**ENERGY SOURCES AND STORAGE DEVICES**	**9**
Nuclear fission and fusion- light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy; Batteries: Types of batteries, Primary battery – dry cell, Secondary battery – lead acid battery and lithium-ion battery; Electric vehicles – working		

principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell and its advanced technology, supercapacitor.
TOTAL: 45 PERIODS
LIST OF EXPERIMENTS **TOTAL: 30 PERIODS**
1. Determination of hardness causing salts in water sample by EDTA method. 2. Determination of alkalinity in water sample. 3. Determination of chloride content of water sample by argentometric method. 4. Determination of strength of given Barium chloride using conductivity meter. 5. Determination of strength of Acid using pH meter. 6. Determination of strength of FAS by potentiometer 7. Determination of strength of acids in a mixture using conductivity meter. 8. Preparation of nanoparticles (TiO_2/ZnO/CuO) by Sol-Gel method. **9.** Estimation of Nickel in steel
COURSE OUTCOMES:
After completion of the course, the students will be able to:

CO1	Interpret the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
CO2	Illustrate the basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
CO3	Estimate the knowledge of phase rule and composites for material selection requirements
CO4	Choose a suitable fuel for engineering processes and applications
CO5	Relate the different forms of energy resources and apply them for suitable applications in energy sectors.
CO6	Explain the different types of batteries, fuel cells and working principles of Electric vehicles

TEXT BOOKS:	
1	P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3	S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44^{th} Edition, 2018.
REFERENCES:	
1	B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2	O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3	Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014New Delhi, 2018.
4	ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019
5	O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	-	2	-	-	-	-	1	2	-	-
2	2	1	-	-	-	-	2	-	-	-	-	1	2	-	-
3	2	1	-	-	-	-	2	-	-	-	-	1	2	-	-
4	3	2	1	1	-	-	3	-	-	-	-	2	3	-	-
5	3	2	1	1	-	-	3	-	-	-	-	2	3	-	-
6	2	1	-	-	-	-	2	-	-	-	-	1	2	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**3**	**-**	**-**

Recommended by Board of Studies	**28-07-2023**		
Approved	**1^{st} ACM**	**Date**	**09-09-2023**

23AD121	PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

The main objective of this laboratory is to put into practice computational thinking. The students will be expected to write, compile, run and debug Python programs to demonstrate the usage of:

- Operators and Conditional Statements
- Control Structures and Functions (both recursive and iterative) and Recursion.
- String functions
- Lists, Sets, Dictionaries, Tuples and Files.
- Object-Oriented Programming

Exercise 1 Programs to demonstrate the usage of operators and conditional statements.

1. Write a program that takes two integers as command line arguments and prints the sum of two integers.
2. Program to display the information:
   Your name, Full Address, Mobile Number, College Name, Course Subjects
3. Program that reads the URL of a website as input and displays contents of a webpage.

Exercise 2 Programs to demonstrate usage of control structures.

4. Program to find the sum of all prime numbers between 1 and 1000.
5. Program to find the product of two matrices.
6. Program to find the roots of a quadratic equation.

Exercise 3 Programs to demonstrate the usage of Functions and Recursion

7. Write both recursive and non-recursive functions for the following:
   a. To find GCD of two integers
   b. To find the factorial of positive integer
   c. To print Fibonacci Sequence up to given number n
   d. To convert decimal number to Binary equivalent

	8. Program with a function that accepts two arguments: a list and a number n. It should display all the numbers in the list that are greater than the given number n. 9. Program with a function to find how many numbers are divisible by 2, 3,4,5,6 and 7 between 1 to 1000.
Exercise 4	**Programs to demonstrate the usage of String functions.**
	10. Program that accepts two strings S1, S2, and finds whether they are equal are not. 11. Program to count the number of occurrences of characters in each string. 12. Program to find whether a given string is palindrome or not.
Exercise 5	**Programs to demonstrate the usage of lists, sets, dictionaries, tuples and files.**
	13. Simple sorting, Histogram, Students marks statement, Retail bill preparation 14. Write a program that combines lists L1 and L2 into a dictionary. 15. Program to display a list of all unique words in a text file and word count, copy file, Voter's age validation, Marks range validation (0-100).
Exercise 6	**Programs to demonstrate the usage of Object-Oriented Programming**
	16. Program to implement the inheritance. 17. Program to implement polymorphism
	TOTAL: 60 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1	Develop algorithmic solutions to simple computational problems.
CO2	Develop and execute simple Python programs.
CO3	Construct programs in Python using conditionals and loops for solving problems.

CO4	Utilize functions to decompose a Python program.
CO5	Analyse compound data using Python data structures.
CO6	Interpret data from/to files in Python Programs

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	-	-	-	-	1	3	1	-
2	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
3	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
4	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
5	3	3	2	2	1	-	-	-	-	-	-	1	3	1	-
6	2	1	-	-	1	-	-	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

Recommended by Board of Studies	**28-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23HS121	COMMUNICATION SKILLS LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To enable the students to comprehend the main idea and specific information of the listening passage
- To help students express themselves clearly, and communicate effectively with others.
- To introduce authentic language use and context-specific vocabulary that might not be encountered in textbooks.

Exercise : 1	Listening to conversations set in everyday social context and complete gap-filling exercise
Exercise : 2	Listening to a monologue in everyday social context. Diagram labelling and MCQ
Exercise : 3	Listening to a group conversation in academic setting and answer MCQ
Exercise : 4	Listening to a lecture and answer MCQ or gap filling
Exercise : 5	Listening to Ted Talks, podcasts, documentaries - discussion
Exercise : 6	Listening to a lecture and reading a text on the same subject- compare and contrast
Exercise : 7	Speaking Introducing oneself
Exercise : 8	Answering questions based on the introduction
Exercise : 9	Speaking on a given prompt for 2 mins.
Exercise :10	Answering questions based on the topic spoken
Exercise :11	Role play- Engaging in conversation
Exercise :12	Engaging in Podcast Discussion
	TOTAL: 25 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Demonstrate fluency in speaking in variety of situations.
CO2	Express their knowledge by talking continuously for more than two minutes on a topic.

CO3	Develop active listening for more meaningful interactions and conversations.
CO4	Use a full range of structures naturally and appropriately.
CO5	Identify the specific information in conversations, interviews, talks and lectures.
CO6	Develop the ability to compare and analyse different forms of information, identifying key similarities and differences.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
3	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
4	-	-	-	-	-	-	-	-	-	3	-	2	-	-	-
5	-	-	-	-	-	1	1	-	3	3	-	2	-	-	-
6	-	-	-	-	-	1	1	-	2	3	-	-	-	-	-
Overall Correlation	-	-	-	-	-	**1**	**1**	-	**3**	**3**	-	**2**	-	-	-

Recommended by Board of Studies	**28-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

SEMESTER - II

23HS201	PROFESSIONAL ENGLISH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To help learners extract information from longer, technical and scientific texts
- To familiarize learners with different text structures by engaging them in reading, writing and grammar learning activities
- To help learners write coherent, extensive reports and essays.
- To enable learners to use language efficiently while expressing their opinions in professional and business situations

UNIT I	WORKPLACE COMMUNICATION	9

Reading – Reading brochures (technical context), advertisements, telephone messages, gadget reviews social media messages, digital communication relevant to technical contexts and business. Writing – Writing emails -emails on professional contexts including introducing oneself, writing checklist, writing single sentence definition, product description- advertising or marketing slogans, Language Development– Tenses, Concord, Question types: Wh/ Yes or No/ and Tags, imperative sentences, complex sentences. Vocabulary - One-word substitutes; Abbreviations and Acronyms as used in technical contexts and social media.

UNIT II	EXPRESSING CAUSE AND EFFECT	9

Reading - Reading longer technical texts– Cause and Effect Essays, and emails of complaint. Writing - writing complaint emails (raising tickets) and responses to complaints, writing Cause and effect paragraphs and essays. Language Development– Active, Passive and Impersonal Passive Voice transformations, Infinitive and Gerunds Vocabulary – Synonyms- contextual meaning of

words, Same word acting as different parts of speech, causal expressions.		
UNIT III	**PROVIDING SOLUTIONS TO PROBLEMS**	**9**
Reading - Case Studies, editorials, news reports etc. Writing – Letter to the Editor, Writing instructions and recommendations, Problem solution essay / Argumentative Essay, Language Development – Error correction; If conditional sentences Vocabulary - Compound Words, discourse markers.		
UNIT IV	**INTERPRETATION OF GRAPHICS**	**9**
Reading - Reading newspaper articles, nonverbal communication (charts and graphs) Writing –Transferring information from nonverbal (chart, graph etc, to verbal mode) Process– description. Language development–Possessive and Relative pronouns, numerical adjectives Vocabulary Homonyms and Homophones, sequence words.		
UNIT V	**REPORT WRITING AND RESUME WRITING**	**9**
Reading – Company profiles, journal reports. Language Development– Reported Speech Vocabulary-reporting words and phrases. Writing - Writing accident report, survey report and progress report, project proposal, minutes of the meeting, writing statement of purpose, internship application and resume		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1	Summarize long technical and scientific text of not less than 500 words recognizing main ideas and specific details.
CO2	Demonstrate the understanding of more complex grammatical structures and diction while reading and writing.
CO3	Use appropriate expressions to describe process and product, compare and contrast data, analyze problems, provide solutions and prove an argument in writing.

CO4	Establish the ability to communicate effectively in professional environment through emails and reports.
CO5	Determine the language use appropriate for different social media platforms used for digital marketing.
CO6	Convert skills to assets and position themselves in job market through their own professional narratives.

TEXT BOOKS:

1	V. Chellammal, Deepa Mary Francis, K N Shoba, P R Sujatha Priyadharshini, Veena Selvam, English for Science and Technology I, Cambridge University Press and Assessment
2	V. Chellammal, Deepa Mary Francis, K N Shoba, P R Sujatha Priyadharshini, Veena Selvam, English for Science and Technology II, Cambridge University Press and Assessment

REFERENCES:

1	Business Correspondence and Report Writing by Prof. R.C. Sharma and Krishna Mohan, Tata McGraw Hill and Co. Ltd., 2001, New Delhi.
2	Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
3	-	-	-	-	-	-	1	-	2	3	-	2	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
5	-	-	-	-	-	-	1	-	2	3	-	2	-	-	-
6	-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
Overall Correlation	-	-	-	-	-	1	1	-	2	3	-	3	-	-	-

Recommended by Board of Studies	**28-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23MA203	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I	TESTING OF HYPOTHESIS	9+3

Sampling distributions – Standard error-Large sample test for single mean, proportion, difference of means -Small sample Tests– T Test for single mean and difference of means-F test for equality of variance – Chi square test for single variance- Independence of attribute-Goodness of fit (Binomial Distribution, Poisson Distribution).

UNIT II	DESIGN OF EXPERIMENTS	9+3

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design.

UNIT III	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	9+3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss

Seidel - Eigenvalues of a square matrix by Power method		
UNIT IV	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION**	**9+3**
Interpolation - Newton's forward and backward difference interpolation -Lagrange's and Newton's divided difference interpolations –– Approximation of derivative using interpolation polynomials – Numerical single integration and double using Trapezoidal and Simpson's 1/3 rules.		
UNIT V	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9+3**
Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge- Kutta method for solving first order differential equations - Multi step methods: Milne's and Adam's Bashforth method.		
		TOTAL: 60 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Examine the given data for large and small samples problems.
CO2	Examine the problems involving design of experiments.
CO3	Find the numerical solutions for nonlinear (algebraic or transcendental) equations, large system of linear equations and Eigen value problem of a matrix, when analytical methods fail to give solution.
CO4	Determine the intermediate values of the experimental data, using Newton's forward, backward, divided difference and Lagrange's methods.
CO5	Find the solutions for the problems involving numerical differentiation and integration.
CO6	Solve numerically, ordinary differential equations which is used to solve different kinds of problems occurring in engineering and technology.
TEXT BOOKS:	

1	Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
2	Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES:

1	P. Sivarama Krishna Das "A Text Book of Statistics and Numerical Methods" Viji's Academy.
2	Burden, R.L. and Faires, J.D. "Numerical Analysis" 9th Edition, Cengage Learning, 2016.
3	Devore.J.L " Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014
4	Gerald.C.F. and Wheatley.P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**28-07-2023**		
Approved by Academic	**1st ACM**	**Date**	**09-09-2023**

23PH206	MATERIALS SCIENCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make the students to understand the basics of crystallography and its importance in studying materials properties.
- To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
- To instil knowledge on physics of semiconductors, determination of charge carriers and device applications.
- To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications
- To inculcate an idea of significance of nano structures, quantum confinement and ensuing nano device applications.

UNIT I	CRYSTALLOGRAPHY	9

Crystal structures: BCC, FCC and HCP – directions and planes - linear and planar densities – crystal imperfections- edge and screw dislocations – grain and twin boundaries - Burgers vector and elastic strain energy- Slip systems, plastic deformation of materials - Polymorphism.

UNIT II	ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS	9

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory: Tunneling – degenerate states – Fermi- Dirac statistics – Density of energy states. Magnetic materials: Dia, para and ferromagnetic effects –Domain theory and hysteresis of ferromagnets – exchange interaction and ferromagnetism – quantum interference devices – GMR devices.

UNIT III	SEMICONDUCTORS AND TRANSPORT PHYSICS	9

Intrinsic Semiconductors – Energy band diagram – direct and

indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type and P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion (qualitative) – Hall effect and devices – Ohmic contacts – Schottky diode – introduction to solid state drive (SSD).		
UNIT IV	**OPTICAL PROPERTIES OF MATERIALS**	**9**
Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –excitonic state.		
UNIT V	**NANOELECTRONIC DEVICES**	**9**
Quantum confinement – Quantum structures – quantum wells, wires and dots – Zener-Bloch oscillations – Resonant tunnelling – quantum interference effects - mesoscopic structures - Single electron phenomena – Single electron Transistor. Active and passive optoelectronic devices – photo processes – spintronics – carbon nanotubes: Properties and applications.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Apply the basics of crystallography and its importance in studying materials properties.
CO2	Compute charge carrier density of metals and fermi energy level.
CO3	Apply the knowledge of magnetic properties of materials in data storage.
CO4	Compute carrier concentration in intrinsic and extrinsic semiconductor.
CO5	Build a sound grasp of knowledge in different optical properties of materials, optical displays and applications.

CO6	Develop an idea of significance of nano structures, quantum confinement and ensuring nano device applications.
TEXT BOOKS:	
1	V.Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.
2	Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, Mc- Graw Hill India (2019.
3	G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.
REFERENCES:	
1	R.Balasubramaniam, Callister's Materials Science and Engineering. Wiley (Indian Edition), 2014.
2	Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3	Robert F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006
4	Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Pearson, 2017.
5	Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**-**

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23ME201	APPLIED MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Inculcate the ability to analyze any problem in a simple and logical manner.
- Learn the use of scalar and vector analytical techniques for analyzing forces in staticallydeterminate structures.
- Introduce the equilibrium of rigid bodies, vector methods and free body diagram.
- Learn the principles of friction, forces and to determine and apply the concepts offrictional forces at the contact surfaces of various engineering systems.
- To develop basic dynamics concepts such as force, momentum, work and energy.
- To apply the well understood basic principles for the real time.

UNIT I	BASICS AND STATICS OF PARTICLES	9

Introduction – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces - vector representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product - Coplanar Forces - rectangular components - Equilibrium of a particle – Forces in space – Equilibrium of a particle in space - Equivalent systems of forces, Free body diagram.

UNIT II	EQUILIBRIUM OF RIGID BODIES	9

Principle of transmissibility - Varignon's theorem - Types of supports - Action and reaction forces - stable equilibrium - Moment of a force about a point and about an axis – Single equivalent force - Equilibrium of rigid bodies in two dimensions - Equilibrium of rigid bodies in three dimensions, Analysis of Trusses – Method of Joints and Method of sections.

UNIT III	PROPERTIES OF SURFACES AND SOLIDS	9
Centroids and centre of mass - Centroids of lines and areas - Rectangular, circular, triangular areas by integration - T section, I section, Angle section, Hollow section by using standard formula - Theorems of Pappus - Area moments of inertia of plane areas - rectangular, circular, triangular areas by integration - T section, I section, Angle section, Hollow section by using standard formula - Parallel axis theorem and Perpendicular axis theorem - Principal moments of inertia of plane areas - Principal axes of inertia-Mass moment of inertia - mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.		
UNIT IV	**FRICTION**	**9**
Friction force - Ladder Friction, Wedge friction, Screw friction - Rolling resistance, Square threaded Screws, Journal Bearings, Thrust Bearings, Disc friction, Wheel friction, Rolling resistance.		
UNIT V	**DYNAMICS OF PARTICLES**	**9**
Newton's laws of motion - Principle of Work and Energy, Applications of the Principle of Work and Energy, Power and Efficiency, Conservation of Energy, Principle of Impulse and Momentum, Impacts of bodies - Work Energy Equation - Impulse and Momentum equation.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Apply law of forces on particles.
CO2	Calculate forces on rigid bodies.
CO3	Determine reaction forces at the support.
CO4	Calculate area moment of inertia of planar body and mass moment of inertia of rigid bodies.
CO5	Determine friction and its effects at the surfaces of contact for ladder, wedge, belt and bearings.

CO6	Calculate dynamic forces on rigid bodies.
TEXT BOOKS:	
1	Beer, F.P and Johnston Jr. E.R., ―Vector Mechanics for Engineers (In SI Units): Statics and Dynamics‖, 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2	Bhavikatti, S.S and Rajashekarappa, K.G., ―Engineering Mechanics‖, New Age International (P) Limited Publishers, 1998.
REFERENCES:	
1	Hibbeller, R.C and Ashok Gupta, ―Engineering Mechanics: Statics and Dynamics‖, 11th Edition, Pearson Education 2010.
2	Irving H. Shames and Krishna Mohana Rao. G., ―Engineering Mechanics – Statics and Dynamics‖, 4th Edition, Pearson Education 2006.
3	Meriam J.L. and Kraige L.G., ― Engineering Mechanics- Statics - Volume 1, Dynamics - Volume 2‖, Third Edition, John Wiley and amp; Sons, 1993.
4	Rajasekaran S and Sankarasubramanian G., ―Engineering Mechanics Statics and Dynamics‖, 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	2	-	-	1	-	-	-	2	3	1	1
2	3	2	1	1	2	-	-	1	-	-	-	2	3	1	1
3	3	2	1	1	2	-	-	1	-	-	-	2	3	1	2
4	3	2	1	1	2	-	-	1	-	-	-	2	3	1	2
5	3	2	1	1	2	-	-	1	-	-	-	2	3	1	2
6	3	2	1	1	2	-	-	1	-	-	-	2	3	1	2
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**1**	**2**

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

<table>
<tr><td rowspan="2">23HS203</td><td rowspan="2">TAMILS AND TECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• To summarize the weaving industry and ceramic technology during Sangam Age .
• To explain the design and construction of houses during Sangam Age and the sculptures and temples of Chola, Pallava and Pandya period.
• To explain about the water bodies of Sangam age and relate it to the agricultural usage.
• To outline to students the agriculture and irrigation technology during the Chola Period .
• To help students Interpret and explain the digitalization of Tamil books and development of Tamil software.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">WEAVING AND CERAMIC TECHNOLOGY</td><td>3</td></tr>
<tr><td colspan="6">Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.</td></tr>
<tr><td>UNIT II</td><td colspan="4">DESIGN AND CONSTRUCTION TECHNOLOGY</td><td>3</td></tr>
<tr><td colspan="6">Designing and Structural construction House and Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram – Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.</td></tr>
<tr><td>UNIT III</td><td colspan="4">MANUFACTURING TECHNOLOGY</td><td>3</td></tr>
<tr><td colspan="6">Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences – Gem stone types described in Silappathikaram.</td></tr>
</table>

UNIT IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	**3**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.		
UNIT V	**SCIENTIFIC TAMIL and TAMIL COMPUTING**	**3**
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books –Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.		
		TOTAL: 15 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Summarize the weaving industry and ceramic technology during Sangam Age.
CO2	Explain the design and construction of houses during Sangam Age.
CO3	Explain the sculptures and temples of Chola,Pallava and Pandya period.
CO4	Explain about the water bodies of Sangam age and relate it to the agricultural usage.
CO5	Outline the agriculture and irrigation technology during the Chola Period.
CO6	Interpret and explain the digitalization of tamil books and development of Tamil software.
TEXT BOOKS:	
1	Dr.K.K.Pillay ,"Social Life of Tamils", A joint publication of TNTB and ESC and RMRL.
REFERENCES:	
1	Dr.S.Singaravelu ,"Social Life of the Tamils - The Classical Period", Published by: International Institute of Tamil Studies.

2	Dr.S.V.Subatamanian , Dr.K.D. Thirunavukkarasu, “Historical Heritage of the Tamils”, Published by: International Institute of Tamil Studies

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
2	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
3	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
4	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
5	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
6	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
Overall Correlation	-	-	-	-	-	**1**	**1**	**1**	-	-	-	-	-	-	-

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23EE281	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To introduce the basics of electric circuits and analysis.
- To impart knowledge in the basics of working principles and application of electrical machines.
- To introduce analog devices and their characteristics.
- To educate on the fundamental concepts of digital.electronics, functional elements and working of measuring instruments.
- To demonstrate the load test on DC machines, working of PN Junction diodes, Zener diodes and rectifiers.

UNIT I	ELECTRICAL CIRCUITS	6

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor– Ohm 's Law-Kirchhoff's Laws -Nodal Analysis, Mesh analysis with independent sources only (Steady State)-Introduction to AC Circuits –Steady state analysis of RL, RC, and RLC circuits (Simple problems only).

UNIT II	ELECTRICAL MACHINES	6

Construction and Working principle of DC Generators, EMF equation, Types and Applications- Working Principle of DC motors, Torque Equation, Types and Applications. - Construction, Working principle and Applications of Single- Phase Transformer.

UNIT III	ANALOG ELECTRONICS	6

PN Junction Diodes, Zener Diode–Characteristics and Applications–Bipolar Junction Transistor, JFET, SCR, MOSFET, –Types, I-V Characteristics and Applications – Rectifier.

UNIT IV	DIGITAL ELECTRONICS	6

Review of number systems, Combinational logic (adder and subtractor) – representation of logic functions-SOP and POS forms, K-map representations and minimization using K-maps (up to 3 variables).

UNIT V	MEASUREMENTS AND INSTRUMENTATION	6
Functional elements of an instrument, Standards and calibration, Operating Principle, types- Moving Coil and Moving Iron meters, Instrument Transformers- CT and PT, DSO-Block Diagram.		
		Total : 30 PERIODS

LAB COMPONENT

1. Verification of Ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Characteristics of PN and Zener Diodes
4. Design and analysis of Half wave and Full Wave rectifiers
5. Implementation of Binary Adder and Subtractor
6. Study of DSO

Total : 30 + 30 = 60 Periods

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Apply fundamental laws to DC electric circuits and demonstrate it experimentally.
CO2	Explain the steady state AC circuits with RL, RC, and RLC circuits.
CO3	Identify the working principle and applications of electrical machines with experimental results.
CO4	Demonstrate the characteristics of various analog electronic devices.
CO5	Experiment with the basic concepts of digital electronics and demonstrate the implementation of Binary Adder and Subtractor.
CO6	Illustrate the operating principles of measuring instruments and demonstrate DSO for the basic measurements.

TEXT BOOKS:	
1	Kothari D P and I.J Nagrath,—Basic Electrical and Electronics Engineering‖ , Second Edition, McGraw Hill Education,2020

2	Sedha R. S.,A textbook of Applied Electronics‖, S. Chand and Co.,2008.
3	A.K. Sawhney, Puneet Sawhney .,A Course in Electrical and Electronic Measurements and Instrumentation‘, Dhanpat Rai and Co, 2015.
REFERENCES:	
1	Kothari D P and I.J Nagrath, ―Basic Electrical Engineering‖, Fourth Edition, Mc Graw Hill Education, 2019.
2	S.K. Bhattacharya ―Basic Electrical and Electronics Engineering‖, Pearson Education, Second Edition, 2017.
3	Thomas L. Floyd,‗ Digital Fundamentals‘, 11thEdition,Pearson Education,2017.
4	Albert Malvino, David Bates, ‗Electronic Principles, McGraw Hill Education; 7th edition, 2017.
5	Mahmood Nahvi and Joseph A. Edminister, ―Electric Circuits‖, 86 Schaum 'Outline Series, McGraw Hill, 2002.
6	H.S. Kalsi, ‗Electronic Instrumentation‘ , Tata McGraw-Hill, New Delhi, 2010
7	James A. Svoboda, Richard C. Dorf,― Dorf's Introduction to Electric Circuits‖, Wiley, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	1	1	1	-	1	3	-	1
2	2	1	-	-	-	-	-	1	1	1	-	1	2	-	1
3	3	2	1	1	-	1	1	1	1	1	-	1	3	-	1
4	2	1	-	-	-	1	1	1	1	1	-	1	2	-	1
5	3	2	1	1	-	-	-	1	1	1	-	1	3	-	1
6	2	1	-	-	-	-	-	1	-	-	-	-	3	-	1
Overall Correlation	**3**	**2**	**1**	**1**	**-**	1	1	1	1	1	-	1	**3**	**-**	1

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23ME211	ENGINEERING GRAPHICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- Gain a solid foundation in the fundamental principles and concepts of engineering graphics, including conic sections, orthographic projection, isometric projection, section views and development of surfaces, perspective projection, and dimensioning.
- Develop graphic skills for communication of concepts, ideas and design of engineering products.
- Gain knowledge on drafting software to construct part models.
- Familiarize with existing national standard practices and conventions related to technical drawings.
- Enhance the ability to visualize objects in three dimensions and translate them into 2D representations.

UNIT I	PLANE CURVES	9+6

Basic Geometrical constructions, Curves used in engineering practices: Conics - Construction of ellipse, parabola and hyperbola by eccentricity method - Construction of cycloid - construction of involutes of square and circle - Drawing of tangents and normal to the above curves.

LIST OF EXERCISES:

1. Drawing of a title block with necessary text, projection symbol and lettering using drafting software
2. Drafting of Conic curves - Ellipse, Parabola and Hyperbola

UNIT II	PROJECTION OF POINTS, LINES AND PLANE SURFACE	9+6

Orthographic projection - principles - Principal planes - First angle projection - projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method. Projection of planes (hexagonal and pentagonal planes

<table>
<tr><td colspan="3">only) inclined to both the principal planes by rotating object method.
LIST OF EXERCISES:
1. Draw the projection of points when it is placed in different quadrants
2. Draw the projection of lines when it is placed in first quadrant
3. Draw the planes when it is placed in first quadrant.</td></tr>
<tr><td>UNIT III</td><td>PROJECTION OF SOLIDS AND FREE HAND SKETCHING</td><td>9+6</td></tr>
<tr><td colspan="3">Projection of simple solids - hexagonal prism, pentagonal pyramid and cone inclined to the horizontal plane by rotating object method. Free Hand sketching: Visualization principles - Representation of Three Dimensional objects - Layout of views - Free hand sketching of multiple views from pictorial views of objects
LIST OF EXERCISES:
1. Practicing three dimensional modelling of simple objects.
2. Drawing of orthographic views from the given pictorial diagram</td></tr>
<tr><td>UNIT IV</td><td>PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES</td><td>9+6</td></tr>
<tr><td colspan="3">Sectioning of hexagonal prism, pentagonal pyramid and cone when the cutting plane is inclined to the horizontal plane, Development of lateral surfaces of simple and sectioned solids – hexagonal prism and cone cut by a plane inclined to horizontal plane only.
LIST OF EXERCISES:
1. Draw the sectioned views of prisms and pyramids
2. Draw the development of hexagonal prism cut by a section plane inclined to the horizontal plane</td></tr>
</table>

UNIT V	ISOMETRIC PROJECTION	9+6

Principles of isometric projection - Isometric scale – Isometric view - Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions.

LIST OF EXERCISES:

1. Drawing Isometric view and projection of simple solids.
2. Drawing three dimensional modeling of isometric projection of combination of solids.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Construct the conic curves, involutes and cycloids.
CO2	Develop and Sketch the orthographic projections of points, lines and plane surfaces.
CO3	Develop and Sketch the orthographic projections of simple solids.
CO4	Construct the projections of sectioned solids and development of the lateral surfaces of solids.
CO5	Develop and Sketch the isometric sections of solids.
CO6	Develop and Sketch the orthographic projection 2D and 3D objects using Auto CAD.

TEXT BOOKS:

1	Bhatt N.D. and Panchal V.M., Engineering Drawing, Charotar Publishing House, 53rd Edition, 2019.
2	Basant Agarwal and Agarwal C.M.,Engineering Drawing, McGraw Hill, 2nd Edition, 2019.

REFERENCES:

1	Natrajan K.V., A Text Book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 2018.
2	Gopalakrishna K.R., Engineering Drawing (Vol. I and II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3	Luzzader, Warren.J. and Duff, John M., ―Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern

	Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4	Parthasarathy N. S. and Vela Murali, ―Engineering Graphics‖, Oxford University, Press, New Delhi, 2015. 5. Shah M.B., and Rana B.C., ―Engineering Drawing‖, Pearson Education India, 2nd Edition, 2009.
5	Venugopal K. and Prabhu Raja V., ―Engineering Graphics", New Age International (P) Limited, 2008.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
2	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
3	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
4	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
5	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
6	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
Overall Correlation	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23ME221	ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Familiarize students with basic engineering tools and equipment.
- Educate students on the importance of safety practices, including proper handling of equipment, adherence to safety protocols, and understanding potential hazards in the laboratory environment. Develop basic manufacturing and fabrication skills.
- Provide hands on training to the students in plumbing and woodworking.
- Provide hands on training to the students in welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipment; Making a tray out of metal sheet using sheet metal work.
- Demonstrate the wiring and measurement methods in common household electrical applications.
- Study the basic electronic components, gates and provide hands on training in soldering.

GROUP A (CIVIL and MECHANICAL)

PART I	CIVIL ENGINEERING PRACTICES	15

PLUMBING WORK

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in households.
b) Preparation of plumbing line sketches.
c) Laying pipe connection to the suction side of a pump.
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK

a) Sawing
b) Planning

c) Making of T-Joint, Mortise joint and Tenon joint and Dovetail joint.

WOOD WORK STUDY

a) Study of joints in door panels and wooden furniture.

b) Study of common industrial trusses using models.

PART II	MECHANICAL ENGINEERING PRACTICES	15

WELDING WORK

a) Study of Welding and its tools.

b) Welding of Butt Joints, Lap Joints and Tee Joints by metal arc welding.

c) Study of Gas Welding.

BASIC MACHINING PRACTICE

a) Facing and Plain Turning

b) Taper Turning

c) Drilling and Tapping

SHEET METAL WORK

a) Forming and Bending

b) Making of a square Tray

MACHINE ASSEMBLY WORK

a) Study of Centrifugal Pump

b) Study of Air Conditioner

FOUNDRY PRACTICE

Demonstration on Foundry operations like mould preparation.

TOTAL: 30 PERIODS

GROUP B (ELECTRICAL and ELECTRONICS)

PART III	ELECTRICAL ENGINEERING PRACTICES	15

1. Residential House wiring using Switches, Fuse, Indicators, Lamp and Energy Meter.

2. Staircase Wiring. 3. Fluorescent Lamp Wiring with Introduction to CFL and LED Types. 4. Measurement of Energy using Single Phase Energy Meter. 5. Study of Iron Box Wiring and Assembly **6.** Study of Fan Regulator – Electronic Type		
PART IV	**ELECTRONICS ENGINEERING PRACTICES**	**15**
1. Study of Electronic components and equipment – Resistors, Colour coding measurement of AC signal parameter (peak-peak, RMS period, frequency) using CRO. 2. Study of logic gates AND, OR, EX-OR and NOT. 3. Generation of Clock Signal. 4. Soldering simple electronic circuits and checking continuity. 5. Study the elements of smart phone **6.** Study of LED TV (Block diagram)		

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1:	Plan the pipeline layout for common household plumbing work.
CO2	Make use of welding equipment and carpentry tool for making joints.
CO3	Demonstrate on centrifugal pump, air conditioner and foundry operations.
CO4	Demonstrate the electrical wiring connections for household applications and study the working of iron box and fan regulator.
CO5	Identify the basic electronic components and explain the gates and soldering methods.
CO6	Examine the performance and operation of CRO, LED TV and Smart phone.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
2	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
3	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
4	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
5	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
6	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**2**	**2**	**2**	**2**	**1**	**-**
Recommended by Board of Studies							**26-07-2023**								
Approved							**1st ACM**			**Date**			**09-09-2023**		

23ME222	APPLIED MECHANICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Study the physics behind the physical systems.
- Acquire knowledge on application of laws of mechanics.
- Study the dynamics of rigid bodies

LIST OF EXPERIMENTS:

1. Verify the Law of Polygon of Forces
2. Determination of Rolling Friction
3. Determination of Sliding Friction
4. Determination of Efficiency of Square Threaded Screw Jack
5. Equilibrium of Forces in space Apparatus
6. Determination of the Force acting on a Balloon
7. Determination of Torque transmitted by a Drum
8. Static and Dynamic conditions - Spring mass system
9. Power and Efficiency of the rope brake arrangement
10. Determination of centre of gravity of connecting rod

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Apply the laws of mechanics.
CO2	Apply the concept of rolling friction.
CO3	Apply the concept of screw friction.
CO4	Solve the forces acting on the body in space.
CO5	Make use of the static and dynamic conditions of a rigid body.
CO6	Apply the concept to find the support reactions.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	1	-	2	2	2	2	1	1
2	3	2	1	1	1	-	-	1	-	2	2	2	2	1	1
3	3	2	1	1	1	-	-	1	-	2	2	2	2	1	1
4	3	2	1	1	1	-	-	1	-	2	2	2	2	1	1
5	3	2	1	1	1	-	-	1	-	2	2	2	2	1	1
6	3	2	1	1	1	-	-	1	-	2	2	2	2	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**2**	**2**	**2**	**2**	**1**	**1**
Recommended by Board of Studies	26-07-2023														
Approved	1st ACM			Date					09-09-2023						

23HS221	SOFT SKILLS	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To help learners improve their interpersonal skills and critical thinking.
- To familiarize learners with the attributes of a leader to enhance team performance.
- To prepare students to face job interviews.
- To help learners to know the importance of ethics in work place.

UNIT I	INTERPERSONAL COMMUNICATION	3

Basic communication- verbal and non-verbal communication; passive, assertive and aggressive communication; presentation skills; giving feedback and responding to feedback.

UNIT II	TEAM WORK AND LEADERSHIP	3

Vision- setting realistic goals and objectives, collaboration, cooperation, dependability, empathy, sympathy, motivation, delegation of responsibilities, open mindedness, creativity, flexibility, adaptability, cross cultural communication and group dynamics.

UNIT III	TIME MANAGEMENT AND STRESS MANAGEMENT	3

Effective Planning, Planning activities at macro and micro levels, setting practical deadlines and realistic limits/targets, punctuality, prioritizing activities, spending the right time on the right activity, positive attitude, emotional intelligence, self- awareness and regulation.

UNIT IV	CRITICAL THINKING AND WORK ETHICS	3

Questioning, analysing, inferencing, interpreting, evaluating, solving problems, explaining, self-regulation, open-mindedness, conflict management- ethical dilemmas, appearance, attendance, attitude, character, organizational skills, productivity, respect.

UNIT V	INTERVIEW SKILLS AND RESUME BUILDING TECHNIQUES	3
Telephonic interview, online interviews, f2f interviews, FAQ soft skills interview questions, drafting error-free CVs/ Resumes and Cover Letters, selecting the ideal format for resume, content drafting along with sequencing, art of representing one's qualifications and most relevant work history, video resume, website resume.		
		TOTAL: 15 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Express their thoughts, opinions and ideas confidently to one or more people in spoken form.
CO2	Develop evolving competences required for professional success.
CO3	Demonstrate knowledge and skills in a group as team player and leader.
CO4	Compose a comprehensive resume reflecting qualifications, exposure and achievements.
CO5	Exhibit knowledge and skills confidently during job interviews.
CO6	Demonstrate ethical and professional behaviour at workplace in all situations.

TEXT BOOKS:

1	Soft Skills: Key to Success in Workplace and Life by Meenakshi Raman and Shalini Upadhyay. Cengage

REFERENCES:

1	English for Job Seekers (Language and Soft Skills for the Aspiring) by Geetha Rajeevan, C.L.N. Prakash) Cambridge University Press Pvt, Ltd.
2	Business Benchmark by Norman Whitby. Cambridge University Press Pvt, Ltd.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-
2	-	-	-	-	-	2	2	2	3	3	2	2	-	-	2
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
6	-	-	-	-	-	-	-	3	3	3	-	-	-	-	3
Overall Correlation	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**-**	**-**	**2**

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

SEMESTER –III

23MA302	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I	PARTIAL DIFFERENTIAL EQUATIONS	9+3

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II	FOURIER SERIES	9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

UNIT III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	9+3

Classification of second order Quasi Linear PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of Heat

conduction – Steady state solution of two dimensional equation of heat conduction (Infinite) (Cartesian coordinates only).		
UNIT IV	**FOURIER TRANSFORMS**	**9+3**
Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem (Without proof) – Parseval's identity.		
UNIT V	**Z-TRANSFORMS AND DIFFERENCE EQUATIONS**	**9+3**
Z-transforms - Elementary properties – Convergence of Z-transforms – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.		
		TOTAL: 60 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Solve the given standard partial differential equations.
CO2	Compute the general Fourier series which plays a vital role in engineering applications.
CO3	Examine the half range Fourier series and harmonic analysis.
CO4	Find the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems, one dimensional wave equations.
CO5	Apply the mathematical principles on Fourier transforms to solve some of the physical problems of engineering.
CO6	Apply the effective mathematical tools for the solutions of difference equations by using Z transform techniques for discrete time systems.
TEXT BOOKS:	
1	Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.

2	Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2018.
3	P.Sivaramakrishna Das and C.Vijayakumari "A Text Book on TPDE" Pearson Publications.
REFERENCES:	
1	Narayanan. S., Manicavachagom Pillay. T.K. and Ramanaiah. G "Advanced Mathematics for Engineering Students", Vol. II and III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
2	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23ME301	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Impart knowledge on the basics and application of zeroth and first law of thermodynamics.
- Impart knowledge on the second law of thermodynamics in analyzing the performance of thermal devices.
- Impart knowledge on availability and applications of second law of thermodynamics.
- Teach the various properties of steam through steam tables and Mollier chart.
- Impart knowledge on the macroscopic properties of ideal and real gases.

UNIT I	BASICS, ZEROTH AND FIRST LAW OF THERMODYNAMICS	9

Review of Basics – Thermodynamic systems, Properties and processes Thermodynamic Equilibrium -Displacement work - P-V diagram. Thermal equilibrium - Zeroth law – Concept of temperature and temperature Scales. First law – application to closed and open systems – steady and unsteady flow processes.

UNIT II	SECOND LAW OF THERMODYNAMICS AND ENTROPY	9

Heat Engine – Refrigerator - Heat pump. Statements of second law and their equivalence and corollaries. Carnot cycle - Reversed Carnot cycle - Performance - Clausius inequality. Concept of entropy - T-s diagram – Tds Equations - Entropy change for a pure substance.

UNIT III	AVAILABILITY AND APPLICATIONS OF SECOND LAW OF THERMODYNAMICS	9

Ideal gases undergoing different processes - principle of increase in entropy. Applications of second Law. High and low-grade energy. Availability and Irreversibility for open and closed system

processes – First and Second law Efficiency.		
UNIT IV	**PROPERTIES OF PURE SUBSTANCES**	**9**
Steam - formation and its thermodynamic properties - p-v, p-T, T-v, T-s, h-s diagrams. PVT surface. Determination of dryness fraction. Calculation of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart.		
UNIT V	**GAS MIXTURES AND THERMODYNAMIC RELATIONS**	**9**
Properties of Ideal gas, real gas - comparison. Equations of state for ideal and real gases. Vander Waal's relation - Reduced properties - Compressibility factor - Principle of Corresponding states – Generalized Compressibility Chart. Maxwell relations - TdS Equations - heat capacities relations - Energy equation, Joule-Thomson experiment - Clausius-Clapeyron equation.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Make use of the basics of thermodynamic systems and equilibrium.
CO2	Apply thermodynamic concepts in closed and open engineering systems.
CO3	Examine the performance of thermal devices using thermodynamic concepts.
CO4	Evaluate the properties of steam.
CO5	Apply gas laws and appropriate thermodynamic relations.
CO6	Calculate property changes of gas mixtures.
TEXT BOOKS:	
1	Nag .P.K., "Engineering Thermodynamics", 6th Edition, Tata McGraw Hill (2017), New Delhi.
2	Natarajan, E., "Engineering Thermodynamics: Fundamentals and Applications", 2nd Edition (2014), Anuragam Publications, Chennai.

REFERENCES:	
1	Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill, 9th Edition, 2019.
2	Chattopadhyay, P, "Engineering Thermodynamics", 2nd Edition Oxford University Press, 2016.
3	Rathakrishnan, E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006.
4	Claus Borgnakke and Richard E. Sonntag, "Fundamentals of Thermodynamics", 10th Edition, Wiley Eastern, 2019.
5	Venkatesh. A, "Basic Engineering Thermodynamics", Universities Press (India) Limited, 2007

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	1	2	1	2	1	2	1
2	3	2	1	1	1	1	-	1	1	2	1	2	1	3	2
3	3	2	1	1	1	1	-	1	1	2	1	2	1	3	2
4	3	3	3	3	1	1	-	2	1	2	1	2	1	3	2
5	3	2	1	1	1	1	-	2	1	2	1	2	1	3	2
6	3	2	1	1	1	1	-	2	1	2	1	2	1	3	2
Overall Correlation	3	3	2	2	1	1	-	1	1	2	1	2	1	3	2

Recommended by Board of Studies	**25-03-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

<table>
<tr><td rowspan="2">23ME302</td><td rowspan="2">ENGINEERING MATERIALS AND METALLURGY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• Construct the phase diagram and to use iron-iron carbide phase diagram for microstructure formation.
• Select and apply various heat treatment processes and its microstructure formation.
• Illustrate the different types of ferrous and non-ferrous alloys and their uses in engineering field.
• Illustrate the different polymer, ceramics and composites and their uses in engineering field.
• Various testing procedures and failure mechanism in engineering field.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS</td><td>9</td></tr>
<tr><td colspan="6">Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast-Iron microstructure, properties and application.</td></tr>
<tr><td>UNIT II</td><td colspan="4">HEAT TREATMENT</td><td>9</td></tr>
<tr><td colspan="6">Definition – Full annealing, stress relief, recrystallization and spheroidising – normalizing, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability, Jominy end quench test - case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and induction hardening – Vacuum and Plasma hardening – Thermo-mechanical treatments - elementary ideas on sintering.</td></tr>
<tr><td>UNIT III</td><td colspan="4">FERROUS AND NON-FERROUS METALS</td><td>9</td></tr>
<tr><td colspan="6">Effect of alloying additions on steel (Mn, Si, Cr, Mo, Ni, V, Ti and</td></tr>
</table>

W) – stainless and tool steels – HSLA - Maraging steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and its alloys – Brass, Bronze and Cupronickel – Aluminum and its alloys; Al-Cu – precipitation strengthening treatment – Titanium alloys, Mg-alloys, Ni-based super alloys – shape memory alloys- Properties and Applications - overview of materials standards.		
UNIT IV	**NON-METALLIC MATERIALS**	**9**
Polymers – types of polymers, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PAI, PPO, PPS, PEEK, PTFE, Thermoset polymers – Urea and Phenol formaldehydes – Nylon, Engineering Ceramics – Properties and applications of Al_2O_3, SiC, Si_3N_4, PSZ and SIALON – inter-metallics- Composites- Matrix and reinforcement Materials - applications of Composites - Nano composites.		
UNIT V	**MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS**	**9**
Mechanisms of plastic deformation, slip and twinning – Types of fracture – fracture mechanics- Griffith's theory- Testing of materials under tension, compression and shear loads – Hardness tests (Brinell, Vickers and Rockwell), Micro and nano-hardness tests, Impact test lzod and Charpy, fatigue and creep failure mechanisms.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to		
CO1	Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.	
CO2	Demonstrate knowledge on isothermal transformation, continuous cooling diagrams and different heat treatment processes.	
CO3	Identify the effect of alloying elements on ferrous and non-ferrous metals.	

CO4	Summarize the properties and applications of non-metallic materials.
CO5	Explain the testing of mechanical properties.
CO6	Demonstrate the deformation mechanisms.
TEXT BOOKS:	
1	Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall of India Private Limited, 9th edition, 2018.
2	Sydney H.Avner, “Introduction to Physical Metallurgy”, McGraw Hill Book Company, 1994.
REFERENCES:	
1	A. Alavudeen, N. Venkateshwaran, and J. T.WinowlinJappes, A Textbook of Engineering Materials and Metallurgy, Laxmi Publications, 2006.
2	Amandeep Singh Wadhwa, andHarvinder Singh Dhaliwal, A Textbook of Engineering Material and Metallurgy, University Sciences Press, 2008.
3	G.S. Upadhyay and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt.Ltd, New Delhi, 2020.
4	Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt.Ltd. 6th edition, 2019.
5	Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, 2nd edition Reprint 2019.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	2	2	1	-	-	-	2	2	-	1
2	2	1	-	-	-	2	2	1	-	-	-	2	2	-	1
3	3	2	1	1	-	2	2	1	-	-	-	2	2	-	1
4	2	1	-	-	-	2	2	1	-	-	-	2	2	-	1
5	2	1	-	-	-	2	2	1	-	-	-	2	2	-	1
6	2	1	-	-	-	2	2	1	-	-	-	2	2	-	1
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**2**	**2**	**1**	**-**	**-**	**-**	**2**	**2**	**-**	1

Recommended by Board of Studies	**25-03-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

<table>
<tr><td rowspan="2">23HS301</td><td rowspan="2" colspan="2">UNIVERSAL HUMAN VALUES AND ETHICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
Strengthening of self-reflection.
Development of commitment and courage to act.</td></tr>
<tr><td>UNIT I</td><td colspan="5">COURSE INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="7">Need, Basic Guidelines, Content and Process for Value Education - Understanding the need, basic guidelines, content and process for Value Education -Self Exploration–what is it? - its content and process; ‘Natural Acceptance’ and Experiential Validation- as the mechanism for self-exploration - Continuous Happiness and Prosperity- A look at basic Human Aspirations -Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority - Understanding Happiness and Prosperity correctly - A critical appraisal of the current scenario - Method to fulfil the above human aspirations: understanding and living in harmony at various levels.</td></tr>
<tr><td>UNIT II</td><td colspan="5">UNDERSTANDING HARMONY IN THE HUMAN BEING</td><td>9</td></tr>
<tr><td colspan="7">Harmony in Myself - Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’ - Understanding the needs of Self (‘I’) and ‘Body’ - Sukh and Suvidha - Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer) - Understanding the characteristics and activities of ‘I’ and harmony in ‘I’ - Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity.</td></tr>
</table>

UNIT III	**UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY**	**9**
Harmony in Human-Human Relationship - Understanding Harmony in the family – the basic unit of human interaction - Understanding values in human-human relationship; meaning of Nyaya and program for its fulfilment to ensure satisfaction; Trust (Vishwas) and Respect as the foundational values of relationship - Understanding the meaning of Vishwas; Difference between intention and competence - Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship -Understanding the harmony in the society (society being an extension of family) - Visualizing a universal harmonious order in society - Undivided Society (Akhand Samaj), Universal Order - from family to world family.		
UNIT IV	**ENGINEERING ETHICS**	**9**
Senses of ‗Engineering Ethics„ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.		
UNIT V	**SAFETY, RESPONSIBILITY AND RIGHTS**	**9**
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination - Moral Leadership – Code of Conduct – Corporate Social Responsibility.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Understand the need of value education.
CO2	Comprehend the difference between self and body.

CO3	Understand the need to exist as an unit of Family and society.
CO4	Understand Harmony at all levels.
CO5	Apply the values acquired in the professional front.
CO6	Identify appropriate technologies for ecofriendly production systems.
TEXT BOOKS:	
1	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010 3.
2	Mike W. Martin and Roland Schinzinger, ―Ethics in Engineering, Tata McGraw Hill, New Delhi, 2003.
3	Govindarajan M, Natarajan S, Senthil Kumar V. S, ―Engineering Ethics‖, Prentice Hall of India, New Delhi, 2004.
REFERENCES:	
1	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3	The Story of Stuff (Book).
4	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi AICTE Model Curriculum in Humanities, Social Science and Management Courses (UG Engineering and Technology).
5	Small is Beautiful - E. F Schumacher.
6	Slow is Beautiful - Cecile Andrews.
7	Economy of Permanence - J C Kumarappa 8. Bharat Mein Angreji Raj – Pandit Sunderlal.
8	Rediscovering India - by Dharampal.
9	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
10	India Wins Freedom - Maulana Abdul Kalam Azad.
11	Vivekananda - Romain Rolland (English) 13. Gandhi - Romain Rolland (English).
12	Charles B. Fleddermann, ―Engineering Ethics‖, Pearson Prentice Hall, New Jersey, 2004.

13	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, ― Engineering Ethics – Concepts and Cases‖, Cengage Learning, 2009.
WEB SOURCES:	
1	www.onlineethics.org
2	www.nspe.org
3	www.globalethics.org

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
2	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
3	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
4	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
5	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
6	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
Overall Correlation	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23ME311	MANUFACTURING PROCESSES	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To illustrate the working principles of various metal casting processes.
- To learn and apply the working principles of various metal joining processes.
- To analyze the working principles of bulk deformation of metals.
- To study the concepts and basic mechanics of metal cutting and the factors affecting machinability.
- To learn working of basic and advanced turning machines and super finishing process.

UNIT I	METAL CASTING PROCESSES	9+3

Sand Casting: Sand Mould – Type of Patterns - Pattern Materials - Cores –Types and Applications – Melting Furnaces: Cupola Furnaces; Principle of Special Casting Processes: Shell - Investment – Pressure Die Casting - Centrifugal Casting – Stir Casting – CO_2 Casting; Defects in Sand Casting Process-Remedies.

UNIT II	PRINCIPLES AND APPLICATIONS OF JOINING PROCESSES	9+3

Operating Principle, Basic Equipment, Merits And Applications of: Fusion Welding Processes: Gas Welding - Manual Metal Arc Welding – Gas Tungsten Arc Welding - Gas Metal Arc Welding – Submerged Arc Welding; Operating Principle And Applications of: Resistance Welding - Plasma Arc Welding – Thermit Welding; Brazing And Soldering; Weld Defects.

UNIT III	FORMING PROCESSES	9+3

Hot and Cold Working of metal – Forging processes- Open, impression and closed die forging - Rolling Mills – Rolling Operations - Principle of rod and wire drawing – Principles of Extrusion – Types – Hot and Cold extrusion. . Sheet metal operations – Blanking, Punching and Working principle and

applications – Hydro forming – Metal spinning and Explosive forming,		
UNIT IV	**MECHANICS OF METAL CUTTING**	**9+3**
Mechanics of Chip Formation, Forces in Machining, Types of Chip, Cutting Tools – Single Point Cutting Tool Nomenclature, Orthogonal and Oblique Metal Cutting, Thermal Aspects, Cutting Tool Materials, Tool Wear, Tool Life, Surface Finish, Cutting Fluids.		
UNIT V	**TURNING, GEAR CUTTING, SHAPING AND FINISHING PROCESSES**	**9+3**
Centre Lathe, Constructional Features, Specification, Operations - Taper Turning Methods, Thread Cutting- Capstan and Turret Lathes. Gear cutting, Gear hobbing and Gear shaping. Types of grinding Process – Cylindrical grinding, surface grinding and internal grinding, Shaper and Milling machines and operations.		

LIST OF EXPERIMENTS:

1. Preparing green sand moulds with cast patterns.
2. Taper Turning and Eccentric Turning on circular parts using lathe machine.
3. Knurling, external and internal thread cutting on circular parts using lathe machine.
4. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
5. Drilling using radial drilling machine.
6. Cutting spur and helical gear using milling machine.
7. Generating gears using gear hobbing machine.
8. Generating gears using gear shaping machine.
9. Grinding components using cylindrical grinding machine.
10. Grinding components using surface grinding machine.

TOTAL: 45 +15 =60PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Explain the principle of different metal casting processes.
CO2	Describe the various metal joining processes.

CO3	Summarize various bulk deformation processes and sheet metal forming processes.
CO4	Apply the mechanism of metal removal process and to identify the factors involved in Improving machinability.
CO5	Explain the constructional and operational features of Centre lathe and other special purpose Lathes.
CO6	Describe the constructional features of gear cutting and super finishing process.
TEXT BOOKS:	
1	Kalpakjian, S., "Manufacturing Engineering and Technology", Pearson education India, 4th Edition, 2009.
2	P.N.Rao Manufacturing Technology Volume 1 Mc Grawhill Education 5th edition, 2018.
REFERENCES:	
1	Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2009.
2	Hajra Chouldhary S.K and Hajra Choudhury. AK., Elements of workshop Technology, volume I and II, Media promoters and Publishers Private Limited, Mumbai, 1997 .
3	Sharma, P.C., A Text book of production Technology, S.Chand and Co. Ltd., 2004.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	2	3	1	1	2	2	2	1	1	1
2	2	1	-	-	-	2	3	1	1	2	2	2	1	1	1
3	2	1	-	-	-	2	3	1	1	2	2	2	1	1	1
4	3	2	1	1	1	1	3	1	-	2	2	2	1	1	1
5	2	1	-	-	1	1	3	1	-	2	2	2	1	1	1
6	2	1	-	-	1	1	3	1	-	2	2	2	1	1	1
Overall Correlation	3	2	1	1	1	1	1	1	1	2	2	2	1	1	1

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23ME312	FLUID MECHANICS AND HYDRAULIC MACHINERY	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- Study about the properties of the fluids and behaviour of fluids under static conditions.
- Gain basic knowledge of the dynamics of fluids and boundary layer concepts.
- Study the applications of the conservation laws to flow measurements, flow through pipes and forces on pipe bends.
- Learn the significance of boundary layer theory and its thicknesses.
- Study the basic principles of working and design of Pelton wheel, Francis and Kaplan turbine.

  Acquire knowledge on working principles of centrifugal, reciprocating and rotary pumps.

UNIT I	FLUID PROPERTIES AND FLOW CHARACTERISTICS	9+3

Fluid Definition and Classification – Properties of fluids, Fluid statics - Pressure Measurements - Buoyancy and floatation - forces on submerged bodies, stability of floating bodies, Flow characteristics - Concept of control volume and system – Velocity potential and stream functions, Continuity equation, energy equation and momentum equation - Applications.

UNIT II	FLOW THROUGH PIPES AND BOUNDARY LAYER	9+3

Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation - friction factor - Moody diagram - Major and minor losses - Hydraulic and energy gradient lines - Pipes in series and parallel - Boundary layer concepts - Types of boundary layer thickness.

UNIT III	**DIMENSIONAL ANALYSIS AND MODEL STUDIES**	**9+3**
Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.		
UNIT IV	**TURBINES**	**9+3**
Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.		
UNIT V	**PUMPS**	**9+3**
Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and it's variations - Work saved by fitting air vessels - Rotary pumps.		

LIST OF EXPERIMENTS

1. Determination of coefficient of discharge of a venture meter.
2. Determination of coefficient of discharge of an orifice meter.
3. Determination of friction factor for flow through pipes.
4. Determination of metacentric height.
5. Characteristics of centrifugal pumps.
6. Characteristics of reciprocating pump.
7. Characteristics of gear pump.
8. Characteristics of Pelton wheel turbine.
9. Flow measurement using Rotameter.
10. Characteristics of Francis turbine.

TOTAL: 45 +15 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Apply the conservation laws applicable to fluids and its application through fluid kinematics and dynamics and also to understand the properties and behaviour of fluids in static conditions.
CO2	Estimate the losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel.
CO3	Apply the concept of boundary layer and its thickness on the flat solid surface.
CO4	Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies.
CO5	Calculate the power developed by the turbines.
CO6	Calculate the efficiency of the different pumps.
TEXT BOOKS:	
1	Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019)
2	R K Bansal, A Text Book of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, New Delhi.
3	Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House (p) Ltd. New Delhi, 2016.
REFERENCES:	
1	Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.
2	Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
3	S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	2	2	1	-	2	2	2	1	1	1
2	3	3	3	3	1	2	2	1	-	2	2	2	1	1	1
3	3	2	1	1	1	2	2	1	-	2	2	2	1	1	1
4	3	3	3	3	1	1	2	1	-	2	2	2	1	1	1
5	3	2	1	1	1	1	2	1	-	2	2	2	1	1	1
6	3	2	1	1	1	1	2	1	-	2	2	2	1	1	1
Overall Correlation	3	3	3	3	1	1	2	1	-	2	2	2	1	1	1
Recommended by Board of Studies	**01-04-2024**														
Approved	**2nd ACM**				**Date**				**25-05-2024**						

23ME321	COMPUTER AIDED MACHINE DRAWING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Make students understand and interpret drawings of machine components.
- Prepare assembly drawings both manually and using standard CAD packages.
- Familiarize the students with Indian Standards on drawing practices and standard components.
- Gain practical experience in handling 2D drafting and 3D modeling software systems.

UNIT I	DRAWING STANDARDS, FITS AND TOLERANCES	15

Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners – Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. - Limits, Fits – Tolerancing of individual dimensions – Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of geometric dimensioning and tolerancing.

UNIT II	INTRODUCTION TO 2D DRAFTING	15

Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed drawing. - Bearings - Bush bearing, Plummer block -Valves - Safety and non-return valves.

UNIT III	3D GEOMETRIC MODELING AND ASSEMBLY	30

Sketcher - Datum planes – Protrusion – Holes - Part modeling – Extrusion – Revolve – Sweep – Loft – Blend – Fillet - Pattern – Chamfer - Round - Mirror – Section - Assembly - Couplings – Flange, Universal, Oldham's, Muff, Gear couplings , Joints – Knuckle, Gib and cotter, strap, sleeve and cotter joints ,Engine parts – Piston, connecting rod, cross-head (vertical and horizontal), stuffing box, multi-plate clutch , Miscellaneous machine components – Screw jack, machine vice, tail stock, chuck, vane and gear pump

TOTAL: 60 PERIODS

Note: 25% of assembly drawings must be done manually and

remaining 75% of assembly drawings must be done by using any CAD software. The above tasks can be performed manually and using standard commercial 2D / 3D CAD software.	
COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Examine the drawing standards, Fits and Tolerances.
CO2	Experiment with part drawings, sectional views and assembly drawings as per standards.
CO3	Develop standard drawing layout for modelled parts.
CO4	Develop orthogonal views of machine components.
CO5	Sketch standard drawing layout for modelled assemblies with BoM.
CO6	Identify the importance of GD and T.
TEXT BOOKS:	
1	Gopalakrishna K.R., "Machine Drawing", 22nd Edition, Subhas Stores Books Corner, Bangalore, 2013.
2	N. D. Bhatt and V.M. Panchal, "Machine Drawing", 48th Edition, Charotar Publishers, 2013.
3	Junnarkar, N.D., "Machine Drawing", 1st Edition, Pearson Education, 2004.
4	N. Siddeshwar, P. Kanniah, V.V.S. Sastri, "Machine Drawing", published by Tata Mc Graw Hill, 2006.
5	S. Trymbaka Murthy, "A Text Book of Computer Aided Machine Drawing", CBS Publishers, New Delhi, 2007.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	3	-	-	3	3	2	2	3	2	2	2
2	3	2	1	1	3	-	-	3	3	2	2	3	2	2	2
3	3	2	1	1	3	-	-	3	3	2	2	3	2	2	2
4	3	2	1	1	3	-	-	3	3	2	2	3	2	2	2
5	3	2	1	1	3	-	-	3	3	2	2	3	2	2	2
6	3	2	1	1	3	-	-	3	3	2	2	3	2	2	2
Overall Correlation	3	2	1	1	3	-	-	3	3	2	2	3	2	2	2

Recommended by Board of Studies	**25-03-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23ES391	PRESENTATION SKILLS	L	T	P	C
		0	0	2	1*
COURSE OBJECTIVES:					

- To help learners use brainstorming techniques for generating, organizing and outlining ideas.
- To familiarize learners with different speech structures by engaging them in watching speeches with great opening and closing
- To give practice on voice modulation and use of body language and eye contact for making captivating presentations
- To give hands on training on preparing presentation slides and using remote presentation tools
- To train students on responding to question and feedback with confidence.

UNIT I	BRAINSTORMING AND OUTLINING	6

Mind Mapping based on prior knowledge, collecting additional information from external resources, giving prompts to Generative AI tools seeking information, organizing ideas generated, knowing your audience.

UNIT II	STRUCTURING THE PRESENTATION	6

3 Ts of a presentation, writing effective introduction- Beginning the introduction with a hook (question, data, storytelling) and closing the introduction with the objective of the presentation. Structuring the body paragraphs -Choosing key ideas from the list of ideas generated during brainstorming. Substantiating ideas with examples, data, reasons and anecdotes. Summarizing the ideas for conclusion.

UNIT III	DELIVERY TECHNIQUES	6
Vocal variety, intonation, reducing filler words and improving articulation, inflection, engaging the audience. Body language- eye contact, gestures, movement on stage.		
UNIT IV	**USE OF TECHNOLOGICAL AIDS**	**6**
Use of presentation software like MS Power Point, Google Slides etc, incorporating images, graphs, charts and videos, using interactive tools like quizzes and polls, using remote presentation tools like zoom, MS Teams, WebEx for screen sharing, virtual whiteboards and chat functionalities, incorporating AR/VR for more immersive presentations.		
UNIT V	**HANDLING QUESTIONS AND FEEDBACK**	**6**
Audience engagement through questions, PAR (Point, Answer, Redirect) strategy for structuring responses to questions. Understanding feedback process - Receiving, interpreting and evaluating constructively, active listening techniques for processing feedback, responding to feedback- acknowledging, clarifying and appreciating, Dealing with challenging feedback.		
		TOTAL: 30 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to
CO1	Construct ideas for presentation through mind mapping techniques
CO2	Organize ideas and structure the presentation with captivating introduction, body paragraphs illustrated with examples and reasons and compelling conclusion
CO3	Apply vocal variety and body language techniques to enhance delivery
CO4	Prepare engaging presentations by integrating multimedia elements

CO5	Demonstrate proficiency in delivering presentations in remote platforms utilizing various technological tools and strategies to engage audience in Virtual environments
CO6	Exhibit active listening skills by responding to questions with clarity and confidence and incorporating constructive feedback for professional development
TEXT BOOKS:	
1	Nancy Duarte "Slide:ology: The Art and Science of Creating Great Presentations" O' Reilly Media.
2	Garr Reynolds "The Naked Presenter: Delivering Powerful Presentations with or Without Slides" New Riders.
REFERENCES:	
1	Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds" by Carmine Gallo.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
2	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
3	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
4	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
5	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
6	2	2	1	1	-	-	-	1	1	1	-	1	2	2	1
Overall Correlation	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**-**	**1**	**2**	**2**	**1**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

SEMESTER –IV

23MA401	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- Formulate and solve linear programming problems (LPP).
- Evaluate Transportation and Assignment Problems.
- Manage purchasing/manufacturing policies.
- Obtain solution to network problems using CPM and PERT techniques.
- Optimize the function subject to the constraints.

UNIT I	LINEAR PROGRAMMING MODELS	9+3

Introduction of Operations Research - mathematical formulation of LPP- Graphical Methods to solve LPP- Simplex Method- Big M method, Two phase method.

UNIT II	TRANSPORTATION PROBLEMS AND ASSIGNMENT PROBLEMS	9+3

Transportation problem (TP) - finding basic feasible solution of TP using North-West Corner Rule, Least Cost and Vogel's Approximation Method - MODI method for finding optimal solution for TP - Assignment problem - Hungarian method for solving Assignment problem - Travelling salesman problem as assignment problem – Production Scheduling problem – Introduction, Problems in single machine scheduling.

UNIT III	INVENTORY CONTROL	9+3

Introduction, Models – Problems in Purchase and Production (Manufacturing) models with and without shortages – Theory on types of inventory control systems: P and Q, ABC, VED, FNS, XYZ, SDE and HML.

UNIT IV	PROJECT MANAGEMENT	9+3

Project definition - Gantt chart - Project network - Diagram representation – Floats - Critical path method (CPM) – PERT- Cost considerations in PERT and CPM.

UNIT V	CLASSICAL OPTIMIZATION THEORY	9+3

Unconstrained problems – necessary and sufficient conditions -

Newton-Raphson method, Constrained problems – equality constraints – inequality constraints - Kuhn-Tucker conditions.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Solve linear programming problems.
CO2	Examine Transportation Problems.
CO3	Examine Assignment Problems.
CO4	Plan the purchase/ manufacturing policies to meet customer demands.
CO5	Find solutions to network problems using CPM and PERT techniques.
CO6	Optimize the function subject to the constraints.

TEXT BOOKS:

1	Hamdy A Taha, Operations Research: An Introduction, Pearson, 10th Edition,2017 .
2	R. Pannerselvan, Operations Research, 2nd Edition, PHI Publications, 2006.

REFERENCES:

1	Dontzig G.B, Linear Programming and extensions, Princeton University Press.
2	ND Vohra, Quantitative Techniques in Management, Tata McGraw Hill, 4th Edition, 2011.
3	J. K. Sharma, Operations Research Theory and Applications, Macmillan, 5th Edition, 2012.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3		
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

<table>
<tr><td rowspan="2">23ME401</td><td rowspan="2" colspan="2">THERMAL ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">
To learn the concepts and laws of thermodynamics to predict the operation of thermodynamic cycles and performance of Internal Combustion(IC) engines and Gas Turbines.
To analyze the performance of steam nozzle, calculate critical pressure ratio.
To evaluate the performance of steam turbines through velocity triangles, understand the need for governing and compounding of turbines.
To analyze the working of IC engines and various auxiliary systems present in IC engines.
To evaluate the various performance parameters of IC engines.
</td></tr>
<tr><td>UNIT I</td><td colspan="5">THERMODYNAMIC CYCLES</td><td>9</td></tr>
<tr><td colspan="7">Air Standard Cycles – Carnot, Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison, Basic Rankine Cycle, modified, reheat and regenerative cycles.</td></tr>
<tr><td>UNIT II</td><td colspan="5">STEAM NOZZLES AND INJECTOR</td><td>9</td></tr>
<tr><td colspan="7">Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow.</td></tr>
<tr><td>UNIT III</td><td colspan="5">STEAM AND GAS TURBINES</td><td>9</td></tr>
<tr><td colspan="7">Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing. Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheat cycles and their combination.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">INTERNAL COMBUSTION ENGINES – FEATURES AND COMBUSTION</td><td>9</td></tr>
<tr><td colspan="7">IC engine – Classification, working, components and their</td></tr>
</table>

functions. Ideal and actual : Valve and port timing diagrams, p-v diagrams- two stroke and four stroke, and SI and CI engines – comparison. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI and CI Engines – Knocking – phenomena and control.			
UNIT V	**INTERNAL COMBUSTION ENGINE PERFORMANCE AND AUXILIARY SYSTEMS**		**9**
Performance and Emission Testing, Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common rail direct injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms.			
			TOTAL: 45 PERIODS
COURSE OUTCOMES:			
After completion of the course, the students will be able to			
CO1	Identify the thermodynamic cycles in Internal Combustion(IC) engines and Gas Turbines.		
CO2	Determine the performance of steam nozzle, calculate critical pressure ratio.		
CO3	Evaluate the performance of steam turbines.		
CO4	Optimize the working of IC engines and various auxiliary systems present in IC engines.		
CO5	Evaluate the various performance parameters of IC engines.		
CO6	Examine the performance of thermodynamic cycles, steam nozzles, steam turbines, gas turbines and IC engines.		
TEXT BOOKS:			
1	Mahesh. M. Rathore, "Thermal Engineering", 1st Edition, Tata McGraw Hill, 2010.		
2	Ganesan.V, " Internal Combustion Engines" 4th Edition, Tata McGraw Hill, 2012.		

REFERENCES:	
1	Ballaney. P, "Thermal Engineering", 25th Edition, Khanna Publishers, 2017.
2	Domkundwar, Kothandaraman, and Domkundwar, "A Course in Thermal Engineering", 6th Edition, Dhanpat Rai and Sons, 2011.
3	Gupta H.N, "Fundamentals of Internal Combustion Engines", 2nd Edition Prentice Hall of India, 2013.
4	Mathur M.L and Mehta F.S., "Thermal Science and Engineering", 3rd Edition, Jain Brothers Pvt. Ltd, 2017.
5	Soman. K, "Thermal Engineering", 2nd Edition, Prentice Hall of India, 2011.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	1	-	2	-	-	1	2	3	-	2
2	3	3	3	3	-	1	-	2	-	-	1	2	3	-	2
3	3	3	2	2	-	1	-	2	-	-	1	2	3	-	2
4	3	2	1	1	-	1	-	2	-	-	1	2	3	-	2
5	3	3	3	3	-	1	-	2	-	-	1	2	3	-	2
6	3	3	2	2	-	1	-	2	-	-	1	2	3	-	2
Overall Correlation	3	3	2	2	-	1	-	2	-	-	1	2	3	-	2

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

<table>
<tr><td rowspan="2">23ME402</td><td rowspan="2" colspan="2">THEORY OF MACHINES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">
Study the basic components of mechanisms, analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism and design cam mechanisms for specified output motions.
Study the basic concepts of toothed gearing and kinematics of gear trains.
Analyze the effects of friction in machine elements.
Analyze the force-motion relationship in components subjected to external forces and analyzing of standard mechanisms.
Analyze the undesirable effects of unbalances resulting from prescribed motions in mechanism and the effect of dynamics of undesirable vibrations.
</td></tr>
<tr><td>UNIT I</td><td colspan="5">KINEMATICS OF MECHANISMS</td><td>9+3</td></tr>
<tr><td colspan="7">Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms , Mechanisms with lower pairs- Straight line mechanism, steering gear mechanisms– velocity and acceleration polygons – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion.</td></tr>
<tr><td>UNIT II</td><td colspan="5">GEARS AND GEAR TRAINS</td><td>9+3</td></tr>
<tr><td colspan="7">Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.</td></tr>
<tr><td>UNIT III</td><td colspan="5">FRICTION IN MACHINE ELEMENTS</td><td>9+3</td></tr>
<tr><td colspan="7">Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction</td></tr>
</table>

clutches – Belt and rope drives – Friction aspects in brakes– Friction in vehicle propulsion and braking.		
UNIT IV	**FORCE ANALYSIS**	**9+3**
Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses- Dynamics of Cam- follower mechanism.		
UNIT V	**BALANCING AND VIBRATION**	**9+3**
Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation. Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.		
		TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Select the mechanism for particular application.
CO2	Solve problems in gears and gear trains.
CO3	Examine friction in machine elements.
CO4	Calculate the static and dynamic forces of mechanisms.
CO5	Calculate the balancing masses and their locations of reciprocating and rotating masses.
CO6	Compute the frequency of free vibration, forced vibration and damping coefficient and gyroscopic effect on Aeroplanes and ships.

TEXT BOOKS:

1	Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017.

2	Ramamurthi. V, “Mechanics of Machines”, Narosa Publishing House, 3rd edition 2019.
REFERENCES:	
1	AmitabhaGhosh and Asok Kumar Mallik, “Theory of Mechanisms and Machines”, Affiliated East-West Pvt. Ltd., 1988.
2	Rao.J.S. and Dukkipati.R.V. “Mechanism and Machine Theory”, New Age International Pvt. Ltd., 2nd edition, 2014.
3	Rattan, S.S, “Theory of Machines”, McGraw-Hill Education Pvt. Ltd., 5th edition, 2019.
4	Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2013.
5	Wilson and Sadler, Kinematics and Dynamics of Machinery, Pearson, 2008.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	2	-	-	2	-	-	-	1	3	1	1
2	3	2	1	1	2	-	-	2	-	-	-	1	3	1	1
3	3	3	2	2	2	-	-	2	-	-	-	1	3	1	1
4	3	2	1	1	2	-	-	2	-	-	-	1	3	1	1
5	3	2	1	1	2	-	-	2	-	-	-	1	3	1	1
6	3	2	1	1	2	-	-	2	-	-	-	1	3	1	1
Overall Correlation	3	2	1	1	2	-	-	2	-	-	-	1	3	1	1

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23CE412	STRENGTH OF MATERIALS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9+3

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants, Poisson's ratio – Volumetric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle for plane stress.

UNIT II	TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAMS	9+3

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Shear stress distribution.

UNIT III	DEFLECTION OF BEAMS	9+3

Double Integration method – Macaulay's method – Area moment method - Conjugate beam method for computation of slopes and deflections in determinate beams.

<table>
<tr><td>UNIT IV</td><td>TORSION, SPRINGS AND COLUMNS</td><td>9+3</td></tr>
<tr><td colspan="3">Theory of Torsion - Stresses and deformations in solid and hollow circular shafts – Stepped shafts – Power transmitted by a shaft. Helical springs – Differences between closely coiled and open coiled helical springs – Closely coiled helical springs – Calculation of shear stress, deflection and stiffness. Columns – Euler's theory – Calculation of crippling load for different end conditions for a long column.</td></tr>
<tr><td>UNIT V</td><td>THIN CYLINDERS, SPHERES AND THICK CYLINDERS</td><td>9+3</td></tr>
<tr><td colspan="3">Stresses in thin and thick cylindrical shell, deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells.</td></tr>
<tr><td colspan="3" align="right">TOTAL: 45 PERIODS</td></tr>
<tr><td colspan="3">LIST OF EXPERIMENTS:</td></tr>
<tr><td colspan="3">1. Tension test on mild steel rod
2. Double shear test on mild steel rod
3. Torsion test on mild steel rod
4. Izod Impact test on metal specimen
5. Charpy Impact test on metal specimen
6. Rockwell Hardness test on metals
7. Brinell Hardness test on metals
8. Compression test on helical spring
9. Heat Treatment Processes- Annealing, Normalizing, Quenching and Tempering
10. Jominy End Quench Test</td></tr>
<tr><td colspan="3" align="right">TOTAL:15 PERIODS</td></tr>
<tr><td colspan="3">COURSE OUTCOMES:</td></tr>
<tr><td colspan="3">After completion of the course, the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="2">Calculate the different stresses developed in the solids when subjected to different loading conditions.</td></tr>
<tr><td>CO2</td><td colspan="2">Analyse the shear force and bending moment diagrams of the beams under the various loading conditions.</td></tr>
<tr><td>CO3</td><td colspan="2">Examine the bending stress and shear stress distribution of various sections of the beam.</td></tr>
</table>

CO4	Calculate the slope and deflection of beams using different methods.
CO5	Apply the basic equations to design shafts, springs and columns.
CO6	Calculate the stresses developed in the thin cylinder, thick cylinder, and spherical shells.
TEXT BOOKS:	
1	Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016.
2	Rattan S.S., "Strength of Materials", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2017.
REFERENCES:	
1	Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand and Company Ltd., New Delhi, 7th edition, 2018.
2	Egor P Popov, "Engineering Mechanics of Solids", 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015.
3	Beer. F.P. and Johnston. E.R. "Mechanics of Materials", Tata McGraw Hill, 8th Edition, New Delhi 2019.
4	Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
2	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
3	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
4	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
5	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
6	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-
Overall Correlation	3	2	1	1	1	1	-	-	2	-	-	-	3	1	-

Recommended by Board of Studies	**08-04-2024**		
Approved	**2^{nd} ACM**	**Date**	**25-05-2024**

23ME421	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Study the valve and port timing diagram of IC engines.
- Conduct the performance test of IC engines.
- Conduct the performance test on reciprocating air compressor.
- Study the performance of steam generator and steam turbine.

LIST OF EXPERIMENTS:

1. Valve Timing and Port Timing diagrams.
2. Actual p-v diagrams of IC engines.
3. Determination of Flash Point and Fire Point of various fuels / lubricants.
4. Performance Test on four – stroke Diesel Engine.
5. Heat Balance Test on 4 – stroke Diesel Engine.
6. Morse Test on Multi-Cylinder Petrol Engine.
7. Retardation Test on a Diesel Engine.
8. Determination of p-θ diagram and heat release characteristics of an IC engine.
9. Performance test on a two stage Reciprocating Air compressor.
10. Study of Steam generators.
11. Study of Steam turbines.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Evaluate the performance characteristics of IC engines.
CO2	Examine the Performance of a Steam generator.
CO3	Test the Performance of a Steam turbine.
CO4	Evaluate performance characteristics of reciprocating air compressor.
CO5	Experiment with the valve and port timing diagram of engines.
CO6	Test the performance characteristics of Air compressor.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	1	1	-	-	2	2	2	2	3	1	-
2	3	3	2	2	1	1	-	-	2	2	2	2	3	1	-
3	3	3	3	3	1	1	-	-	2	2	2	2	3	1	-
4	3	2	1	1	1	1	-	-	2	2	2	2	3	1	-
5	3	2	1	1	1	1	-	-	2	2	2	2	3	1	-
6	3	3	2	2	1	1	-	-	2	2	2	2	3	1	-
Overall Correlation	3	3	2	2	1	1	-	-	2	2	2	2	3	1	-
Recommended by Board of Studies							**01-04-2024**								
Approved							**2nd ACM**			**Date**			**05-05-2024**		

23ME422	KINEMATICS AND DYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Supplement the principles learnt in kinematics and Dynamics of Machinery.
- Demonstrate how certain measuring devices are used for dynamic testing.

LIST OF EXPERIMENTS:

1. a) Study of gear parameters. b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms. b) Kinematics of single and double universal joints.
3. a) Determination of Mass moment of inertia of Fly wheel and Axle system. b) Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus. c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing, Motion curves and study of jump phenomenon.
7. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination. b) Multi degree freedom suspension system – Determination of influence coefficient.
8. a) Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies. b) Vibration Absorber – Tuned vibration absorber.
9. Vibration of Equivalent Spring mass system – undamped and damped vibration.
10. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.

11. a) Balancing of rotating masses. (b) Balancing of reciprocating masses. 12. a) Transverse vibration of Free - Free beam – with and without concentrated masses. b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies. c) Determination of transmissibility ratio using vibrating table.
TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Apply the principles of kinematics in epicyclic gear trains and slider crank mechanism.
CO2	Apply the principles to determine mass moment of inertia by flywheel and axle system, turn table apparatus and bifilar suspension.
CO3	Analyze the effects of controlling mechanism by doing experiments on Universal Governor apparatus and gyroscope.
CO4	Determine the natural frequency of Undamped and damped spring mass system.
CO5	Determine the natural frequency of torsional vibrations.
CO6	Make use of measuring devices for dynamic testing.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	-	2	2	2	3	1	1	-
2	3	2	1	1	1	1	-	-	2	2	2	3	1	1	-
3	3	3	2	2	1	1	-	-	2	2	2	3	1	1	-
4	3	3	3	3	1	1	-	-	2	2	2	3	1	1	-
5	3	3	3	3	1	1	-	-	2	2	2	3	1	1	-
6	3	2	1	1	1	1	-	-	2	2	2	3	1	1	-
Overall Correlation	3	3	2	2	1	1	-	-	2	2	2	3	1	1	-

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23ES491	APTITUDE AND LOGICAL REASONING – 1	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To improve the problem solving and logical thinking ability of the students.
- To acquaint student with frequently asked questions and patterns in quantitative aptitude and logical reasoning.

UNIT I		4
Numbers, LCM, HCF, Averages, Ratio & Proportion, Mixtures & Allegation.		
UNIT II		**4**
Percentages, Time and work, Pipes and Cistern, coding and decoding.		
UNIT III		**4**
Time Speed Distance, Train, Boats and Streams, Analogy.		
UNIT IV		**4**
Data Interpretation (BAR,PIE,LINE), Seating arrangement.		
UNIT V		**4**
Simple Interest and Compound Interest, Profit loss and Discount, Partnership.		
		TOTAL: 20 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Analyse and solve complex problems, and foster critical thinking and logical reasoning skills.
CO2:	Solve fundamental mathematical problems, and enhance their computational skills and numerical ability.
CO3:	Develop strategies for tackling a variety of problem types, and encourage the use of multiple approaches to solve problems efficiently.
CO4:	Analyse and solve different data analysis problems for time and distance, and interpret data analysis for a case study.
CO5:	Derive information from graphs, and solve questions based on mathematical operations such as ratios, proportions, basic algebra, and statistical estimation.
CO6:	Solve questions in a fraction of a minute using shortcut methods

TEXT BOOK:		
1	Smith, John. "APTIPEDIA." 2nd ed., Wiley Publishers, 2020.	
2	Agarwal, R.S. "Quantitative Aptitude." 2nd ed., S. Chand Publishing.	
REFERENCES:		
1	Agarwal, R.S. "A Modern Approach to Verbal & Non-Verbal Reasoning." 2nd ed., S. Chand Publishing	

Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	-	-	2	1	1	2	1	2	3	1	-	3
2	2	3	3	-	-	2	-	1	3	2	2	3	2	1	3
3	3	3	3	-	-	2	-	1	2	2	2	3	2	-	3
4	2	3	2	3	-	2	1	2	3	3	2	3	1	2	3
5	3	2	2	-	1	3	-	2	2	3	3	3	3	1	3
6	3	3	3	3	2	3	1	3	3	2	3	3	3	1	3
Overall Correlation	3	3	3	1	1	3	1	2	3	3	3	3	2	1	3

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23ME423	MINI PROJECT -1	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- Encourage students to apply foundational theoretical knowledge to practical engineering problems.
- Develop collaborative and project management skills through teamwork and effective communication.
- Train students in basic research methodology, technical documentation, and presentation techniques to articulate project outcomes clearly.
- Enhance students' ability to systematically design, analyze, and evaluate simple prototypes or models.
- Prepare students for real-world engineering challenges and lay the foundation for multidisciplinary teamwork and problem-solving in advanced projects.

COURSE DESCRIPTION:

This course serves as an introductory platform for students to apply the foundational knowledge acquired from their core and interdisciplinary subjects in a practical setting. This course enables students to work on small-scale, department-relevant projects that focus on problem identification, basic design, and preliminary prototype development. With limited prior expertise, students will explore the process of translating theoretical concepts into tangible solutions, fostering creativity, teamwork, and critical thinking. The course emphasizes hands-on learning, communication, and project documentation, laying a strong foundation for advanced projects and professional challenges in later semesters.

PROJECT OUTLINE:

Week 1	Course Orientation and Topic Selection
Week 2	Problem Definition and Objective Setting

Week 3	Literature Review and Research
Week 4	First Review and Feedback
Week 5	Problem Refinement and Research Gap Identification
Week 6	Conceptual Design and Initial Approach
Week 7	Methodology and Project Planning
Week 8	Second Review and Project Evaluation
Week 9	Design Refinement and Testing
Week 10	Resource Identification and Budget Estimation
Week 11	Report Writing and Presentation Preparation
Week 12	Third Review Presentation and Submission of Thesis

EVALUATION:

- The progress of the mini project will be evaluated through three reviews, conducted by a committee appointed by the Head of the Department. A final project report must be submitted at the end of the semester. Evaluation will be based on oral presentation and the written report, assessed by internal examiners designated by the Head of the Department.
- The project should focus on topics from first three or four semester (whichever is applicable) subjects / industry demand topics, or futuristic technologies. It is recommended for Faculty of Aeronautical Engineering, Civil Engineering, and Mechanical Engineering students, the project should demonstrate an understanding of first principles of engineering.
- Similarly for students of Faculty of Computer Science Engineering, the project may involve programming using Python or C language. For Faculty of Electronics and Communication Engineering, the student project shall

	incorporate appropriate techniques and systems relevant to the field. For the students of Faculty of Fashion Technology, the project based on material innovations, or technology in fashion is recommended. • The evaluation will focus on how well the project is structured, including clarity and logical flow in both oral presentations and written texts. • The relevance and innovation of the project will be assessed, particularly its potential to contribute to sustainability, innovation, and SDG-aligned goals. • The accuracy of English usage, including grammar, clarity, and coherence, will be reviewed in both oral and written communication to ensure effective delivery of technical content.
COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Apply basic engineering principles to solve simple problems.
CO2	Choose relevant sources to understand the current knowledge and identify areas to improve.
CO3	Utilise basic tools and techniques to test simple solutions.
CO4	Interpret the impact of engineering solutions on society and the environment.
CO5	Combine in teams to plan and complete projects within given constraints.
CO6	Develop comprehensive technical reports and deliver structured presentations to effectively convey project outcomes.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
2	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
3	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
4	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
5	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
6	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
Overall Correlation	3	2	**1**	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**2**	**1**	**3**	**1**	**3**
Recommended by Board of Studies	**01-04-2024**														
Approved	**2nd ACM**				**Date**								**25-05-2024**		

SEMESTER -V

23RE501	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

- To provide an overview on selection of research problem based on the Literature review
- To enhance knowledge on the Data collection and Analysis
- To outline the importance of ethical principles to be followed in Research work and IPR

UNIT I	INTRODUCTION TO RESEARCH FORMULATION	6

Meaning of research problem, Sources of research problem, Criteria - good research problem, and selecting a research problem, Scope and objectives of research problem. Defining and formulating the research problem - Necessity of defining the problem - Importance of literature review in defining a problem.

UNIT II	LITERATURE REVIEW	6

Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

UNIT III	DATA ANALYSIS	6

Execution of the research - Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Generalization and Interpretation.

UNIT IV	REPORT, THESIS PAPER, AND RESEARCH PROPASAL WRITING	6

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports –

Illustrations and tables - Bibliography, types of referencing, citations- index and footnotes, how to write report- Paper Developing,- Plagiarism- Research Proposal- Format of research proposal- a presentation - assessment by a review committee.		
UNIT V	**INTELLECTUAL PROPERTY AND PATENT RIGHTS**	**6**
Ethical principles- Plagiarism, Nature of Intellectual Property - Patents, Designs, Trade and Copyright- patent search, Process of Patenting and Development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of Patent Rights – Scope of Patent Rights, Geographical Indications.		
		TOTAL: 30 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1	Analyze the literature to identify the research gap in the given area of research.
CO2	Identify and formulate the research Problem.
CO3	Analyze and synthesize the data using research methods and knowledge to provide scientific interpretation and conclusion.
CO4	Prepare research reports and proposals by properly synthesizing, arranging the research documents to provide comprehensive technical and scientific report.
CO5	Conduct patent database search in various countries for the research problem identified.
CO6	Apply ethical principles in research and reporting to promote healthy scientific practice .

TEXT BOOKS:	
1	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An Introduction to Research Methodology, RBSA Publishers.
2	Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

3	Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 Volumes.
4	Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.
5	Wadehra, B.L. 2000. Law relating to patents, Trade Marks, Copy right designs and Geographical indications. Universal Law Publishing.
REFERENCES:	
1	Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2	Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3	Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4	Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5	Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
6	Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7	Satarkar, S.V., 2000. Intellectual property rights and copy right. ESS Publications.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
2	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
3	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
4	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
5	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
6	2	2	1	1	1	-	-	1	1	2	-	1	3	2	1
Overall Correlation	3	2	**1**	**1**	**1**	**-**	**-**	**1**	**1**	2	**-**	**1**	**3**	**2**	**1**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME501	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce basic concepts of design process.
- To provide experience to students in solving design problems.
- To impart design principles involved in evaluating the critical design parameters of machine elements to satisfy functional and strength requirements.
- To make the students understand about the various failure modes.
- To familiarize standard codes and practices to select materials and geometric parameter.

UNIT I	FUNDAMENTAL CONCEPTS IN DESIGN	9

Introduction to the design process - Factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending and torsional loading - Modes of failure - Factor of safety – Combined loads – Principal stresses – Eccentric loading – Curved beams – Crane hook and 'C' frame - theories of failure – Design based on strength and stiffness – Stress concentration – Fluctuating stresses – Endurance limit – Design for finite and infinite life under variable loading - Exposure to standards.

UNIT II	DESIGN OF SHAFTS AND COUPLINGS	9

Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys and splines – Rigid and flexible couplings.

UNIT III	DESIGN OF TEMPORARY AND PERMANENT JOINTS	9

Threaded fasteners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints Butt, Fillet and parallel transverse fillet welds – Welded joints subjected to bending, torsional and eccentric loads, riveted joints for structures.

UNIT IV	DESIGN OF ENERGY STORING ELEMENTS AND ENGINE COMPONENTS	9
Types of springs, design of helical and concentric springs – surge in springs, Design of laminated springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines -- Solid and Rimmed flywheels - Connecting rods and Crank shafts		
UNIT V	**DESIGN OF BEARINGS**	**9**
Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Select the correct size and materials for the given static loads.
CO2	Evaluate stress induced in machine elements subjected to variable loads.
CO3	Apply the concepts of stresses to design shafts, key and couplings.
CO4	Evaluate the dimensions of helical and leaf springs.
CO5	Evaluate the size of the welded joints.
CO6	Select the sliding and rolling contact bearings based on load conditions.

TEXT BOOKS:	
1	V.B. Bhandari, “Design of Machine Elements”, 5e, TMH, 2020.
2	Richard G.Budynas, J.Keith Nisbett, Kiatfa Tangchaichit “Shigley's Mechanical Engineering Design", 11e, MGH, 2020.

REFERENCES:	
1	Hall, Holowenko, Laughlin, "Machine Design", Special Indian Edition, TMH, 2008.

2	Robert L.Norton, "Machine Design- An integrated Approach", 6e, Pearson Education, 2021.
3	J.A.Charles, F.A.A Crane, J.A.G, Furness, Selection and use of engineering materials, Butterworth Heinemann, 1997.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	2	2	2	3	1	1
2	3	3	3	3	1	1	-	1	-	2	2	2	3	1	1
3	3	2	1	1	1	1	-	1	-	2	2	2	3	1	1
4	3	3	3	3	1	1	-	1	-	2	2	2	3	1	1
5	3	3	3	3	1	1	-	1	-	2	2	2	3	1	1
6	3	2	1	1	1	1	-	1	-	2	2	2	3	1	1
Overall Correlation	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

<table>
<tr><td rowspan="2">23ME502</td><td rowspan="2">HEAT AND MASS TRANSFER</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">To learn the mechanism of heat transfer under steady state and transient conditions.
To learn the fundamental concept and principles in convective heat transfer.
To learn the theory of phase change heat transfer and design of heat exchangers.
To study the fundamental concept and principles in radiation heat transfer.
To develop the basic concept and diffusion, convective mass transfer.</td></tr>
<tr><td>UNIT I</td><td colspan="4">CONDUCTION</td><td>9</td></tr>
<tr><td colspan="6">General Differential equation – Cartesian, Cylindrical and Spherical Coordinates – One Dimensional Steady State Heat Conduction – plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids – Use of Heisler's charts – Methods of enhanced thermal conduction.</td></tr>
<tr><td>UNIT II</td><td colspan="4">CONVECTION</td><td>9</td></tr>
<tr><td colspan="6">Conservation Equations, Boundary Layer Concept – Forced Convection: External Flow – Flow over Plates, Cylinders Spheres and Bank of tubes. Internal Flow – Entrance effects. Free Convection – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres. Mixed Convection.</td></tr>
<tr><td>UNIT III</td><td colspan="4">PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS</td><td>9</td></tr>
<tr><td colspan="6">Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling - Correlations in boiling and condensation. Heat Exchanger Types – TEMA Standards - Overall Heat Transfer</td></tr>
</table>

Coefficient – Fouling Factors. LMTD and NTU methods. Fundamentals of Heat Pipes and its applications.		
UNIT IV	**RADIATION**	**9**
Introduction to Thermal Radiation - Radiation laws and Radiative properties - Black Body and Gray Body Radiation - Radiosity - View Factor Relations. Electrical Analogy, Radiation Shields.		
UNIT V	**MASS TRANSFER**	**9**
Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state and Transient Diffusion - Stefan flow – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Apply heat conduction principles to solve problems.
CO2	Apply convection principles to solve problems.
CO3	Apply the correlations in the phenomena of boiling and condensation.
CO4	Solve problems using LMTD and NTU methods.
CO5	Solve problems on radiative heat transfer.
CO6	Apply diffusive and convective mass transfer equations to solve problems.
TEXT BOOKS:	
1	R.C. Sachdeva, "Fundamentals of Engineering Heat and Mass transfer", New Age International Publishers, 2009.
2	Yunus A. Cengel, "Heat Transfer A Practical Approach" – Tata McGraw Hill, 5th Edition – 2013.
REFERENCES:	
1	Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, 7th Edition, 2014.

2	Holman, J.P., “Heat and Mass Transfer”, Tata McGraw Hill, 2010.
3	Kothandaraman, C.P., “Fundamentals of Heat and Mass Transfer”, New Age International, New Delhi, 2012.
4	Ozisik, M.N., “Heat Transfer”, McGraw Hill Book Co., 1994.
5	S.P. Venkateshan, “Heat Transfer”, Ane Books, New Delhi, 2014.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	1	1	-	-	1	3	1	1
2	3	2	1	1	1	-	-	1	1	-	-	1	3	1	1
3	3	2	1	1	1	-	-	1	1	-	-	1	3	1	1
4	3	2	1	1	1	-	-	1	1	-	-	1	3	1	1
5	3	2	1	1	1	-	-	1	1	-	-	1	3	1	1
6	3	2	1	1	1	-	-	1	1	-	-	1	3	1	1
Overall Correlation	3	2	**1**	1	**1**	**-**	**-**	**1**	**1**	**-**	**1**	**1**	3	**1**	**1**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME511	ENGINEERING METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To learn basic concepts of metrology and the importance of measurements.
- To teach measurement of linear and angular dimensions assembly and transmission elements.
- To study the tolerance analysis in manufacturing.
- To develop the fundamentals of GD and T, surface metrology and advanced measurements for quality control in manufacturing industries.
- To study the different measurement equipment and use of this in industry for quality inspection.

UNIT I	BASICS OF METROLOGY	9+3

Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, Principle of air gauging - ISO standards.

UNIT II	MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS, ASSEMBLY AND TRANSMISSION ELEMENTS	9+

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto - mechanical measurements using measuring microscope. Angular measuring instruments – Bevel protractor, Angle gauges, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurement of Screw threads - Single element measurements –

Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose – Analytical measurement – Runout, Pitch variation, Tooth profile, Tooth thickness, Lead – Functional checking – Rolling gear test.		
UNIT III	**TOLERANCE ANALYSIS**	**9+3**
Tolerancing – Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables IS919); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stack-up, tolerance charting.		
UNIT IV	**METROLOGY OF SURFACES**	**9+3**
Fundamentals of GD and T- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations like straightness, flatness, roundness deviations; Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology - Parameters		
UNIT V	**ADVANCES IN METROLOGY**	**9+3**
Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multi sensor CMMs. Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and In-process monitoring in production - Computed tomography – White light Scanners.		
		TOTAL: 45 PERIODS
LIST OF EXPERIMENTS(Any six experiments)		
1. Calibration and use of linear measuring instruments – Vernier Caliper, micrometres, Vernier height gauge.		

2. Measurement of internal diameter using bore gauge and telescopic gauge 3. Measurement of angles using bevel protractor, sine bar. 4. Measurement of given components using mechanical / optical comparator 5. Measurement of assembly and transmission elements - screw thread parameters – Floating carriage micrometres. 6. Measurement of gear parameters – Micrometers, Vernier caliper, Gear Tooth Thickness. 7. Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM) 8. Non-contact (Optical) measurement using Measuring microscope - Toolmaker's microscope. 9. Surface metrology - Measurement of form parameters – Straightness, Flatness, Roundness, Cylindricity, Perpendicularity, Runout, Concentricity – in the given component using Roundness tester. 10. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments.
TOTAL: 15 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Identify the various types of errors, standards in measurements.
CO2	Explain various types of linear, angular and form measuring instruments and methods.
CO3	Apply the concept of limits, fits and tolerances in manufacturing.
CO4	Apply the principles and methods of form, surface metrology.
CO5	Explain the principle of CMM for quality control.

CO6	Summarize the principles of laser metrology and machine vision techniques in measurements.
TEXT BOOKS:	
1	Dotson Connie, "Dimensional Metrology", Cengage Learning, First edition, 2012.
2	Mark Curtis, Francis T. Farago, "Handbook of Dimensional Measurement", Industrial Press, Fifth edition, 2013.
REFERENCES:	
1	Ammar Grous, J "Applied Metrology for Manufacturing Engineering", Wiley-ISTE, 2011.
2	Galyer, J.F.W. Charles Reginald Shotbolt, "Metrology for Engineers", Cengage Learning EMEA; 5th revised edition, 1990.
3	National Physical Laboratory Guide No. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131. http://www.npl.co.uk.
4	Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.
5	Venkateshan, S. P., "Mechanical Measurements", Second edition, John Wiley and Sons, 2015.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	1	1	2	2	2	3	1	1
2	2	1	-	-	-	-	-	1	1	2	2	2	2	-	1
3	3	2	1	1	1	-	-	1	1	2	2	2	3	1	1
4	3	2	1	1	1	-	-	1	1	2	2	2	3	1	1
5	2	1	-	-	1	-	-	1	1	2	2	2	2	1	1
6	2	1	-	-	1	-	-	1	1	2	2	2	2	1	1
Overall Correlation	3	2	1	1	1	-	-	1	1	2	2	2	3	1	1

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME521	HEAT TRANSFER LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To acquire practical knowledge in predicting the thermal conductivity of solids and liquids.
- To obtain hands-on experience determining various fluids' heat transfer coefficient values.
- To attain experimental experience in analyzing the performance of tubes in tube heat exchangers.
- To acquire practical knowledge in predicting COP and analyzing the psychrometric process in refrigeration and air conditioning system.

LIST OF EXPERIMENTS:

1. Evaluation of the thermal conductivity measurement using the guarded hot plate method.
2. Measurement of the thermal conductivity of pipe insulation using the lagged pipe apparatus.
3. Evaluation of the thermal conductivity of a composite wall.
4. Determination of the thermal conductivity of insulating powder.
5. Calculation of the heat transfer coefficient of air under natural convection from a vertical cylinder.
6. Evaluation of the heat transfer coefficient of air under forced convection.
7. Analyze the heat transfer rate from a pin fin in both natural and forced convection modes.
8. Determination of the Stefan-Boltzmann constant.
9. Measurement of the emissivity of a grey surface.
10. Estimation of the effectiveness of parallel flow and counter flow heat exchangers.
11. Calculate the coefficient of performance (COP) of a vapor compression refrigeration system.
12. Analyze the experimentation on the psychometric process in the year-round air conditioning system.

TOTAL: 60 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Examine the thermal conductivity of solids and liquids.
CO2	Test the heat transfer coefficient values of forced and free convection.
CO3	Test the effectiveness of heat exchangers.
CO4	Test the radiation constant and emissivity of the given object.
CO5	Examine the performance of the vapour compression refrigeration system.
CO6	Analyze the psychometric process at different operating conditions of the air conditioning system.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1
2	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1
3	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1
4	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1
5	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1
6	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**1**	**-**	**1**	**-**	**2**	**2**	**2**	**3**	**1**	**1**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ES591	APTITUDE AND LOGICAL REASONING –2	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To improve the problem solving and logical thinking ability of the students.
- To acquaint the student with frequently asked patterns in quantitative aptitude and logical reasoning during various examinations and campus interviews

UNIT I		4
Probability, Permutation & Combination, Algebra, Problems on ages		
UNIT II		**4**
Mensuration, Logarithms, inequalities and modulus, Syllogism		
UNIT III		**4**
Directions, logical sequence words, number series, Analytical Reasoning		
UNIT IV		**4**
Blood relation, Clock and Calendar, Picture puzzles		
UNIT V		**4**
Data sufficiency, cube and cuboids, odd man out		
		TOTAL: 20 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Apply concepts of probability, permutation, and combination to solve real-world problems.
CO2:	Solve algebraic problems and age-related problems using logical approaches and techniques.
CO3:	Analyze and solve problems in mensuration, logarithms, and inequalities.
CO4:	Interpret and solve problems related to directions, logical sequence, and number series.
CO5:	Identify and solve problems in logical reasoning such as syllogism, blood relations, clock and calendar.
CO6:	Identify and solve problems in logical reasoning such as syllogism, blood relations, clock and calendar.

TEXT BOOK:	
1	Smith, John. "APTIPEDIA." 2nd ed., Wiley Publishers, 2020.
2	Agarwal, R.S. "Quantitative Aptitude." 2nd ed., S. Chand Publishing.
REFERENCES:	
1	Agarwal, R.S. "A Modern Approach to Verbal & Non-Verbal Reasoning." 2nd ed., S. Chand Publishing.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	3	2	2	2	1	3	1	2	3	2	2
2	3	2	2	2	3	2	3	2	1	2	1	2	3	2	3
3	3	3	2	2	2	2	2	2	1	3	1	2	3	3	2
4	2	3	2	1	2	3	1	2	3	3	2	3	2	2	3
5	2	3	3	2	2	2	2	3	2	2	2	3	3	3	3
6	3	3	2	2	3	2	3	3	2	2	1	2	3	3	2
Overall Correlation	3	3	3	2	3	3	3	3	2	3	2	3	3	3	3

Recommended by Board of Studies	**13-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

SEMESTER –VI

23CE611	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
		3	0	1	4

COURSE OBJECTIVES:

- To provide basic knowledge on environment impact assessment.
- To create an awareness on the pollutants in the environment.
- To familiarize the student with the technology for restoring the environment.
- Applying the technology for producing ECO safe products
- To develop simple climate models and evaluate climate changes using models.

UNIT I	INTRODUCTION TO ENVIRONMENT IMPACT ASSESSMENT	9+3

Impacts of Development on Environment – Rio Principles of Sustainable Development- Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework.

UNIT II	MOVEMENT OF POLLUTANTS IN ENVIRONMENT	9+3

Concepts of diffusion and dispersion, point and area source pollutants, pollutant dispersal; Gaussian plume model, hydraulic potential, Darcy’s equation, types of flow, turbulence. Concept of heat transfer, conduction, convection; concept of temperature, lapse rate (dry and moist adiabatic); mixing heights, laws of thermodynamics; concept of heat and work, Carnot engine, transmission of electrical power, efficiency of turbines, wind mills and hydroelectric power plants.

UNIT III	ECOLOGICAL RESTORATION	9+3

Wastewater treatment: anaerobic, aerobic process, methanogenesis, treatment schemes for waste water: dairy, distillery, tannery, sugar, antibiotic industries; solid waste

treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment).		
UNIT IV	**ECOLOGICALLY SAFE PRODUCTS AND PROCESSES**	**9+3**
Bio-fertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation		
UNIT V	**CLIMATE CHANGE MODELS**	**9+3**
Constructing a climate model – climate system modeling – climate simulation and drift – Evaluation of climate model simulation – regional (RCM) – global (GCM) – Global average response to warming –climate change observed to date.		
		TOTAL: 45+45 PERIODS

LIST OF EXPERIMENTS:

1. Determination of Bio fuel parameters such as flash point and fire point.
2. Determination of density of biofuels.
3. Determination of BOD/COD in water.
4. Simulating the RCM and GCM model for different geographic conditions.
5. Measurement of Pollutant in environment by Gaussian Plume model.

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Explain the importance of the process of Environmental impact assessment and its types.
CO2	Illustrate the chemical processes and pollutant chemistry
CO3	Identify the methods to solve environmental problems
CO4	Apply the knowledge to develop eco-friendly products.
CO5	Construct the various simple climate models for simulation
CO6	Apply the climate model simulation to monitor climate change

TEXT BOOKS:	
1	David .E Neelin "Climate Change and Modelling", Cambridge University Press, California 2012.
2	Evans, G.G. and Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2nd edition). Wiley-Blackwell Publications.
3	Pani, B. 2007. Textbook of Environmental Chemistry. IK international Publishing House
4	N.S. Raman , A.R. Gajbhiye and S.R. Khandeshwar, Environmental Impact Assessment, 2014,IK International Pvt. Ltd.
REFERENCES:	
1	Carson (1907-1964). Environment Conservation - book
2	Encyclopaedia of Environmental Issues by Craig W. Allin Probe.
3	Encyclopaedia of Environmental studies by William Ashworth.
4	Climate Change and Climate Modeling- Kindle Edition.
5	Environmentally- Friendly Product development -Eberhand Abile ,Reiner Anderl,2005.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	2	1	-	-	-	-	-	2	-	-
2	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
3	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
4	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
5	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
6	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**-**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME611	CAD/CAM	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To provide an overview of how computers are being used in mechanical component design.
- To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout and Material Handling system.
- To understand and apply various CAD standards in computer-aided design systems.
- To study the basic concepts of CNC of machine tools and constructional features of CNC.
- To train students to apply group technology and FMS.

UNIT I	FUNDAMENTALS OF COMPUTER GRAPHICS	9+3

Introduction to CAD, CAD/CAM –CAD/CAM concepts - Product cycle- Design process Shigley model - sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co - ordinate systems - 2D and 3D transformations - Line drawing – Clipping - Viewing Transformation.

UNIT II	GEOMETRIC MODELING	9+3

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves- Techniques for surface modeling – surface patch- Coons and bi - cubic patches- Bezier and B - spline surfaces. Solid modeling techniques- CSG and B-rep.

UNIT III	CAD STANDARDS	9+3

Standards for computer graphics - Graphical Kernel System (GKS) - standards for exchange images - Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards.

UNIT IV	PROGRAMMING OF CNC MACHINE TOOLS	9+3
Numerical Control (NC) machine tools – CNC types, constructional details, part programming fundamentals CNC – Absolute vs Incremental, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – CNC Milling - Linear and circular interpolation and Mirroring and sub program call.		
UNIT V	**CELLULAR MANUFACTURING AND FLEXIBLE MANUFACTURING SYSTEM (FMS)**	**9+3**
Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Types of Flexibility - FMS – FMS Components – FMS Application and Benefits – FMS Planning and Control.		
		TOTAL: 45 +15 PERIODS

LIST OF EXPERIMENTS:

3D GEOMETRIC MODELLING

Introduction of 3D Modelling software – (Any three experiments)

1. Creation of 3D assembly model of following machine elements using 3D Modelling software
2. Flange Coupling
3. Plummer Block
4. Screw Jack
5. Universal Joint

Manual Part Programming

i) Part Programming - CNC Machining Centre

a) Step Turning.

ii) Part Programming - CNC Milling

	b) Linear and circular interpolation c) Mirroring and sub program call
	TOTAL: 15 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics.
CO2	Explain the fundamentals of parametric curves, surfaces and Solids.
CO3	Summarize the different types of Standard systems used in CAD.
CO4	Apply NC and CNC programming concepts to develop part program.
CO5	Explain different types of techniques used in Cellular Manufacturing and Group Technology (GT).
CO6	Summarize Flexible Manufacturing System, Components, planning and Control.
TEXT BOOKS:	
1	Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill Publishing Co. 2007.
2	Mikell. P .Groover, "Automation, ProductionSystems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
3	Radhakrishnan P, Subramanyan S, and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
REFERENCES:	
1	Chris McMahon and Jimmie Browne "CAD/CAM Principles", "Practice and Manufacturing Management ", Second Edition, Pearson Education, 1999.
2	Donald Hearn and M. Pauline Baker "Computer Graphics"'. Prentice Hall, Inc, 1992.

3	Foley, Wan Dam, Feiner and Hughes - "Computer graphics principles and practice" Pearson Education -2003.
4	William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	-	-	1	1	2	2	2	2	1	1
2	2	1	-	-	1	-	-	1	1	2	2	2	2	1	1
3	2	1	-	-	1	-	-	1	1	2	2	2	2	1	1
4	3	2	1	1	1	-	-	1	1	2	2	2	3	1	1
5	2	1	-	-	1	-	-	1	1	2	2	2	2	1	1
6	2	1	-	-	1	-	-	1	1	2	2	2	2	1	1
Overall Correlation	3	2	1	1	1	-	-	1	1	2	2	2	3	1	1

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME612	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To study the use of computer in mobility software or mobility.
- To study the concepts computer aided design and rapid prototyping.
- To introduce the basic concepts of the finite element methods.
- To introduce basics and fundamental of the computational fluid dynamics.
- To introduce Turbulence Modelling and various simulation techniques.

UNIT I	FINITE ELEMENT FORMULATION OF BOUNDARY VALUE PROBLEMS	9+3

Introduction to FEA – Weighted residuals methods (Least square method, collocation, subdomain collocation, Galerkin's method) – Variational approach – Rayleigh Ritz method.

UNIT II	ONE DIMENSIONAL FINITE ELEMENT ANALYSIS	9+3

General form of total potential for 1-D applications - generic form of finite element equations - nodal approximation - Development of shape functions - Element matrices and vectors – 1-D finite element analysis: bar element, beam element, spring element and truss element, quadratic element.

UNIT III	TWO-DIMENSIONAL FINITE ELEMENT ANALYSIS	9+3

2-D finite element analysis: types of elements, shape functions, natural coordinate systems - Iso-parametric elements - Transformations to natural coordinates - Gaussian quadrature - Plane stress, plane strain and axisymmetric applications.

UNIT IV	DYNAMIC ANALYSIS USING FINITE ELEMENT METHOD	6
Introduction - Vibration problems - Equations of motion based on weak form - Longitudinal vibration of bars - Transverse vibration of beams – Consistent mass matrices element equations - Solution of Eigenvalue problems - Vector iteration methods - Normal modes - Transient vibrations - Modelling of damping - Mode superposition technique - Direct integration methods.		
UNIT V	**APPLICATIONS IN HEAT TRANSFER AND FLUID MECHANICS**	**9+3**
1-D heat transfer element - Application to one-dimensional heat transfer problems - Scalar variable problems in 2-D - Applications in heat transfer in 2-D Problems.		
		TOTAL: 45+15 PERIODS

LIST OF EXPERIMENTS: (Any six experiments)

1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axi–symmetric components.
5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.
7. Vibration analysis of spring-mass systems.
8. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.

TOTAL:15 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Apply the governing equation and boundary conditions for the structural and thermal problems.

CO2	Develop finite element formulation using 1D elements.
CO3	Develop finite element formulation for 2D plane stress, plane strain and axi-symmetric conditions.
CO4	Analyze dynamic problems using different elements.
CO5	Apply heat transfer problems.
CO6	Analyze fluid mechanics problems.
TEXT BOOKS:	
1	Chandrupatla and Belagundu, "Introduction to Finite Elements in Engineering", 4th Edition, Prentice Hall College Div, 2011.
2	Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
REFERENCES:	
1	Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.
2	Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002.
3	Rao, S.S., "The Finite Element Method in Engineering", 3rd Edition, Butterworth Heinemann, 2004.
4	Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley and Sons, 2005 (Indian Reprint 2013).

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	2	2	2	3	1	1
2	3	2	1	1	1	1	-	1	-	2	2	2	3	1	1
3	3	2	1	1	1	1	-	1	-	2	2	2	3	1	1
4	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1
5	3	2	1	1	1	1	-	1	-	2	2	2	3	1	1
6	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1
Overall Correlation	3	3	2	2	1	1	-	1	-	2	2	2	3	1	1

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME621	PROJECT WORK PHASE-1	L	T	P	C
		0	0	4	2

COURSE DESCRIPTION:

This course provides an opportunity for students to apply their engineering knowledge to solve real-world problems through project-based learning. Students, working in groups with maximum of 4 under faculty supervision, undertake a comprehensive project addressing an approved topic. The course focuses on fostering collaboration, research, and practical skills, culminating in a detailed Phase 1 project report and oral presentations. Regular reviews ensure consistent progress and adherence to academic standards.

COURSE OBJECTIVES:

- Encourage students to apply theoretical knowledge to practical engineering problems.
- Develop collaborative and project management skills through teamwork.
- Train students in research methodology, technical documentation, and presentation skills.
- Enhance students' ability to design, analyze, and evaluate solutions systematically.
- Prepare students for real-world engineering challenges and multidisciplinary teamwork

PROJECT OUTLINE:

Week 1	Orientation and course overview. Formation of project teams and approval of topics by HoD.
Week 2	Initial meeting with supervisors. Define problem statement and objectives
Week 3	Literature review: Research methodologies and topic-specific studies.
Week 4	Zeroth Review.

Week 5	Refinement of literature review and identification of research gaps.
Week 6	Identification of Base Paper.
Week 7	First Review.
Week 8	Conceptual design discussions and brainstorming solutions.
Week 9	Narrowing done on the exact work.
Week 10	Completion of first stage of the Project.
Week 11	Development of detailed conceptual design and methodology.
Week 12	Incorporation of feedback and refinement of design and methodology.
Week 13	Second Review.
Week 14	Compilation of Phase 1 results, report writing, and presentation preparation.
Week 15	Final Viva Voce Presentations.
Individual meetings will be set up on a need's basis in conjunction with developing work	
EVALUATION:	

- The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A phase 1 project report is to be submitted at the end of the semester. Evaluation is based on oral presentation and the phase 1 project report jointly by internal examiners constituted by the Head of the Department.
- Evaluate how effectively the project is structured and communicated in both oral presentations and written texts, emphasizing logical flow and coherence.
- Evaluate the relevance and innovation of practical resources or prototypes developed, focusing on their potential to support sustainability, innovation, and SDG-aligned goals.

- Review the accuracy of English usage, including grammar, clarity, and coherence in oral and written communication, ensuring effective delivery of technical content.

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Develop feasible solutions by analyzing complex engineering problems using foundational knowledge, mathematics, and science.
CO2	Survey literatures to identify gaps, define research questions, and propose designs and methods for solving engineering problems.
CO3	Make use of modern tools to check the feasibility of the solutions effectively.
CO4	Evaluate societal and environmental impacts of solutions while incorporating sustainability and ethical practices.
CO5	Combine in teams to plan, manage, and lead projects within professional and economic constraints.
CO6	Formulate technical reports, deliver presentations, and engage in lifelong learning to adapt to new technologies.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
2	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
3	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
4	3	2	2	2	1	1	2	3	3	3	3	3	3	1	3
5	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
6	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
Overall Correlation	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**3**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME622	TECHNICAL TRAINING	L	T	P	C
		0	0	2	1

PREAMBLE:

The course 'Technical Training' is intended to enable a B.E./B.Tech. graduate to practice, learn, apply and prepare report about the training undergone. The learner shall be trained in the latest technology in relevant Industry preferably in computer-oriented platform. This course can help the learner to experience training and learn practical skills for the relevant domain. Learner should also be able to present his learning through PPT and report articulating his level of learning about the specific training.

COURSE OBJECTIVES:

- To equip students with practical skills and real-world experience in technical domains, enabling them to effectively apply theoretical knowledge to hands-on applications.
- To develop competencies in working with industry-relevant tools and software technologies.
- To foster teamwork, problem-solving, and technical skills through innovative technologies

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Identify specific domain from the enrolled branch and to get training preferable in computer-oriented platform.
CO2	Survey and apprehend the learning modules in the training program and to become expert in the specific domain.
CO3	Apply theoretical learning in the practical environment and enhance the skillset of learner.

CO4	Estimate the learning using available data.
CO5	Defend a presentation about the learning done in the specified skillset.
CO6	Construct a technical report about the training.

GUIDELINES:

- More than one training program may be given depending on availability and interest of the students. One training coordinator may be appointed for the same.
- Training coordinator shall provide required input to their students regarding the selection of training topic.
- Choosing a Training topic: The topic for a Technical Training should be current and broad based rather than very specific area of interest. It should also be outside the present syllabus. It's advisable to choose a training topic to be computer oriented as the resources for the same may be readily available. Every student of the program should be involved and assessed.
- Head of Department shall approve the selected training topic by the second week of the semester. Training may be assessed based on the ability to apply the skillset in a practical domain.

EVALUATION PATTERN:

Training Coordinator:

50 marks (Training Manual – 40 (Each student shall maintain a Training Manual and the Coordinator shall monitor the progress of the training work on a weekly basis and shall approve the entries in the Training Manual during the weekly meeting with the student), Attendance – 10).

Presentation of Application:

Candidate should apply the skillset attained in training. 20 marks to be awarded by the Examiners (Clarity of presentation – 5, Interactions – 10, Quality of the slides – 5).

Report about Application:

30 marks to be awarded by the Examiners (check for technical content, overall quality, templates followed, adequacy of application of the skillset etc.).

Training duration – 30 Hours

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	2	1	-	-	-	-	3	3	-	-
2	3	3	2	1	-	2	1	-	-	-	-	3	3	-	-
3	3	3	3	3	3	-	-	1	-	2	-	3	3	3	1
4	3	3	3	2	2	-	-	1	-	3	-	3	3	2	1
5	3	3	3	2	1	2	-	2	-	2	-	2	3	1	2
6	3	3	3	3	2	2	-	2	-	3	-	3	3	2	2
Overall Correlation	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**3**	**-**	**3**	**3**	**2**	**2**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME623	TECHNICAL SEMINAR – 1	L	T	P	C
		0	0	2	1

PREAMBLE:

The course 'Technical Seminar' is intended to enable a B.E./B. Tech graduate to read, understand,present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar coordinator. This course can help the learner to experience how a presentation can be made about a selected academic document and empower her/him to prepare a technical report.

COURSE OBJECTIVES:

- To do Literature surveys in a selected area of study
- To understand an academic document from the literature and to give a presentation about it
- To prepare a technical report.

GUIDELINES:

- The Department shall form an Internal Assessment Committee (IAC) for the seminar with academic coordinator for that program as the Chairperson and seminar coordinator as member. During the seminar presentation of a student, all members of IAC shall be present.
- Formation of IAC shall be completed within a week after the End Semester Examination (or last working day) of the previous semester.
- Seminar Coordinator shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than very specific research work, beyond the syllabus. Every member of the project team could choose or be assigned

Seminar topics that covers various aspects linked to the Project area. • A topic/paper relevant to the discipline shall be selected by the student during the semester break. • Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IAC. The IAC shall approve the selected topic/paper by the second week of the semester. • Accurate references from genuine peer reviewed published material to be given in the report and to be verified.
EVALUATION PATTERN
Seminar Coordinator: 40 marks (Background Knowledge – 10 (The coordinator shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10). (Seminar Diary – 10 (Each student shall maintain a seminar diary and the coordinator shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10). **Presentation:** 40 marks to be awarded by the IAC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10). **Report:** 20 marks to be awarded by the IAC (check for technical content, overall quality, templates followed, adequacy of references etc.).
TOTAL: 45 PERIODS
COURSE OUTCOMES:
After completion of the course, the students will be able to

CO1	Identify academic documents from the literature which are related to his/her areas of interest.
CO2	Survey and apprehend an academic document from the literature which is related to his/her areas of interest.
CO3	Compile a presentation about an academic document.
CO4	Estimate the Contents using available literature.
CO5	Defend a presentation about an academic document.
CO6	Construct a technical report.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	2	1	1	2	3	3	2	2	3	2	2
2	3	3	3	1	2	1	1	2	3	3	2	2	3	2	2
3	3	3	2	2	2	1	1	1	3	3	1	1	3	2	2
4	3	3	2	1	1	1	2	2	3	3	2	1	3	2	2
5	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
6	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
Overall Correlation	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

SEMESTER – VII

23ME701	FLUID POWER AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic principles of fluid power.
- Explain the working principles of various pumps.
- To understand the working principle of hydraulic and pneumatic components and its selection.
- To design hydraulic and pneumatic circuits for different applications.
- To learn about the fundamentals of Programmable Logic Controller.

UNIT I	INTRODUCTION TO FLUID POWER	9

Introduction to fluid power controls - Hydraulics and pneumatics - Selection criteria, Application of Fluid power, Application of Pascal's Law, equation, Transmission, and multiplication of force - Pressure Losses - Fluids, selection and properties - ISO symbols. Pumps - working principle and construction details of Gear, vane and piston pumps.

UNIT II	FLUID POWER ACTUATORS	9

Fluid power actuators - Cylinders – Types and construction, Application, - Hydraulic motors, Pneumatic power supply - compressors, air distribution, air motors. Actuators - Selection and specification, cylinders, mounting, cushioning- Hydrostatic transmission drives and characteristics; Accumulators – Intensifiers.

UNIT III	FLUID POWER CONTROL ELEMENTS	9

Control valves - pressure, flow, direction - working principle and construction - Special type – valves - Cartridge, modular, proportional, and servo - Selection and actuation method - Hydraulic supply components -pipe fittings - Fluid conditioning elements.

UNIT IV	**HYDRAULIC AND PNEUMATIC CIRCUITS DESIGN**	**9**
Regenerative, speed control and synchronizing circuits - Design of Hydraulic and pneumatic circuits for automation, selection and specification of circuit components, sequencing circuits, cascade method.		
UNIT V	**ELECTRO PNEUMATICS AND PLC CIRCUITS**	**9**
Use of electrical timers, switches, solenoid, relays and proximity sensors electro pneumatic sequencing - PLC - elements, functions and selection - PLC programming - Ladder diagram and different programming methods - Sequencing circuits.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the concepts of fluid power system.
CO2	Describe the features and working of fluid power actuators.
CO3	Explain the pneumatic system and its control components.
CO4	Describe the features and working of control valves and its functions.
CO5	Design hydraulic and pneumatic circuits for industrial applications.
CO6	Apply the basic concepts, elements and functions of Programmable Logic Controller.
TEXT BOOKS:	
1	Anthony Esposito "Fluid power with applications",7th Edition, Pearson education 2014.
2	Majumdar, "Pneumatic system: Principles and Maintenance", Tata McGraw Hill, 2006.
3	Majumdar, "Oil hydraulics: Principles and Maintenance",7th Edition, Tata McGraw Hill,2005.

REFERENCES:

1	Srinivasan. R., "Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints Private Limited,2011.
2	Andrew Parr "Hydraulics and Pneumatics, Jaico Publishing House, 2004 .
3	William W.Reaves, "Technology of Fluid Power", Delmer Publishers, 1997
4	PeterRohner, "Fluid Power Logic circuit", Design Macmillon Press Ltd., 1990.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	1	-	-	-	1	-	-	-	1	1	-
2	2	1	-	-	1	-	-	-	1	-	-	-	1	1	-
3	2	1	-	-	1	-	-	-	1	-	-	-	1	1	-
4	2	1	-	-	1	-	-	-	1	-	-	-	1	1	-
5	2	1	-	-	1	-	-	-	1	-	-	-	1	1	-
6	3	2	1	1	1	-	-	-	1	-	-	-	1	1	-
Overall Correlation	3	1	1	1	1	-	-	-	1	-	-	-	1	1	-

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME702	COMPREHENSION	L	T	P	C
		2	0	0	2

PURPOSE:

To provide a complete review of the topics covered in the previous semesters, to ensure that a comprehensive understanding of the subjects is achieved. The student will be tested as per the guidelines given by national level examinations like GATE, TANCET etc. It will also help students to face job interviews and competitive examinations.

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Analyse the phenomena involved in the concerned problem and solve them.
CO2	Apply principles to new and unique circumstances.
CO3	Estimate concepts and principles of concerned branch of engineering.
CO4	Distinguish between facts and opinion in the engineering field.
CO5	Deduct cause-and-effect relationships of any relationship.
CO6	Interpret data from charts and graphs and judge the relevance of information.

GUIDELINES:

- The Department shall form an Internal Assessment Committee for the Comprehension with Academic coordinator for that class as the Comprehension Instructor and Class coordinator as member.
- Instructor shall provide required input to their students regarding the overview of all topics covered in the previous semesters.
- Periodic tests can be conducted to assess students.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	1	-	2	1	-	-	-	-	1	3	-	-
2	3	2	1	1	-	1	1	-	-	-	-	1	3	-	-
3	3	3	3	3	3	-	-	3	-	3	-	3	3	3	3
4	3	2	1	1	2	-	-	1	-	3	-	3	3	2	1
5	3	3	3	2	1	2	-	2	-	2	-	2	3	1	2
6	3	3	3	2	1	2	-	2	-	2	-	2	3	1	2
Overall Correlation	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**-**	**3**	**-**	**3**	**3**	**3**	**2**
Recommended by Board of Studies	**07-11-2024**														
Approved	**3rd ACM**			**Date**				**30-11-2024**							

23ME711	MECHATRONICS AND IoT	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To make students get acquainted with the sensors and the actuators, which are commonly used in mechatronics systems.
- To provide insight into the signal conditioning circuits, and also to develop competency in PLC programming and control.
- To make students familiarize with the fundamentals of IoT and Embedded systems.
- To impart knowledge about the Arduino and the Raspberry Pi.
- To inculcate skills in the design and development of mechatronics and IoT based systems.

UNIT I	INTRODUCTION	9+3

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors.

UNIT II	MICROPROCESSOR AND MICROCONTROLLER	9+3

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram,. Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT III	PROGRAMMABLE LOGIC CONTROLLER	9+3

Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays

– Data handling – Selection of PLC.		
UNIT IV	**ACTUATORS AND MECHATRONIC SYSTEM DESIGN**	**9+3**
Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process. Advanced system design, - communication tools like GPS and Zig Bee		
UNIT V	**FUNDAMENTALS OF IOT AND EMBEDDED SYSTEMS**	**9+3**
The Internet of Things (IoT) - Introduction to the IoT Framework – IoT Enabling Technologies. Embedded Systems: An Introduction - Single-Chip Microcontroller Systems - Single-Board Microcontroller Systems. Introduction to Arduino-Types of Arduino Boards - Arduino Peripherals- Arduino IDE.		
		TOTAL: 45 +15 PERIODS
LIST OF EXPERIMENTS:		

MECHATRONICS

1. Sequencing of Hydraulic and Pneumatic circuits.
2. Electro-pneumatic/hydraulic control using PLC.
3. Programming and Interfacing of Stepper motor and DC motor using 8051/PLC.
4. Sequencing of Hydraulic, Pneumatic and Electro-pneumatic circuits using Software.

INTERNET OF THINGS:

1. Familiarization with concept of IoT and its open source microcontroller/SBC.
2. Write a program to turn ON/OFF motor using microcontroller/SBC through internet.
3. Write a program to interface sensors to display the data on the screen through internet.
4. Interface the sensors with microcontroller/SBC and write a program to turn ON/OFF Solenoid

	valve through internet when sensor data is detected.
	TOTAL: 15 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain select suitable sensors and actuators to develop mechatronics systems.
CO2	Explain signal conditioning circuit for mechatronics systems, and also able to implement PLC as a controller for an automated system.
CO3	Explain the fundamentals of IoT and Embedded Systems.
CO4	Discuss Control I/O devices through Arduino and Raspberry Pi.
CO5	Develop an apt mechatronics/IoT based system for the given real-time application.
CO6	Analyze the mechatronics system.
TEXT BOOKS:	
1	Bradley D.A., Burd N.C., Dawson D., Loader A.J., “Mechatronics: Electronics in Products and Processes”, Routledge, 2017.
2	Sami S.H and Kisheen Rao G “The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers”, CRC Press, 2022.
REFERENCES:	
1	John Billingsley, “Essentials of Mechatronics”, Wiley, 2006.
2	David H., Gonzalo S., Patrick G.,Rob B. and Jerome H.,“IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Pearson Education, 2018.
3	Nitin G and Sharad S, “Internet of Things: Robotic and Drone Technology”, CRC Press, 2022
4	Newton C. Braga, “Mechatronics for the Evil Genius”, Mc Graw Hill, 2005.

5	Bell C., “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	-	-	-	1	-	-	-	2	1	-
2	2	1	-	-	1	-	-	-	1	-	-	-	2	1	-
3	2	1	-	-	1	-	-	-	1	-	-	-	2	1	-
4	2	1	-	-	1	-	-	-	1	-	-	-	2	1	-
5	3	2	1	1	2	-	-	-	2	-	-	-	3	2	-
6	3	3	2	2	2	-	-	-	2	-	-	-	3	2	-
Overall Correlation	3	2	1	1	2	-	-	-	2	-	-	-	3	2	-

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ME721	PROJECT WORK PHASE - 2	L	T	P	C
		0	0	4	3

COURSE DESCRIPTION:

Project Phase 2 is a continuation of Project Phase 1, focusing on implementing the proposed methodology through fabrication, simulation, or experimental validation. Students will refine their designs, validate test problems, and commission setups for final testing. This phase emphasizes hands-on application, calibration, and demonstration of results, culminating in a final presentation and report submission.

COURSE OBJECTIVES:

- Implement the proposed methodology to address engineering problems identified in Phase 1.
- Develop and fabricate prototypes or simulate solutions for the selected project integrating theoretical knowledge with practical application across hardware and software systems.
- Validate solutions through testing ensuring reliability and performance in both physical and virtual environments.
- Enhance problem-solving and critical thinking skills by troubleshooting and optimizing either experiment setups or software code to improve results.
- Prepare a research manuscript or applying for patent grant either for design or research.

PROJECT OUTLINE:

Week 1	Review of Phase 1 outcomes and refinement of proposed methodology.
Week 2	Material procurement/ software setup for simulation, and initiation of fabrication/simulation work.
Week 3	Intermediate fabrication/simulation work and initial testing or calibration, troubleshooting challenges.

Week 4	Second Review.
Week 5	Validation of test problem or refinement of prototype/simulation
Week 6	Optimisation of the test setup or solution trials, Data curation / uncertainty analysis
Week 7	Final testing of setup or simulation outcomes, Validation of Data .
Week 8	Third Review
Week 9	Demonstration of the solution with high level of data accuracy and precision.
Week 10	Compilation of Phase 2 results, report writing, and presentation preparation.
Week 11	Preparing or publishing of research article/ Filing or Grant of Patent
Week 12	Final Viva Voce Presentations.

Individual meetings will be set up on a need's basis in conjunction with developing work

EVALUATION:

- The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.
- Assess the depth of understanding demonstrated in the project's conceptualization and the ability to answer questions during public presentations.

- Publication of Research article in indexed journal or Patent award is necessary at the end of completion of the project.

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Apply appropriate methodologies to implement solutions for complex engineering problems identified in phase -1 using hardware / software or both systems.
CO2	Develop existing functional prototypes or simulations models by integrating theoretical and practical knowledge.
CO3	Evaluate solutions ensuring compliance with design specifications.
CO4	Appraise the performance of solutions by refining designs or improving algorithms for enhanced outcomes.
CO5	Collaborate effectively with team members to plan, manage, and execute engineering projects adhering to ethical principles and professional standards.
CO6	Prepare technical reports, impactful presentations that communicate solutions effectively.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
2	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
3	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
4	3	2	2	2	1	1	2	3	3	3	3	3	3	1	3
5	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
6	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
Overall Correlation	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**3**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

<table>
<tr><td rowspan="2">23ME722</td><td rowspan="2">TECHNICAL SEMINAR – 2</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
</table>

PREAMBLE:

The course 'Technical Seminar 2' is intended to be continuation of Technical Seminar 1. It enables a B.E./B. Tech graduate to read, understand, present and prepare report about higher level academic document. The selected topic should be outside the given syllabus. The learner shall search in the literature / current affairs including mass media, print media, peer reviewed journals, conference, books, project reports etc., and identify an appropriate topic/paper/thesis/report in her/his area of interest, in consultation with her/his seminar coordinator. This course can help the learner to experience how a higher-level presentation can be made about a selected academic document and empower her/him to prepare a technical report.

COURSE OBJECTIVES:

- To do Literature surveys in a selected area of study
- To understand an academic document from the literature and to give a presentation about it
- To prepare a technical report.

GUIDELINES:

- The Department shall form an Internal Assessment Committee (IAC) for the seminar with academic coordinator for that program as the Chairperson and seminar coordinator as member. During the seminar presentation of a student, all members of IAC shall be present.
- Formation of IAC shall be completed within a week after the End Semester Examination (or last working day) of the previous semester.
- Seminar Coordinator shall provide required input to their students regarding the selection of topic/ paper.

• Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than very specific research work, beyond the syllabus. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area. • A topic/paper relevant to the discipline shall be selected by the student during the semester break. • Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IAC. The IAC shall approve the selected topic/paper by the second week of the semester. • Accurate references from genuine peer reviewed published material to be given in the report and to be verified.
EVALUATION PATTERN
Seminar Coordinator: 40 marks (Background Knowledge – 10 (The coordinator shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10). (Seminar Diary – 10 (Each student shall maintain a seminar diary and the coordinator shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10). **Presentation:** 40 marks to be awarded by the IAC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10). **Report:** 20 marks to be awarded by the IAC (check for technical content, overall quality, templates followed, adequacy of references etc.).

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Identify academic documents from the literature which are related to her/his areas of interest.
CO2	Survey and apprehend an academic document from the literature which is related to her/ his areas of interest.
CO3	Compile a presentation about an academic document.
CO4	Estimate the Contents using available literature.
CO5	Defend a presentation about an academic document.
CO6	Construct a technical report.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	2	1	1	2	3	3	2	2	3	2	2
2	3	3	3	1	2	1	1	2	3	3	2	2	3	2	2
3	3	3	2	2	2	1	1	1	3	3	1	1	3	2	2
4	3	3	2	1	1	1	2	2	3	3	2	1	3	2	2
5	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
6	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
Overall Correlation	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**

Recommended by Board of Studies	**13-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

SEMESTER -VIII

23ME821	CAPSTONE PROJECT COURSE	L	T	P	C
		0	0	20	10

COURSE DESCRIPTION:

Prerequisites:

i) Team segregation.
ii) Identification of Project Guide.
iii) Identification of Area of Interest.
iv) Literature Review on the chosen area of interest.

Zeroth Review needs to be completed in the previous semester by the project coordinator

The *Capstone Project* **(CP)** provides an opportunity for students to engage in high-level inquiry focusing on an area of specialization within the engineering field. Capstone projects will be investigative, practice-centered. All capstones aim to bridge theory and practice and are aimed to have an impact on the professional life of students

The aim of the course is to facilitate the development of your *Capstone Projects.* Students are encouraged to apply and expend knowledge gained on teaching and learning throughout the Bachelor of Engineering Education program as part of this process

COURSE OBJECTIVES:

The Capstone Project should demonstrate the depth and extent of knowledge of students

During this course, students will

- Investigate and evaluate prominent literature connected to your CP.
- Present a clearly articulated investigative framework, while situating projects within established academic

practices and/ or ideas. • Develop and create practical resources (either computational or experimental) for the concerned area of interest in engineering field. • Offer inquiry-based argumentation for development in the concerned area within engineering field. • Summarize the findings in the form of report, documentation and presentation	
PROJECT OUTLINE:	
Week 1	Identification problem.
Week 2	Literature review.
Week 3	Preliminary work.
Week 4	First review.
Week 5	Completion of first stage of the Project methodology.
Week 6	Development.
Week 7	Testing and Validation.
Week 8	Second review.
Week 9	Repeatability.
Week 10	Report correction and Documentation
Week 11	Third review-Submission of paper for conference/journal
Week 12	Thesis Correction and Submission
Individual meetings will be set up on a need's basis in conjunction with developing work	
COURSE OUTCOMES:	
After completion of the course, the students will be able to	

CO1	Take part in challenging practical problems and find solutions by formulating proper methodology.
CO2	Plan research methodology to tackle a specific problem.
CO3	Construct extensive study on particular research projects.
CO4	Develop experimental and computational studies on innovative research projects.
CO5	Estimate incremental study on existing research projects.
CO6	Take part in real life engineering challenges and propose appropriate solutions.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	2	3	3	2	3	2	3	2	3	2	3	3	2	3
3	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3
6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Overall Correlation	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

VERTICAL -1 - MANUFACTURING ENGINEERING

23ME031	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES:					
• To introduce the development of Additive Manufacturing (AM), various business opportunities and applications. • To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM. • To be acquainted with vat polymerization and direct energy deposition processes.					
UNIT I	**INTRODUCTION**				**9**
Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping - Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing - Electronics Printing. Case studies: Automobile, Aerospace, Healthcare.					
UNIT II	**DESIGN FOR ADDITIVE MANUFACTURING (DFAM)**				**9**
Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization - Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL -Problems with STL - AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation– Design rules for Extrusion based AM.					
UNIT III	**VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION**				**9**
Photo polymerization: Stereo lithography Apparatus (SLA) - Materials - Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing					

(DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP) Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits - Applications.		
UNIT IV	**POWDER BED FUSION AND MATERIAL EXTRUSION**	**9**
Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM) – Process - Materials - Applications and Limitations.		
UNIT V	**OTHER ADDITIVE MANUFACTURING PROCESSES**	**9**
Binder Jetting: Three - Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multi-jet Modeling - Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM) - Basic Principle - Mechanism: Gluing or Adhesive Bonding – Materials - Applications and Limitations.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Identify the development of AM technology into various businesses.
CO2	Explain about process of transforming a concept into the final product in AM technology.
CO3	Explain the VAT polymerization and direct energy deposition processes and its applications.
CO4	Summarize about the process and applications of powder bed fusion and material extrusion.
CO5	Compare the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

CO6	Evaluate the mechanism of gluing or other adhesive bonding and other techniques used in rapid prototype.
TEXT BOOKS:	
1	Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland, 2021.
2	Andreas Gebhardt and Jan-Steffen Hötter, "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015.
REFERENCES:	
1	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011.
2	Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies and Applications", Woodhead Publishing, United Kingdom, 2016.
3	Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press, United States, 2015.
4	Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States, 2006.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
5	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
6	3	3	3	3	-	-	-	-	-	-	-	-	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-

<table>
<tr><td rowspan="2">23ME032</td><td rowspan="2" colspan="2">DIGITAL MANUFACTURING AND IoT</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">

To study the various aspects of digital manufacturing.
To inculcate the importance of DM in Product Lifecycle Management and Supply chain Management.
To formulate of smart manufacturing systems in the digital work environment.
To interpret IoT to support the digital manufacturing.
To elaborate the significance of digital twin.

</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="7">Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.</td></tr>
<tr><td>UNIT II</td><td colspan="5">DIGITAL LIFE CYCLE AND SUPPLY CHAIN MANAGEMENT</td><td>9</td></tr>
<tr><td colspan="7">Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain – Scope and Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM</td></tr>
<tr><td>UNIT III</td><td colspan="5">SMART FACTORY</td><td>9</td></tr>
<tr><td colspan="7">Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory - Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cyber security.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">INDUSTRY 4.0</td><td>9</td></tr>
<tr><td colspan="7">Introduction – Industry 4.0 – Internet of Things – Industrial</td></tr>
</table>

Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems –Machine to Machine communication – Case Studies.		
UNIT V	**STUDY OF DIGITAL TWIN**	**9**
Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact and Challenges – Future of Digital Twins		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the use of various elements in the digital manufacturing.
CO2	Apply the concepts involved in digital product development life cycle process
CO3	Apply the concepts of supply chain management in digital environment.
CO4	Select the proper procedure of validating practical work through digital validation in Factories.
CO5	Summarize the concepts of IoT and its role in digital manufacturing.
CO6	Analyze and optimize various practical manufacturing process through digital twin.
TEXT BOOKS:	
1	Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
2	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.

REFERENCES:

1	Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019.
3	Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing the Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2017.
4	Ronald R. Yager and Jordan Pascual Espada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	2	1	1	-	-	-	1	2	2	1
2	3	2	1	1	1	2	1	1	-	-	-	1	3	2	1
3	3	2	1	1	1	2	1	1	-	-	-	1	3	2	1
4	3	2	1	1	1	2	1	1	-	-	-	1	3	2	1
5	2	1	-	-	1	2	1	1	-	-	-	1	2	2	1
6	3	3	2	2	3	2	1	1	-	-	-	1	3	2	1
Overall Correlation	3	2	1	1	1	1	1	1	-	-	-	1	3	2	1

23ME033	SURFACE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the Engineering students about the value of surface engineering.
- To make the engineering students to understand the importance of surface and its interactions with its environment.
- To equip the students to understand the various and Advanced surface modification techniques.
- To develop the skill among the students to evaluate and inspect the surface modified materials for various industrial usages.

UNIT I	BASICS OF SURFACE PROPERTIES	9

Introduction – Tribology – surface degradation – wear – types of wear – adhesive – abrasive – oxidative – corrosive – erosive and fretting wear – roles of friction and lubrication – corrosion – types – passivity – mechanism of growth and break down of passive film – corrosion control.

UNIT II	SURFACE CLEANING	9

Introduction – surface pretreatment of metallic and electronic materials – mechanical cleaning polishing – chemical cleaning – acid, alkaline, acetone and carbon tetra chloride cleaning – alumina and diamond polishing – degreasing – ultrasonic cleaning

UNIT III	SURFACE COATING TECHNIQUES	9

Introduction – principle – parameters of electro deposition – Faraday's laws of electrode position of copper, nickel, chromium and gold for industrial practices – organic coatings paints-requirements of good paints - constituents of paints-function-formulation of durable paint enamel coatings-special paints-heat resistant and fire retardant paints - electroless coatings conversion coatings.

UNIT IV	**ADVANCED SURFACE MODIFICATION PROCESS**	**9**
Introduction – physical vapor deposition-chemical vapor deposition- ion beam process – ion beam assisted vapour deposition – ion implantation – reactive ion sputtering coating – electron beam process – electron beam assisted vapour deposition – laser assisted surface modification – laser alloying – laser melting – laser ablation – laser sprayed deposit – direct metal deposition by laser.		
UNIT V	**STANDARDS FOR SURFACE ENGINEERING MEASUREMENTS**	**9**
Constructing a climate model – climate system modeling – climate simulation and drift – Evaluation of climate model simulation – regional (RCM) – global (GCM) – Global average response to warming –climate change observed to date.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Describe the fundamentals of surface features and different types of friction associated with metals and non-metals.
CO2	Classify the different types of wear mechanism and its standard measurement.
CO3	Classify the different types of corrosion and its preventive measures.
CO4	Analyze the different types of surface properties
CO5	Classify the different types of surface modification techniques.
CO6	Analyze the various types of materials used in the friction and wear applications.
TEXT BOOKS:	
1	Ramnarayan Chattopadhyay, advanced thermally assisted surface engineering processes, Kluwer academic publishers, 2004

2	Sudarshan T S, Surface modification technologies – an engineer’s guide; Marcel Dekkar, Newyork, 1989.
REFERENCES:	
1	Varghese C D, Electroplating and other surface treatments – a practical guide, TMH, 1993.
2	Adamson A W and Gast A P, Physical chemistry of surfaces, 6th Ed., John Willey and Sons 1997.
3	Stanley J.Dapkunas, Surface Engineering Measurement Standards for inorganic materials,National institute of standards and technology (special publication,960-9).

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	1	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	1	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	1	2	1	1
4	3	3	2	2	1	1	-	1	-	-	-	1	3	1	1
5	2	1	-	-	1	1	-	1	-	-	-	1	2	1	1
6	3	3	2	2	1	1	-	1	-	-	-	1	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	1	3	1	1

23ME034	NON-TRADITIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To classify non-traditional machining processes and describe mechanical energy based non-traditional machining processes.
- To differentiate chemical and electro chemical energy-based processes.
- To describe thermo-electric energy-based processes
- To explain nano finishing processes.
- To introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes.

UNIT I	INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES	9

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations.

UNIT II	CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES	9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro - chemical deburring.

UNIT III	THERMO-ELECTRIC ENERGY BASED PROCESSES	9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire

electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.		
UNIT IV	**NANO FINISHING PROCESSES**	**9**
Principles, equipments, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magneto rheological finishing, Magneto rheological abrasive flow finishing.		
UNIT V	**HYBRID NON-TRADITIONAL MACHINING PROCESSES**	**9**
Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the different types of non-traditional machining processes.
CO2	Explain mechanical energy based non-traditional machining processes.
CO3	Illustrate chemical and electro chemical energy based processes.
CO4	Summarize the thermo-electric energy based processes.
CO5	Interpret nano finishing processes.
CO6	Explain hybrid non-traditional machining processes and differentiate non- traditional machining processes.
TEXT BOOKS:	
1	Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458
2	Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.

REFERENCES:	
1	Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.
2	Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.
3	Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017, ISBN:978-3- 319-52008-7.
4	Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
5	Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016, ISBN13: 978-3319259208.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	1	2	-	-	-	-	-	2	-	-
2	2	1	-	-	-	1	2	-	-	-	-	-	2	-	-
3	2	1	-	-	-	1	2	-	-	-	-	-	2	-	-
4	2	1	-	-	-	1	2	-	-	-	-	-	2	-	-
5	2	1	-	-	-	1	2	-	-	-	-	-	2	-	-
6	2	1	-	-	-	1	2	-	-	-	-	-	2	-	-
Overall Correlation	2	1	-	-	-	1	2	-	-	-	-	-	2	-	-

23ME035	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the process planning concepts to make cost estimation for various products after process planning.
- To learn the various Process Planning Activities.
- To provide the knowledge of importance of costing and estimation.
- To provide the knowledge of estimation of production costing.
- To learn the knowledge of various Machining time calculations.

UNIT I	INTRODUCTION TO PROCESS PLANNING	9

Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps in process selection-. Production equipment and tooling selection.

UNIT II	PROCESS PLANNING ACTIVITIES	9

Process parameters calculation for various production processes - Selection jigs and fixture selection of quality assurance methods - Set of documents for process planning- Economics of process planning - case studies

UNIT III	INTRODUCTION TO COST ESTIMATION	9

Importance of costing and estimation – methods of costing – elements of cost estimation – Types of estimates – Estimating procedure – Estimation labor cost, material cost – allocation of overhead charges – Calculation of depreciation cost.

UNIT IV	PRODUCTION COST ESTIMATION	9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop.

UNIT V	MACHINING TIME CALCULATION	9
Estimation of Machining Time - Importance of Machine Time Calculation - Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining time Calculation for Milling, Shaping and Planning - Machining time Calculation for Grinding.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the process, equipment and tools for various industrial products.
CO2	Illustrate the process planning activity chart .
CO3	Explain the concept of cost estimation.
CO4	Solve the job order cost problems for different type of shop floor.
CO5	Solve the machining time problems for various machining operations.
CO6	Analyze the process plan and do the cost estimation of any one industry .
TEXT BOOKS:	
1	Peter Scalon, "Process Planning, Design/Manufacture Interface", Elsevier Science Technology Books, Dec 2002.
2	Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 1995.
REFERENCES:	
1	Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2	Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley, 1998.
3	Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.

4	Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001.
5	K.C. Jain and L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers 1990.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
2	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
3	2	1	-		1	-	-	1	-	-	1	-	2	1	1
4	3	2	1	1	1	-	-	1	-	-	1	-	3	1	1
5	3	2	1	1	1	-	-	1	-	-	1	-	3	1	1
6	3	3	2	2	1	-	-	1	-	-	1	-	3	1	1
Overall Correlation	3	2	1	1	1	-	-	1	-	-	1	-	3	1	1

23ME036	NON-DESTRUCTIVE TESTING AND EVALUATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the importance, principle, concept and inspection methods of various surface NDT methods and develop the skills of interpretation of results effectively.
- To study the working and instrumentation of thermography and eddy current testing methods and apply to interpret the results and investigate the possible defects.
- To get full exposure about principle, instrumentation and standards of various radiographic NDT methods and improve the skill to identify the defects suitably.
- To get deep insight into the principle, types of waves, instrumentation, standards, and calibration methods of ultrasonic NDT methods.
- To understand the importance, principle, concept and inspection methods of various surface NDT methods and develop the skills of interpretation of results effectively.

UNIT I	INTRODUCTION	9

NDT Versus Mechanical testing – Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT - Visual inspection – Unaided and aided.

UNIT II	SURFACE NDT METHODS	9

Liquid Penetrant Inspection – Principles, Types of dye and methods of application, developers, advantages and limitations of various methods, Interpretation of results. Magnetic Particle Inspection - Magnetic particle testing, Basic theory of magnetism, Magnetization methods, Interpretation of field indicators, Particle application, Inspection, Residual magnetism Principles and methods of demagnetization.

UNIT III	**THERMOGRAPHY AND EDDY CURRENT TESTING**	**9**
Thermography- Principles, Contact and non-contact inspection methods, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing - Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Applications, advantages, Limitations, Interpretation/Evaluation.		
UNIT IV	**ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)**	**9**
Ultrasonic Testing - Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A - Scan, B - scan, C- scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications.		
UNIT V	**RADIOGRAPHY**	**9**
Principle, interaction of X - Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square law, characteristics of films - graininess, density, speed, contrast, characteristic curves. Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero - Radiography, Digital Radiography.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the fundamental concepts of NDT.
CO2	Interpret the different methods of NDE.
CO3	Explain the concept of Thermography and Eddy current testing.
CO4	Explain the concept of Ultrasonic Testing.
CO5	Explain the concept of Acoustic Emission.

CO6	Explain the concept of Radiography.
TEXT BOOKS:	
1	"ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals", Metals Park, Ohio, USA, 200, 2018.
2	Baldev Raj, T. Jayakumar, M. Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
REFERENCES:	
1	Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.
2	Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005.
3	Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
4	B.P.C. Rao, "Practical Eddy Current Testing", Alpha Science International Limited (2006).
5	Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
2	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
3	2	1	-		1	-	-	1	-	-	1	-	2	1	1
4	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
5	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
6	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
Overall Correlation	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1

23ME037	DESIGN FOR MANUFACTURING AND ASSEMBLY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
- To learn design consideration principles of forming in the design of extruded, stamped, and forged products.
- To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
- To learn design consideration principles of welding in the design of welded products.
- To learn design consideration principles of assembly in the design of assembled products.

UNIT I	INTRODUCTION AND CASTING	9

Introduction - Economics of process selection - General design principles for manufacturability; Design considerations for: Sand cast – Die cast – Permanent mold cast parts.

UNIT II	FORMING	9

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts –Forged parts.

UNIT III	MACHINING	9

Design considerations for: Turned parts – Drilled parts – Milled, planed, shaped and slotted parts– Ground parts.

UNIT IV	WELDING	9

Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment and heat

treatment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash and Upset weldment.		
UNIT V	**ASSEMBLY**	**9**
Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket and Seals – Press fits – Snap fits – Automatic assembly.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications.
CO2	Apply design consideration principles of casting in the design of cast products.
CO3	Explain design consideration principles of forming in the design of extruded, stamped, and forged products.
CO4	Explain design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
CO5	Explain design consideration principles of welding in the design of welded products.
CO6	Explain design consideration principles of assembly in the design of assembled products.
TEXT BOOKS:	
1	James G. Bralla, "Handbook of Product Design for Manufacture", McGraw Hill, 1986.
2	O. Molloy, E.A. Warman, S. Tilley, "Design for Manufacturing and Assembly: Concepts, Architectures and Implementation", Springer, 1998.

REFERENCES:	
1	Corrado Poli, “Design for Manufacturing: A Structured Approach”, Elsevier, 2001.
2	David M. Anderson, “Design for Manufacturability and Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production”, CIM Press, 2004.
3	Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, “Manufacturing and Design: Understanding the Principles of How Things Are Made”, Elsevier, 2014.
4	Henry Peck, “Designing for Manufacture”, Sir Isaac Pitman and Sons Ltd., 1973.
5	Matousek, “Engineering Design”, Blackie and Sons, 1956.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	-	-	-	-	1	2	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	2	1	-	-	-	-	-	-	-	-	-	1	2	-	-
4	2	1	-	-	-	-	-	-	-	-	-	1	2	-	-
5	2	1	-	-	-	-	-	-	-	-	-	1	2	-	-
6	2	1	-	-	-	-	-	-	-	-	-	1	2	-	-
Overall Correlation	2	2	1	1	-	-	-	-	-	-	-	1	2	-	-

23ME038	QUALITY CONTROL AND RELIABILTY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concept of SQC.
- To understand process control and acceptance sampling procedure and their application.
- To learn the concept of reliability.
- To illustrate the basic concepts and techniques of modern reliability engineering tools.

UNIT I	INTRODUCTION AND PROCESS CONTROL FOR VARIABLES	10

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation –Theory of control chart- uses of control chart – Control chart for variables – X chart, R chart and σ chart - process capability – process capability studies and simple problems. Six sigma concepts.

UNIT II	PROCESS CONTROL FOR ATTRIBUTES	8

Control chart for attributes –control chart for non-conforming – p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.

UNIT III	ACCEPTANCE SAMPLING	9

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts - standard sampling plans for AQL and LTPD- uses of standard sampling plans.

UNIT IV	LIFE TESTING – RELIABILITY	9

Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate –

Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.		
UNIT V	**QUALITY AND RELIABLITY**	**9**
Reliability improvements – techniques - use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Apply the basic techniques of quality improvement, statistics and probability.
CO2	Make Use of control charts to analyze for improving the process quality.
CO3	Explain different sampling plans.
CO4	Summarize basic knowledge of total quality management.
CO5	Find the most important areas to improve a product's reliability.
CO6	Make Use of Pareto analysis to improve a product's reliability.

TEXT BOOKS:

1	Douglas. C. Montgomery, “Introduction to Statistical quality control”, 4th edition, John Wiley 2001.
2	Srinath. L.S., “Reliability Engineering”, Affiliated East west press, 1991.

REFERENCES:

1	John.S. Oakland. "Statistical process control”, 5th edition, Elsevier, 2005.
2	Connor, P.D.T.O., “Practical Reliability Engineering”, John Wiley, 1993.

3	Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 1996.
4	Monohar Mahajan, "Statistical Quality Control", Dhanpat Rai and Sons, 2001.
5	Gupta. R.C, "Statistical Quality control", Khanna Publishers, 1997.
6	Besterfield D.H., "Quality Control", Prentice Hall, 1993.
7	Sharma S.C., "Inspection Quality Control and Reliability", Khanna Publishers, 1998.
8	Danny Samson, "Manufacturing and Operations Strategy", Prentice Hall, 1991.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

VERTICAL – 2 – COMPUTATIONAL ENGINEERING

23ME039	DESIGN CONCEPTS IN ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the various design requirements and get acquainted with the processes involved in product development.
- To study the design processes to develop a successful product.
- To learn scientific approaches to provide design solutions.
- Designing solution through relate the human needs and provide a solution.
- To study the principles of material selection, costing and manufacturing in design.

UNIT I	DESIGN TERMINOLOGY	9

Definition - various methods and forms of design-importance of product design-static and dynamic products - various design projects - morphology of design - requirements of a good design - concurrent engineering-computer aided engineering - codes and standards - product and process cycles - bench marking.

UNIT II	INTRODUCTION TO DESIGN PROCESSES	9

Basic modules in design process - scientific method and design method-Need identification, importance of problem definition-structured problem, real life problem- information gathering - customer requirements Quality Function Deployment (QFD)-product design specifications-generation of alternative solutions Analysis and selection - Detail design and drawings-Prototype, modeling, simulation, testing and evaluation.

UNIT III	CREATIVITY IN DESIGN	9

Creativity and problem solving - vertical and lateral thinking – invention - psychological view, mental blocks Creativity methods

-brainstorming, synectics, force fitting methods, mind map, concept map - Theory of innovative problem solving (TRIZ) - conceptual decomposition creating design concepts.		
UNIT IV	**HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT**	**9**
Human factors in design, ergonomics, user friendly design-Aesthetics and visual aspects environmental aspects-marketing aspects-team aspects-legal aspects-presentation aspects		
UNIT V	**MATERIAL AND PROCESSES IN DESIGN**	**9**
Material selection for performance characteristics of materials - selection for new design substitution for existing design-economics of materials- selection methods - recycling and material selection-types of manufacturing process, process systems - Design for Manufacturability (DFM) - Design for Assembly (DFA).		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to
CO1	Apply the processes involved in product development.
CO2	Apply the design processes to develop a successful product.
CO3	Apply scientific approaches to provide design solutions.
CO4	Solve Societal problems using the developed product.
CO5	Apply the principles of material selection in design.
CO6	Apply the principles of costing and manufacturing in design.
TEXT BOOKS:	
1	Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013..
2	Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2010.
REFERENCES:	
1	Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013.

2	Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2010.
3	Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013.
4	Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2010.
5	Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME040	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements spur gears and parallel axis helical gears.
- To learn the design bevel, worm and cross helical gears of Transmission system.
- To learn the concepts of design multi and variable speed gear box for machine tool applications.
- To learn the concepts of design to cams, brakes and clutches.

(Use of P S G Design Data Book is permitted)

UNIT I	DESIGN OF FLEXIBLE ELEMENTS	9

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

UNIT II	SPUR GEARS AND PARALLEL AXIS HELICAL GEARS	9

Speed ratios and number of teeth - Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur and helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane - Equivalent number of teeth-forces for helical gears.

UNIT III	BEVEL, WORM AND CROSS HELICAL GEARS	9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits

terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology - helix angles - Estimating the size of the pair of cross helical gears.		
UNIT IV	**GEAR BOXES**	**9**
Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.		
UNIT V	**CAMS, CLUTCHES AND BRAKES**	**9**
Cam Design: Types - pressure angle and under cutting base circle determination - forces and surface stresses. Design of plate clutches – axial clutches-cone clutches-internal expanding rim Clutches - Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Apply the concepts of design to belts, chains and rope drives.
CO2	Apply the concepts of design to spur, helical gears.
CO3	Apply the concepts of design to worm and bevel gears.
CO4	Apply the concepts of design to gear boxes.
CO5	Apply the concepts of design to cams and brakes.
CO6	Apply the concepts of design to clutches.
TEXT BOOKS:	
1	Bhandari V, "Design of Machine Elements", 4th Edition, Tata McGraw-Hill Book Co, 2016.
2	Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8th Edition, Tata McGraw-Hill, 2008.

REFERENCES:	
1	Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements" 8th Edition, Prentice Hall, 2003.
2	Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
3	Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
4	Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, 2005.
5	Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications,Chennai, 2003.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	1	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	1	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	1	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	1	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	1	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	1	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	1	1	1

23ME041	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the modern product development processes.
- To understand and explain the concept of industrial design and robust design concepts.
- To understand the concept of design for manufacture and assembly.

UNIT I	INTRODUCTION	9

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

UNIT II	CONCEPT GENERATION AND SELECTION	9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT III	PRODUCT ARCHITECTURE	9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specification.

UNIT IV	INDUSTRIAL DESIGN	9

Integrate process design – Managing costs – Robust design –

Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.		
UNIT V	**DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT**	**9**
Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the characteristics used for product design and development .
CO2	Solve for the customer requirements in product design.
CO3	Apply structural approach to concept generation, selection and testing.
CO4	Identify various aspects of design to solve the problems.
CO5	Apply strategies to reduce manufacturing and assembly costs.
CO6	Make use of prototyping principles to plan and execute a project.
TEXT BOOK:	
1	Kari T.Ulrich and Steven D.Eppinger, "Product Design and Development", McGraw-Hill International Edns. 1999

REFERENCES:	
1	Kemnneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2	Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3	Staurt Pugh, "Tool Design –Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New York, NY.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

<table>
<tr><td colspan="2">23ME042</td><td colspan="2">COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER</td><td>L
3</td><td>T
0</td><td>P
0</td><td>C
3</td></tr>
<tr><td colspan="8">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="8">To study the fluid flow simulation techniques and its mathematical behavior.
To learn the discretize 1D and 2D systems using finite difference and finite volume techniques.
To Formulate diffusion –convection problems using finite volume method.
To study the flow field for different types of grids.
To learn the essential for turbulence models and its types.</td></tr>
<tr><td>UNIT I</td><td colspan="6">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="8">Basics of Computational Fluid Dynamics – Governing equations– Continuity, Momentum and Energy equations – Boundary conditions and Types – Time-averaged equations for Turbulent Flow – Classification and Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations, comparison between Analytical, Experimental and Numerical techniques, Techniques of Discretization and Numerical errors.</td></tr>
<tr><td>UNIT II</td><td colspan="6">FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION</td><td>9</td></tr>
<tr><td colspan="8">Derivation of finite difference equations – General Methods for first and second order accuracy – Finite volume formulation for steady and transient diffusion 1D and 2D problems – Use of Finite Difference and Finite Volume methods, Accuracy of solution, optimum step - size, Euler, Crank Nicholson, and pure implicit methods, stability of schemes.</td></tr>
<tr><td>UNIT III</td><td colspan="6">FINITE VOLUME METHOD FOR CONVECTION DIFFUSION</td><td>9</td></tr>
<tr><td colspan="8">Steady one-dimensional convection and diffusion – Central,</td></tr>
</table>

upwind differencing schemes, properties of discretization schemes, Hybrid, Power-law, QUICK Schemes, Computation of Boundary layer flow, von Neumann stability analysis.		
UNIT IV	**FLOW FIELD ANALYSIS**	**9**
Stream function and vortices, Representation of the pressure gradient term, Staggered grid – Momentum equations, Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms, Computation of internal and external thermal boundary layer.		
UNIT V	**TURBULENCE MODELLING**	**9**
Turbulence model requirement and types, mixing length model, Two equation (k-Є) models – High and low Reynolds number models, LES, DNS, Mesh Generation and refinement Techniques-software tools, Stability of solver, Courant Fredrick Levy number, relaxation factor, and grid independence test.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to		
CO1	Apply the fundamentals of CFD, and develop the governing equations.	
CO2	Apply finite difference and finite volume based analysis for steady and transient diffusion problems.	
CO3	Make use of various mathematical schemes under the finite volume method for convention diffusion	
CO4	Solve complex problems in the field of fluid flow and heat transfer with the support of high-speed computers.	
CO5	Make Use of turbulence models to simulate fluid flow.	
CO6	Evaluate the discretization to improve simulation accuracy.	
TEXT BOOKS:		
1	Versteeg, H.K., and Malalasekera, W.," An Introduction to Computational Fluid Dynamics": The finite volume Method, Pearson Education, 2014.	

2	Ghoshdastidar, P.S., "Computational Fluid Dynamics and Heat Transfer", Cengage Learning, 2017.
REFERENCES:	
1	John. F. Wendt, "Computational Fluid Dynamics – An Introduction", Springer, 2013.
2	K. Muralidhar and T.Sundararajan, Computational Fluid Flow and Heat Transfer, Narora Publishing House, 1994.
3	Suhas V, Patankar, "Numerical Heat transfer and Fluid flow", Taylor and Francis, 2009.
4	Uriel Frisch, Turbulence, Cambridge University Press, 1999.
5	Yogesh Jaluria and Kenneth E. Torrance, "Computational Heat Transfer", CRC press, 2002.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	3	3	3	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	3	2	2	1	1	-	1	-	-	-	-	3	1	1

23ME043	MECHANICAL SYSTEM DESIGN	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To develop competency for system visualization and design.
- To enable student to design cylinders and pressure vessels and to use IS code.
- To enable student select materials and to design internal engine components.
- To introduce student to optimum design and use optimization methods to design mechanical components.
- To enable student to design machine tool gearbox.
- To enable student to design material handling systems.
- To apply the statistical considerations in design and analyze the defects and failure modes in components.

UNIT I	DESIGN OF MACHINE TOOL GEARBOX	6

Introduction to machine tool gearboxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, deviation diagram, difference between numbers of teeth of successive gears in a change gear box.

UNIT II	STATISTICAL CONSIDERATIONS IN DESIGN	6

Frequency distribution - Histogram and frequency polygon, normal distribution - units of central tendency and dispersion - standard deviation-population combinations-design for natural tolerances - design for assembly - statistical analysis of tolerances, mechanical reliability and factor of safety.

UNIT III	DESIGN OF BELT CONVEYER SYSTEM FOR MATERIAL HANDLING	6

System concept, basic principles, objectives of material handling system, unit load and containerization. Belt conveyors, Flat belt

and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take - up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys.		
UNIT IV	**DESIGN OF CYLINDERS AND PRESSURE VESSELS**	**6**
Thin cylinders and spherical vessels, Wire wound cylinders. Thick cylinders :Principal stresses in cylinder subjected to internal/external pressure, Lame's equation, Clavarion's and Bernie's equations, Autofrettage, Compounding of cylinders, Gasketted Joints, Thickness of cylindrical and spherical shells, Design of End closures, Area compensations for nozzles. Introduction to Design codes.		
UNIT V	**OPTIMUM DESIGN AND DFMA**	**6**
Optimum Design: Objectives of optimum design, adequate and optimum design, Johnsons Method of optimum design, primary design equations, subsidiary design equations and limit equations, optimum design with normal specifications of simple machine elements-tension bar, transmission shaft and helical spring, Pressure vessel Introduction to redundant specifications (Theoretical treatment). Design For Manufacture, Assembly And Safety: General principles of design for manufacture and assembly (DFM and DMFA), principles of design of castings and forgings, design for machining, design for safety.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to		
CO1	Develop the gear arrangements for a machine tool gearbox using ray and deviation diagrams.	
CO2	Apply statistical methods to design components with appropriate tolerances and reliability.	

CO3	Construct a belt conveyor system considering capacity, belt tensions, and power requirements.
CO4	Develop cylinders and pressure vessels considering stress distribution and thickness requirements.
CO5	Apply optimum design methods to design simple machine elements.
CO6	Apply design principles for manufacturing, assembly, and safety to create components.
TEXT BOOKS:	
1	Shigley S," Mechanical Engineering Design", 8thEdition, McGraw Hill.
2	V Bhandari, "Design of Machine Elements", 3/e, McGraw Hill.
REFERENCES:	
1	R C Juvinall, "Fundamentals of Machine Component Design", 4/e, Wiley.
2	R L Norton, "Machine Design An Introduction", Pearson.
3	E J Hearn, "Mechanics of Materials", BH

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

<table>
<tr><td rowspan="2">23ME044</td><td rowspan="2">COMPUTATIONAL BIO MECHANICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• To Introduction of principles and concepts of bio-mechanics.
• Focuses on the studies of tissues and structure of musculoskeletal system.
• To study the mechanics of joints and human motion.
• To explain the computational approaches in biomechanics.
• To learn the quantification of forces and motion.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION TO BIOMECHANICS</td><td>9</td></tr>
<tr><td colspan="6">Perspective of biomechanics, Terminologies, Kinematic and kinetic concepts for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human Movement, Mechanical properties of soft tissues, bones, and muscles.</td></tr>
<tr><td>UNIT II</td><td colspan="4">BIOMECHANICS OF TISSUES AND STRUCTURES OF THE MUSCULOSKELETAL SYSTEM</td><td>9</td></tr>
<tr><td colspan="6">Biomechanics of Bone, Biomechanics of Articular Cartilage, Tendons and Ligaments, Peripheral Nerves and Spinal Nerve Roots, Skeletal Muscle.</td></tr>
<tr><td>UNIT III</td><td colspan="4">BIOMECHANICS OF JOINTS AND HUMAN MOTION</td><td>9</td></tr>
<tr><td colspan="6">Knee, Hip, Foot and Ankle, Lumbar Spine, Cervical Spine, Shoulder, Elbow Wrist, and Hand, Linear kinematic and kinetic aspects of human movement, angular kinematic and kinetic aspects of human movement, equilibrium and human moment.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">COMPUTATIONAL APPROACHES IN BIOMECHANICS</td><td>9</td></tr>
<tr><td colspan="6">Finite Element Analysis in Biomechanics, Computational</td></tr>
</table>

modelling of Vancouver Periprosthetic Fracture in Femur, Scaffolds, artificial hip and knee joints, Aortic Valve.		
UNIT V	**GAIT ANALYSIS**	**9**
Exoskeleton design, Ergonomics, Sports mechanics, Performance Analysis, Biomechanical analysis, 3D printing.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Explain the principles of mechanics.
CO2	Summarize the tissues and structures of the musculoskeletal system.
CO3	Apply kinematic and kinetic principles to analyze the movement of human joints.
CO4	Make use of biomechanical concepts to assess human motion activities.
CO5	Develop the computational mathematical modelling in biomechanics.
CO6	Apply gait analysis techniques to design exoskeletons and ergonomic solutions.

TEXT BOOKS:

1	Susan J Hall, - Basic Biomechanics, 6th Edition, The McGraw-Hill Companies Inc., 2011.
2	Jay D Humphrey and Sherry L Delange, - An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, 1st edition, Springer-Verlag, 2010.

REFERENCES:

1	Margareta Nordin and Victor H Frankel,"Basic Biomechanics of the Musculoskeletal System", 3rd Edition, Lippincott Williams and Wilkins, 2001.
2	Ozkaya, Nihat, Nordin, and Margareta, "Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation", 2nd Edition, Springer, 2009.

3	Pritam Pain, Sreerup Banerjee, Goutam Kumar Bose , “Advances in Computational Approaches in Biomechanics”, 2022.
4	Piotr Paneth and Agnieszka Dybala-Defratyka ,”Kinetics and Dynamics: From Nano- to Bio-Scale: 12” (Challenges and Advances in Computational Chemistry and Physics) | 12 August 2010.
5	Gábor Náray-Szabó and Arieh Warshel ,”Computational Approaches to Biochemical Reactivity: 19 (Understanding Chemical Reactivity)”, 31 March 2002.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME045	ERGONOMICS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce to industrial design based on ergonomics.
- To consider ergonomics concept in manufacturing.
- To apply ergonomics in design of controls and display.
- To apply environmental factors in ergonomics design.
- To develop aesthetics applicable to manufacturing and product.

UNIT I	INTRODUCTION	9

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems - Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man - machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

UNIT II	ERGONOMICS AND PRODUCTION	9

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT III	DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS	9

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs.

Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools.		
UNIT IV	**ENVIRONMENTAL FACTORS**	**9**
Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style.		
UNIT V	**AESTHETIC CONCEPTS**	**9**
Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Apply ergonomics need in the industrial design.
CO2	Apply ergonomics in creation of manufacturing system
CO3	Apply design principles to display indicators for various systems.
CO4	Develop and design control mechanisms with user effort and ergonomics.
CO5	Summarize the environmental factors in ergonomics design.
CO6	Explain the importance of aesthetics to manufacturing system and product.
TEXT BOOKS:	
1	Marcelo M. Soares , Francisco Rebelo "Ergonomics in Design: Methods and Techniques" (Human Factors and Ergonomics)

2	"Ergonomics in Product Design" Sendpoints Publishing Co. Ltd.
REFERENCES:	
1	Benjamin W.Niebel, "Motion and Time Study", Richard, D. Irwin Inc., 7thEdition, 2002.
2	Brain Shakel," Applied Ergonomics Hand Book", Butterworth Scientific London 1988.
3	Bridger, R.C., "Introduction to Ergonomics", 2ndEdition, 2003, McGraw Hill Publications.
4	Martin Helander, "A Guide to human factors and Ergonomics", Taylor and Francis, 2006.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	2	1	-	-	1	1	1	1	-	-	-	-	2	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	1	1	1	1	1	-	-	-	-	3	1	1

23MT055	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce basic machine learning techniques such as regression, classification.
- To learn about introduction of clustering, types and segmentation methods.
- To learn about fuzzy logic, fuzzification and defuzzification.
- To learn about basics of neural networks and neuro fuzzy networks.
- To learn about Recurrent neural networks and Reinforcement learning.

UNIT I	INTRODUCTION TO MACHINE LEARNING	9

Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics.

UNIT II	CLUSTERING AND SEGMENTATION METHODS	9

Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K-nearest neighbor algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.

UNIT III	FUZZY LOGIC	9

Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application.

UNIT IV	NEURAL NETWORKS	9
Mathematical Models of Neurons, ANN architecture, Learning rules, Multi - layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics.		
UNIT V	**RNN AND REINFORCEMENT LEARING**	**9**
Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q -learning. Application Case Study of reinforcement learning in Robotics.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Apply basic machine learning techniques such as regression, classification.
CO2	Summarize about clustering and segmentation.
CO3	Model a fuzzy logic system with fuzzification and defuzzification.
CO4	Explain the concepts of neural networks and neuro fuzzy networks.
CO5	Apply recurrent neural networks (RNNs) to solve problems in robotics.
CO6	Apply reinforcement learning techniques and their application in robotics.

TEXT BOOK:	
1	Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011.

REFERENCES:	
1	Bruno Siciliano, Oussama Khatib, "Handbook of Robotics", 2016 2nd Edition, Springer.

2	Simon Haykin, “Neural Networks and Learning Machines: A Comprehensive Foundation”, Third Edition, Pearson, delhi 2016.
3	Timothy J Ross, “Fuzzy Logic with Engineering Applications”, 4th Edition, Chichester, 2011, Sussex Wiley.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

VERTICAL -3 – THERMAL SCIENCES

23ME046	**POWER PLANT ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To study the coal based thermal power plants.
- To study the diesel, gas turbine and combined cycle power plants.
- To learn the basic of nuclear engineering and power plants.
- To learn the power from renewable energy.
- To study energy, economic and environmental issues of power plants.

UNIT I	**COAL BASED THERMAL POWER PLANTS**	**9**

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam and Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

UNIT II	**DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS**	**9**

Otto, Diesel, Dual and Brayton Cycle - Analysis and Optimization. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT III	**NUCLEAR POWER PLANTS**	**9**

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV	**POWER FROM RENEWABLE ENERGY**	**9**
Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.		
UNIT V	**ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS**	**9**
Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits and demerits, Capital and Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to
CO1	Explain the layout, construction and working of the components of thermal power plant.
CO2	Explain the layout, construction and working of the components of Diesel, Gas and Combined cycle power plants.
CO3	Explain the layout, construction and working of the components of nuclear power plants.
CO4	Explain the layout, construction and working of the components of Renewable energy power plants
CO5	Apply concepts tariffs and load distribution to optimize power plant operations.
CO6	Evaluate pollution control technologies and waste disposal options for coal and nuclear power plants.
TEXT BOOKS:	
1	Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008.

2	R.K. Rajput ,"A Textbook of Power Plant Engineering", January 2016.
REFERENCES:	
1	El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2	Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3	Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.
4	B. Vijaya Ramnath C. Elanchezhian, L. Saravanakumar ,"Power Plant Engineering November 2019.
5	Dipak Kumar Mandal, Somnath Chakrabarti, "Power Plant Engineering", As per AICTE: Theory and Practice by, et al. | 1 January 2019.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	3	2	2	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME047	REFRIGERATION AND AIRCONDITIONING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the underlying principles of operations in different Refrigeration and Air-conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration and Air conditioning systems.
- To study the various refrigeration systems.
- To learn the psychrometric properties and processes.
- To study the air conditioning systems and load estimation.

UNIT I	INTRODUCTION	9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles - Refrigerants Desirable properties – Classification - Nomenclature - ODP and GWP.

UNIT II	VAPOUR COMPRESSION REFRIGERATION SYSTEM	9

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – sub - cooling and super heating- effects of condenser and evaporator pressure on COP- multi pressure system - low temperature refrigeration - Cascade systems – problems. Equipment: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III	OTHER REFRIGERATION SYSTEMS	9

Working principles of vapor absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems - Thermoelectric refrigeration- Air refrigeration – Magnetic, Vortex and Pulse tube refrigeration systems.

UNIT IV	PSYCHROMETRIC PROPERTIES AND PROCESSES	9

Properties of moist Air - Gibbs Dalton law, Specific humidity, Dew

point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air - conditioning processes, mixing of air streams.		
UNIT V	**AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION**	**9**
Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort and IAQ principles, effective temperature and chart, calculation of summer and winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators and safety controls.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain the basic concepts of refrigeration and the impact of refrigerants in the environment.	
CO2:	Illustrate the vapour compression refrigeration systems and to solve problems.	
CO3:	Summarize the various types of refrigeration systems.	
CO4:	Apply and calculate the psychrometric properties and its use in psychrometric processes.	
CO5:	Develop and calculate the air conditioning system load	
CO6:	Apply the principles of air distribution and control systems to design efficient air conditioning.	
TEXT BOOKS:		
1	Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010.	

2	R.S. Khurmi ,"Textbook of Refrigeration And Air-Conditioning" 10 February.
REFERENCES:	
1	ASHRAE Hand book, Fundamentals, 2010
2	JonesW.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007
3	Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
4	Stoecker,W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi,1986.
5	R.K. Rajput ,"A Textbook of Refrigeration and Air-Conditioning" January 2013.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME048	NON-CONVENTIONAL ENERGY SOURCES	L	T	P	C
		3	0	0	3
COURSE OBJECTIVES:					
At the end of the course, the students are expected to identify the new methodologies technologies for effective utilization of renewable energy sources					
UNIT I	**SOLAR AND WIND ENERGY**				**9**
Introduction - Flat plate collectors – Concentrating solar Collector – Solar power – Tower plant – Solar pond – Photovoltaic cell- Passive solar applications (Trombe wall and solar heat gain through windows). Wind turbines and power performance curve – Wind power potential – Wind power density – Wind turbine efficiency – Betz limit for wind turbine efficiency – Considerations in wind power applications.					
UNIT II	**GEOTHERMAL ENERGY**				**9**
Introduction – Geothermal applications – Geothermal heating – Degree day method for annual energy consumption – Geothermal cooling – Absorption cooling system – Geothermal heat pump systems – Heat pump systems - Ground source heat pump systems- Geothermal cogeneration.					
UNIT III	**OCEAN ENERGY, HYDROGEN AND FUEL CELLS**				**9**
Introduction – Ocean thermal energy conservation – Wave energy- Power production from waves – Waves power technologies- Tidal energy – Hydrogen: An energy carrier – Fuel cells – Thermodynamic analysis of fuel cell.					
UNIT IV	**BIOMASS ENERGY**				**9**
Introduction – Biomass resources – Conversion of biomass to biofuel – Biomass products – Ethanol – Biodiesel – Methanol – Pyrolysis Oil – Biogas – Producer gas – Synthesis gas – Electricity and heat production by biomass.					

UNIT V	ENVIRONMENT AND ECONOMICS OF RENEWABLE ENERGY	9
Introduction – Air pollutants – Emissions from automobiles – The greenhouse effect – CO_2 Production – Stratospheric ozone depletion – Introduction of engineering economics – The time value of money – Effect of inflation and taxation on interest rate – Life cycle cost analysis – cost benefit analysis – Unit product cost – Comparison of projects based on life cycle cost analysis – Payback period analysis.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Explain the Indian and global energy scenario.
CO2	Summarize the various solar energy technologies and its applications.
CO3	Explain the various wind energy technologies.
CO4	Interpret the various bio-energy technologies.
CO5	Compare the different methods of ocean energy production.
CO6	Apply knowledge of geothermal energy sources and power plant types to assess their applications and environmental impacts.

TEXT BOOKS:

1	Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, McGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2	Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

REFERENCES:

1	Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
2	Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.

3	Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4	Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME049	BIO ENERGY CONVERSION TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To elucidate on biomass, types, availability, and characteristics
- To study the bio-methanation process.
- To impart knowledge on combustion of biofuels
- To describe on the significance of equivalence ratio on thermochemical conversion of biomass
- To provide insight to the possibilities of producing liquid fuels from biomass

UNIT I	INTRODUCTION	9

Biomass: types – advantages and drawbacks – typical characteristics – proximate and ultimate analysis – comparison with coal - Indian scenario - carbon neutrality – biomass assessment studies – typical conversion mechanisms - densification technologies.

UNIT II	BIOMETHANATION	9

Biomethenation process – influencing parameters – typical feed stocks – Biogas plants: types and design, Biogas appliances – burner, luminaries and power generation systems – Industrial effluent based biogas plants.

UNIT III	COMBUSTION	9

Perfect, complete and incomplete combustion – stoichiometric air requirement for biofuels - equivalence ratio – fixed bed and fluid bed combustion

UNIT IV	BIO-ENERGY	9

Chemistry of gasification - types – comparison – typical application – performance evaluation – economics. Pyrolysis - Classification - process governing parameters – Typical yield rates. Carbonization – merits of carbonized fuels – techniques adopted for carbonization.

UNIT V	LIQUIFIED BIOFUELS	9
Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae - Process and chemistry - Biodiesel Vs Diesel – comparison on emission and performance fronts. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Develop e the surplus biomass availability of any given area.
CO2	Construct a biogas plant for a variety of biofuels.
CO3	Apply and compare the cost of steam generation from biofuels with that of coal and petroleum fuels.
CO4	Apply gasification and pyrolysis principles to evaluate performance and economic factors in energy production.
CO5	Develop carbonization techniques and assess the merits of carbonized fuels.
CO6	Summarize on liquid biofuels for power generation from biomass.

TEXT BOOKS:	
1	Nidhi Adlakha, Rakesh Bhatnagar , Syed Shams Yazdani " Biomass for Bioenergy and Biomaterials" CRC Press; 1st edition (22 October 2021), ISBN-10 : 0367745550
2	Augustine O. Ayeni, Samuel Eshorame Sanni , Solomon U. Oranusi ,"Bioenergy and Biochemical Processing Technologies" Springer (30 June 2022).

REFERENCES:	
1	Ellis Hoknood, Chichester, David Boyles, "Bio Energy Technology Thermodynamics and costs",1984 .
2	Iyer PVR et al, "Thermochemical Characterization of Biomass", M N E S.
3	Khandelwal KC, Mahdi SS, "Biogas Technology – A Practical Handbook", Tata McGraw Hill, 1986.

4	Mahaeswari, “R.C. Bio Energy for Rural Energisation”, Concepts Publication, 1997.
5	Tom B Reed, “Biomass Gasification – Principles and Technology”, Noyce Data Corporation, 1981.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	2	1	1	-	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME050	THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the working principle of Li-ion Batteries and Battery Packs.
- To learn the thermal management system in Battery modules.
- To develop the different case studies in Battery Thermal Management System.
- To learn the working principle of Fuel Cells cooling methods.
- To learn the inside components of Thermal Management Systems .

UNIT I	ADVANCED BATTERIES	9

Li-ion Batteries - chemistry, different formats, operating areas, efficiency, aging. Battery Management System - Configuration, Characteristics. Tesla Model S - 18650 Cell specifications, P85 Battery pack mechanical structure, Texas Instruments BMS. Super capacitors Vs batteries. Diamond battery concepts.

UNIT II	THERMAL MANAGEMENT IN BATTERIES	9

Thermal Management Systems- impact, Types - Air, Liquid, Direct refrigerant, Heat pipe, Thermo Electric, Phase Change Material Cooling methods. Solid-liquid PCM Types - Organic, Inorganic, Eutectics. PCM Thermal properties and applications. Tesla Model - S Battery Module - bonding techniques, thermal management.

UNIT III	BATTERY THERMAL MANAGEMENT CASE STUDIES	9

EV Battery Cooling - challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs - system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System- Case study. Modelling Liquid Cooling of a Li-Ion Battery Pack with COMSOL Multiphysics-

simulation concepts.		
UNIT IV	**THERMAL MANAGEMENT IN FUEL CELLS**	**9**
Fuel Cells - operating principle, hydrogen - air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management - basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.		
UNIT V	**FUEL CELL THERMAL MANAGEMENT CASE STUDIES**	**9**
Fuel cell system - balance of plant- components required. Fuel cell power plant sizing problems - Fuel Cell Electric Vehicle Fuel Economy Calculations-Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV- Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refueling - Case studies.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the different Li-ion Batteries and Fuel Cell performances.
CO2	Develop a Battery Pack with appropriate PCM.
CO3	Apply Cooling Models using Simulation.
CO4	Develop the fuel economy estimation.
CO5	Apply fuel cell system principles to size and evaluate fuel cell power plants.
CO6	Summarize the components and principles of fuel cell operated vehicles.
TEXT BOOKS:	
1	Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, “Thermal Management of Electric Vehicle Battery Systems’’, Wiley, 2017.

2	Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles'', Wiley, 2015.
3	Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design'', CRC Press, 2005.
4	John G. Hayes and G. Abas Goodarzi, "Electric Powertrain", Wiley, 2018.
5	Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.
REFERENCES:	
1	Nag.P.K, "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill Education, New Delhi, 2013.
2	"Vehicle thermal Management Systems Conference Proceedings", 1st Edition; 2013, Coventry Techno Centre, UK.
3	Younes Shabany," Heat Transfer: Thermal Management of Electronics Hardcover" 2010, CRC Press.
4	T. Yomi Obidi, "Thermal Management in Automotive applications", 2015, SAE.
5	Jerry Sergent, Al Krum, "Thermal Management Handbook: For Electronic Assemblies Hardcover", 1998, McGraw- Hill.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	2	1	1	1	-	1	-	1	-	-	-	-	2	-	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

<table>
<tr><td>23ME051</td><td colspan="2">ENERGY STORAGE DEVICES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td></td><td colspan="2"></td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">

To study the various types of energy storage devices and technologies and them comparison.
To learn the techniques of various energy storage devices and their performances.
To learn the basics of batteries and hybrid systems for EVs and other mobile applications.
To learn about the renewable energy storage systems and management systems.
To have an insight into other energy storage devices, hydrogen, and fuel cells.

</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION TO ENERGY STORAGE</td><td>9</td></tr>
<tr><td colspan="7">Need for Energy Storage – Types of Energy Storage – Various forms of Energy Storage – Mechanical– Thermal - Chemical– Electrochemical – Electrical - Other alternative energy storage technologies – Efficiency and Comparison.</td></tr>
<tr><td>UNIT II</td><td colspan="5">ENERGY STORAGE SYSTEMS</td><td>9</td></tr>
<tr><td colspan="7">Pumped Air Energy Storage – Compressed Air Energy Storage – Flywheel – Sensible and Latent Heat Storage – Storage Materials – Performance Evaluation - Thermochemical systems – Batteries – Types Charging and Discharging – Battery testing and performance.</td></tr>
<tr><td>UNIT III</td><td colspan="5">MOBILE AND HYBRID ENERGY STORAGE SYSTEMS</td><td>9</td></tr>
<tr><td colspan="7">Batteries for electric vehicles - Battery specifications for cars, heart pacemakers, computer standby supplies – V2G and G2V technologies – HESS</td></tr>
<tr><td>UNIT IV</td><td colspan="5">RENEWABLE ENERGY STORAGE AND ENERGY MANAGEMENT</td><td>9</td></tr>
<tr><td colspan="7">Storage of Renewable Energy Systems – Solar Energy – Wind</td></tr>
</table>

Energy – Energy Storage in Micro grid– Smart Grid – Energy Conversion Efficiency - Battery Management Systems – EVBMS – Energy Audit and Management.		
UNIT V	**OTHER ENERGY DEVICES**	**9**
Superconducting Magnetic Energy Storage (SMES), Super capacitors – MHD Power generation – Hydrogen Storage - Fuel Cells – Basic principle and classifications – PEMFC, AMFC, DMFC, SOFC,MCFC and Biofuel Cells – Biogas Storage.		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Summarize the need and identify the suitable energy storage devices for applications.
CO2	Explain the working of various energy storage devices and their importance.
CO3	Explain the basic characteristics of batteries for mobile and hybrid systems.
CO4	Apply knowledge of energy storage systems to manage solar and wind energy effectively.
CO5	Make use of energy management techniques to improve efficiency and conduct energy audits.
CO6	Explain the need for other energy devices and their scope for applications.
TEXT BOOKS:	
1	Rober Huggins, "Energy Storage: Fundamentals, Materials and Applications", 2 nd Edition, Springer, 2015.
2	Dell, Ronald M Rand, David A J, "Understanding Batteries", Royal Society of Chemistry, 2001.
REFERENCES:	
1	Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, 2016.

2	Ibrahim Dincer and Mark A Rosen, "Thermal Energy Storage Systems and Applications", John Wiley and Sons, 2002.
3	Lindon David, "Handbook of Batteries", McGraw Hill, 2002.
4	Aulice Scibioh M. and Viswanathan B, "Fuel Cells – principles and applications', University Press(India), 2006.
5	Ru-Shiliu, Leizhang, Sueliang Sun, "Electrochemical Technologies for Energy Storage and Conversion", Wiley Publications, 2012.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME052	ENERGY CONSERVATION IN INDUSTRIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn Quantifying the energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign
- To analyze factors behind energy billing and applying the concept of demand side management for lowering energy costs
- To learn Computing the stoichiometric air requirement for any given fuel and quantifying the energy losses associated with thermal utilities of industries
- To diagonize the causes for under performance of various electrical utilities and suggesting remedies for improving their efficiency
- To apply CUSUM and other financial evaluation techniques to estimating the accruable energy savings/monetary benefits for any energy efficiency project

UNIT I	INTRODUCTION	9

Energy scenario of World, India and TN - Environmental aspects of Energy Generation – Material and Energy balancing - Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Basic instruments for Energy Auditing.

UNIT II	ELECTRICAL SUPPLY SYSTEMS	9

Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers – Harmonics

UNIT III	ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES	9

Stoichiometry - Combustion principles. Energy conservation in: Boilers - Steam Distribution Systems - Furnaces - Thermic Fluid

Heaters – Cooling Towers – D.G. sets. Insulation and Refractories - Waste Heat Recovery Devices.		
UNIT IV	**ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES**	**9**
Energy conservation in: Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems		
UNIT V	**ENERGY MONITORING, TARGETING, LABELLING AND ECONOMICS**	**9**
Elements of Monitoring and Targeting System – CUSUM - Energy / Cost index diagram – Energy Labelling - Energy Economics – Cost of production and Life Cycle Costing - Economic evaluation techniques – Discounting and Non-Discounting - ESCO concept – PAT scheme		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the energy demand and supply scenario of nation and need for energy auditing.
CO2	Analyze factors behind energy billing.
CO3	Develop and compute the stoichiometric air requirement for any given fuel.
CO4	Summarize the causes for under performance of various electrical utilities.
CO5	Apply energy monitoring techniques to track and optimize energy usage.
CO6	Make use of economic evaluation methods to assess the cost-effectiveness of energy projects.
TEXT BOOKS:	
1	Guide book for National Certification Examination for "Energy Managers and Energy Auditors" (4 Volumes). Available at http://www.em-ea.org/gbook1.asp. This website is administered by Bureau of Energy Efficiency

	(BEE), a statutory body under Ministry of Power, Government of India.
2	K. Nagabhushan Raju," Industrial Energy Conservation Techniques: (concepts, Applications and Case Studies)", Atlantic Publishers and Dist, 2007.
REFERENCES:	
1	Abbi Y P, Shashank Jain., "Handbook on Energy Audit and Environment Management", TERI Press, 2006.
2	Albert Thumann and Paul Mehta D, "Handbook of Energy Engineering", 7th Edition, The Fairmont Press, 2013.
3	Murphy. W.R. and McKay. G, "Energy Management", Butterworth, London 1982.
4	Paul W.O 'Callaghan, "Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers", Pergamon Press, 1981.
5	Steve Doty, Wayne Turner C, "Energy Management Handbook 7th Edition", The Fairmont Press, 2009.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	3	3	2	2	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23MT047	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the construction and working principle of various parts of an automobile.
- To study the practice for assembling and dismantling of engine parts and transmission system.
- To study various transmission systems of automobile.
- To study about steering, brakes and suspension systems.
- To study alternative energy sources.

UNIT I	VEHICLE STRUCTURE AND ENGINES	9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines – components - functions and materials, variable valve timing (VVT).

UNIT II	ENGINE AUXILIARY SYSTEMS	9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT III	TRANSMISSION SYSTEMS	9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV	STEERING, BRAKES AND SUSPENSION SYSTEMS	9
Steering geometry and types of steering gear Box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.		
UNIT V	**ALTERNATIVE ENERGY SOURCES**	**9**
Use of Natural Gas, Liquefied Petroleum Gas, Bio - diesel, Bio - ethanol, Gasohol and Hydrogen in Automobiles - Engine modifications required – Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the various parts of the automobile and their functions and materials.
CO2	Summarize the engine auxiliary systems and engine emission control.
CO3	Compare the working of different types of transmission systems.
CO4	Apply knowledge of steering and suspension systems to improve vehicle handling and stability.
CO5	Interpret on braking systems like ABS and EBD to enhance vehicle safety.
CO6	Develop the possible alternate sources of energy for IC Engines.

TEXT BOOKS:	
1	Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.

2	Kirpal Singh, “Automobile Engineering”, Vol 1 and 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.
REFERENCES:	
1	Ganesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2012.
2	Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.
3	Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 1999.
4	Martin W, Stockel and Martin T Stockle , “Automotive Mechanics Fundamentals,” The Good heart - Will Cox Company Inc, USA, 1978.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

VERTICAL 4 – MODERN MOBILITY SYSTEMS

23AU064	AUTOMOTIVE CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the technologies relevant to intelligent vehicle systems
- To appreciate the role of electronics in providing improved control to a variety of vehicle systems.
- To recognize the electronically controlled system used in driving mechanics.

UNIT I	DRIVER ASSISTANCE SYSTEMS	9

Overview and examples of vehicle control system - Sensors, actuators and controller modules - Vehicle communication Network - System Engineering V-diagram - Algorithm Development - Steps in vehicle control system design - Selection of controlled, Manipulated, Measured disturbance variables - Classification of the variables in various automotive systems like engines, Suspension, Braking.

UNIT II	CONTROL SCHEMES, CRUISE AND HEADWAY CONTROL	9

Feed - Forward control - Cascade control - Design considerations for cascade control, Time delay compensation, Inferential control - Nonlinear control - Adaptive control etc. Cruise control design - Autonomous cruise control - Anti locking brakes - Traction control system - Vehicle stability control linear and non-linear vehicle model.

UNIT III	DRIVER MODELING AND POWERTRAIN CONTROL SYSTEMS	9

Driving simulators - Percentage of road departure - Driver modeling - Transfer function models - Preview/ Predictive models - Longitudinal driver models Control oriented engine modeling - Air intake model - Fuel dynamics model - Air Fuel ratio dynamics

- Engine Control Loops - Air Fuel Ratio control - EGR Control.		
UNIT IV	**CONTROL OF HYBRID AND FUEL CELL VEHICLES**	**9**
Series-Parallel - Split Hybrid Configurations - Hybrid Vehicle Control Hierarchy - Control Concepts of Series Hybrids - Equivalent Consumption minimization strategy - Control concepts for split hybrid modelling of fuel cell systems - Fuel stack model - Control of fuel cell system.		
UNIT V	**HUMAN FACTORS AND INTELLIGENT TRANSPORT SYSTEM**	**9**
The safety risks - Guidelines to fly safely - Specific aviation regulation and standardization - Drone license - Miniaturization of drones - Increasing autonomy of drones - The use of drones in swarms.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the basics of control system used in automobiles.
CO2	Identify the electronically controlled system used in driving mechanics.
CO3	Summarize the working principle of driver modelling and power train control systems.
CO4	Identify the control system used in hybrid and electrical vehicles.
CO5	Illustrate the need of automated transport systems.
CO6	Categorize the recent trends and intelligent technologies associated with modern day vehicles.
TEXT BOOKS:	
1	Galip Ulsoy, “Automotive Control System”, Cambridge University Press, 2012.
2	Uwe Kiencke and Lars Nielson, “Automotive Control System”, SAE Publications, 2006.

REFERENCES:	
1	Bosch Automotive Handbook, Sixth Edition, 2004.
2	Benjamin C.Kuo and Farid Golnaraghi, "Automatic Control System", John Wiley & Sons, Eighth edition, 2003.
3	Katsuhiko Ogata, "System Dynamics", Prentice Hall International, Inc. Third Edition, 1998.
4	Richard C.Dorf and Robert H.Bishop, "Modern Control Systems", Pearson Prentice Hall, 2008.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	2	-	-	-	-	-	-	-	2	2	-
2	3	2	1	1	2	-	-	-	-	-	-	-	3	2	-
3	2	1	-	-	2	-	-	-	-	-	-	-	2	2	-
4	3	2	1	1	2	-	-	-	-	-	-	-	3	2	-
5	2	1	-	-	2	-	-	-	-	-	-	-	2	2	-
6	3	3	2	2	2	-	-	-	-	-	-	-	3	2	-
Overall Correlation	3	2	1	1	2	-	-	-	-	-	-	-	3	2	-

23AU701	INTELLIGENT VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the importance of intelligent vehicle systems to the modern world and learn the working principles of various ADAS systems and focusing on those in-vehicle solutions.
- To appreciate the role of electronics in providing improved control to a variety of vehicle systems.
- To utilize appropriate methodologies and be aware of the design and implementation issues of advanced techniques.

UNIT I	INTRODUCTION TO INTELLIGENT VEHICLE SYSTEMS	9

Definition, modern trends in Auto industry, various intelligent systems present in the vehicle, Need for IVS, Benefits, Advanced Driver Assistance System -Types/Levels, Next Generation Intelligent Vehicles, and General Vehicle Control.

UNIT II	AUTOMOTIVE IOT INTEGRATION	9

Developments on IoT in Automotive Sector, Connected Car Services and Applications- Infotainment, Vehicle and Smartphone Integration, Driving Insights- Analytics, On Board Diagnostics, Stolen Vehicle Tracking, Biometrics Information for Driver Identification, Vehicle Communication- V2V, V2X, V2R, IoT in Intelligent Transportation, Introduction to Autonomous Vehicle.

UNIT III	TRAFFIC SURROUNDING SYSTEM	9

Modelling traffic and driver interactions, Simulation of driver and city interaction, Behavior and driving pattern, simulation of driver and highway interaction, Behavior and driving pattern, Application: Traffic alert - Real time road data on Navigation, Navigation System- Global Positioning System, Geographical Information Systems Architecture, Road Sign Recognition.

UNIT IV	ADVANCED VEHICLE CONTROL SYSTEMS AND SAFETY SYSTEMS FOR MODERN VEHICLES	9
Introduction- Design overview, circuit diagram and Algorithm, Driver safety systems- ABS, Driver Aid system - ESP, Blind Spot monitoring system, Collision mitigation system, Adaptive Headlamps, Automatic parking system, Eight-way seating system, Adaptive cruise control system, Collapsible and tiltable steering column, Lane Departure Warning.		
UNIT V	**CONNECTED VEHICLE SYSTEMS**	**9**
Introduction to CVS, Telematics control system architecture - driver information systems, Vehicle -vehicle interaction using TCS, Current trends in auto industry, In-Vehicle Entertainment System – Mirror link, Web link, App link, Apple Car Play, Android Auto. Application: e-call system - design, functions and limitations.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Analyze the importance of modern trends in vehicle System.
CO2	Apply the knowledge for selection of sensor and communication protocols for interfacing sensors.
CO3	Apply the knowledge for understanding the traffic information in the surroundings.
CO4	Illustrate the various intelligent systems used in automobiles and entertainment features inside the vehicle.
CO5	Explain the intelligent systems associated with Autonomous vehicle.
CO6	Explain the perception, prediction and routing of autonomous driving.

TEXT BOOKS:	
1	A. Perallos, U. Hernandez-jayo, E. Onieva and I. Garcia-Zuazola (Eds.), Intelligent Transport Systems: Technologies and Applications, Wiley publications, 2015.
2	A. Eskandarian (Ed.), Handbook of Intelligent Vehicles, Springer-Verlag London Ltd, 2012.
REFERENCES:	
1	R. K. Jurgen, Navigation and Intelligent Transportation Systems - Progress Technology, Automotive Electronics Series, Warrendale, PA: SAE International 2014.
2	H. Cheng, Autonomous Intelligent Vehicles: Theory, Algorithms, and Implementation, Berlin: Springer, 2011.
3	P. C. Cacciabue (Ed.), Modelling Driver Behavior in Automotive Environments Critical Issues in Driver Interactions with Intelligent Transport Systems Springer-Verlag London Ltd, 2007.
4	Michael E. McGrath, ―Autonomous Vehicles: Opportunities, Strategies, and, Disruptions‖, Amazon, 2018.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	1	2	-	1	-	-	-	1	3	1	1
2	3	2	1	1	1	2	-	1	-	-	-	1	3	1	1
3	3	2	1	1	1	2	-	1	-	-	-	1	3	1	1
4	2	1	-	-	1	2	-	1	-	-	-	1	2	1	1
5	2	1	-	-	1	2	-	1	-	-	-	1	2	1	1
6	2	1	-	-	1	2	-	1	-	-	-	1	2	1	1
Overall Correlation	3	2	1	1	1	2	-	1	-	-	-	1	3	1	1

23ME053	HYBRID AND ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concept of hybrid and electric drive trains.
- To elaborate on the types and utilization of hybrid and electric drive trains.
- To expose on different types of AC and DC drives for electric vehicles.
- To learn and utilize different types of energy storage systems.
- To introduce concept of energy management strategies and drive sizing

UNIT I	INTRODUCTION	9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT II	HYBRID ELECTRIC DRIVE TRAINS	9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT III	CONTROL OF AC and DC DRIVES	9

Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.

UNIT IV	**ENERGY STORAGE**	**9**
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.		
UNIT V	**DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES**	**9**
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Interpret and configure hybrid drivetrains requirement for a vehicle.
CO2	Apply appropriate hybrid and electric drive trains in a vehicle.
CO3	Select suitable AC and DC drives for electric vehicles.
CO4	Illustrate a suitable energy storage system for a hybrid / electric vehicle.
CO5	Apply drive sizing techniques to match electric machines, internal combustion engines, and energy storage systems in vehicles.
CO6	Make use of energy management strategies to optimize the performance of hybrid vehicles.

TEXT BOOKS:

1	Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Third Edition, 2021.

2	2. James Larminie, John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2003.
REFERENCES:	
1	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, “Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.
2	Rand D.A.J, Woods, R “Dell RM Batteries for Electric vehicles”, John Wiley.
3	Jack Erjavec “Hybrid,Electric and Fuel-Cell Vehicles”, International Edition June 2012.
4	Christian Paar ,”Energy Management in Hybrid Electric Vehicles using Co-Simulation” February 2011.
5	Yangsheng Xu, Jingyu Yan, et al. “Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids”. December 2013.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME054	ENERGY STORAGE AND MANAGEMENT SYSTEMS FOR ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the various types of energy storage devices and technologies.
- To learn the techniques of various energy storage devices and their performances.
- To learn the basics of batteries and hybrid systems for EVs and other mobile applications.
- To learn about the renewable energy storage systems and management systems.
- To have an insight into other energy storage devices, hydrogen, and fuel cells.

UNIT I	ENERGY STORAGE TECHNOLOGIES	9

Classification of Storage Technologies by Energy type- Thermal Energy: Heat Storage; Chemical Energy: Organic and Non-Organic; Mechanical Energy: Kinetic and Potential Energy; Electrical Energy: Electrical Potential.

UNIT II	ENERGY STORAGE SYSTEMS IN MODERN ELECTRICAL SYSTEMS	9

Lead-acid battery, Nickel - cadmium battery, Lithium - ion battery, Sodium-sulfur battery, Nickel metal hydride battery, Fuel cells, Capacitors and Super capacitors. Solid state Batteries. Differences amongst different ESS.

UNIT III	TYPICAL ESS AND BATTERY CHEMISTRY	9

Electrodes, Electrolytes, Collectors, Thermal management, Packaging of battery pack Lithium based batteries: Lithium manganese oxide, Lithium iron phosphate, Lithium nickel manganese cobalt oxide, Lithium nickel cobalt aluminum oxide and Lithium titanate; Silicon based Batteries, Sodium-sulfur Batteries, Proton Batteries, Graphite Dual-Ion Batteries, Salt-water Batteries and Potassium - Ion Batteries.

UNIT IV	BATTERY MANAGEMENT SYSTEMS (BMS)	9
Introduction to BMS, Objectives of the BMS: Discharging control, Charging control, State – of - Charge Determination, State - of - Health Determination, Cell Balancing; BMS topologies: Distributed Topology, Modular Topology and Centralized Topology, Firmware development, Certification, Aging.		
UNIT V	**BATTERIES FOR THE EV APPLICATION**	**9**
Performance criterion for EV batteries Energy density, Amp hour density, Energy efficiency, Cost, Operating temperature, number of life cycles, recharge and self - discharge rates and commercial availability, some reference batteries and extension to nonautomotive sectors.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Apply knowledge of different energy storage technologies to select appropriate storage methods based on energy type.
CO2	Compare various energy storage systems to select and differentiate between battery types and other storage technologies in modern electrical systems.
CO3	Apply knowledge of battery components to understand different types of batteries used in energy storage.
CO4	Discuss battery management systems to control charging, discharging, and monitor battery health.
CO5	Apply performance criteria for EV batteries based on energy density, efficiency, cost, and other factors.
CO6	Compare different battery types for electric vehicles and their applications in non-automotive sectors.

TEXT BOOKS:

1	Alfred Rufer, "Energy Storage systems and components", CRC Press, 2017.

2	Tom Denton, “Automotive Electrical and Electronic Systems”, 5th Edition, Routledge, 2018.
3	Mehard Ehsani, Yiming Gao, Stefano longo and Kambiz Ebrahimi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC Press, 3rd Edition. 2019.
REFERENCES:	
1	E. Karden, S. Ploumen, B. Fricke, T. Miller and K. Snyder, “Energy storage devices for future hybrid electric vehicles,” J. Power Sources, vol. 168, no. 1, pp. 2–11, 2007.
2	Iqbal Husain, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press. 2021.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME055	ELECTRIC VEHICLE DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To model and design of electric vehicle technology with high efficiencies.
- To evaluate various choices available to designers to optimize their vehicle design.
- To select various electric drives and controller suitable for electric vehicles.
- To design and select ancillaries such as the heating and cooling system.
- To investigate the need for further research in promising areas.

UNIT I	ELECTRIC VEHICLE MODELLING	9

Tractive Effort - Rolling resistance force - Aerodynamic drag - Hill climbing force - Acceleration force - Total tractive effort - Modelling Vehicle Acceleration – Acceleration performance parameters - Modelling the acceleration of a small car - Modelling Electric Vehicle Range - Driving cycles - Range modelling of battery electric vehicles – Constant velocity range modelling - Range modelling of fuel cell vehicles - Range modelling of hybrid electric vehicles.

UNIT II	ELECTRIC VEHICLE DESIGN CONSIDERATIONS	9

Transmission Efficiency - Consideration of Vehicle Mass - Electric Vehicle Chassis and Body Design - Body/chassis requirements - Body/chassis layout - Body/chassis strength, rigidity and crash resistance - Designing for stability - Suspension for electric vehicles - Chassis used in modern fuel cell electric vehicles.

UNIT III	SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN	9

Operation Patterns - Control Strategies - maximum state-of-charge

of peaking power source (PPS) – Thermostat Control Strategy (Engine-On–Off) - Sizing of the Major Components - Power Rating Design of the Traction Motor - Power Rating Design of the Engine/Generator - Design of PPS - Power Capacity of PPS - Energy Capacity of PPS.		
UNIT IV	**PARALLEL HYBRID ELECTRIC DRIVE TRAIN DESIGN**	**9**
Control Strategies of Parallel Hybrid Drive Train - Maximum State-of-Charge of Peaking Power Source (Max. SOC-of PPS) Control Strategy - Engine Turn-On and Turn-Off (Engine-On–Off) Control Strategy Design of Drive Train Parameters - Design of Engine Power Capacity - Design of Electric Motor Drive Power Capacity - Transmission Design - Energy Storage Design.		
UNIT V	**ANCILLARY SYSTEMS AND THE ENVIRONMENT**	**9**
Heating and Cooling Systems - Design of the Controls – stick controller - Power Steering - Choice of Tyres – Electric Vehicle Recharging and Re-fuelling Systems - Vehicle Pollution in context with conventional vehicles – Quantitative Analysis - Alternative and Sustainable Energy.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Explain the given design specification and model the various components required for electrical vehicles with high performance .
CO2	Choose proper drives and control for developing a new electric vehicle.
CO3	Summarize the behaviour of electric vehicle by sophisticated mechanical and mathematical knowledge.
CO4	Interpret the design and controls of heating, cooling, and power steering systems to enhance vehicle comfort and performance.

CO5	Model the environmental impact of vehicle pollution and alternative energy sources to promote sustainable practices in automotive systems.
CO6	Evaluate the environmental impact of vehicle pollution and alternative energy sources to promote sustainable practices in automotive systems.
TEXT BOOKS:	
1	James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley and Sons, 2013.
2	Mehrdad Ehsani, Yimin Gao, Stefano Longo Kambiz M. Ebrahimi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRS Press, 2018.
REFERENCES:	
1	Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2011.
2	Seref Soylu "Electric Vehicles - The Benefits and Barriers" InTech Publishers, Croatia, 2011.
3	Amir Khajepour, M. Saber Fallah, Avesta Goodarzi "Electric and hybrid vehicles technologies, modeling and control: a mechatronic approach" John Wiley and Sons Ltd 2014.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	1	-	1	-	-	-	-	2	1	1
6	3	3	3	3	1	1	-	1	-	-	-	-	3	1	1
Overall Correlation	3	2	1	-	1	1	-	1	-	-	-	-	3	1	1

<table>
<tr><td rowspan="2">23ME056</td><td rowspan="2">VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">

To enable the student to understand the principles, functions and practices adapted in maintenance activities of vehicles.
To study the powertrain maintenance, fault diagnosis, maintenance of Batteries.
To develop vehicle system maintenance and service of clutch, brake.
To study the concepts of vehicle safety and regulations.
To study and understand the simulation of safety concepts.

</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="6">Need for Maintenance – importance, classification of maintenance work-basic problem diagnosis. Maintenance of vehicle systems – power pack, tyres, safety systems. Scheduled maintenance services – service intervals – On-board diagnostics, Computerized engine analyzer study and practice- OBD and scan tools.</td></tr>
<tr><td>UNIT II</td><td colspan="4">POWERTRAIN MAINTENANCE</td><td>9</td></tr>
<tr><td colspan="6">Exhaust emission test of petrol and diesel engine; - Electronic fuel injection and engine management service - fault diagnosis- OBD-III and scan tool, identifying DTC and servicing emission controls, Maintenance of Batteries, Starting System, Charging System and Body Electrical -Fault Diagnosis Using Scan Tools.</td></tr>
<tr><td>UNIT III</td><td colspan="4">VEHICLE SYSTEM MAINTENANCE</td><td>9</td></tr>
<tr><td colspan="6">Clutch- adjustment and service, Maintenance and Service of Hydraulic brake, Bleeding of brakes, Checking ABS and components. Maintenance and Service of McPherson strut, coil spring. tyre wear, measurement of read depth and tyre rotation, Computerized wheel balancing and wheel alignment,</td></tr>
</table>

Maintenance and Service of steering linkage, steering column, Rack and pinion steering.		
UNIT IV	**VEHICLE SAFETY**	**9**
Concepts of vehicle safety -Seat belt, regulations, automatic seat belt tightner system, collapsible steering column, air bags, electronic system for activating air bags, bumper design for safety, Active Safety - ABS, EBD, CSC, Traction control system, Modern electronic features in vehicles like tyre pressure monitoring, Automatic headlamp ON, Rain sensing wipers.		
UNIT V	**SIMULATION OF SAFETY CONCEPTS**	**9**
Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to		
CO1	Illustrate the performance of the vehicle and follow the safety operations.	
CO2	Explain the power train maintenance concepts	
CO3	Identify and analyze the problems in vehicle system	
CO4	Explain the vehicle safety.	
CO5	Summarize active and passive safety concepts and their impact on vehicle safety	
CO6	Explain collision warning and object detection systems.	
TEXT BOOKS:		
1	Tom Denton "Advanced Automotive Fault Diagnosis Automotive Technology: Vehicle Maintenance and Repair" 5th Edition.	

2	S. V. Paul,"Safety Management System and Documentation Training Programme Handbook" ISBN: 9788123923444.
REFERENCES:	
1	Ed May, "Automotive Mechanics Volume One" and Two, Mc Graw Hill Publications, Tenth edition, 2018.
2	"Bosch Automotive Handbook", Tenth Edition, 2018.
3	Jack Erjavek, "A systems approach to Automotive Technology", Cengage Learning, 5th Edition, 2012.
4	William H. Crouse and Donald L. Anglin, "Automotive Mechanics", Tata McGraw Hill, 10thEdition, 2004.
5	"Vehicle Service Manuals of Reputed Indian Manufacturers".

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	1	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	1	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	1	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	1	1	1
5	2	1	-	-	1	1	-	1	-	-	-	-	1	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	1	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	1	1	1

23ME057	CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the advanced engine technologies.
- To learn various advanced combustion technologies and its benefits.
- To learn the methods of using low carbon fuels and its significance.
- To learn and understand the hybrid and electric vehicle configurations.
- To study the application of fuel cell technology in automotives.

UNIT I	ADVANCED ENGINE TECHNOLOGY	9

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

UNIT II	COMBUSTION TECHNOLOGY	9

Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT III	LOW CARBON FUEL TECHNOLOGY	9

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward.

UNIT IV	**HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED**	**9**
Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward.		
UNIT V	**FUEL CELL TECHNOLOGY**	**9**
Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the latest trends in engine technology
CO2	Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.
CO3	Analyze the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.
CO4	Explain the working and energy flow in various hybrid and electric configurations.
CO5	Explain the technology and advances in fuel cell systems for automotive applications.
CO6	Summarize different types of fuel cells and their control systems to evaluate their potential for market integration.
TEXT BOOKS:	
1	1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, “Modern Electric,Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.
2	2. Rakesh Kumar Maurya, “Characteristics and Control of Low Temperature Combustion”.

REFERENCES:

1	Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.
2	James Larminie, John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2003.
3	Rand D.A.J, Woods, “R and Dell RM Batteries for Electric vehicles”, John Wiley and Sons, 1998.
4	Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.
5	James Larminie, John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2003.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	3	3	2	2	1	1	-	1	-	-	-	-	2	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	2	1	1

23ME058	AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the functional requirements of engine components and suitable materials.
- To learn to design of cylinder and piston components.
- To learn to design of connecting rod and crank shaft.
- To learn to design of flywheel and valve train.
- To study the Engine Testing cycles, Emission measurement technologies.

UNIT I	FUNCTIONAL REQUIREMENTS OF ENGINE COMPONENTS AND SUITABLE MATERIALS	9

Functional requirements of engine components – Piston, piston pin, cylinder liner, connecting rod, crank shaft, valves, spring, engine block, cylinder head, and flywheel. Suitable materials for engine components.

UNIT II	DESIGN OF CYLINDER AND PISTON COMPONENTS	9

Design of cylinder, cylinder head, piston, piston rings and piston pin – more details is necessary.

UNIT III	DESIGN OF CONNECTING ROD AND CRANK SHAFT	9

Design of connecting rod – Shank design – small end design – big end design – bolts design. Design of overhang crank shaft under bending and twisting – Crank pin design – Crank web design – Shaft design.

UNIT IV	DESIGN OF FLYWHEEL AND VALVE TRAIN	9

Design of valve – inlet valve – exhaust valve - Valve springs – tappet – rocker arm. Determination of mass of flywheel for a given coefficient of fluctuation of speed. Design of flywheel - rim - hub - arm.

UNIT V	ENGINE TESTING	9
Engine test cycles – WLTC – WHSC – WHVC – NRTC – ISO 8178. Dynamometer - Chassis dynamometer - transient dynamometer. Emission measurement technologies and instruments - NOX – Smoke – Particulate matter – CO – CO2 - HC.-Particle counter.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Explain the requirements of engine components and select suitable materials.
CO2	Apply the concept of design to cylinder and piston components and solve problems.
CO3	Apply the concept of design to Connecting rod and crank shaft and solve problems.
CO4	Apply the concept of design to flywheel and valve train and solve problems.
CO5	Interpret engine test cycles and measurement technologies to assess engine performance and emissions.
CO6	Summarize dynamometer types and emission measurement instruments to evaluate engine efficiency and environmental impact.

TEXT BOOKS:

1	Khurmi. R.S. and Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2	Giancarlo Genta and Lorenzo Morello,”The Automotive Chassis: Volume 1: Components Design (Mechanical Engineering Series)” 24 December 2019.

REFERENCES:

1	Hiroshima Yamagata, “The science and technology of materials in automotive engines”, Woodhead Publishing Limited, Cambridge, England.
2	Jain.R.K, “Machine Design”, Khanna Publishers, New Delhi, 2005.

3	Lobna A. Elseify, Mohamad Midani, et al. “Manufacturing Automotive Components from Sustainable Natural Fiber Composites” (SpringerBriefs in Materials), 9 August 2021.
4	Andreas Öchsner and Holm Altenbach, “Mechanical and Materials Engineering of Modern Structure and Component Design” (Advanced Structured Materials Book 70) June 2015.
5	George C. Sih, Alberto Carpinteri, et al. “Advanced Technology for Design and Fabrication of Composite Materials and Structures: Applications to the Automotive, Marine, Aerospace and Applications of Fracture Mechanics)” December 2010.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

VERTICAL 5: ROBOTICS AND AUTOMATION

<table>
<tr><td rowspan="2">23AE069</td><td rowspan="2">DRONE TECHNOLOGIES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
To understand the fundamental concepts, history, and business opportunities associated with drone technology.
To acquire knowledge of drone design, fabrication, and programming, including assembling and configuring components.
To learn drone flight operations, control mechanisms, and the integration of sensors and storage devices.
To explore commercial applications of drones in various industries such as agriculture, logistics, and inspection services.
To understand safety practices, aviation regulations, licensing, and advancements in drone autonomy and swarm technology.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION TO DRONE TECHNOLOGY</td><td>9</td></tr>
<tr><td colspan="6">Drone Concept - Vocabulary Terminology - History of drone - Types of current generation of drones based on their method of propulsion - Drone technology impact on the businesses - Drone business through entrepreneurship - Opportunities/applications for entrepreneurship and employability.</td></tr>
<tr><td>UNIT II</td><td colspan="4">DRONE DESIGN, FABRICATION AND PROGRAMMING</td><td>9</td></tr>
<tr><td colspan="6">Classifications of the UAV - Overview of the main drone parts - Technical characteristics of the parts - Function of the component parts - Assembling a drone - The energy sources - Level of autonomy- Drones configurations -The methods of programming drone - Download program - Install program on computer- Running Programs - Multi rotor stabilization - Flight modes - Wi-Fi connection.</td></tr>
</table>

UNIT III	**DRONE FLYING AND OPERATION**	**9**
Concept of operation for drone - Flight modes - Operate a small drone in a controlled environment - Drone controls Flight operations – management tool – Sensors - Onboard storage capacity - Removable storage devices - Linked mobile devices and applications.		
UNIT IV	**DRONE COMMERCIAL APPLICATIONS**	**9**
Choosing a drone based on the application - Drones in the insurance sector - Drones in delivering mail, Parcels and other cargo - Drones in agriculture - Drones in inspection of transmission lines and power distribution - Drones in filming and panoramic picturing.		
UNIT V	**FUTURE DRONES AND SAFETY**	**9**
The safety risks - Guidelines to fly safely - Specific aviation regulation and standardization - Drone license - Miniaturization of drones - Increasing autonomy of drones - The use of drones in swarms.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1	Know about a various type of drone technology, drone fabrication and programming.
CO2	Execute the suitable operating procedures for functioning a drone.
CO3	Select appropriate sensors and actuators for Drones.
CO4	Develop a drone mechanism for specific applications.
CO5	Create the programs for various drones.
CO6	Summarize drone commercial applications.
TEXT BOOKS:	
1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, John Wiley & Sons, Inc. 2021.

2	Garvit Pandya, “Basics of Unmanned Aerial Vehicles: Time to start working on Drone Technology”, Notion Press, 2021.
REFERENCES:	
1	John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016.
2	Jha, A. R. “Theory, design, and applications of unmanned aerial vehicles”. CRC Press, 2016.
3	Sachi Nandan Mohanty, J.V.R. Ravindra, “Drone Technology: Future Trends and Practical Applications”, Wiley, 2023.
4	Terry Kilby and Belinda Kilby, “Make: Getting Started with Drones “, Maker Media, Inc., 2016.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	1	1	1	2	-	-	-	2	2	3	3
2	3	3	2	1	1	2	1	2	-	-	-	3	2	3	3
3	3	3	2	1	1	2	1	2	-	-	-	3	2	3	3
4	3	2	2	1	1	1	1	2	-	-	-	2	2	3	3
5	3	3	2	1	1	2	1	2	-	-	-	3	2	3	3
6	3	3	2	1	1	2	1	2	-	-	-	3	2	3	3
Overall Correlation	**3**	**3**	**2**	**1**	**1**	**2**	**1**	**2**	**-**	**-**	**-**	**3**	**2**	**3**	**3**

23ME059	ELECTRICAL DRIVES AND AUTOMOTIVE ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic concepts of different types of electrical machines and their performance.
- To study the different methods of starting D.C motors and induction motors.
- To study the conventional and solid-state drives.
- To understand the basic concepts of different types of Actuators.

UNIT I	INTRODUCTION	9

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors.

UNIT II	DRIVE MOTOR CHARACTERISTICS	9

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound - single phase and three phase induction motors.

UNIT III	DC MOTORS AND DRIVES	9

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase Squirrel cage and slip ring induction motors.

UNIT IV	AUTOMOTIVE ACTUATORS	9

Electromechanical actuators - Fluid-mechanical actuators - Electrical machines - Direct-current machines - Three-phase machines - Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

UNIT V	**AUTOMATIC TEMPERATURE CONTROL ACTUATORS**	**9**
Different types of actuators used in automatic temperature control - Fixed and variable displacement temperature control - Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the principles and working of relays, drives and motors.
CO2	Explain the working and characteristics of various drives and motors.
CO3	Apply the solid state switching circuits to operate various types of Motors and Drivers.
CO4	Explain the performance of Motors and Drives.
CO5	Explain the classifications and operation of stepper motors and their applications in various systems.
CO6	Explain the principles and working of relays, drives and motors.
TEXT BOOKS:	
1	Theraja B.L. and Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand and Co. Ltd., New Delhi, 2012.
2	William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
REFERENCES:	
1	Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2	Mehta V.K. and Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand and Co. Ltd., New Delhi, 2016.

3	Singh M.D. and Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23ME060	INTRODUCTION TO ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about basics of robots and their classifications.
- To understand the robot kinematics in various planar mechanisms.
- To learn about the concepts in robot dynamics.
- To understand the concepts in trajectory planning and programming.
- To know about the various applications of robots.

UNIT I	BASICS OF ROBOTICS	9

Introduction- Basic components of Robot-Laws of robotics-classification of robot- robot architecture, work space-accuracy-resolution –repeatability of robot.

UNIT II	ROBOT KINEMATICS	9

Robot kinematics: Introduction- Matrix representation- rigid motion and homogeneous transformation- D-H, forward and inverse kinematics of 2DOF and 3 DOF planar and spatial mechanisms.

UNIT III	ROBOT DYNAMICS	9

Introduction - Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation.

UNIT IV	TRAJECTORY, PATH PLANNING AND PROGRAMMING	9

Trajectory Planning- Joint space and Cartesian space technique, Introduction to robot control, Robot programming and Languages- Introduction to ROS.

UNIT V	ROBOT AND ROBOT APPLICATIONS	9

Sensors and Actuators for Robots, Power transmission systems, Rotary to rotary motion, Rotary to linear motion, Harmonics drives – gear system - belt drives. Robot end effectors and

Grippers: Introduction- types and classification- Mechanical gripper- gripper force analysis- other types and special purpose grippers. Robot Applications: pick and place, manufacturing, automotive, medical, space and underwater.	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the basic concepts and terminologies of robots.
CO2	Summarize the Procedures for Forward and Inverse Kinematics, Dynamics for various Robots.
CO3	Interpret the Forward and Inverse Kinematics, Dynamics for Various Robots.
CO4	Apply the various programming techniques in industrial applications.
CO5	Illustrate the types and functions of sensors and actuators in robots to understand their role in robotic systems.
CO6	Explain robot applications and end effectors to interpret their use in various fields.
TEXT BOOKS:	
1	John.J.Craig, " Introduction to Robotics: Mechanics and control", Pearson Publication, Fourth edition, 2018.
2	K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision and Intelligence", Tata McGraw-Hill Publication, First Edition, 1987.
REFERENCES:	
1	M.P.Groover, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata, McGraw-Hill Education Pvt. Limited 2nd Edition, 2012.
2	Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer, 2nd Edition, 2010.
3	S K Saha, Introduction to Robotics, Tata McGraw-Hill, ISBN: 9789332902800, Second Edition, 9789332902800.

4	Sathya Ranjan Deb, "Robotics Technology and flexible Automation" Second edition, Tata McGraw-Hill Publication, 2009.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
5	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	-	1	1	-	1	-	-	-	-	3	1	1

<table>
<tr><td rowspan="2">23ME061</td><td colspan="2" rowspan="2">DIGITAL TWIN AND INDUSTRY 5.0</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">To understand the basics concepts in digital twin.
To introduce the concepts in digital twin in a discrete Industry.
To introduce the concepts in digital twin in a process Industry.
To obtain the knowledge in industry 5.0
To know about the advantages in industry 5.0</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="7">Digital twin – Definition, types of Industry and its key requirements, Importance, Application of Digital Twin in process, product, service industries, History of Digital Twin, DTT role in industry innovation, Technologies/tools enabling Digital Twin – Virtual CAD Models – control Parameters- Real time systems – control Parameters – Handshaking Through Internet – cyber physical systems.</td></tr>
<tr><td>UNIT II</td><td colspan="5">DIGITAL TWIN IN A DISCRETE INDUSTRY</td><td>9</td></tr>
<tr><td colspan="7">Basics of Discrete Industry, Trends in the discrete industry, control system requirements in a discrete industry, Digital Twin of a Product, Digital Thread in Discrete Industry, Data collection and analysis for product and production improvements, Automation simulation, Digital Enterprise.</td></tr>
<tr><td>UNIT III</td><td colspan="5">DIGITAL TWIN IN A PROCESS INDUSTRY</td><td>9</td></tr>
<tr><td colspan="7">Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise.</td></tr>
</table>

UNIT IV	**INDUSTRY 5.0**	**9**
Industrial Revolutions, Industry 5.0 – Definition, principles, Application of Industry 5.0 in process and discrete industries, Benefits of Industry 5.0, challenges in Industry 5.0, Smart manufacturing, Internet of Things 5.0, Industrial Gateways, Basics of Communication requirements – cognitive systems 5.0.		
UNIT V	**ADVANTAGES OF DIGITAL TWIN**	**9**
Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
	After completion of the course, the students will be able to	
CO1	Apply the basics concepts in digital twin.	
CO2	Explain the concepts in digital twin in a discrete Industry.	
CO3	Summarize the knowledge in industry 5.0.	
CO4	Interpret the benefits of digital twin technology.	
CO5	Explain the benefits of digital twin technology.	
CO6	Explain digital twins to enhance production processes.	
TEXT BOOKS:		
1	Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2018.	
2	Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019.	
REFERENCES:		
1	Uthayan Elangovan,” Industry 5.0: The Future of the Industrial Economy”, CRC Press, 2022.	

2	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress., United States, 2015.
3	Christoph Jan Bartodziej, "The Concept Industry 4.0 an Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler., Germany, 2017.
4	Ibrahim Garbie, "Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0", Springer., Switzerland, 2016.
5	Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.
6	Ulrich Sendler, "The Internet of Things, Industries 4.0 Unleashed", Springer., Germany, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1
2	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
4	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
5	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
6	2	1	-	-	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	3	2	1	1	1	1	-	1	-	-	-	-	3	1	1

23MT031	ROBOTS AND SYSTEMS IN SMART MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To get a knowledge of working on Industrial robots and their load handling capacity.
- To enlist with an application of robots in various operation.
- To familiar with a material handling system.
- To impart the knowledge on robotic welding.
- To obtain the knowledge on various type of robot welding operation.

UNIT I	INTRODUCTION	7

Types of industrial robots - Load handling capacity - general considerations in Robotic material handling-material transfer - machine loading and unloading - CNC machine tool loading - Robot centered cell.

UNIT II	SELECTION OF ROBOTS AND OTHER APPLICATIONS	9

Factors influencing the choice of a robot - robot performance testing - economics of robotization - Impact of robot on industry and society. Application of Robots in continuous arc welding - Spot welding - Spray painting -assembly operation - cleaning - robot for underwater applications.

UNIT III	MATERIAL HANDLING	13

Concepts of material handling - principles and considerations in material handling systems design - conventional material handling systems - industrial trucks - monorails - rail guided vehicles - conveyor systems -cranes and hoists - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems (ASRS) - bar code technology - radio frequency identification technology -Introduction to Automation Plant design software.

UNIT IV	ROBOTIC WELDING	8
Robotic welding system, Programmable and flexible control facility –Introduction-Types- Flex Pendant-Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding.		
UNIT V	**APPLICATIONS OF ROBOTS IN WELDING AND ALLIED PROCESSES**	**8**
Application of robot in manufacturing: Exploration of practical application of robots in welding: Robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering – Applications in nuclear, aerospace and ship building, case studies for simple and complex applications.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the various concepts of Industrial Robot.
CO2	Apply the appropriate manufacturing procedure for Robots
CO3	Explain the various industrial applications of robots.
CO4	Explain the applications of robots in material handling.
CO5	Explain the concepts of robots for the Welding operation.
CO6	Construct the procedure of a manufacturing plan for developing a robot.

TEXT BOOKS:	
1	Richard D Klafter, Thomas Achmielewski, MickaelNegin , "Robotic Engineering – An integrated Approach", Prentice Hall India, New Delhi, 2006.
2	Mikell P Groover , "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, New York, 2019.

REFERENCES:

1	Pires J N, Loureiro A, Bolson G, "Welding Robots: Technology, System Issues and Application", Springer, London, 2010.
2	Parmar R S , "Welding Processes and Technology", Khanna Publishers, New Delhi, 2nd Edition, 2013.
3	John A. Piotrowski, William T. Randolph, "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987.
4	Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, Ashish Dutta "Industrial Robotics (SIE): Technology, Programming and Applications", 2nd Edition, McGraw Hill Education India Pvt Ltd, 2012.
5	Yoram Koren , "Robotics for Engineers", McGraw-Hill, 1987.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
2	3	2	1	1	-	-	-	3	-	-	-	3	3	2	3
3	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
4	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
5	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
6	3	2	1	1	-	-	-	3	-	-	-	3	3	2	3
Overall Correlation	2	1	1	1	-	-	-	2	-	-	-	2	2	2	2

<table>
<tr><td rowspan="2">23MT033</td><td rowspan="2">AGRICULTURAL ROBOTICS AND AUTOMATION</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To learn about Farming-related Machines.
• To understand the global position and information system in machines.
• To know about traction and testing.
• To familiarize the concept on weed management.
• To learn about machinery selection.</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="6">History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, Planting Cultivation, and Harvesting, Agricultural Automation - Agricultural Vehicle Robot.</td></tr>
<tr><td>UNIT II</td><td colspan="4">PRECISION AGRICULTURE</td><td>9</td></tr>
<tr><td colspan="6">Sensors – types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks.</td></tr>
<tr><td>UNIT III</td><td colspan="4">TRACTION</td><td>9</td></tr>
<tr><td colspan="6">Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches, Tires and Traction models, Traction predictor spread sheet, Soil Compaction, Traction Aids, Tractor Testing.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">SOIL TILLAGE AND WEED MANAGEMENT</td><td>9</td></tr>
<tr><td colspan="6">Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements, Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation.</td></tr>
<tr><td>UNIT V</td><td colspan="4">MACHINERY SELECTION</td><td>9</td></tr>
<tr><td colspan="6">Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage</td></tr>
</table>

Blowers and Miscellaneous Conveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements, Machinery Costs.	
	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
After completion of the course, the students will be able to	
CO1	Explain the fundamental concepts of mechanizing robots in agricultural automation.
CO2	Illustrate sensor and system for a required specific process in agricultural applications.
CO3	Explain traction system for agricultural robots.
CO4	Explain the methods, performance and equipment mechanics of soil tillage.
CO5	Explain the concepts of weed management cropping and cultivation system.
CO6	Develop suitable robotic system for specific agricultural tasks.
TEXT BOOKS:	
1	Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.
2	Myer Kutz , "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2019.
REFERENCES:	
1	Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.
2	Stephen L Young, Francis J. Pierce, "Automation: The Future of Weed Control in Cropping Systems", Springer, Dordrecht Heidelberg New York London, 2014.
3	R.A. Kepner, Roy Bainer, E.L. Barger, "Principles of Farm Machinery", 3rd Edition, CBS Publishers, New Delhi, 2005.
4	Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition, CRC Press, 2021.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
2	2	1	-	-	-	-	-	3	-	-	-	2	2	2	3
3	2	1	-	-	-	-	-	2	-	-	-	2	2	2	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	2	2
5	2	1	-	-	-	-	-	2	-	-	-	2	2	2	3
6	3	2	1	1	-	-	-	3	-	-	-	2	2	2	2
Overall Correlation	3	2	1	1	-	-	-	2	-	-	-	2	2	2	3

23MT065	TOTAL INTEGRATED AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To gain knowledge in automation in industries.
- To gain knowledge in various electrical and electronic programmable automations and their applications.
- To know about the basic in SCADA and DCS systems.
- To gain knowledge in communication protocols in an integrated system
- To know about the advanced in automation industries

UNIT I	TOTALLY INTEGRATED AUTOMATION	9

Need, components of TIA systems, advantages, Programmable Automation Controllers (PAC), Vertical Integration structure.

UNIT II	HUMAN MACHINE INTERFACE (HMI)	9

Necessity and Role in Industrial Automation, Need for HMI systems. Types of HMI- Text display - operator panels - Touch panels - Panel PCs - Integrated displays (PLC & HMI).

UNIT III	SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)	9

Overview – Dev eloper and runtime packages – architecture – Tools – Tag – Internal &External graphics, Alarm logging – Tag logging – structured tags– Trends – history– Report generation, VB & C Scripts for SCADA application.

UNIT IV	COMMUNICATION PROTOCOLS OF SCADA	9

Proprietary and open Protocols – OLE/OPC- UPC UA/DA – DDE – server/Client Configuration – Messaging – Recipe – User administration – Interfacing of SCADA with PLC, drive, and other field device.

UNIT V	DISTRIBUTED CONTROL SYSTEMS (DCS)	9

DCS – architecture – local control unit- programming language – communication facilities – operator interface – engineering interfaces. APPLICATIONS OF PLC & DCS: Case studies of

Machine automation, Process automation, Introduction to SCADA Comparison between SCADA and DCS.
TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Explain the concepts of totally integrated system.
CO2	Explain Human Machine Interface systems.
CO3	Apply concepts of SCADA and C programming for report generation.
CO4	Explain the information's on communication protocols in automation systems.
CO5	Develop the automatic control system using distributed control systems.
CO6	Explain the Distributed Control System.

TEXT BOOKS:

1	John. W. Webb& Ronald A. Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2009.
2	Michael P. Lukas, "Distributed Control systems", "Van Nostrand Reinfold Company"1995.

REFERENCES:

1	Win C C Software Manual, Siemens, 2003.
2	RS VIEW 32 Software Manual, Allen Bradly, 2005.
3	CIMPLICITY SCADA Packages Manual, Fanuc India Ltd, 2004.

Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
2	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
3	3	2	1	1	-	-	-	3	-	-	-	3	3	1	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
5	3	2	1	1	-	-	-	3	-	-	-	3	3	1	3
6	2	1	-	-	-	-	-	2	-	-	-	2	2	1	2
Overall Correlation	2	2	1	1	-	-	-	2	-	-	-	2	2	1	2

23MT401	SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the concepts of measurement technology.
- To learn the various sensors used to measure various physical parameters.
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.
- To learn about the optical, pressure and temperature sensor.
- To understand the signal conditioning and DAQ systems.

UNIT I	INTRODUCTION	9

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II	MOTION, PROXIMITY AND RANGING SENSORS	9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III	FORCE, MAGNETIC AND HEADING SENSORS	9

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV	OPTICAL, PRESSURE AND TEMPERATURE SENSORS	9

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber

optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.		
UNIT V	**SIGNAL CONDITIONING AND DAQ SYSTEMS**	**9**
Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi- channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1	Explain with various calibration techniques and signal types for sensors.
CO2	Explain the concepts, working principle and motion, proximity and ranging sensor.
CO3	Explain the fundamental concepts of force, magnetic and heading sensors.
CO4	Apply the photo conductive, voltaic and resistive concepts in optical and pressure sensors.
CO5	Explain the concepts of various types of temperature sensors and its application.
CO6	Apply the concepts of signal conditioning and DAQ system for various industrial applications.

TEXT BOOKS:

1	Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009.
2	Sawney A K and Puneet Sawney, "A Course in Mechanical measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES:

1	C. Sujatha Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2	Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3	John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4	Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3
2	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3
3	3	2	1	1	1	1	-	2	-	-	-	2	2	1	3
4	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3
5	3	2	1	1	1	1	-	2	-	-	-	2	2	1	3
6	2	2	1	1	1	1	-	2	-	-	-	2	2	1	3
Overall Correlation	2	1	-	-	-	-	-	2	-	-	-	2	2	1	3