Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
Udumalai Road, Pollachi, Coimbatore District - 642003
Established in 1998 ♦ Approved by AICTE ♦ Affiliated to Anna University
(A DIVISION OF NIA EDUCATIONAL INSTITUTIONS)

An Autonomous Institution
Since 2011

NAAC A++ GRADE
Cycle 3 (2023-2030)
The Highest Grade

Curriculum and Syllabi

Semesters I to VIII

Regulations 2023

Programme: B.E. Mechanical Engineering
Curriculum and Syllabi: Semester I toVIII
Recommended by Board of Studies on:
Approved by Academic Council on:

Action	**Responsibility**	**Signature of Authorized Signatory**
Designed and Developed By		
Compiled By	Office of Controller of Examination	
Approved By	Principal	

Dr. Mahalingam College of Engineering and Technology, Pollachi – 642003.

(An autonomous institution approved by AICTE and affiliated to Anna University)

Department of Mechanical Engineering

Vision

To transform students from background into professional leaders of tomorrow in the field of mechanical engineering with strong sense of social commitment.

Mission

- To impart quality –engineering education leading to specialization in the emerging areas of CAD/CAM/CAE, Energy Engineering and Materials Technology.

- To provide continually updated and intellectually stimulating environment to pursue research and consultancy activities.

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Programme Educational Objectives (PEOs)

B.E. Mechanical Engineering graduates will:

PEO1.Technical Expertise: Actively apply technical and professional skills in engineering practices towards the progress of the organization or the entrepreneurial venture in competitive and dynamic environment.

PEO2.Lifelong Learning: Own their professional and personal development by continuous learning and apply the learning at work to create new knowledge.

PEO3.Ethical Knowledge: Conduct themselves in a responsible, professional and ethical manner supporting sustainable economic development which enhances the quality of life.

Programme Outcomes (POs)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: 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.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: 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.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: 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.

11. Project management and finance: 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.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs)

On successful completion of B.E. Mechanical Engineering programme, graduating students/graduates will be able to:

PSO 1: Demonstrate functional competencies for roles in design, manufacturing and service by learning through centers of excellence and industrial exposure.

PSO 2: Demonstrate behavioural competencies required for roles in design, manufacturing and service by learning through structured professional skills training.

Dr. Mahalingam College of Technology, Pollachi

2023 Regulations - Course Code Generation Procedure for UG Courses

Regulation

Mode of Assessment	
Character Type – Number	
T	Theory
I	Theory with Practical
L	Practical Practical with Theory
E	Elective
O	Open Elective
P	Project
S	Skill Development Course/Internship
C	Customized

Semester Number	
Character Type – Number	
1 to 8	Semester
0	Floating

Sequence Number
Character Type – Number
01, 02, 03, . . . , 99

1	2	3	4	5	6	7	8
2	3	A	U	X	X	0	1

Board/Department/Programme/Course Type			
Character Type – Alphabet			
AD	Artificial Intelligence & Data Science	**ME**	Mechanical
AM	CSE (Artificial Intelligence & Machine Learning)	**SC**	CSE (Cyber Security)
AU	Automobile	**PH**	Physics
CE	Civil	**CH**	Chemistry
CS	Computer Science	**EN**	English
EA	Advanced Communication Technology	**MA**	Mathematics
EC	Electronics and Communication	**ES**	Employability Skills
EE	Electrical and Electronics	**VA**	Value Added Course
EV	VLSI Design & Technology	**SA**	Studio Activities
IT	Information Technology		

Programme: B.E. Mechanical Engineering
2023 Regulations (2023 batch only)

Course Category	Course Code	Course Title	Duration	Credits	Marks
VAC	23VAL101	Induction Program	3 Weeks	-	100

Semester I

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
AEC	23ENI101	Communication Skills I	2	0	2	3	100	All
Minor	23MAI102	Matrices and Calculus	3	0	2	4	100	AU, EA, EC,EE, EV, ME
Minor	23PHT102	Physics for Mechanical Sciences	3	0	0	3	100	AU,ME
Multi-disciplinary	23ADT101	Python Programming for Mechanical Sciences	3	0	0	3	100	AU,ME
Major	23MEL001	Engineering Drawing	1	0	3	2.5	100	AD, AM, AU, CS, EA ,EC, EE, EV,IT,ME, SC
Minor	23PHL102	Physics for Mechanical Sciences Laboratory	0	0	3	1.5	100	AU,ME
Multi-disciplinary	23ADL101	Python Programming Laboratory for Mechanical Sciences	0	0	3	1.5	100	AU,ME
VAC	23VAL102	Wellness for Students	0	0	2	1	100	All
VAC	23VAT101	தமிழர்மரபு / Heritage of Tamils	1	0	0	1	100	All
AEC	23SAL101	Studio Activities	0	0	2	-	-	All
		Total	**13**	**0**	**17**	**20.5**	**900**	

Semester II

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
AEC	23ENI201/ 23FLT201/ 23FLT202	Communication Skills II/ Foreign Language-Japanese/ Foreign Language-German	2	0	2	3	100	All
Minor	23MAI202	Complex Variables and Transforms	3	0	2	4	100	AU,EC,EE,EV, ME
Minor	23CHT201	Chemistry for Mechanical Sciences	3	0	0	3	100	AU,ME
Major	23MEI201	Engineering Materials	3	0	2	4	100	AU,ME
Major	23MEL201	Computer Aided Drafting and Modelling Laboratory	1	0	3	2.5	100	AU,ME
Minor	23CHL201	Chemistry for Mechanical Sciences Laboratory	0	0	3	1.5	100	AU,ME
SEC	23MEL202	Engineering Practices Laboratory	0	0	3	1.5	100	AU,CE,ME
SEC	23ESL201	Professional Skills 1: Problem solving skills & Logical Thinking 1	0	0	2	1	100	All
VAC	23VAT201	தமிழரும்தொழில்நுட்பமும்/ Tamils and Technology	1	0	0	1	100	All
Multi-disciplinary	23CHT202	Environmental Sciences	1	0	0	-	100	All
AEC	23SAL201	Studio Activities	0	0	2	-	-	All
		Total	**14**	**0**	**19**	**21.5**	**1000**	

Programme: B.E. Mechanical Engineering

2023 Regulations (2024 batch onwards)

Course Category	Course Code	Course Title	Duration	Credits	Marks
VAC	23VAL101	Induction Program	3 Weeks	-	100

Semester I

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
AEC	23ENI101	Communication Skills I	2	0	2	3	100	All
Minor	23MAI102	Matrices and Calculus	3	0	2	4	100	AU,EA,EC,EE, EV, ME
Minor	23PHT102	Physics for Mechanical Sciences	3	0	0	3	100	AU,ME
Multi-disciplinary	23ADT101	Python Programming for Mechanical Sciences	3	0	0	3	100	AU,ME
Major	23MEL002	Engineering Graphics and Design	1	0	3	2.5	100	AU,ME
Minor	23PHL102	Physics for Mechanical Sciences Laboratory	0	0	3	1.5	100	AU,ME
Multi-disciplinary	23ADL101	Python Programming Laboratory for Mechanical Sciences	0	0	3	1.5	100	AU,ME
VAC	23VAL102	Wellness for Students	0	0	2	1	100	All
VAC	23VAT101	தமிழர்மரபு / Heritage of Tamils	1	0	0	1	100	All
AEC	23SAL101	Studio Activities	0	0	2	-	-	All
		Total	**13**	**0**	**17**	**20.5**	**900**	

Semester II

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
AEC	23ENI201/ 23FLT201/ 23FLT202	Communication Skills II/ Foreign Language - Japanese/ Foreign Language-German	2	0	2	3	100	All
Minor	23MAI202	Complex Variables and Transforms	3	0	2	4	100	AU,EC,EE,EV,ME
Minor	23CHT201	Chemistry for Mechanical Sciences	3	0	0	3	100	AU,ME
Major	23MEI201	Engineering Materials	3	0	2	4	100	AU,ME
Major	23MEL201	Computer Aided Drafting and Modelling Laboratory	1	0	3	2.5	100	AU,ME
Minor	23CHL201	Chemistry for Mechanical Sciences Laboratory	0	0	3	1.5	100	AU,ME
SEC	23MEL202	Engineering Practices Laboratory	0	0	3	1.5	100	AU,CE,ME
SEC	23ESL201	Professional Skills 1: Problem solving skills & Logical Thinking 1	0	0	2	1	100	All
VAC	23VAT201	தமிழரும்தொழில் நுட்பமும்/ Tamils and Technology	1	0	0	1	100	All
Multi-disciplinary	23CHT202	Environmental Sciences	1	0	0	-	100	All
AEC	23SAL201	Studio Activities	0	0	2	-	-	All
		Total	**14**	**0**	**19**	**21.5**	**1000**	

Semester III

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
Minor	23MAT302	Numerical Methods	3	1	0	4	100	AU,ME
Major	23MET301	Engineering Mechanics	2	1	0	3	100	AU,ME
Major	23MEI301	Engineering Thermodynamics	2	0	2	3	100	-
Major	23MET302	Fluid Mechanics and Hydraulics Machinery	2	1	0	3	100	AU,ME
Major	23MET303	Manufacturing Processes	3	0	0	3	100	AU,ME
Major	23MEL301	Manufacturing Processes Laboratory	0	0	3	1.5	100	AU,ME
Major	23MEL302	Fluid Mechanics and Hydraulics Machinery Laboratory	0	0	3	1.5	100	All
SEC	23ESL301	Professional Skills 2:Problem Solving Skills& Logical Thinking2	0	0	2	1	100	-
VAC	23VAT301	Universal Human Values 2: Understanding Harmony	2	1	0	3	100	-
AEC	23SAL301	Studio Activities	0	0	2	-	-	All
	Total		**15**	**4**	**12**	**23**	**900**	

Semester IV

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
Minor	23MAT401	Probability and Statistics	3	1	0	4	100	AU,ME
Major	23MET401	Strength of Materials	3	0	0	3	100	AU,ME
Major	23MET402	Mechanics of Machinery	3	1	0	4	100	AU,ME
Major	23MET403	Design Thinking	3	0	0	3	100	-
Major	23MEI401	Metrology and Measurements	2	0	2	3	100	-
Major	23MEL401	Strength of Materials & Mechanics of Machinery Laboratory	0	0	3	1.5	100	AU,ME
Major	23MEL402	Computer Aided Machine Drawing Laboratory	0	0	3	1.5	100	All
SEC	23ESL401	Professional Skills 3 : Professional Development and Etiquette	0	0	2	1	100	-
AEC	23SAL401	Studio Activities	0	0	2	-	-	All
	Total		**14**	**2**	**12**	**21**	**800**	

Course Category	Course Code	Course Title	Duration	Credits	Marks	Common to Programmes
SEC	23XXXXXX	Internship - 1/ Community Internship/Skill Development	2 Weeks - 4 Weeks	1	100	-

Semester V

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
Major	23MEI501	Heat and Mass Transfer	3	0	2	4	100	-
Major	23MET501	Design of Machine Elements	3	1	0	4	100	-
Major	23MET502	Finite Element Analysis	3	1	0	4	100	AU,ME
Major	23XXXXX	Professional Elective - I	3	0	0	3	100	-
Major	23XXXXX	Professional Elective - II	3	0	0	3	100	-
Major	23MEL501	Simulation and Analysis Laboratory	0	0	3	1.5	100	AU,ME
SEC	23ESL501	Professional Skills 4: Communication Skills and Interview Essentials	0	0	2	1	100	-
Project	23MEP501	Reverse Engineering Project	0	0	6	3	100	-
AEC	23SAL501	Studio Activities	0	0	2	-	-	All
		Total	**14**	**3**	**15**	**22.5**	**800**	

Semester VI

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
Major	23MET601	Design of Transmission Systems	2	1	0	3	100	-
Minor	23MET602	Data Science and Machine Learning	3	0	0	3	100	-
Minor	23MET603	Electrical and Electronics Engineering	3	0	0	3	100	-
Major	23XXXXX	Professional Elective - III	3	0	0	3	100	-
Major	23XXXXX	Professional Elective-IV	3	0	0	3	100	-
Minor	23XXXXX	Open Elective - I	3	0	0	3	100	
Minor	23MEL601	Electrical and Electronics Laboratory	0	0	3	1.5	100	-
SEC	23ESL601	Professional Skills 5: Ace and Elevate : Aptitude and Soft Skills	0	0	2	1	100	All
AEC	23SAL601	Studio Activities	0	0	2	-	-	All
	Total		**17**	**1**	**7**	**20.5**	**800**	

Course Category	Course Code	Course Title	Duration	Credits	Marks
SEC	23XXXXXX	Internship - 2/ Research Internship/ Skill Development	2 Weeks - 4 Weeks	1	100

Semester VII

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
Major	23MEI701	Mechatronics	3	0	2	4	100	-
Major	23MET701	Electric Vehicles	3	0	0	3	100	-
Major	23MEI702	CNC programming & Robotics	3	0	2	4	100	
Major	23XXXXX	Professional Elective- V	3	0	0	3	100	
Major	23XXXXX	Professional Elective- VI	3	0	0	3	100	-
Multi-disciplinary	23XXXXX	Open Elective-II	3	0	0	3	100	-
Project	23MEP701	Project Phase-I	0	0	8	4	100	-
		Total	**18**	**0**	**12**	**24**	**700**	

Semester VIII

Course Category	Course Code	Course Title	Hours/Week L	T	P	Credits	Marks	Common to Programmes
Major	23MEP801	Project Phase - II	0	0	12	6	200	-
SEC	23XXXXX	Internship or Skill Development*	8 weeks			4	100	-
		Total	**0**	**0**	**12**	**10**	**300**	-

Total Credits: 165

Course Code	Course Title	Hours / Week			Credits	Marks	Common to Programmes
		L	T	P			
VERTICAL I PRODUCT DEVELOPMENT ELECTIVES							
23MEE001	Rapid Prototyping and Tooling	3	0	0	3	100	
23MEE002	Vibration and Noise Engineering	3	0	0	3	100	
23MEE003	Mechanical System Design	3	0	0	3	100	
23MEE004	Design for Sheet Metal	3	0	0	3	100	
23MEE005	Design for Welding	3	0	0	3	100	
23MEE006	Reverse Engineering	3	0	0	3	100	
23MEE007	Mechanical Engineering Design and Automation	2	0	2	3	100	
23MEE008	PLM for Engineers	2	0	2	3	100	
VERTICAL II MANUFACTURING ELECTIVES							
23MEE009	Additive Manufacturing	3	0	0	3	100	
23MEE010	Process Planning and Cost Estimation	3	0	0	3	100	
23MEE011	Advanced Manufacturing Processes	3	0	0	3	100	
23MEE012	Lean Manufacturing	3	0	0	3	100	
23MEE013	Manufacturing Systems Engineering	3	0	0	3	100	
23MEE014	Sustainable Manufacturing	3	0	0	3	100	
23MEE015	Engineering Economics and Cost Analysis	3	0	0	3	100	
23MEE016	Composite Materials	3	0	0	3	100	
VERTICAL III ENERGY ELECTIVES							
23MEE017	Energy conservation in industry	3	0	0	3	100	
23MEE018	Power Plant Engineering	3	0	0	3	100	
23MEE019	Gas Dynamics and Space Propulsion	3	0	0	3	100	
23MEE020	Computational Techniques for Fluid Dynamics	3	0	0	3	100	
23MEE021	Energy Storage Devices	3	0	0	3	100	
23MEE022	Solar and Wind Energy Engineering	3	0	0	3	100	
23MEE023	Alternative Fuels And Energy Systems	3	0	0	3	100	
23MEE024	Refrigeration and Air-Conditioning	3	0	0	3	100	

Course Code	Course Title	Hours /Week			Credits	Marks	Common to Programmes
		L	T	P			
VERTICAL IV QUALITY SYSTEMS ELECTIVES							
23MEE025	Non Destructive Testing Methods	3	0	0	3	100	ME,AU
23MEE026	Geometric Dimensioning & Tolerancing for Mechanical Design	3	0	0	3	100	
23MEE027	Operations Research	3	0	0	3	100	
23MEE028	Total Productive Maintenance	3	0	0	3	100	
23MEE029	Quality Engineering	3	0	0	3	100	
23MEE030	Principles of Management	3	0	0	3	100	
23MEE031	Lean Six sigma	3	0	0	3	100	
23MEE032	Industrial Safety Management	3	0	0	3	100	
VERTICAL V E-MOBILITY ELECTIVES							
23AUE030	Electric Vehicle Powertrains	3	0	0	3	100	ME,AU
23AUE032	Electric Vehicle Architecture	3	0	0	3	100	ME,AU
23AUE033	Electric Vehicle Mechanics and Control	3	0	0	3	100	ME,AU
23AUE034	Testing of Electric Vehicles	3	0	0	3	100	ME,AU
23AUE035	Intelligent Control of Electric Vehicles	3	0	0	3	100	ME,AU
23AUE036	Electric Vehicle Charging System	3	0	0	3	100	ME,AU
23AUE031	Electric Vehicle Battery Technology	3	0	0	3	100	ME,AU
VERTICAL VI AUTOMATION ELECTIVES							
23MEE033	Industrial IoT	3	0	0	3	100	ME,AU
23MEE034	Industry 4.0 – Smart Factories	3	0	0	3	100	
23MEE035	Fluid power system	3	0	0	3	100	

23MEE037	Flexible Manufacturing Systems	3	0	0	3	100	
23MEE038	Computer Integrated Manufacturing	3	0	0	3	100	ME,AU
23MEE040	Logistics Engineering	3	0	0	3	100	ME,AU
DIVERSIFIED COURSES I ELECTIVES							
23MEE041	Automobile Engineering	3	0	0	3	100	
23MEE042	Java Programming for Mechanical Sciences	3	0	0	3	100	ME,AU
23SCE050	Cyber Security	3	0	0	3	100	
23MEE044	Data Structures and Object Oriented Programming with C++	3	0	0	3	100	ME,AU
23MEE045	Automotive Engine and Its Systems	3	0	0	3	100	
23MEE046	Augmented Reality/Virtual Reality	3	0	0	3	100	
23MEE047	Industrial Engineering	3	0	0	3	100	
23AUE007	Electronic Steering System	3	0	0	3	100	ME,AU
23ITE047	Intellectual Property Rights	3	0	0	3	100	ALL
23AUE051	Design Thinking and Innovation	3	0	0	3	100	ALL
23AUE050	Entrepreneurship Development	3	0	0	3	100	ALL
23AUE006	Design for Manufacture, Assembly and Environment	3	0	0	3	100	ME,AU

OPEN ELECTIVES

Course Code	Course Title	Hours/Week			Credits	Marks	
		L	T	P			
23MEO001	Industrial Automation and Robotics	3	0	0	3	100	
23MEO002	Total Quality Management	3	0	0	3	100	
23MEO003	Industrial Safety Engineering	3	0	0	3	100	
23MEO004	Renewable Sources of Energy	3	0	0	3	100	

SEMESTER 1

Course Code:23VAL101		Course Title: INDUCTION PROGRAM (Common to all B.E/B.Tech Programmes)
Course Category: VAC		Course Level: Introductory
Duration: 3 weeks	Mandatory Non-Credit Course	Max Marks:100

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Explain various sources available to meet the needs of self, such as personal items andlearning resources
2. Explain various career opportunities, opportunity for growth of self and avenues available in the campus
3. Explain the opportunity available for professional development
4. Build universal human values and bonding amongst all the inmates of the campus and the society.

List of Activities:

1. History of Institution and Management: Overview on NIA Educational Institutions – Growth of MCET – Examination Process –OBE Practices –Code of Conduct – Centre ofExcellence.
2. Lectures, interaction sessions and Motivational Talks by Eminent people, Alumni, Employer and Industry Experts
3. Familiarisation of Department / Branch:HoD's & Senior Interaction- Department Associatio
4. Universal Human Value Modules : Aspirations and concerns, Self Management, Relations Social and Natural Environment.
5. Orientation on Professional Skills Courses
6. Proficiency Modules : Mathematics, English, Physics and Chemistry
7. Introduction to various Chapters, Cells, Clubs and its events
8. Creative Arts : Painting, Music and Dance
9. Physical Activity :Games, Sports and Yoga
10. Group Visits: Visit to local area and Campus Tour

Course Outcomes	Cognitive Leve
At the end of this course, students will be able to:	
CO1 : Explain various sources available to meet the needs of self, such as personal items and learning resources through visit to local areas and campus	Understand
CO2: Explain various career opportunities and avenues available in the campus through orientation sessions	Understand
CO3: Explain the opportunity available for professional development through professional skills, curricular, co-curricular and extracurricular activities	Understand
CO4: Build universal human values and bonding amongst all the inmates of the campus and society for having a better life	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO2	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO3	1	-	-	-	-	-	-	2	1	2	-	-	-	-
CO4	2	-	-	-	-	-	-	2	1	2	-	-	-	-

High : 3, Medium :2, Low: 1

Text Book(s):

T1. Reading material, Workbook prepared by PS team of the college

Reference Book(s):

R1. Sean Covey, “Seven habits of highly effective teenagers”, Simon & Schuster Uk, 2004.

R2. Vethathiri Maharishi Institute For Spiritual and Intuitional Education, aliyar, “value educat harmonious life (Manavalakalai Yoga)”, Vethathri Publications, Erode, 2010.

R3. Dr.R.Nagarathna, Dr.H.R. Nagendra, “ Integrated approach of yoga therapy for positive Swami Vivekananada Yoga Prakashana Bangalore,2008 Ed.

Web References:

1. https://youtube.com/playlist?list=PLYwzG2fd7hzc4HerTNkc3pS_IvcCfKznV
2. https://www.youtube.com/watch?v=P4vjfEVk&list=PLWDeKF97v9SO0frdgmpaghDMjkom1
3. https://fdp-si.aicte-india.org/download/AboutSIP/About%20SIP.pdf

<table>
<tr><td>Course Code: 23ENI101</td><td colspan="3">Course Title: COMMUNICATION SKILLS I
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="2">Course Category: AEC</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week) 2:0:2</td><td>Credits: 3</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Course Objectives

The course is intended to impart formal and informal language effectively and accurately in various real-life contexts on par with B1 level of CEFR Scale.

Module I **20 Hours**

Grammar: Synonyms & Antonyms -Tense forms - Modals - Passives – Reported Speech – Comparatives and Descriptive adjectives.

Listening: Listening for gist and specific information - Listening to past events, experiences and job preferences - Listening to descriptions of monuments - Listening for excuses - Listening to description: transportation systems and public places.

Speaking: Introducing oneself - Exchanging personal information — Effective Conversations: Role Play Situations (Describing personality traits - Describing landmarks, monuments and festivals - Making polite requests and excuses - Discussing facts - Asking for and giving information — Expressing wishes - Talking about lifestyle changes - Talking about transportation and its problems - Describing positive and negative features of things and places - Making comparisons)

Reading: Skimming and Scanning - Reading Comprehension - Reading and comprehending online posts and emails – Case Studies

Writing: Letter writing (Permission letters - Online cover letter for job applications) - Instructions - Recommendations - Write a blog (General) - Report Writing (Industrial Visit Report and Event Reports) - formal and informal emails.

Module II **20 Hours**

Grammar: Sequence adverbs - Phrasal verbs - Relative clauses – Imperatives - Infinitives - Conditionals.

Listening: Listening to review of food items - Listening to results of surveys- Listening to motivational talks & podcasts

Speaking: Expressing likes and dislikes - Describing a favourite snack - Giving advices and suggestions - Speculating about past and future Events – Group Discussion

Reading: Reading different expository texts - Reading to factual texts - Print and online media- Reading Comprehension

Writing: Process Descriptions – Email Writing (Requesting for information) - Reviewing Movie – Social media feeds/posts (Any Social Media)

List of Experiments: **20 Hours**

1. Mini Presentation and Picture Prompt Discussion
2. Debate Tournament
3. Listening, Mind Mapping & Summarization
4. Listening to Stories and Providing the Innovative Climax
5. Reading Comprehension
6. Writing - Interpretation of Visuals

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO 1 : Utilize the basic English grammar and vocabulary to acquire professional communication skills.	Apply
CO 2 : Develop listening and speaking skills through classroom activities based on listening comprehension, recapitulation, interpretation and debate on the same	Apply
CO 3 : Read and write social media posts and comments	Apply
CO 4 : Perform as a member of a team and engage in individual presentation	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-

High-3; Medium-2;Low-1

Textbooks:

T1. Jack C. Richards, Jonathan Hull, and Susan Proctor, “Interchange - Student’s book 2”, 5^{th}Edition, Cambridge University Press, South Asia Edition, 2022.

T2. Jack C. Richards, Jonathan Hull, and Susan Proctor, “Interchange - Student’s Book 1”, 5^{th}Edition, Cambridge University Press, South Asia Edition, 2022.

Reference Book(s):

R1. David Bohlke, Jack C. Richards, “Four Corners”, 2^{nd} Edition, Cambridge University Press,2018.

R2. Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis-Jones, Graham Burton,Empower B1 – Student’s Book, Cambridge University Press, 2020.

R3. Raymond Murphy, “Intermediate English Grammar” 30^{th} Edition, Cambridge University Press,2022.

Web References:

1. https://speakandimprove.com/
2. https://writeandimprove.com/
3. https://www.cambridgeenglish.org/exams-and-tests/linguaskill/

Course Code: 23MAI102		Course Title: MATRICES AND CALCULUS (Common to AU, EA, EC, EE, EV & ME)	
Course Category: Minor		**Course Level: Introductory**	
L:T:P(Hours/Week) 3:0 :2	**Credits: 4**	**Total Contact Hours:75**	**Max Marks:100**

Course Objectives:
The course is intended to impart knowledge on the use of matrix algebra techniques for practical applications, familiarize with differential calculus and acquire knowledge of mathematical tools to evaluate multiple integrals.

Module I **23 Hours**

Matrices
Definitions and examples of symmetric, skew symmetric and orthogonal matrices - Eigenvalues and Eigenvectors – Properties of Eigenvalues and Eigenvectors-Diagonalization of matrices through orthogonal transformation - Cayley-Hamilton Theorem (without proof) – verification problems and properties - Transformation of quadratic forms to canonical forms through orthogonal transformation.

Differential and Integral Calculus
Curvature — Radius of curvature –Centre of curvature- Circle of curvature - Evolutes and Involutes - Evaluation of definite and improper integrals - Beta and Gamma functions — Properties and applications.

Multivariable Differentiation I
Limit — continuity - Mean value theorems and partial derivatives - Taylor’s series and Maclaurin’s series – Jacobian of functions of several variables.

Module II **22 Hours**

Multivariable Differentiation II
Maxima, Minima and saddle points of functions of several variables - Method of Lagrange’s multipliers.

Multiple Integral
Multiple Integration: Double integrals - Change of order of integration in double integrals - Change of variables (Cartesian to polar, Cartesian to spherical and Cartesian to cylindrical) - Triple integrals - Applications: Finding areas and volumes.

Ordinary Differential Equations Of Second and Higher Orders
Second and higher order linear differential equations with constant coefficients — Second order linear differential equations with variable coefficients (Cauchy - Euler equation, Legendre’s equation) — Method of variation of parameters — Solution of first order simultaneous linear ordinary differential equations

List of Experiments: **30 Hours**

1. Introduction to MATLAB.
2. Rank of matrix and solution of system of linear algebraic equations.
3. Finding Eigen values and Eigen vectors of a matrix.
4. Solving ordinary differential equation.
5. Gram Schmidt Procedure.
6. Finding Maxima, Minima of a function.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Determine the canonical form of a quadratic form using orthogonal transformation.	Apply
CO2: Identify the evolute of a curve and solve the improper integrals using beta gamma functions.	Apply
CO3: Examine the extreme value of multivariate functions.	Apply
CO4: Evaluate the area and volume using multiple integrals and solve the higher order differential equations.	Apply
CO5: Demonstrate the understanding of calculus concepts through modern tools.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Erwinkreyzig, Advanced Engineering Mathematics, 9th edition, John Wiley& Sons, 2006.

T2. Veerarajan T., Engineering Mathematics for first year, 3rd edition, Tata McGraw-Hill,

Reference Book(s):

R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9th edition, Pearson, Reprint, 2002.

R2. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

R3. P. Sivaramakrishna Das , C. Vijayakumari , Engineering Mathematics, Pearson India, 2017.

Web References:

1. https://nptel.ac.in/courses/111107112
2. https://nptel.ac.in/courses/111104031

Course Code: 23PHT102	Course Title: PHYSICS FOR MECHANICAL SCIENCES (Common to AU & ME)		
Course Category: Minor		Course Level: Introductory	
L:T:P(Hours/Week)3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to develop capacity to predict the effect of force and motion in the design functions of engineering and to impart knowledge on the fundamental concepts of heat transfer and applications of laws of thermodynamics.

Module I **22 Hours**

Basics of Mechanics: Classification of mechanics, Review of fundamental laws of mechanics — Physical quantities — scalars, vectors — Newton's law of mechanics, Gravitational law. Particles and rigid body, Resolution of forces in to components, Rectangular components of forces,-Free body diagram-principle of transmissibility-Resultant force-equilibrium conditions-equilibrium of particles subjected to coplanar and non-coplanar force system — equilibrium of particles subjected to coplanar system of forces - Triangle law, Parallelogram law and Lami's theorem.

Kinematics and Kinetics of Particles: Kinematic parameters – displacement, velocity, acceleration and time. Types of motion – uniform, non-uniform motion, motion of particles in a plane – Rectinlear and curvilinear motion of particles – motion of projectile. Kinetics of particles – Force and acceleration - D'Alembert's principle – Work energy, and impulse momentum method.

Elasticity: Introduction – Concept of Load, Stress and Strain – Hooke's law – Stress- Strain Diagram – Elastic and Plastic Materials – Factors affecting Elastic Properties – Three Moduli of Elasticity – Relation between Young's, Rigidity and Bulk moduli (Qualitative – No derivation) – Bending Moment of a Beam – Determination of Young's modulus using a Cantilever – Twisting Couple of a wire – Determination of Rigidity Modulus of a thin wire using Torsional Pendulum.

Module II **23 Hours**

Viscosity: Coefficient of Viscosity — Experimental determination of coefficient of viscosity: Poiseuille's method and Stoke's method.

Thermal Physics: Introduction – Modes of Heat Transfer – Thermal Conductivity – Newton's law of cooling – Specific Heat Capacity determination – Advantages and disadvantages of Newton's law of cooling method – Verification of Newton's law of cooling – Lee's disc method for the determination of thermal conductivity of a bad conductor – Conduction of Heat through a compound media : Bodies in both series andParallel.

Elements of Thermodynamics: Concept of temperature – heat – thermodynamics – work – heat in thermodynamics – comparison of heat and work – internal energy – first law of thermodynamics – applications of the first law– limitations of first law, second law of thermodynamics-Statements of second law – the Carnot cycle – heat engine – heat pump – refrigerators – third law of thermodynamics.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: **Apply** the basic concepts of mechanics and elastic properties of matter to solve the physical characteristics of an object using analytical problems.	Apply
CO2: Perform as a member of team in **analyzing** the recent advancements of mechanical engineering related to the concepts of basic mechanics, elasticity and make a presentation.	Apply
CO3: **Interpret** the concepts of viscosity, heat and thermodynamics and apply it for different real life applications.	Apply
CO4: Perform as a member of team in **articulating** the modern technologies behind the flow of fluids and different thermodynamic systems.	Apply

Course Articulation Matrix

CO PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	1	3	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	1	3	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. R. C. Hibbeller, “Engineering Mechanics: Combined Static and Dynamics”, Prentice Hall, 2010.

T2. M.N.Avadhanulu and P.G.Kshirsagar, “Text Book of Engineering Physics”, S. Chand & Company Ltd., New Delhi, 2018.

Reference Book(s):

R1. Balasubramaniam "Callister's Material Science and Engineering", John Wiley and Sons Inc., 2nd Edition, 2015.

R2. Yunus A Sengel, Michel A Boles, Thermodynamics: An Engineering Approach, MCGraw Hill, 9th Edition, 2017.

R3. P.K.Nag, Engineering Thermodynamics, MCGraw Hill, 6th Edition, 2017.

Web References:

1. http://www.physicsclassroom.com/class/thermal.
2. https://nptel.ac.in/courses/112105123
3. https://nptel.ac.in/courses/112106286

Course Code: 23ADT101		Course Title: PYTHON PROGRAMMING FOR MECHANICAL SCIENCES (Common to AU & ME)	
Course Category: Multidisciplinary		**Course Level: Introductory**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives:

The course is intended to provide the basic knowledge of Python. The course imparts the fundamentals concepts of python for writing the simple application.

Module I **22 Hours**

Computational Thinking and Problem Solving: Fundamentals of Computing — Identification of Computational Problems -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).

Data Types, Expressions, Statements: Python interpreter and interactive mode, debugging-values and data types –int, float, boolean, string and list – variables – expressions – statements

– tuple assignment – precedence of operators – comments

Control Flow : Conditionals: Boolean values and operators – conditional (if) – alternative (if- else) – chained conditional (if-elif-else) – Iteration: state, while, for, break, continue, pass

Module II **23 Hours**

Functions and Strings: Fruitful functions: return values – parameters – local and global scope — function composition — recursion — Strings: string slices — immutability — string functions and methods – string module– Lists as arrays

Lists, Tuples, Dictionaries: 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, Modules, Packages: Files and exception: text files – reading and writing files – format operator – command line arguments – errors and exceptions – handling exceptions – modules– packages

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Develop algorithmic solutions to simple computational problems including read, write and execute the simple python programs	Apply
CO2: Apply Python programming effectively, using variables, data types, functions, recursion, and file handling to solve practical problems and build functional applications	Apply
CO3: Decompose a python program into functions for reusability and easy debugging	Apply
CO 4: Represent compound data using python lists, tuples, dictionaries	Apply
CO 5: Manipulate the data from/to files in python programs.	Apply
CO 6: Utilize built-in packages for developing simple python application	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO6	-	-	-	-	-	-	-	3	3	-	3	3	3	3

High-3; Medium-2;Low-1

Text Book(s):

T1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.

T2. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, 2^{nd} edition, Updated for Python 3, Shroff/O‘Reilly Publishers, 2016

T3. Guido van Rossum and Fred L. Drake Jr, “An Introduction to Python – Revised and updated for Python 3.2”, Network Theory Ltd., 2011.

Reference Book(s):

R1. John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and expanded Edition, MIT Press , 2013

R2. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Interdisciplinary Approach”, Pearson India Education Services Pvt. Ltd., 2016.

Web References:

1. https://www.w3schools.com/python/
2. https://realpython.com/
3. https://nptel.ac.in/courses/106106145

<table>
<tr><td colspan="2">Course Code: 23MEL001</td><td colspan="2">Course Title: ENGINEERING DRAWING (2023 batch only)
(Common to AD,AM,AU,CS,EA ,EC,EE,EV,IT,ME, SC)</td></tr>
<tr><td colspan="2">Course Category: Major</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
1: 0: 3</td><td>Credits:2.5</td><td>Total Contact Hours: 60</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to

- To impart knowledge on basic dimensioning. 2D and 3 D drawings such as points, lines, planes and solids on first quadrant.

Module I **8 Hours**

Basics of Engineering Drawing: Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. Basic Geometrical constructions –Orthographic projection- Free hand Sketching.

Projection of Points, Lines: 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 and traces by rotating object method.

Projection of Solids: Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method. Practicing three dimensional modeling of simple objects by CAD Software (Not for examination).

Module II **7 Hours**

Sectioned Solids: Sectioning of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by cutting planes inclined to one reference plane and perpendicular to the other — Orthographic views of sections of simple solids.

Development of Surfaces: Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders using straight line and radial line method.

Isometric Projection: Principles of isometric projection — Isometric scale –Isometric projections of simple solids and truncated solids. Practicing three dimensional modeling of isometric projection of simple objects by CAD Software (Not for examination).

List of Experiments **45 Hours**

1. Lettering & Dimensioning
2. Projection of Points & Lines
3. Orthographic projections
4. Projection of Simple Solids
5. Projection of Section of Simple Solids
6. Development of Surfaces
7. Isometric Projections

Course Outcomes:

CO 1: Apply the concepts related to free hand sketching, orthographic and Isometricprojection in first quadrant.	Understand
CO2: Apply the concepts and draw projections of points in four different quadrants and lines located first quadrant.	Apply
CO3: Apply the concepts and draw projections and sections of simple solids using rotatingobject method.	Apply
CO4: Apply the concepts and draw lateral surface of simple solids using straight line andradial line development methods.	Apply
CO5: Apply the concepts and draw isometric view of simple solids and truncated solids using principles of isometric projection.	Apply
CO6: Conduct experiments to demonstrate concepts, implement and analyze the drawing concepts using engineering tool : Using AutoCAD.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	-	3	-	-	3	-	-	-	1	1	-	1	-	-

High-3; Medium-2; Low-1

Textbook:

T1. Cencil Jensen, Jay D.Helsel and Dennis R. Short, “ Engineering Drawing and Design”, Tata McGraw Hill India, New Delhi, 3rd edition, 2019.

Reference Book(s):

R1. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill India, New Delhi, 2nd edition, 2014.

R2. Dhananjay A. Jolhe, “Engineering Drawing with an introduction to AutoCAD” Tata McGraw India, New Delhi, 3rd edition, 2010.

R3. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, Gujarat, 54rd edition, 2023.

PUBLICATIONS OF BUREAU OF INDIAN STANDARDS

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.IS9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
2. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.IS 11669 – 1986 &SP 46 – 2003: Dimensioning of Technical Drawings.
3. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods. The mode ofdelivery is like practical.

Web References:

1 http://nptel.ac.in/courses/112103019/

2 https://www.coursera.org/specializations/autodesk-cad-cam-cae-mechanical-engineering

<table>
<tr><td>Course Code:23MEL002</td><td colspan="3">Course Title: ENGINEERING GRAPHICS AND DESIGN
(Common to all programs)</td></tr>
<tr><td>Course Category: Major</td><td colspan="3">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week) :1: 0: 3</td><td>Credits: 2.5</td><td>Total Contact Hours: 60</td><td>Max Marks: 100</td></tr>
</table>

Course Objectives:

The course is intended to impart knowledge and skills on creating 2D and 3D objects using CAD tool.

Module I **20 Hours**

Basics of Engineering Graphics: Importance of graphics in engineering applications – BIS conventions and specifications – Standards and symbols. Basic Geometrical constructions – principles of projections – free hand sketching Isometric to Orthographic and Orthographic to Isometric.

Introduction to data collaboration and management: Account creation and verification, Tool overview, and navigation to user interface- data storage, open, close, and saving a file. Import, and export project files, navigation through workspaces, data collaboration and customizing of the tool bars.

Introduction to modeling: Create a new project, create and edit a sketch; create and edit a 3D model.

Introduction to parametric sketching: Create parameter-based sketches, Sketch splines and slots, Sketch text.

Module II **10 Hours**

Introduction to parametric modeling Create a 3D mechanical link, add sketch Canvas images, Create 3D model solid trigger, Manage physical materials and appearances.

Introduction to Assembly modelling: Create a component Create a joint, Edit a joint limit, Drive a joint.

Introduction to technical drawing: Explode a 3D model for a drawing, create a drawing sheet and views, Add geometry and dimensions to a drawing, Add text and symbols, Place an exploded view, Edit a title block.

Introduction to rendering: Set up a render scene, Set up a render appearances, Create rendered images and turntable animations.

Electronics design: Copy and manage an electronics library, Create a new electronics design schematic, Create an electronics layout, Generate 3D models and gerber files. (Electrical CAD)

Practice on drafting tool: **30 Hours**

Projects

1. Create a 3D model of a wallet
2. Create a 3D model of a storage bin
3. Create a 3D model of a water pump impeller
4. Create a printed circuit board design with connectors, transistors, voltage regulator, and an LED. (Electrical CAD)
5. Model a simple coffee table with a rectangular top and four legs (Civil)
6. Model a chair with a curved backrest and seat (Civil)
7. Model a truss bridge, focusing on the arrangement of the trusses and the connections between them (Civil)

Course Outcomes:

CO1: Apply the concepts related to free hand sketching, orthographicand Isometric projection in first quadrant.	Apply
CO2: Apply the concept of CAD to create 2D and 3D models	Apply
CO3: Create 3D model and print using a 3D printer.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	3	-	-	-	-	-	-	-	-	-

Textbook(s):

T1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House,Gujarat, 54rd edition, 2023.

T2. Autodesk Fusion 360 Black Book (V 2.0.15293) – Part 1 by Gaurav Verma andMatt Weber

Reference Book(s):

R1. Autodesk Fusion 360 Black Book (V 2.0.12670) – Part 2 by Gaurav Verma andMatt Weber.

R2. Autodesk Fusion 360 – The Master Guide by Samar Malik.

R3. Parametric Modeling with Autodesk Fusion 360 by Randy H. Shih.

R4. AUTODESK FUSION 360 EXERCISES: 200 Practice drawings for Fusion 360 by Sachidanand Jha.

R5. Autodesk Fusion 360: A Tutorial Approach – 2nd edition by Prof. Sham Tickoo , Purdue University, Northwest , USA

Learning online resources:

1. Introduction to 3D Modeling for Manufacturing:
   https://www.autodesk.com/learn/ondemand/course/fusion360-intro-to-3d-modeling-associate.

2. Rendering:
   https://www.autodesk.com/learn/ondemand/module/fusion-rendering

3. Assembly modeling:
   https://www.autodesk.com/learn/ondemand/module/fusion-assembly-modeling

4. Electronics Design:
   Electronics design | Autodesk

Course Code: 23PHL102		Course Title: PHYSICS FOR MECHANICAL SCIENCES LABORATORY (Common to AU & ME)	
Course Category: Minor		**Course Level: Introductory**	
L:T:P (Hours/Week) 0:0:3	**Credits: 1.5**	**Total Contact Hours: 45**	**Max Marks: 100**

Course Objectives

The course is intended to expose the students to various experimental skills which is very essential for an Engineering student.

List of Experiments (Any ten):

1. Verify Lami's theorem using triangle law of forces.
2. Verify the parallelogram law of forces.
3. Determination of Young's modulus of the Material – Cantilever bending method.
4. Determination of Young's modulus of the Material – Uniform bending method.
5. Determination of Young's Modulus of the material – Non-Uniform bending method.
6. Determination of Rigidity modulus of the metallic wire – Torsion Pendulum.
7. Determination of viscosity of low viscous liquid – Poiseuille's method.
8. Determination of viscosity of high viscous liquid – Stoke's method.
9. Determination of thermal conductivity of the bad conductor – Lee's Disc method.
10. Determination of specific heat capacity of the given liquid — Newton's law of coolingmethod.
11. Determination of velocity of ultrasonic waves and compressibility of the given liquid –Ultrasonic interferometer.
12. Determination of Wavelength of laser using plane transmission grating and hence estimate particle size of lycopodium powder.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Elucidate the basic principles involved in the given experiments	Understand
CO2: Conduct, analyze and interpret the data and results from physics experiment	Evaluate

Course Articulation Matrix

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	3	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Reference Book(s):

R1. Physics Laboratory Manual Prepared by Faculty of Physics, Dr. Mahalingam College of Engineering and Technology

R2. Engineering Physics Laboratory Manual, Dr. R. Jayaraman, V. Umadevi, S. Maruthamuthu, B. Saravanakumar, Pearson India Education Services Pvt. Ltd, 2022.

R3. B.Sc., Practical Physics, C.L. Arora, S. Chand and Co, 2012.

Web References:

1. https://archive.nptel.ac.in/courses/115/105/115105110/
2. https://vlab.amrita.edu/index.php?sub=1&brch=280
3. https://vlab.amrita.edu/index.php?sub=1&brch=194

Course Code:23ADL101	Course Title: PYTHON PROGRAMMING LABORATORY FOR MECHANICAL SCIENCES (Common to AU & ME)		
Course Category: Multi-displicinary		**Course Level: Introductory**	
L:T:P (Hours/Week) 0:0:3	**Credits:1.5**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives

The course is intended to impart the programming knowledge. This will enable the students to develop simple applications in Python.

List of Experiments:

1. Draw the flowchart and algorithm for finding the weight of a steel bar for the given crosssection, length and density of the material
2. Implement programs using data types, operators and expressions
3. Implement programs using branching statements
4. Implement programs using looping statements to form a pyramid pattern
5. Develop programs with all the list/tuple operations for the given list/ tuples
6. Develop a dictionary consisting of auto components and apply the dictionary operations
7. Implement program to find the factorial of the given number using function
8. Implement program for string operations.
9. Develop the program to count the number of words and characters in the given TXT fileusing file handling methods.
10. Implement the program to plot the components of a given force for the different angleranges.

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Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Construct the flowchart and algorithm for any given scenario	Apply
CO2: Develop programs using branching and looping statements for simple business logic	Apply
CO3: Apply advanced data structure techniques in Python, utilizing functions, methods, and operators to efficiently manipulate lists, tuples, sets, dictionaries, and strings for various computational tasks	Apply
CO4: Employ the Matplotlib library function for data visualization, enabling to present data and to get insights of visual impactful method on data	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3	-	-	-	-	-	-	-		
CO2	-	3	-	-	-	-	-	-	-	-	-	-		
CO3	-	-	3	-	-	-	-	-	3	-	-	-		
CO4	-	-	-	3	-	-	-	-	3	-	-	-		

High-3; Medium-2;Low-1

Text Book(s):

T1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.

T2. Peter Wentworth, Jeffrey Elkner, Allen B. Downey, and Chris Meyers, “How to Think Like a Computer Scientist: Learning with Python”,3rd Edition, O’Reilly, 2016.

T3. Mark Lutz, “Powerful Object Oriented Programming Python”, 4th Edition, O’Reilly, 2012.

Reference Book(s):

R1. Mark Lutz, “Learning Python, Powerful OOPs”, 5th Edition, O’Reilly, 2013.

R2. Zelle, John M, “Python Programming: An Introduction to Computer Science”, Franklin Beedle& Associates, 2003.

Web References

1. https://docs.python.org/3/tutorial/
2. https://www.learnpython.org/
3. https://www.pyschools.com/

Course Code: 23VAL102		**Course Title: WELLNESS FOR STUDENTS** (Common to all B.E/B.Tech Programmes)	
Course Category: VAC		**Course Level: Introductory**	
L:T:P(Hours/Week) 0: 0 :2	**Credits:1**	**Total Contact Hours:30**	**Max Marks:100**

Course Objectives:
The course is intended to impart knowledge on setting SMART goals for academic, career and life, applying time management techniques, articulating the importance of wellness for success in life and understanding the dimensions of wellbeing and relevant practices.

Module I **15 Hours**

GOAL SETTING Understanding Vision and mission statements - Writing personal mission statements — „Focus‟ as a way of life of most successful people. Clarifying personal values, interests and orientations — Awareness of opportunities ahead — Personal SWOT analysis - Principles driving goal setting: Principle of response and stimuli, Circle of influence and circle of concern, What you see depends on the role you assume. Potential obstacles to setting and reaching your goals - Five steps to goals setting: SMART goals, Inclusive goals, Positive stretch, Pain vs gain, Gun-point commitment.

TIME MANAGEMENT - TOOLS AND TECHNIQUES Importance of planning and working to time. Pareto 80-20 principle of prioritization — Time quadrants as a way to prioritize weekly tasks – The glass jar principle - Handling time wasters – Assertiveness, the art of saying "NO‟– Managing procrastination.

CONCEPT OF WELLNESS — impact of absence of wellness - Wellness as important component to achieve success. Wellbeing as per WHO - Dimensions of Wellbeing: Physical, Mental, Social, Spiritual – indicators and assessment methods

Module II **15 Hours**

Simplified Physical Exercises. Fitness as a subset of Wellness — health related physical fitness - skill related physical fitness. Joint movements, Warm up exercises, simple asanas, WCSC simplified exercises.

PRACTICES FOR MENTAL WELLNESS

Meditation: Mind and its functions - mind wave frequency – Simple basic meditation – WCSC meditation and introspection tables. Greatness of friendship and social welfare – individual, family and world peace – blessings and benefits.

Food & sleep for wellness: balanced diet - good food habits for better health (anatomic therapy) — hazards of junk food - food and the gunas.

PUTTING INTO PRACTICE

Practicals: Using the weekly journal – Executing and achieving short term goals – Periodic reviews.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Set well-articulated goals for academics, career, and personal aspirations	Apply
CO 2: Apply time management techniques to complete planned tasks on time	Apply
CO 3: Explain the concept of wellness and its importance to be successful in career and life	Apply
CO 4: Explain the dimensions of wellness and practices that can promote wellness	Apply
CO 5: Demonstrate the practices that can promote wellness	Valuing

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	1	1	-	-	1	1
CO2	-	-	-	-	-	-	-	-	1	-	1	1	1	1
CO3	-	-	-	-	-	-	-	-	1	-	-	-	1	1
CO4	-	-	-	-	-	-	-	-	1	-	-	-	1	1
CO5	-	-	-	-	-	1	1	-	1	-	-	-	1	1

High-3; Medium-2;Low-1

Text Book(s):

T1. Reading material, workbook and journal prepared by PS team of the college

Reference Book(s):

R1. Stephen R Covey, "First things first", Simon & Schuster UK, Aug 1997

R2. Sean Covey, "Seven habits of highly effective teenagers", Simon & Schuster UK, 2004.

R3. Vethathiri Maharishi Institute for Spiritual and Intuitional Education, Aliyar, "Value education for harmonious life (Manavalakalai Yoga)", Vethathiri Publications, Erode, I Ed. (2010).

R4. Dr. R. Nagarathna, Dr. H.R. Nagendra, "Integrated approach of yoga therapy for positive health", Swami Vivekananda Yoga Prakashana, Bangalore, 2008 Ed.

R5. Tony Buzan, Harper Collins, "The Power of Physical Intelligence English"

Course Code: 23VAT101	**Course Title: HERITAGE OF TAMILS (Common to all B.E/B.Tech Programmes)**		
Course Category: VAC		**Course Level: Introductory**	
L:T:P (Hours/Week) 1: 0 :0	**Credit: 1**	**Total Contact Hours: 15**	**Max Marks:100**

Pre–requisites

- NIL

Course Objectives

மாணவர்கள் இப்பாடத்தை கற்றலின் மூலம்

CO.1 மொழி மற்றும் இலக்கியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை , நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் , திணைக் கோட்பாடுகள் மூலம் தமிழர் மரபை அறிந்து கொள்ள இயலும்.

CO.2இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பை அறிந்து கொள்ள இயலும்.

தமிழர் மரபு

அலகு 1 – மொழி மற்றும் இலக்கியம் 3

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு 2 – மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு 3 – நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு 4 – தமிழர்களின் திணைக் கோட்பாடுகள் **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக் கோட்பாடு – சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறைமுகங்களும் – சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு 5 – இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு **3**

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறபகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுய மரியாதை இயக்கம் – இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெ முத்துப் படிகள்– தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

Course Outcomes		Cognitive Level
மாணவர்கள் இப்பாடத்தை கற்றபின்		
CO.1	மொழி மற்றும் இலக்கியம், பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை , நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் , திணைக் கோட்பாடுகள் மூலம் தமிழர் மரபை அறிந்து கொள்வார்கள்.	அறிதல் (Understand)
CO.2	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பை அறிந்து கொள்வார்கள்.	அறிதல் (Understand)

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)

2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)

3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by:

   Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)

11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

<table>
<tr><td colspan="2">Course Code: 23VAT101</td><td colspan="2">Course Title: HERITAGE OF TAMILS
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="2">Course Category: VAC</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week)
1: 0 :0</td><td>Credit: 1</td><td>Total Contact Hours: 15</td><td>Max Marks:100</td></tr>
</table>

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Understand the Heritage of Tamils in terms of Language and Literature, Rock Art Paintings to Modern Art – Sculpture, Folk and Martial Arts, Thinai Concept.
2. Understand the Contribution of Tamils to Indian National Movement and Indian Culture.

HERITAGE OF TAMILS

UNIT I LANGUAGE AND LITERATURE 3

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 & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

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.

UNIT III FOLK AND MARTIAL ARTS **3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS **3**

Flora and Fauna of Tamils & 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 & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO.1 Understand the Heritage of Tamils in terms of Language and Literature, Rock Art Paintings to Modern Art – Sculpture, Folk and Martial Arts, Thinai Concept.	Understand
CO.2 Understand the Contribution of Tamils to Indian National Movement and Indian Culture.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
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9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by:
   Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

SEMESTER 2

Course Code: 23ENI201		**Course Title: COMMUNICATION SKILLS II** (Common to all B.E/B.Tech Programmes)	
Course Category: AEC		**Course Level: Introductory**	
L:T:P(Hours/Week) 2:0:2	**Credits: 3**	**Total ContactHours:60**	**Max Marks:100**

Course Objectives

The course is intended to impart effective and accurate language in business correspondence on par with B2 level of CEFR Scale.

Module I **20 Hours**

Grammar: Linking Words - Collocations –Sentence Completion - Articles –Adverbs– Indefinite Pronoun

Listening: Listening to short conversations - Listening for gist and summarizing - Listening fordetail - Responding to straightforward questions.

Speaking: Making statements of facts - Agreeing and disagreeing to opinions - Respond to queries - Group Discussion.

Reading: Read and select (phrasal verbs & relative clause)- Cloze Test - Gapped sentences - Multiple- choice gap-fill

Writing: Paragraph Writing: Descriptive, narrative, persuasive and argumentative - Emails: Giving information - Making enquiries - Responding to enquiries - Power Point Presentation

Module II **20 Hours**

Grammar: Expressions of cause and result – Concord - Error Spotting (Parts of Speech & Indian English) - Prepositions

Listening: Listening for identifying main points - Responding to a range of questions about different topics - Listening to identify relevant information

Speaking: Empathetic Enunciation – Situation handling – Visual Interpretation - - Short presentations

Reading: Intensive Reading: Comprehending business articles, reports and proposals and company websites-- Open gap-fill - Extended reading

Writing: – Report Writing - Memo – Complaint letter - Business Letters (Seeking permission & Providing Information)

List of Experiments: **20 Hours**

1. Listening to Monologue and Extended Listening Activity I
2. Listening to Monologue and Extended Listening Activity II
3. Expressing Opinions and Situational based speaking
4. Mini Presentation and Visual Interpretation
5. Reading Comprehension
6. Writing letter, email and report

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Identify the common errors in written and spoken correspondence.	Apply
CO2: Develop listening, reading and speaking skills through task based activities in listening, reading comprehension, recapitulation, interpretation and discussion.	Apply
CO3: Read business correspondences like memo, Email, letter, proposals and write reports and website entries and product launches.	Apply
CO4: Perform as an individual and member of a team and engage effectively in group discussion and individual presentation.	Apply

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-

High-3; Medium-2;Low-1

Textbooks:

T1. Guy Brook- Hart, "Business Benchmark Upper Intermediate", 2nd Edition, SouthAsian, Cambridge University Press, 2020.

T2. Norman Whitby, "Business Benchmark pre-intermediate to Intermediate", 2nd Edition, South Asian, Cambridge University Press, 2014.

Reference Book(s):

R1. Hewings Martin - Advanced Grammar in use Upper-intermediate Proficiency, CUP,3rd Edition,2013.

R2. Clark David – Essential BULATS (Business Language Testing Service), CUP, 2006. R3. Adrian Doff, Craig Thaine, Herbert Puchta, Jeff Stranks, Peter Lewis-Jones, Rachel Godfrey,Gareth Davies, Empower B1+ – Student's Book, Cambridge University Press,2015.

Web References:

1. https://speakandimprove.com/
2. https://writeandimprove.com/
3. https://www.cambridgeenglish.org/exams-and-tests/linguaskill/

<table>
<tr><td colspan="2">Course Code:23FLT201</td><td colspan="3">Course Title: FOREIGN LANGUAGE - JAPANESE
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">Course Category: AES</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Course Objectives:

The course objectives intended to:

1. Express a basic exposure on Japanese language and culture
2. Express thoughts and communicate in the beginner level of Japanese with native Japanese speaker
3. Identify the kanji etymology as well as use it in basic vocabulary required for the JLPT/NAT 5 examination level
4. Read and write 100 kanji of the official JLPT N5
5. Choose the appropriate verb forms for learning and practicing the Japanese language

UNIT I Introduction to Japan and greetings 9 Hours

Japan : Land and culture - Introduction to Japanese language – Greetings – Seasons - Days of the week - Months of the year – Dates of the month - Self introduction – Numbers (Upto 99,999) – Expressing time – Conversation audio and video.

Listening: Listening to Greetings - Listening for Specific Information: Numbers, Time. Speaking: Self-Introduction

UNIT II Building vocabulary 9 Hours

Family relationships - Colours - Parts of body - Profession - Directions - Time expressions (today, tomorrow, yesterday, day before, day after) - Japanese housing and living style - Food and transport (vocabulary) - Stationery, fruits and vegetables

Listening: Listening for Specific Information: Directions, Family Members, Parts of body Speaking: Introducing one’s family.

UNIT III **Writing systems** **9 Hours**

Hiragana Chart 1 - vowels and consonants and related vocabulary – Hiragana Charts 2&3, double consonants, vowel elongation and related vocabulary – Introduction to Kanji – Basic Vocabulary – Basic Conversational Phrases.

Listening: Listening to Japanese Alphabet Pronunciation, Simple Conversation. Speaking: Pair Activity (Day to day situational conversation)

UNIT IV **Kanji and preposition** **9 Hours**

Katakana script and related vocabulary – Basic kanjis: naka, ue, shita, kawa , yama , numbers (1- 10, 100, 1000, 10,000 and yen) , person, man, woman, child, tree , book , hidari, migi, kuchi , 4 directions - Usage of particles wa, no, mo and ka and exercises - Usage of kore, sore, are, kono, sono, ano, arimasu and imasu - Particles – ni (location) and ga , donata and dare - Particles ni (time), kara, made , ne , koko, soko, asoko and doko - Directions : kochira, sochira, achira and dochira , associated vocabulary (mae, ushiro, ue, shita, tonari, soba, etc.)

Listening: Listening to conversation with related particles

UNIT V **Verb forms** **9 Hours**

Introduction to Verbs - Verbs –Past tense, negative - i-ending and na-ending adjectives introduction - ~masen ka, mashou - Usage of particles de, e , o, to, ga(but) and exercises - Adjectives (present/past – affirmative and negative) – Counters - ~te form

Listening: Listening to different counters, simple conversations with verbs and adjectives. Speaking: Pair Activity (Explaining one's daily routine by using appropriate particles and verbs)

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1:	Recognize and write Japanese alphabet	Understand
CO2:	Comprehend the conversation and give correct meaning	Understand
CO3:	Apply appropriate vocabulary needed for simple conversation in Japanese language	Apply
CO4:	Apply appropriate grammar to write and speak in Japanese language	Apply
CO5:	Speak using words of the Japanese language	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO5	-	-	-	-	-	-	-	-	2	3	-	1	--	-

High-3; Medium-2; Low-1

Text Book:

T1.Genki 1 Textbook: An Integrated Course in Elementary Japanese by EriBanno, Yoko Ikeda, Yutaka Ohno, Yoko Sakane, Chikako Shinagawa, Kyoko Tokashiki published by The Japan Times

T2.Genki 1 Workbook: An Integrated Course in Elementary Japanese by Eri Banno published by The Japan Times

Reference:

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007
2. Japanese for Everyone: Elementary Main Textbook1-2, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007
3. www.japaneselifestyle.com
4. www.learn-japanese.info/
5. www.learn.hiragana-katakana.com/typing-hiragana-characters/
6. www.kanjisite.com/

<table>
<tr><td colspan="2">Course Code:23FLT202</td><td colspan="3">Course Title: FOREIGN LANGUAGE - GERMAN
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">Course Category: AEC</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td colspan="2">L:T:P (Hours/Week) 2: 0: 2</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to:

1. Listen and understand numbers, names and dialogues of a native speaker on par with A1 level.
2. Speak and introduce self in simple sentences to convey their opinion and ideas on par with A1 level.
3. Read simple passages and given text on par with A1 level.
4. Write letter and simple sentences on par with A1 level.

UNIT I BASIC INTRODUCTION TO GERMAN SCRIPTS 9

Theme and Text (Introduction to German - German script, Deutsche Namen, Daily Greetings and Expressions) – Grammar (‘wh’ questions, das Alphabet)– Speak Action (Buchstabieren, sich und andere vorstellen nach Namen und Herkunft fragen, internationale Wörter auf Deutsch verstehen, jemanden begrüßen)– pronunciation (Buchstabieren J,V,W,Y, - Long vowels A,E,I,O,U - Pronunciation of Ä,Ü,Ö) – To learn (internationale Wörter in Texten finden, Wörter sortieren)

Theme and Text (Gespräche im caf’e, Getränkekarte, Telefon-buch, Namen, Rechnungen) – Grammar (Frägesatze mit wie, woher, wo, was Verben in präsens Singular und Plural, das Verb Sein, Personalpronomen und Verben)– Speak Action (eine Gespräch beginnen sich und andere vorstellen zählen, etwas bestellen und bezhalen Telefonnummern und verstehen)– pronunciation (Wortakzent in Verben und in Zahlen) – To learn (Grammatiktabelle ergänzen, mit einem Redemittelkasten arbeiten)

UNIT II NUMBERS AND NOMINATIVE CASE 9

Theme and Text (Numbers – 1 to 12 (Eins bis Zwolf) – 20, 30, 40, 90 (zwanzig-Neunzig)

– All Numbers (1-10000) – German Currency (Euro) – Basic Mathematics (plus, Minus, Malen, Geteilt durch)) – Grammar (Introduction of verbs –Have Verb – To Come, To Speak, To Read, To Drive, To Fly, To write, To Eat, To sleep, To take etc.,)

Theme and Text (Communication in course) – Grammar (Singular and Plural, Artikel: der,das,die/ ein,eine, verneinung: kein, keine, Komposita: das Kursbuch) – Speak Action (Gegenständen fragen/ Gegenstände benennen im kurs:) – pronunciation (word accent Marking, Umlaute ö ä ü hören und sprechen) – To learn (Lernkarten schreiben, Memotipps, eine Regel selbst finden)

Theme and Text (City, Town, Language: Nachbar, Sprachen, Sehenswürdigkeiten in Europa) – Grammar (Past tense for Sein, W-Frage, Aussagesatz und Satzfrage) – Speak Action (about city and siteseeing) – pronunciation (Satzakzent in Frage- und Aussagesätzen) – To learn (eine Regel ergänzen, eine Grammatiktabelle erarbeiten, Notizen machen)

UNIT III AKKUSATIVE CASE AND PREPOSITIONS 9

Theme and Text (Menschen und Hauser, Furniture catalogue, E-Mail, Houseinformation) – Grammar (possesivartikel im Nominativ, Artikel im Akkusativ, Adjektive im satz, Graduierung mit zu)– Speak Action (Whonung bescreiben about perons andthings)– pronunciation (consonant - ch) – To learn (wortschatz systematisch)

Theme and Text (Termine - Appointment and punctuality in Germany) – Grammar (questions with wann?, Preposition (am, um, von... bis), verneinung mit nicht, trennbare verben, präteritum von haben) – Speak Action (Daily plan making, time commitment, excuse for late coming) – pronunciation (consonants- p,b,t,d / k,g) – To learn (Rollenkarten arbeiten)

Theme and Text (orientation in working area, go for work, floor plan city plan, office and computer) – Grammar (preposition: in,neben, unter, auf, vor, hinter, an, zwischen, bei und mit + Datic)– Speak Action (work place, work, giving appointments)– pronunciation (consonants: f,w und v) – To learn (Making notice in calender)

UNIT IV DATIV CASE AND PREPOSITIONS 9

Theme and Text (Holiday and Party, holiday plan, party plan in Germany) – Grammar (regular and iregular verbs) – Speak Action (holiday speak, accident, Ich-Text schreiben) – pronunciation (lange und kurze vokale markieren) – To learn (Text Order)

Theme and Text (organising an Excursion to Berlin through city orientation, Bus plan, City plan, post card, Excursion programme) – Grammar (preposition: in, durch, über + Akkusativ: zu, an... vorbei + Dativ, Modalverb wollen) – Speak Action (Tourism, culture, postcard preparation, travel description) – pronunciation (r and l)– To learn (plaket making)Theme and Text (Beruf und all Tag, Visiten karten, wörterbuch) – Grammar – Speak Action (profession, statistic speaking) – pronunciation (n,ng and nk)– To learn

(wörterbuch , text information in tabel)

UNIT V ADJECTIVES AND PRONUNCIATION 9

Theme and Text (Haushaltstipp, kochrezept, maße und gewichte, Mahlzeiten und Gerichte) – Grammar (jeden Tag, manchmal, nie, Question - welche, Comparison – viel, gut, gern) – Speak Action (about eat, drink question and answers) – pronunciation (e,en,el,er) – To learn (Text auswerten und zusammenfassen)
Theme and Text (Clothing , colour, weather) – Grammar (Adjecktive im Akkusativ, unbestimmer Artikel) – Speak Action (weather, dress and colour understanding) – pronunciation (e-o- ö and ie-u- ü) – To learn (wetter and Farben interkulturelle)
Theme and Text (in super market,purchase, House Maintainence, Emotion, Sports, Body parts) – Grammar (Modal Verb) – Speak Action (Body parts) – To learn (Rollenkarten arbeiten)

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1	Recognize and write German alphabet, numbers.	Understand
CO2	Comprehend the conversation and give correct meaning	Understand
CO3	Apply appropriate grammar and vocabulary to write and speak.	Apply
CO4	Apply appropriate cases and texts to listen, write and speak.	Apply
CO5	Speak and read using words of the German language	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO5	-	-	-	-	-	-	-	-	2	3	-	1	--	-

High-3; Medium-2;Low-1

TEXT BOOK(s)

T1. Netzwerk, “Deutsch als Fremdsprache” by Stefanie Dengler, Paul Rusch, Helen Schmitz published by Goyal Publishers & Distributors Pvt Ltd;

T2. Funk, Kuhn, Demme, “Studio D A1 Deutsch als Fremdsprache” published by Goyal Publishers & Distributors Pvt Ltd;

REFERENCES(s)

R1. Hueber, “Fit for Goethe- Zertifikat A1 (Start Deutsch 1)” by GOYAL PUBLISHERS AND DISTRIBUTORS; 2016

<table>
<tr><td colspan="2">Course Code: 23MAI202</td><td colspan="2">Course Title: COMPLEX VARIABLES AND TRANSFORMS
(Common to AU, EC, EE, EV & ME)</td></tr>
<tr><td colspan="2">Course Category: Minor</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
3:0 :2</td><td>Credits: 4</td><td>Total Contact Hours:75</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

This course is intended to enable the student to acquire the knowledge on the calculus of functions of complex variables and continuous, discrete transforms.

Module I **23 Hours**

Vector Calculus

Gradient – Divergence – Curl – Line integrals – Surface integrals – Volume integrals – Theorems of Green, Gauss and Stokes (without proof) and their applications.

Complex Variables (Differentiation)

Cauchy-Riemann equations – Analytic functions – Properties – Harmonic functions – Finding harmonic conjugate – Conformal mapping (w=z+a, w= az, w=1/z,) – Mobius transformation and their properties.

Complex Variables I (Integration)

Cauchy Integral formula – Cauchy Integral theorem – Taylor’s series – Singularities of analytic functions – Laurent’s series.

Module II **22 Hours**

Complex Variables II (Integration)

Residues – Cauchy Residue theorem – Contour integrals – Evaluation of real definite integrals around unit circle and semi-circle (Excluding poles on the real axis).

Laplace Transform

Laplace Transform – Properties of Laplace Transform – Laplace transform of derivatives and integrals – Laplace transform of periodic functions -Inverse Laplace transforms - Convolution theorem – Solution of ordinary differential equations by Laplace Transform method.

Fourier Series

Dirichlet's condition -Fourier series – Even and odd functions- Half range sine and cosine series - Parseval's identity--Harmonic Analysis.

List of Experiments(Using Python) **30 Hours**

1. Find gradient of a given scalar function, divergence and curl of a vector function.
2. Verify Green's theorem in a plane.
3. Graphically plot time and frequency domain of standard functions and compute Laplace transform of In- built functions.
4. Find the Fourier series of a periodic function.
5. Compute Inverse Laplace transform of In- built functions.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the concepts of Vector Differentiation and Integration.	Apply
CO2: Using the concept of complex variables to construct analytical functions and evaluate definite integrals.	Apply
CO3: Apply Laplace transform techniques to solve ordinary differential equations.	Apply
CO4: Compute the Fourier series expansion for given periodicfunctions.	Apply
CO5: Develop programs using Complex Variables and Transforms concepts through modern tool.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	-	-	-	-	-	-	-

High-3; Medium-2;Low-1

Text Book(s):

T1. Erwinkreyzig, Advanced Engineering Mathematics, 10^{th} edition, John Wiley& Sons, 2011.

T2. Veerarajan T., Engineering Mathematics for first year, 3^{rd} edition, Tata McGraw-Hill, New Delhi, 2019.

Reference Book(s):

R1. G.B.Thomas and R.L Finney, Calculus and Analytic Geometry, 9^{th} edition, Pearson, Reprint, 2002.

R2. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 36^{th} Edition, 2010.

R3. P. Sivaramakrishna Das , C. Vijayakumari , Engineering Mathematics, Pearson India, 2017.

Web References:

1. https://nptel.ac.in/courses/111107112
2. https://nptel.ac.in/courses/111104031

<table>
<tr><td colspan="2">Course Code : 23CHT201</td><td colspan="2">Course Title: CHEMISTRY FOR MECHANICALSCIENCES
(Common to ME & AU)</td></tr>
<tr><td colspan="2">Type of Course: Minor</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week):3:0:0</td><td>Credits: 3</td><td>Total Contact Hours :45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives

The Course is intended to impart the knowledge of Chemistry involved in water technology, Electrochemical cells, Corrosion and its control, Engineering materials and fuels and lubricants.

Module I **23 Hours**

Water Technology: Water quality parameters- Hardness (Definition, types, units)- Estimation of Hardness (EDTA method). Boiler feed water -formation of deposits in steam boilers and heat exchangers (scale, sludge and caustic embrittlement). Water softening-Demineralization (Ion exchange method)- Desalination- Reverse Osmosis method. Roles and responsibility of women and individual in conservation of water.

Batteries and Fuel cells: Electrochemistry- Basic Terminologies - Conductometric, Potentiometric and pH titrations- Batteries- types and Characteristics. Construction, working and applications of Alkaline, Lead acid, and Lithium-ion batteries. Fuels cells- H_2O_2 fuel cell.

Corrosion and control: Corrosion- dry and wet corrosion, Galvanic series, Galvanic corrosion, differential aeration corrosion. Factors influencing corrosion.

Module II **22 Hours**

Corrosion and control: Corrosion control method- material selection and design, cathodic protection techniques. Metallic coating- Galvanizing and Tinning, Electroplating-Nickel plating.

Engineering materials: Polymer-Classification, Functionality, degree of polymerization, number and weight average molecular weight (definition only). Thermo plastic and thermosets, Compounding of plastics. Polymer processing by injection and blow techniques. Polymer composites. Nano materials- Introduction – Difference between bulk and nanomaterials, size dependent properties. Applications of nanomaterials in electronics, energy science and medicine.

Fuels and Lubricants: Automotive fuels- Petrol, diesel, CNG, blended fuels – Composition, properties and uses. Petroleum- refining, knocking in petrol and diesel engine- octane and cetane rating of fuels. Calorific value- Gross and Net calorific value. Catalytic converters. Lubricants- Importance and classification, properties of liquid lubricants and their significance. Greases – common greases, types, and properties.

Course Outcomes **At the end of this course, students will be able to:**	**Cognitive Level**
CO1: Interpret the concepts involved in water treatment, batteriesand fuel cells, corrosion.	Apply
CO2: Apply the acquired knowledge of chemistry to solve theEngineering problems.	Apply
CO3: Analyze the Engineering problems through the concept of electro chemistry, water technology, Engineering materialsand fuels.	Apply

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Jain&Jain, Engineering Chemistry (All India), 17th Edition, Dhanpat RaiPublishing Company Pvt Ltd, New Delhi, 2018.

T2. Wiley Engineering Chemistry, 2nd edition, Wiley India Pvt Ltd, New Delhi, 2011.

Reference Book(s):

R1. Dara S.S., and Umare S.S., A text book of Engineering Chemistry, S. Chand & Co Ltd, New Delhi , 2014.

R2. V.R.Gowariker, N.V.Viswanathan and Jayadev Sreedhar, Polymer Science, New Age International Pvt Ltd, Chennai , 2006.

R3. Renu Bapna and Renu Gupta, Engineering Chemistry, Macmillan India Publisher Ltd, 2010.

Web References:

1. http://nptel.ac.in/courses/122101001/downloads/lec.23.pdf
2. https://nptel.ac.in/courses/104106075/Week1/MODULE%201.pdf
3. https://nptel.ac.in/courses/103102015/

Course Code:23MEI201		**Course Title: ENGINEERING MATERIALS** (Common to AU,ME)	
Course Category: Major		**Course Level: Introductory**	
L:T:P (Hours/Week) **3: 0: 2**	**Credits: 4**	**Total Contact Hours:60**	**Max Marks:100**

Course Objectives:

The course is intended to impart knowledge on crystal structure, phase analysis and heat treatment of ferrous alloy.

Module I **15 Hours**

Crystal Physics: Crystalline and Non crystalline materials. Single crystal, Polycrystalline materials Anisotrophic crystal parameters: Atomic radius, Number of atoms per unit cell, Coordination number, atomic packing factor for SC , BCC , FCC and HCP- Crystal planes: Miller indices, Braggs law . Interplanar distance- Polymorphism and allotrophy. Crystal imperfections: Point, line , surface and volume, grain boundary and its role in mechanical properties.

Ferrous alloy: Effect of alloying elements on properties of steel (Mn, Si, Cr, Mg, V and W). Properties and applications of stainless steel and Tool steel, Cast Iron-White, Malleable, Grey and Spheroidal Cast Iron-Properties and Applications

Non-Ferrous: Aluminium and its alloys, Copper and its alloys, Magnesium and its alloys, Titanium and its alloys, Nickel and its alloys- Composition, Properties and Applications. Industrial standards for alloys and other materials - alloying elements and inclusion of ceramics materials.

Module II **15 Hours**

Constitution of Alloys and Phase diagram: Constitution of alloys- Solid solutions- Substitutional and Interstitial. Phase diagrams- Interpretation of Phase diagram, Lever rule, Gibbs phase rule. cooling curve for pure metal, binary solid solution and binary eutectic system. Iron – Iron Carbide equilibrium diagram. Micro constituents in Fe_3C diagram (Austenite, Ferrite, Cementite, Pearlite, Martensite,Bainite), Pearlite transformation.

Heat Treatment: Heat treatment process-purpose of heat treatment – Process parameters. Bulk treatment: Annealing, Normalizing, Tempering, Quenching (Process parameter, application). Isothermal transformation Diagram (TTT Diagram). Cooling curves superimposed on TTT diagram. CCR - CCT. Hardenability- Jominy end quench test. Austempering, martempering — case hardening, carburizing, Nitriding, cyaniding, carbonitriding — Flame and Induction hardening.

List of Experiments **30 Hours**

1. Conduct the annealing operation for given ferrous alloy and analyze the microstructure.
2. Conduct the normalizing operation for given ferrous alloy and analyze the microstructure.
3. Conduct the Quenching operation for given ferrous alloy and analyze the microstructure.
4. Analyze the microstructure on non-ferrous alloy.
5. Analyze the hardness of the given material (Brinell and Rockwell).

5. Determine the micro hardness for the given sample.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Choose the suitable alloying elements for Ferrous and Non Ferrous alloys for industrial standard and analyze the crystal structures.	Apply
CO2: Apply the knowledge of composition changes in phase diagram and analyze the microstructure.	Apply
CO3: Analyze the heat treatment process for given ferrous material to meet industrial standards.	Analyze
CO4: Conduct experiments to demonstrate concepts related to heat treatment process and analyze the variations of microstructure.	Analyze

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	2	2	-	-	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1. William D Callister “Material Science and Engineering”, John Wiley and Sons, 2014.

Reference Book(s):

R1. Dieter G. E., “Mechanical Metallurgy”, McGraw Hill Book Company, 2013.

R2. Sidney H Avner “Introduction to Physical Metallurgy”, Tata McGRAW-Hill, 2017.

R3. Raghavan.V “Materials Science and Engineering”, Prentice Hall of India Pvt., Ltd., 2015.

Web References:

1 http://nptel.ac.in/courses/113106032/

2 https://www.coursera.org/specializations/ physical metallurgy

Course Code: 23MEL201		Course Title: COMPUTER AIDED DRAFTING AND MODELLING LABORATORY (Common to AU,ME)	
Course Category: Major		Course Level: Introductory	
L:T:P(Hours/Week) 1: 0: 3	Credits:2.5	Total Contact Hours: 60	Max Marks:100

Course Objectives:

The course is intended to create CAD model and 3D print the given part/assembly drawing.

Module I **15 Hours**

The basics of modelling: Create a basic sketch, Fully define a complex sketch, Create and shell a drafted part, Create a Revolve, Apply fillets to a model, Create a feature pattern, Create parameters, Link parameters and dimensions, Use symmetry and construction, geometry, Create construction planes, Create extruded features, Create extruded cuts, Project edges vs. including them, Useboundary fill, Create sheet metal parts.

The basics of assemblies: The different ways to create components, Use scripts to create gears, Component color swatch and color cycling, Use McMaster-Carr parts in a design, Copy, paste, and paste new, Distributed designs, Create as-built joints, Create joints, Joint origins and mid plane joints, Drive joints and motion studies, Interference detection and contact sets, Isolation and opacity control, Create groups and organize a timeline.

Exploring design tools for production : Create draft during a feature, Create draft as a feature, Add ribs and plastic supports, Analyze draft on a design, Create holes and threads, Use a coil feature, Mirrors and patterns, Surface creation for complex geometry, Use surfaces to replace faces, Use surfaces to split bodies and faces.

Module II **15 Hours**

Creating complex designs with form tools: Introduction to forms, Create a form primitive, Add or remove symmetry, Manipulate faces edges and vertices, Convert BREP faces to forms, Crease or uncrease an edge,Insert edges and subdivisions, Repairs and modifications, Add a bevel, Work with a form as a BREP. Additive Manufacturing: Create an additive CAM setup, Create custom material presets, Validate slicingthrough simulation, Generate G-Code for a 3D printer.

List of Experiments **30 Hours**

1. Develop the part drawing of 3D components using CAD tools.
2. Develop the production drawing of given machine components using CAD tools.
3. Develop the assembly model of the simple coupling
4. Model a laundry detergent bottle and print the same using 3D printer.
5. Model and 3D print a device stand Design an adjustable device stand that can be customized to hold any smart phone or small tablet.

Course Outcomes:

CO1: Develop the 3D model for the given concept and print the same using 3D printer as a team.	Apply
CO2: Create the part model and assemble the given parts using CAD tools.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	3	-	-	-	2	_
CO2	3	-	-	-	2	-	-	-	-	-	-	-	2	_

Text book(s):

T1. Parametric Modeling with Autodesk Fusion 360 by Randy H. Shih.

T2. Autodesk Fusion 360 Black Book (V 2.0.15293) – Part 1 by Gaurav Verma and Matt Weber.

T3. Autodesk Fusion 360 Black Book (V 2.0.12670) – Part 2 by Gaurav Verma and Matt Weber.

T4. Autodesk Fusion 360 – The Master Guide by Samar Malik.

T5. Autodesk Fusion 360 Exercises: 200 Practice drawings for Fusion 360 by Sachidanand Jha.

T6. Autodesk Fusion 360: A Tutorial Approach – 2nd edition by Prof. Sham Tickoo , Purdue University, Northwest , USA

Web References:

1. Introduction to Modeling and Design for Manufacturing: https://www.autodesk.com/learn/ondemand/course/fusion360-intro-modeling-design-professional
2. CAM additive manufacturing https://www.autodesk.com/learn/ondemand/module/fusion-cam-additive-manufacturing

<table>
<tr><td colspan="2">Course Code: 23CHL201</td><td colspan="2">Course Title: CHEMISTRY FOR MECHANICAL SCIENCES LABORATORY
(Common to ME &AU)</td></tr>
<tr><td colspan="2">Course Category: Minor</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week):
0:0:3</td><td>credits:1.5</td><td>Total Contact Hours :45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The Course is intended to analyze the Dissolved Oxygen, Hardness, Iron, Chloride content, and Corrosion rate, Molecular weight of polymer and Properties of various lubricants.

List of experiments: (Any 10 experiments)

1. Determination of Total, Temporary and Permanent Hardness of water by EDTA method.
2. Determination of alkalinity in water sample.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of the water sample by Argentometric method.
5. Estimation of iron content of the water sample using Spectrophotometer.
6. Conductometric titration of strong acid Vs strong base.
7. Estimation of Fe^{2+} by potentiometric titration.
8. Determination of strength of given hydrochloric acid using p^H metry.
9. Corrosion experiment - weight loss method.
10. Determination of molecular weight of Polyvinyl alcohol using Ostwald viscometer.
11. Green synthesis of silver nanoparticles by Neem leaf
12. Determination of Cloud and Pour Point.

Course Outcomes At the end of this course, students will able to:	Cognitive Level
CO1: Understand the concept of volumetric and instrumental methods through chemistry laboratory.	Understand
CO2: Apply the knowledge of chemistry to investigate engineeringmaterials by volumetric and instrumental methods and analyze, interpret the data to assess and address the issues of Environmental Problems.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	3	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Reference Book(s):

R1. A Text book on Experiments and calculations in Engineering Chemistry by SS Dara, 9th Edition, S Chand publications, 2015.

R2. Instrumental methods of chemical analysis, Chatwal and Anand, 5th Himalaya Publications,2023.

R3. Lab manual of Chemistry for Mechanical Sciences Laboratory prepared by Chemistry faculty members.

Web References:

1. https://archive.nptel.ac.in/courses/104/106/104106121/

2. https://academic.oup.com/book/42038/chapter-bstract/355779823?redirectedFrom=fulltext

Course Code: 23MEL202		Course Title: ENGINEERING PRACTICESLABORATORY (Common to AU,CE,ME)	
Course Category: SEC		Course Level: Practice	
L:T:P(Hours/Week) 0: 0: 3	Credits:1.5	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on basic electrical, mechanical and civil operations.

List of Experiments

Electrical & Electronics

1) Symbols of electrical and electronic components and study of electrical drawing.
2) Insulation Testing using Megger.
3) Soldering practice of simple circuit and testing.
4) Fluorescent tube, staircase and house wiring.
5) Verification of Kirchhoff's current and voltage law.

Civil & Mechanical

1. Make a wooden Tee joint to the required dimension.
2. Make a "V" filling to the required dimension using fitting tools.
3. Make a tray in sheet metal to the required dimension.
4. Assemble the pipeline connections with different joining components for the given layout.
5. Demonstrate a butt joint using welding process to the required dimension.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply engineering knowledge to conduct experiments and analyze the electrical and electronic connections as per the given circuit.	Analyze
CO2: Apply to make wooden 'T' joint, and pipeline connection individually using various workshop tools as per the given dimensions.	Apply
CO3: Apply to make metal 'V' joint with various joining components and a permanent joint as per the given dimensions using modern workshop tools and engineering principles.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	2	-	-	-	-	2	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	2	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Reference Book(s):

R1. Jeyachandran.K, Natarajan.S & Balasubramanian.S, "A Primer on Engineering Practices Laboratory", Anuradha Publications, TamilNadu (India), 2016.

R2. 19EPL21 - Engineering practices laboratory Manual.

Web References:

1. http://nptel.ac.in/courses/112103019/
2. https://www.aaaenggcoll.ac.in/engineering-practices-lab/
3. https://www.coursera.org/courses?query=engineering

Course Code: 23ESL201		Course Title: PROFESSIONAL SKILLS 1: PROBLEM SOLVING SKILLS &LOGICAL THINKING 1 (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		**Course Level: Introductory**	
L:T:P(Hours/Week) **0: 0: 2**	**Credits: 1**	**Total Contact Hours:30**	**Max Marks:100**

Course Objectives:

The course is intended to enhance the students' numerical, analytical and logical reasoning ability. Also course focus to make learners prepare for various public and private sector exams and placement drives.

Module I Quantitative Ability **20 Hours**

Number System and LCM & HCF- Percentage- Ratio and Proportion - Average- Progressions- Ages- Partnership- Mixture & Allegation - Profit and loss- Interest calculation- Data interpretation.

Module II Reasoning Ability **10 Hours**

Seating Arrangement- Linear, circular and Complex – Direction Problems- Blood Relation- Puzzles- Crypt arithmetic- Venn diagrams- Statement and conclusion- Statement and

Textbook(s):

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Build the competence in numerical, analytical and logical reasoning ability argument- Causes and effects- Self-Learning.	**Apply**

T1: Dr. R. S. Aggarwal. "Quantitative Aptitude for Competitive Examinations" Sultan Chand & Sons Pvt. Ltd,New Delhi, 2018.

T2**:** Dr. R. S. Aggarwal. "A Modern Approach to Logical Reasoning", Sultan Chand & Sons Pvt. Ltd, New Delhi,2018

Reference Book(s):

R1: R. V. Praveen. “Quantitative Aptitude and Reasoning” 2nd Revised Edition, Prentice-Hall of India Pvt.Ltd,2013

R2: Arun Sharma. “Quantitative Aptitude for Common Aptitude Test”, McGraw Hill Publications, 5th Edition,2020

R3**:** Arun Sharma. “Logical Reasoning for Common Aptitude Test”, McGraw Hill Publications, 6th Edition, 2021.

Web References:

1 https://www.indiabix.com/aptitude/questions-and-answers/

2 https://www.geeksforgeeks.org/aptitude-questions-and-answers/

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	-	-	-	-	-	-	-	3	-	-

High-3; Medium-2; Low-1

Course Code: 23VAT201	Course Title: TAMILS AND TECHNOLOGY (Common to all B.E/B.Tech Programmes)		
Course Category: VAC		Course Level: Introductory	
L:T:P (Hours/Week) 1: 0 :0	Credit: 1	Total Contact Hours: 15	Max Marks:100

Pre–requisites

- NIL

Course Objectives

மாணவர்கள் இப்பாடத்தை கற்றலின் மூலம்

CO.1 நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம், உற்பத்தித் தொழில்நுட்பம், வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் ஆகியன குறித்து அறிந்து கொள்ள இயலும்.

CO.2 அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் குறித்து அறிந்து கொள்ள இயலும்.

தமிழரும் தொழில்நுட்பமும்

அலகு 1 – நெசவு மற்றும் பானைத் தொழில்நுட்பம் **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்

அலகு 2 – வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் ஷ சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமானப் பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள், பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ – சாரோசெனிக் கட்டிடக் கலை.

அலகு 3 – உற்பத்தித் தொழில்நுட்பம் **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு 4 வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன் வளம் – முத்து மற்றும் முத்துக் குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு 5 – அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் **3**

அறிவியல் தமிழின் வளர்ச்சி – கணினித் தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின் பதிப்பு செய்தல் – தமிழ் மென் பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக் கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

Course Outcomes மாணவர்கள் இப்பாடத்தை கற்றபின்	**Cognitive Level**
CO.1 நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம், உற்பத்தித் தொழில்நுட்பம், வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம் ஆகியன குறித்து அறிந்து கொள்வார்கள்.	அறிதல் (Understand)
CO.2 அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் குறித்து அறிந்து கொள்வார்கள்.	அறிதல் (Understand)

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - ‘Sangam City C ivilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

<table>
<tr><td colspan="2">Course Code: 23VAT201</td><td colspan="3">Course Title: TAMILS AND TECHNOLOGY
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">Course Category: VAC</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P (Hours/Week)
1: 0 :0</td><td colspan="2">Credit: 1</td><td>Total Contact Hours: 15</td><td>Max Marks:100</td></tr>
</table>

Pre–requisites

- NIL

Course Objectives

The course is intended to:

1. Understand Weaving and Ceramic Technology, Design and Construction Technology, Manufacturing Technology, Agriculture and Irrigation Technology.
2. Understand the Scientific Tamil & Tamil Computing.

TAMILS AND TECHNOLOGY

UNIT I WEAVING AND CERAMIC TECHNOLOGY **3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY **3**

Designing and Structural construction House & 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.

UNIT III MANUFACTURING TECHNOLOGY **3**

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.

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 & 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 At the end of this course, students will be able to:	**Cognitive Level**
CO.1 Understand Weaving and Ceramic Technology, Design and Construction Technology, Manufacturing Technology, Agriculture and Irrigation Technology.	Understand
CO.2 Understand the Scientific Tamil & Tamil Computing.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

High–3; Medium–2; Low–1

TEXT - CUM REFERENCE BOOKS

1 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு. தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

<table>
<tr><td colspan="2">Course Code: 23CHT202</td><td colspan="3">Course Title: ENVIRONMENTAL SCIENCES
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="3">Course Category: Multidisciplinary</td><td colspan="2">Course Level: Introductory</td></tr>
<tr><td>L:T:P(Hours/Week)
1: 0: 0</td><td colspan="2">Mandatory NonCredit Course</td><td>Total Contact Hours: 15</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to impart knowledge on sustainable utilization of natural resources, prevention of pollution, disaster management and environmental issues & public awareness on ecosystem.

Module I **8 Hours**

Natural Resources

Role of individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

Environmental Pollution and Disaster Management

Role of an individual in prevention of pollution; Disaster management : floods, earthquake, cyclone and landslides.

Environmental Ethics and Legislations

Environmental ethics : Environment Protection Act; Air Act; Water Act ; Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislation.

Module II **7 Hours**

Environmental Issues and Public Awareness

Public awareness - Environment and human health.

Environmental Activities

(a) Awareness Activities:

i. Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste.
ii. Slogan making event.
iii. Poster making event.

(b) Actual Activities:

i. Plantation.
ii. Cleanliness drive.
iii. Drive for segregation of waste.
iv. To know about the different varieties of plants.
v. Shutting down the fans and ACs of the campus for an hour or so.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Explain the use of natural resources for a sustainable life as an individual in prevention of pollution.	Understand
CO 2: Apply the environmental ethics and legislations for various environmental issues.	Apply
CO 3: Create the public awareness on environment and human health as an individual or team through various activity based learning.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-		
CO2	3	-	-	-	-	-	3	3	-	-	-	-		
CO3	3	-	-	-	-	3	3	-	3	3	-	-		

High-3; Medium-2;Low-1

Text Book(s):

T1. Benny Joseph, “Environmental Studies‟, Tata McGraw Hill, New Delhi, 2006.

T2. Mackenzie Davis and Susan Masten, “Principles of environmental engineering and science”, Mc-Graw Hill, 3rd Edition, 2014.

Reference Book(s):

R1. Trivedi R.K. “Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards‟, Vol.I and II, Enviro Media.

R2. Cunningham, W.P.Cooper, T.H. Gorhani, “Environmental Encyclopedia‟, Jaico Publishing House, Mumbai, 2001.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_hs155/preview.
2. https://en.wikipedia.org/wiki/Environmental_science.

SEMESTER III

Course Code: 23MAT302		**Course Title: NUMERICAL METHODS** (Common to AE,ME)	
Course Category: Minor		**Course Level: Intermediate**	
L:T:P(Hours/Week) **3:1 :0**	**Credits: 4**	**Total Contact Hours:60**	**Max Marks:100**

Course Objectives:

The students able to solve the system of linear equations and nonlinear equations use of matrix algebra techniques that is needed by engineers for practical applications and familiarize with Interpolate the given data and calculate the numerical derivatives and integration. To familiarize and solve the initial value and boundary value problems using numerical techniques.

Module I **30 Hours**

Solution of System of Linear Equations and Eigenvalue

Solution of system of linear equations, Gauss elimination method, Crout's method, iterative methods of Gauss Jacobi and Gauss Seidal method, Eigen values of matrix by power method.

Solution Of Non-Linear Equations And Curve Fitting

Solution of non-linear equations: Method of false position, Newton Raphson method, order of convergence. Curve fitting: Method of least square fit a straight line, fitting a curve.

Interpolation, Polynomial Approximation

Interpolation with equal intervals, Newton's forward and backward difference formulae, interpolation with unequal interval, Lagrange's interpolation, numerical differentiation

Module II **30 Hours**

Numerical Integration

Numerical integration, trapezoidal rule, Simpson's rule, double integration using trapezoidal rule and Simpson's rule.

Initial Value Problem for Ordinary Differential Equations

Single step methods,Taylor's series method, Euler's method, Modified Euler's method, Fourth order Runge-Kutta method for solving first order equations, Multi step methods, Milne's and Adams method.

Boundary Value Problems in Partial Differential Equations

Solution of two-dimensional Laplace's and Poisson's equations, one dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods, one dimensional wave equation by explicit method.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Demonstrate the concepts of numerical methods to engineering problems.	Understanding
CO2: Apply the concept of various numerical techniques for solving non-linear equations and system of linear equations.	Apply
CO3: Apply the knowledge of Interpolation and determine the integration and differentiation of the function by using the numerical data.	Apply
CO4: Determine the solution of initial and boundary value problems using numerical techniques.	Apply

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Text Book(s):

T1. Erwin Kreyzig, "Advanced Engineering Mathematics", 10th edition, John Wiley & Sons, 2015.

T2. Veerarajan T., "Engineering Mathematics for First Year", Tata McGraw-Hill, New Delhi, 2011.

T3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 1st edition, 2017.

Reference Book(s):

R1. Thomas G.B. and Finney R.L., “Calculus and Analytic Geometry”, 9th edition, Pearson, Reprint, 2010.

R2. Bali N.P. and Manish Goyel, “A Text book of Engineering Mathematics”, Laxmi Publication, 9th edition, 2010.

R3. B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 43rd Edition, 2014.

Web References:

1. https://onlinecourses.nptel.ac.in/noc16_ma05
2. https://nptel.ac.in/courses/122101003/2

<table>
<tr><td>Course Code: 23MET301</td><td colspan="3">Course Title: ENGINEERING MECHANICS
(Common to ME & AU)</td></tr>
<tr><td>Course Category: Major</td><td colspan="3">Course Level: Intermediate</td></tr>
<tr><td>L:T:P(Hours/Week)
2: 1: 0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max Marks: 100</td></tr>
</table>

Course Objectives:

The course is intended to impart knowledge on Static force analysis on simple elements, Kinematics of mechanisms and Kinetics of rigid bodies.

Module I **23 Hours**

Force Analysis of Beams, Frames and Machines: Fundamental laws of mechanics (Review) -Free body diagram-Statics-Particles and Rigid bodies-Types of forces Action(Point, UDL, UVL and couples)-Reaction (Supports, Friction) Governing equations of equilibrium-Equivalent force and couple moment-Types of beams-Determining reactions in statically determinate beams-Bending moment diagram and Shear force diagram of cantilever, simply supported beam and over hanging beams-Analysis of frames-Machines-Laws of dry friction-ladder and wedge frictions.

Geometric Properties of Lamina and Bodies: Properties of surfaces – centroid of composite planes such as L, I and T-Moment of Inertia (MI)-Parallel and perpendicular axis theorem – MI of composite sections involving simple geometries such as rectangle, circle and triangle -Centre of gravity and mass moment of inertia of composite solids involving block, cylinder, cone and sphere. Center of gravity for simple machine structures.

Module II **22 Hours**

Introduction to Mechanisms: Mechanism and structure ––links-pairs-chains – fourbar and slider crank mechanisms –degrees of freedom of linkages – Gruebler’s criterion– Grashof’s condition of rotatability - transmission angle and mechanical advantage-special lower pair mechanisms: Peucelliar straight line mechanism, Ackermann steering mechanism, pantograph, Geneva mechanism.

Kinetics of Rigid Body: Dynamic equilibrium of rigid bodies- Planar kinetics of rigid body- Force and Acceleration, Work and energy, Impulse and momentum.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Determine various forces on rigid bodies such as beams, frames and machines under static conditions.	Apply
CO2: Calculate centroids, center of gravity and moment of inertia of simple Shapes and machine structures	Apply
CO3: Determine the degrees of freedom of given mechanism.	Apply
CO4: Calculate the kinetic parameters of rigid bodies for dynamic equilibrium.	Apply
CO5: Prepare and present a case study on the analysis of the forces in a real world application	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	2	-	-	-	2	3	-	3	-	-

Text Book(s):

T1. R C Hibbeler, “Engineering mechanics – Statics and Dynamics”, 14th Edition, Pearson, New Delhi, 2017.

T2. S.S. Rattan, “Theory of Machines”, McGraw Hill Education, 4thEdition.2017.

Reference Book(s):

R1. F.P. Beer and Jr. E.R. Johnston, “Vector Mechanics for Engineers — Statics and Dynamics”, 10th Edition Tata McGraw Hill publishing company, New Delhi,2017.

R2. R.S. Khurmi, J.K Gupta, “Theory of Machines” , S.Chand, 14th Edition. 2005.

R3. Irving H. Shames, “Engineering mechanics — Statics and Dynamics”, 14th Edition, Pearson, New Delhi, 2014.

Web References:

1. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
2. https://nptel.ac.in/courses/122104015/

Course Code: 23MEI301	Course Title: ENGINEERING THERMODYNAMICS		
Course Category: Major		**Course Level: Intermediate**	
L:T:P(Hours/Week) **2: 0: 2**	**Credits: 3**	**Total Contact Hours: 60**	**Max Marks:100**

Course Objectives:

This course aims to impart knowledge on the fundamentals of Thermodynamics including thermodynamic systems and properties, relationships among the thermo-physical properties, the laws of thermodynamics and applications of these basic laws for the design, analysis and performance improvement of various thermodynamics systems.

Module I **15 Hours**

Basics of Thermodynamics - Thermodynamics systems, Properties and processes, Thermodynamic Equilibrium, Calculation of work and heat in various processes, Zeroth law of thermodynamics, First law of thermodynamics — application to closed and open systems, steady and unsteady flow processes and Limitations. Second Law of thermodynamics – Need, Statements of second law, Carnot cycle and Applications of second law- Heat Engine, Refrigerator and Heat Pump - high and low grade energy, Availability and Irreversibility for open and closed system processes, Concept of Entropy - I & II law's efficiency and Third law of thermodynamics, **Properties of Pure Substances** - Formation of steam and its thermodynamic properties, P-V, P-T, T-V, T- S and h-s diagrams. Use of Steam table and Mollier chart, Determination of dryness fraction of steam.

Module II **15 Hours**

Air standard cycles - Otto, Diesel, Dual and Brayton cycles - Calculation of mean effective pressure and air standard efficiency.

Performance of IC Engines – Performance characteristics, Engine Performance Tests and Heat balance test.

Air Compressors - Introduction to air compressors, Reciprocating air compressor, performance characteristics, effect of clearance volume, multistage compressors with intercooler- Introduction to Gas compressors and its applications,

Rotary compressors –– working principle of vane type, roots blower, screw compressor, centrifugal and axial flow compressors. Applications of various types of compressors.

Refrigeration - Fundamentals of Refrigeration, vapor compression and vapor absorption refrigeration systems, Properties of refrigerants, COP, performance calculations.

Psychrometry and Air-conditioning — Psychrometric properties of air and water vapour mixtures, smart cooling systems, summer, winter and centralized air-conditioning systems,simple cooling load and heating load calculations.

List of Experiments **30 Hours**

1. Valve timing and Port timing diagrams
2. Performance test on single cylinder, four stroke diesel engine
3. Performance and emission test on single cylinder, four stroke VCR diesel engine
4. Performance test on centrifugal air blower
5. Performance test on two-stage reciprocating air compressor
6. Determination of COP of refrigeration system
7. Determination of viscosity of lubricating oil using Redwood viscometer

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Analyze the performance of thermodynamics systems using first and second law analysis	Apply
CO2: Evaluate the thermodynamic characteristics of IC engines	Apply
CO3: Evaluate the performance characteristics of air compressors, refrigeration and air Conditioning systems.	Apply
CO4: Study a domestic/industrial refrigerating unit and present a report about its working principle, major components, technical specifications, critical factors affecting its thermal performance and various energy conservation opportunities for improving its performance as a team.	Analyze
CO5: Present a case study of comparing smart cooling systems with conventional air-conditioning systems with respect to construction, working principle, performance, cost and environmental impact as a team.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	3	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	3	-	3	2	-	3	3	-	3	-	-
CO5	3	3	-	3	-	3	3	-	3	3	-	3	-	-

Text Book(s):

T1. P.K.Nag, "Engineering Thermodynamics", Mc Graw Hill, 6^{th} edition, 2017.

T2. R.K.Rajput, "Thermal Engineering", Laxmi Publications (P) Ltd., New Delhi, 10^{th} edition, 2020.

Reference Book(s):

R1. Yunus A Cengel, Michael A Boles and Mehmet Kanoglu. "Thermodynamics – An Engineering Approach", Mc Graw Hill, 9^{th} edition, 2019.

R2. Mahesh M.Rathore, "Thermal Engineering", Ta Mc Graw Hill, 3^{rd} edition, 2013.

Web Reference(s):

1. https://nptel.ac.in/courses/112106419
2. https://nptel.ac.in/courses/112107216
3. https://nptel.ac.in/courses/112106310

<table>
<tr><td>Course Code: 23MET302</td><td colspan="3">Course Title: FLUID MECHANICS AND HYDRAULICS MACHINERY
(Common to ME & AU)</td></tr>
<tr><td colspan="2">Course Category: Major</td><td colspan="2">Course Level : Intermediate</td></tr>
<tr><td>L:T:P(Hours/Week)
2: 1:0</td><td>Credits: 3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to enable the impart knowledge on laws of fluid mechanics and evaluate pressure, velocity and acceleration fields for various fluid flows and performance parameters for hydraulic machinery.

Module I **24 Hours**

Fluid properties

Fluid- definition, classification of fluids, units and dimensions, Properties of fluids- density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, capillarity and surface tension.

Flow characteristics

Continuity equation and Bernoulli’s equation, Application- venturi meters, orifice meters, Pitot tube, flow through pipes.

Laminar flow- boundary layer concepts, boundary layer thickness, Turbulent flow –losses- Darcy-Weisbach equation, Friction factor and Moody diagram, Minor losses, Flow through pipes in series and in parallel, Hydraulic and energy gradient.

Module II **21 Hours**

Dimensional analysis and Model analysis

Dimensional analysis- Need and methods - Buckingham's π theorem. Similitude, types of similitude, Dimensionless parameters, application of dimensionless parameters, Model analysis.

Pumps

Classification of pumps- Centrifugal pump- working principle, velocity triangles, Efficiencies and performance curves. Reciprocating pump- classification, working principle, indicator diagram, Air vessels and performance curves , Dismantle and assembly of various types of pumps.

Turbines

Classification of turbines, heads and efficiencies, velocity triangles, Pelton, Francis and Kaplan turbines, working principle and construction, work done by water on the runner, draft tube, performance curves, governing of turbines.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply mathematical knowledge to predict the properties and characteristics of a fluid.	Apply
CO2: Calculate the major and minor losses associated with pipe flow in piping networks.	Apply
CO3: Prepare and present a demonstrate on the dismantle and assembly of various types of pumps	Apply
CO4: Select a suitable hydraulic turbine and pump for the customer specifications	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	3	-	-	-	3	2
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-

Text Book(s):

T1 Bansal, R.K., “Fluid Mechanics and Hydraulics Machines”, Laxmi Publications

(P) Ltd., New Delhi,Ninth Edition, 2017.

T2 YunusCengel, John Cimbalal , “Fluid Mechanics- Fundamentals and Applications”, Tata McGraw-Hill Education, 2014.

Reference Book(s):

R1. White, F.M., "Fluid Mechanics", 5th Edition Tata McGraw-Hill,New Delhi, 2013 R2.

Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", 9th Edition McGraw-Hill education,2017.

R3. Kumar, K.L., "Engineering Fluid Mechanics", 7th edition Eurasia Publishing House (P)Ltd., New Delhi, 2014.

Web Reference(s):

1. https://nptel.ac.in/courses/112104118

2. https://nptel.ac.in/courses/112105171

Course Code: 23MET303	Course Title: MANUFACTURING PROCESSES (Common to ME & AU)		
Course Category: Major	Course Level: Intermediate		
L:T:P(Hours/Week): 3:0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course objectives

The course aims to empower students to effectively apply concepts of manufacturing process.

Module I **22 hours**

Casting process - Introduction, Types, Sand casting - Solidification and Cooling, Patterns, Molds and Cores, Gating system and functions, Runner and riser, Die casting, Centrifugal casting, Casting defects. Moulding of Plastic Components - Injection molding, Blow molding, Compression molding, Molding defects, Testing and inspection of casting.

Forming process Introduction, Types, Fundamentals of Hot and Cold Working Processes, Plastic Deformation and Yield Criteria, Load Estimation for Bulk (Forging, Extrusion, Rolling, and Drawing) and Sheet metal (Blanking, Piercing, Bending, Drawing) forming processes, Explosive Forming, Electro - hydraulic forming, Defects, Introduction of Powder Metallurgy process.

Joining Process - Operating principle, basic equipment, Electrodes and its Coatings, Manual metal arc welding, Gas Tungsten arc welding, Gas metal arc welding, Submerged arc welding, Gas welding, Flame characteristics, Resistance welding, Weld defects, Brazing and soldering, Testing of welded joints.

Module II **23 hours**

Theory of metal cutting - Types of chips, oblique cutting, orthogonal cutting, cutting forces, cutting tools nomenclature, tool wear, tool life, machinability, cutting tool materials, surface finishand machinability, cutting fluids.

Machining Processes: Centre lathe - Constructional features, operations – machining time and power estimation. Drilling machine - Constructional features, operations. Milling machine - Constructional features, operations. Abrasive processes: grinding wheel, specification. Grinding process cylindrical grinding, surface grinding, centerless grinding- dressing, truing and balancing of grinding wheels. process parameters and process planning.

Advanced Manufacturing Methods: EDM, 3D Printing, Digital Manufacturing – Application and Advantages, Automation and Robotics in Manufacturing.

Course Outcomes:

At the end of this course, students will be able to:

CO1: Select appropriate manufacturing processes for the specified design requirement.	Apply
CO2: Estimate the process parameters for forming of bulk, sheet metal Components.	Apply
CO3: Calculate the process parameters for the machining of circular and prismatic components.	Apply
CO4: Prepare and present a process plan for manufacturing the specified design requirement as a team.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	2	2	-	3	3	2	3	-	-

Text Book(s):

1. Hajra Choudhury S.K, Hajra Choudhury. AK., and Nirjhar Roy "Elements of workshop Technology volume I: Manufacturing Processes", Media promoters and Publishers PrivateLimited, 2023
2. Kalpakjian. S, Steven R. Schmid, "Manufacturing Engineering and Technology", PearsonEducation India, 8th edition, 2023
3. Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", 4th Edition, McGraw Hill Education (India) Private Limited, 2018.

Reference Book(s):

1. Hajra Choudhury S.K and Nirjhar Roy, "Elements of workshop Technology

volume II:MachineTools", Media promoters and Publishers Private Limited, 2023.

2. Rao, P.N. "Manufacturing Technology - Foundry, Forming and Welding", 4th Edition,McGrawHill Education (India) Private Limited, 2018.
3. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014.

Web References:

1. https://archive.nptel.ac.in/courses/112/107/112107219/
2. https://onlinecourses.nptel.ac.in/noc22_me28/preview

<table>
<tr><td>Course Code: 23MEL301</td><td colspan="3">Course Title: MANUFACTURING PROCESSES LABORATORY
(Common to ME & AU)</td></tr>
<tr><td>Course Category: Major</td><td colspan="3">Course Level: Intermediate</td></tr>
<tr><td>L:T:P(Hours/Week)
0:0:3</td><td>Credits: 1.5</td><td>Total Contact Hours: 45</td><td>Max. Marks: 100</td></tr>
</table>

Course Objectives

To study and practice the various operations that can be performed in lathe, drilling, milling, grinding, pressing etc. and to equip with the practical knowledge required in the core industries.

List of Experiments:

1. Make a sand mold using the given pattern.
2. Make a component as per the drawing using Hydraulic / Mechanical Press.
3. Join the given thick metal sheets using suitable welding process.
4. Make a shaft as per the drawing using the lathe machine.
5. Make a hole as per the drawing using drilling machine.
6. Perform the milling operation on the part as per the drawing using Vertical milling machine
7. Perform the milling operation on the part as per the drawing using Horizontal milling machine
8. Perform grinding operation on the shaft as per the drawing
9. Perform surface grinding operation as per the drawing
10. Assemble the parts to produce a product as per the drawing.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Select suitable process parameter and prepare process planning sheet for the components in the given drawing.	Apply
CO2: Produce a product as per the given dimensions using various manufacturing processes.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	3	2	-	-	2	-	-	-	-	-	-

Reference Book(s):

1. Hajra Choudhury S.K, Hajra Choudhury. AK., and Nirjhar Roy "Elements of workshop Technology volume I: Manufacturing Processes", Media promoters and Publishers PrivateLimited, 2023
2. Kalpakjian. S, Steven R. Schmid, "Manufacturing Engineering and Technology", PearsonEducation India, 8th edition, 2023
3. Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", 4th Edition, McGraw Hill Education (India) Private Limited, 2018.
4. Hajra Choudhury S.K and Nirjhar Roy, "Elements of workshop Technology volume II: Machine Tools", Media promoters and Publishers Private Limited, 2023.
5. Rao, P.N. "Manufacturing Technology - Foundry, Forming and Welding", 4th Edition, McGrawHill Education (India) Private Limited, 2018.
6. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014.

Web References:

1. https://archive.nptel.ac.in/courses/112/107/112107219/
2. https://onlinecourses.nptel.ac.in/noc22_me28/preview

Course Code: 23MEL302		Course Title: FLUID MECHANICS AND HYDRAULICS MACHINERY LABORATORY (Common to ME & AU)	
Course Category: Major		Course Level : Intermediate	
L:T:P(Hours/Week) 0:0:3	Credits: 1.5	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to provide practical knowledge in verification of principles of fluid flow, pressure, discharge and velocity of fluid flow, Major and Minor Losses and gain knowledge in performance testing of Hydraulic Turbines and Hydraulic Pumps at constant speed and Head.

List of Experiments: **45 Hours**

1. Determination of coefficient of discharge of given Orifice meter.
2. Determination of coefficient of discharge of given Venturi meter.
3. Determination of the velocity of flow using Pitot Tube
4. Determination of friction factor of given set of pipes.
5. Performance study of Centrifugal pumps
6. Performance study of curves of Gear pump.
7. Performance study of reciprocating pumps.
8. Performance characteristics of a Pelton wheel.
9. Performance test on a Francis Turbine.
10. Performance test on a Kaplan Turbine

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1:Determine the actual and theoretical discharge of fluid flow using various flow measuring devices.	Apply
CO2: Determine friction factor and Reynolds Number for a fluid flow through pipe.	Apply
CO3: Conduct performance tests and draw the characteristics curves of pumps and turbines	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	2	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	2	2	-	-	-	2	-	-	-	3	2

Text Book(s):

T1 Bansal, R.K., “Fluid Mechanics and Hydraulics Machines”, Laxmi Publications (P) Ltd., NewDelhi, Ninth Edition, 2017.

T2 YunusCengel, John Cimbalal , “Fluid Mechanics- Fundamentals and Applications”, Tata McGraw-Hill Education, 2014.

Reference Book(s):

R1. White, F.M., "Fluid Mechanics", 5th Edition Tata McGraw-Hill,New Delhi, 2013 R2.

Streeter, V.L., and Wylie, E.B., "Fluid Mechanics", 9th Edition McGraw-Hill education,2017.

Web References:

1. https://nptel.ac.in/courses/112104118
2. https://archive.nptel.ac.in/courses/112/106/112106311/
3. https://www.youtube.com/watch?v=8iZe_UiBtTc&list=PLZ5iF05Ly-kgGWarGh0iIdUIu4cz7Hrdw

Course Code: 23ESL301		Course Title: PROFESSIONAL SKILLS 2: PROBLEM SOLVING SKILLS & LOGICAL THINKING 2 (Common to all B.E/B.Tech programmes)	
Course Category: SEC		**Course Level : Intermediate**	
L:T:P(Hours/Week) 0: 0: 2	**Credits: 1**	**Total Contact Hours:30**	**Max Marks:100**

Course Objectives:

The course is intended to enhance the students' numerical, analytical and logical reasoning ability. Also course focus to make learners prepare for various public and private sector exams and placement drives.

Module I Quantitative Ability 20 Hours

Time and work –Pipes and cisterns- Time Speed Distance-Problems on Trains-Boats and Streams- Permutation and Combination-Probability, Menstruation- Heights and distance-Logarithms- Clocks and Calendars Data Sufficiency

Module II Reasoning Ability 10 Hours

Number & Alpha series- Odd man out-Coding and Decoding-Syllogisms- Problems on Cubes and Dices- Logical Venn diagram -Visual Reasoning- Element & logical series- Analogies.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Enhance their problem solving skills & Logical thinking Skills	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	3	-	-

Text Book(s):

T1: Dr. R. S. Aggarwal. "Quantitative Aptitude for Competitive Examinations" Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018.

T2: Dr. R. S. Aggarwal. "A Modern Approach to Logical Reasoning", Sultan Chand & Sons Pvt. Ltd, New Delhi, 2018

Reference Book(s):

R1: R. V. Praveen. “Quantitative Aptitude and Reasoning” 2nd Revised Edition, Prentice-Hall of India Pvt.Ltd, 2013

R2: Arun Sharma. “Quantitative Aptitude for Common Aptitude Test”, McGraw Hill Publications, 5th Edition, 2020

R3: Arun Sharma. “Logical Reasoning for Common Aptitude Test”, McGraw Hill Publications, 6th Edition, 2021.

Web References:

1 https://www.indiabix.com/aptitude/questions-and-answers/

2 https://www.geeksforgeeks.org/aptitude-questions-and-answers/

<table>
<tr><td rowspan="1">Course Code:23VAT301</td><td colspan="3">Course Title: UNIVERSAL HUMAN VALUES 2 : UNDERSTANDING HARMONY
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="2">Course Category: VAC</td><td colspan="2">Course Level: Intermediate</td></tr>
<tr><td>L:T:P (Hours/Week) 2: 1: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max. Marks:100</td></tr>
</table>

Pre-requisites

- Induction Program

Course Objectives

The course is intended to:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Strengthening of self-reflection
3. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
4. Development of commitment and courage to act
5. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.

Unit I Introduction to Value Education 9 Hours

Need for the Value Education;. Self -exploration as the process for value education ; Continuous Happiness and Prosperity: A look at basic Human Aspirations; Right understanding: Relationship and Physical Facilities ; Happiness and Prosperity: current scenario ; Method to fulfill the Basic human aspirations

Unit II Harmony in Human Being 9Hours

Human being as a co-existence of self (‘I’) and the material ‘Body’; needs of Self ('I') and 'Body'; The Body as an instrument of 'I' ; Harmony in the self(‘I’); Harmony of the self(‘I’) with body ;Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Swasthya.

Unit III Harmony in the Family and Society 9Hours

Harmony in the Family the basic unit of human interaction; Values in human to human relationship;Trust as the foundational values of relationship; Respect as the right evaluation ;Understanding harmonyin the society (society being an extension of family); Vision for the universal human order.

Unit IV Harmony in the Nature 9 Hours

Understanding the harmony in the Nature Interconnectedness, self-regulation and mutual fulfillment among the four orders of nature; Existence as Co-existence at all levels; Holistic perception of harmony in existence.

Unit V Harmony on Professional Ethics 9 Hours

Natural acceptance of human values ;Definitiveness of Ethical Human Conduct; Basic for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics ;Case study: holistic technologies, management models and production systems ;Strategy for transition towards value based life and profession.

Course Outcomes At the end of this course, students will be able to:	**Affective Level**
CO1. Reflect on values, aspiration, relationships and hence identify strengths and weaknesses.	Responding
CO2. Appraise physical, mental and social well being of self and practice techniques to promote well being.	Responding
CO3. Value human relationships in family and society and maintain harmonious relationships.	Valuing
CO4. Respect nature and its existence for survival and sustainable of all life forms and hence practice conservation of nature	Valuing
CO5. Appreciate ethical behaviour as a result of value system in personal and professional situations	Receiving

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	1	2	2	-	-	2	-	-
CO2	-	-	-	-	-	1	2	2	2	1	-	2	-	-
CO3	-	-	-	-	-	2	2	2	2	1	-	2	-	-
CO4	-	-	-	-	-	2	2	2	2	-	-	2	-	-
CO5	-	-	-	-	-	1	2	2	2	-	-	2	-	-

Text Book(s):

T1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, NewDelhi, 2010.

Reference Book(s):

R1.Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.

R2.Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004. R3. The story of stuff, Annie Leonard, Free Press, New York 2010.

Web References:

1 https://aktu.ac.in/hvpe/ResourceVideo.aspx

2 http://hvpenotes.blogspot.com/

3 https://nptel.ac.in/courses/109/104/109104068/

SEMESTER IV

<table>
<tr><td colspan="2">Course Code: 23MAT401</td><td colspan="2">Course Title: PROBABILITY AND STATISTICS
(Common to EC, EE, ME, AU, CS, AM, SC, IT &EV)</td></tr>
<tr><td colspan="2">Course Category: Minor</td><td colspan="2">Course Level: Intermediate</td></tr>
<tr><td>L: T: P (Hours/Week)
3:1:0</td><td>Credits: 4</td><td>Total Contact Hours:60</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

This course aims at helping the students to gain knowledge on random variables, probability distributions and hypothesis testing for data.

Module I **22+8 Hours**

Probability and Random Variables: Axioms of Probability- Conditional Probability- Total Probability -Baye's Theorem- Random Variables-One Dimensional Randon variables- Probability Mass Function- Probability Density Functions- Properties - Moments- Moment generating functions and their properties- Two Dimensional Random Variables - Joint distributions-Marginal and conditional distributions-Covariance-Correlation and linear regression using least square method – Transformation of random variables.

Standard Distributions: Discrete Distributions - Binomial- Poisson- Properties, Moment generating functions -Continuous Distribution-Uniform- Exponential-Normal Distributions and their properties.

Module II **23+7 Hours**

Testing of Hypotheses: Sampling distributions, Estimation of parameters, Statistical hypothesis, Large sample test based on Normal distribution for single mean and difference of means, Tests based on t-test, Chi-square distributions and F distributions for mean, variance and proportion, Contingency table (test for independent), Goodness of fit.

Design of Experiments: Analysis of Variance (ANOVA) - One-way Classification – Completely Randomized Design (CRD) – Two-way Classification – Randomized Block Design (RBD) – Latin square.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Demonstrate the concepts of probability theory to engineering problems.	Understand
CO2: Calculate the expected values, variances and correlation coefficient of random variables	Apply
CO3: Use the theoretical discrete and continuous probability distributions in the relevant application areas.	Apply
CO4: Apply the concepts of testing the hypothesis and design of experiments to solve real life problems.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	-	-	1	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	1	-	-	-	-	-	-	-	-	1	-	-	-	-

Text Book(s):

T1. Veerajan T, “Probability, Statistics and Random process”, 3rd Edition, Tata McGraw-Hill, New Delhi, 2017.

T2. Dr.J.Ravichandran, “Probability and Statistics for Engineers”, 1stEdition, Wiley India Pvt. Ltd., 2010.

Reference Book(s):

R1. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, “Probability and Statistics for Engineers and Scientists”, 9th Edition Pearson Education, Asia, 2013.

R2. M.R. Spiegel, J. Schiller and R.A. Srinivasan, “Schaum's Outlines Probability and Statistics”, 4th Edition Tata McGraw Hill edition, 2012.

R3. Morris DeGroot, Mark Schervish, “Probability and Statistics”, Pearson Educational Ltd,4th Edition, 2014, India.

Web References:

1 https://archive.nptel.ac.in/courses/111/105/111105090/

2. https://archive.nptel.ac.in/courses/111/105/111105041/

Course Code: 23MET401		Course Title: STRENGTH OF MATERIALS (Common to ME & AU)	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to provide knowledge in mechanics of materials so that the students can solve real engineering problems and design engineering systems.

Module I **23 Hours**

Deformation of Solids and Bi-axial State of Stress: Stress and Strain-Types - Hooke's law - Factor of Safety - Poisson's ratio. Deformation of simple and compound bars under axial load. Strain energy - resilience, proof resilience and modulus of resilience - Strain energy due to axial load. Stresses due to gradual load, sudden load and impact load. Principal planes and stresses- Maximum shear stress and planes of maximum shear stress - Mohr's circle.

Flexure in Beams and Deflection of Beams: Theory of simple bending - Bending stress and Shear stress variation in beams of standard section like 'I', 'L' and 'T'. Evaluation of beam deflection and slope for cantilever and simply supported beams- Macaulay and Moment-area methods.

Thin-wall pressure vessels: Longitudinal Stress, Hoop stress - application - Stresses and Strain in cylindrical thin shells.

Module II **22 Hours**

Theories of Failure: Introduction to theories of failure - Maximum Principal Stress theory

- Maximum Principal Strain theory - Maximum Strain Energy Theory - Maximum Distortion Energy theory - Maximum Shear Stress theory.

Shafts and Springs: Theory of torsion and assumptions - torsion equation- polar moment of inertia and polar modulus - Shear stress distribution in solid and hollow circular shafts, Equivalent bending moment and equivalent twisting moment, Stresses in circular shaft with combined bending, axial loading and torsion.

Helical compression springs - terminology, types of end - stress and deflection equation.

Leaf springs - terminology - stress and deflection equation - Nipping of leaf springs.

Columns and Struts: Introduction, short and long columns. Euler's theory; Assumptions, Derivation for Euler's Buckling load for different end conditions, Limitations of Euler's theory. Rankine-Gordon's formula for columns.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the concepts of stresses at a point in a material of structural elements.	Apply
CO2: Select the appropriate theories of failure for the materials.	Analyze
CO3: Evaluate the behavior of torsional members and deflection in beam members.	Apply
CO4: Evaluate the behavior of columns and struts.	Apply
CO5: Present an oral presentation on terms involved in stresses induced and failure of the given component**.**	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	3	-	-	-	-	-

Text Book(s):

T1. F. Beer, E. R. Johnston, J. De Wolf, ―Mechanics of Materials, Tata McGraw-Hill Publishing Company Limited, New Delhi, Indian 1st Edition, 2008.

T2. S. S. Rattan, ―Strength of Materials, Tata McGraw-Hill Publishers, 4th Edition, 2011.

Reference Book(s):

R1. R. K. Rajput, ―Strength of Materials: Mechanics of Solids, S. Chand & Co Limited, New Delhi, 3rdEdition, 2007.

R2. S. S. Bhavikatti, ―Strength of Materials, Vikas Publishing House Pvt. Ltd., New Delhi, 3rd Edition,2013.

Web References:

1. https://nptel.ac.in/courses/112107146

2. https://nptel.ac.in/courses/112106141

Course Code 23MET402		**Course Title : MECHANICS OF MACHINERY** (Common to ME & AU)	
Course category: Major		**Course level: Intermediate**	
L:T:P (hrs/week): 3:1:0	**Credits: 4**	**Total contact Hours: 60**	**Maximum Marks:100**

Course Objective

The course is intended to impart knowledge on mechanism/machine and its kinematics including vibration.

Module 1 **36 Hours**

Velocity and Acceleration in Simple Mechanisms: Basics of kinematics- Link- pair-chain-mechanisms. Configuration/kinematic diagram, degrees of freedom of planar mechanisms — Linear and angular velocities- absolute and relative velocities- rubbing velocity- tangential, radial and Coriolis components of acceleration, graphical method for determination of velocity and acceleration of the links in four bar mechanism and single slider crank mechanism.

Kinematics of cam: Types of cams, types of followers, radial cam, terminology of radial cam, types of follower motions: uniform velocity motion, simple harmonic motion, constant acceleration/deceleration motion, cycloidal motion, construction of cam profile for knife edge, roller and flat faced followers — Graphical method.

Gear Kinematics: Types of gears- Spur, Helical, Bevel and worm gear –its terminologies, law of gearing, Classification of gear trains, calculation of Gear ratio, number of teeth for the gears in the gear trains, velocities of the gears in gear trains such as Simple, Compound, Reverted & Epicyclic (using tabulation method) gear trains, Differential gear train (theory only).

Module II **24 Hours**

Mechanism for Control: Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization– Gyroscopic effects in Automobiles

Balancing of masses: Static and dynamic balancing - Balancing of rotating masses – Balancing of single rotating mass, Balancing of several masses in single or several planes- Balancing of reciprocating masses (Introduction only).

Vibration: Introduction- Terminology- types of vibrations- Types of free vibration- Natural frequency of free longitudinal, transverse and torsional vibrations. Effect of inertia- natural frequency of free transverse vibration due to point load on a simply supported shaft. Introduction to Critical speed and damping. Torsion vibration in single, two and three rotor system- Torsion ally equivalent shaft.

Course Outcome	**Cognitive level**
At the end of the course the students will be able to	
CO1: Calculate the kinematics parameters of simple mechanisms, Cam , gear and gear trains	Apply
CO2: Estimate the gyroscopic effect on automobiles	Apply
CO3: Determine the balancing masses required for balancing rotating masses in single or several planes.	Apply
CO4: Determine the natural frequency of a free longitudinal, transverse and torsional vibrating system.	Apply
CO5: Form teams and develop a model of a simple mechanism and demonstrate its working both written and orally.	Evaluate

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	2	-	-	-	-	-	3	3	-	-	-	-

Text Book(s):

1. Rattan S.S., "Theory of Machines", 4th Edition, McGraw Hill Education, New Delhi, 2017.
2. Kurmi.R.S., Textbook Of Theory of Machines, 5TH Edition, S.CHAND, 2020.

Reference Book(s):

1. Norton R.L., "Kinematics and Dynamics of Machinery", Special Indian Edition, McGraw Hill Education,New Delhi, 2017.

2. Shigley J.E, Pennock G.R, Uicker J.J Cornwell & Sanjeev Sanghi., "Theory of Machines and Mechanisms",5^{th} Edition, Oxford University Press, Oxford, 2017.

3. Dayvid H Myszka, —Machines and Mechanisms Applied Kinematic Analysis, Pearson Prentice Hall, 2012.

Web Reference(s):

1. https://onlinecourses.nptel.ac.in/noc23_me64/preview
2. https://onlinecourses.nptel.ac.in/noc23_me36/preview
3. https://kdm-iitkgp.vlabs.ac.in/

Course Code: 23MET403		Course Title: DESIGN THINKING	
Course Category: Major		**Course Level: Intermediate**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

This course intended to give knowledge on basics of design thinking including empathize, define, ideate, prototyping, testing and implementation.

Module I **23 Hours**

Introduction- Importance of Design Thinking, Human Centered Design, Six-Step Design Thinking Process Empathize- Design Thinking Methodologies, Traits of Design Thinker, Integrate Empathy and Understanding into Design Thinking Process and understanding customer needs.
Define- Uncover Opportunities, definition of a Good Problem Statement, 5W+1H Questions, define needs through the stages of Design Thinking process.
Ideate- Ideating, Metrics, Creative Ideation and Pattern Recognition and Creative Thinking Techniques. Iterative Design and a case study.

Module II **22 Hours**

Prototyping- Proof of Concept, Prototype Methodologies, Critical Stages in Prototyping, MVP, stages in New Product Development, types of Prototypes, innovation-types of innovation, Tools- concept sketching, CAD , Mechatronics, Augmented and Virtual Reality and 3D printing.

Testing- Testing in realtime, market potential, market segmentation, market sizing- TAM- SAM-SOM-EVG Implementing- Implement a solution, redesign and design for X.

Course Outcomes	**Cognitive Level**
At the end of the course students will be able to	
CO1: Apply the principle of design thinking to empathize a need, define a problem and ideate a solution.	Apply
CO2: Apply the fundamentals of prototyping, testing of a concept for real time application.	Apply
CO3: Implement a design thinking approach by forming a team and presenting an idea.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	3	-	2	2	3	3	-	-	-	-

Text Book(s):

T1. Sabell Osann, Lena Mayer , Inga Wiele ,The Design Thinking Quick Start Guide: A 6-Step Processfor Generating and Implementing Creative Solutions, Wiley, 2020.

T2. Christian Müller-Roterberg, Handbook of Design Thinking, Kindle Direct Publishing,2018.

Reference Book(s):

R1. Teun den Dekker, Design Thinking, Taylor & Francis, International edition, 2020.

R2. Kaushik Kumar, Divya Zindani, J.Paulo Davim, Design Thinking to Digital Thinking, Springer, 2019.R3.S. Balaram, Thinking Design, SAGE Publications, 2011.

Web Reference(s):

1. https://onlinecourses.nptel.ac.in/noc22_mg32/preview
2. https://onlinecourses.nptel.ac.in/noc23_me52/preview

Course Code: 23MEI401		Course Title: METROLOGY AND MEASUREMENTS	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 2: 0: 2	Credits:3	Total Contact Hours: 60	Max Marks:100

Course Objectives:

The course is intended to develop capacity to select the appropriate measuring instrument for the given application and to impart knowledge on the advanced measuring instruments and also applications of tolerances and fits.

Module I **23 Hours**

MEASUREMENT SYSTEM

Basics of Metrology: Measurement – Need, Process, Role in quality control; Factors affecting measurement-SWIPE, Precision and Accuracy, Standards-types of standards, Errors in Measurements-Types, Control, Measurement uncertainty-Types, Estimation, Calibration of measuring instruments.

Tolerance Analysis: Tolerancing, Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.

Measurement Of Power, Flow and Temperature: Force, torque, power-Mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement- rotameter, Temperature-bimetallic strip, thermocouples, electrical resistance thermometer, Reliability and Calibration, Readability and Reliability.

Module II **22 Hours**

Metrology

Measurement Of Linear, Angular Dimensions and Form Measurements: Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge, Gauges, Comparators-Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector, Angular measuring instruments-Bevel protractor, Clinometer, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Principles and Methods of straightness, Flatness measurement, Thread measurement, gear measurement, surface finish measurement, Roundness measurement and Applications.

Advances in Metrology: Lasers in metrology, Advantages of lasers, Laser scan micrometers, Laser interferometers – Applications, Computer Aided Metrology, Basic concept of CMM, Types of CMM, Constructional features – Probes , Accessories, Software and Applications. Machine Vision– Basic concepts of Machine Vision System-Elements – Applications - On-line and in-line process monitoring in production - Computed tomography – White light Scanners and Blue light scanner.

List of Experiments **30 Hours**

1. Measure the dimension of the given component using Vernier Caliper
2. Determine the diameter of a cylindrical component of accuracy 0.01 mm using Micrometer
3. Measure the thickness of gear tooth using Gear Tooth Vernier
4. Measure the height of the given component using Vernier Height Gauge
5. Measure the thread parameter using Profile Projector.
6. Measure the dimensions of components in the given mechanical assembly and prepare bill of materials.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the concepts of measurements to apply in various metrological instruments.	Apply
CO2: Apply the principle of basic and advanced metrology to measure the various parameters for the given applications	Apply
CO3: Perform the tolerance analysis for various applications	Analyze
CO4: Conduct an experiment to measure the real life application using the appropriate instruments/tools related to the concepts of basic measuring instrument and prepare the bill of material as a team.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	2	-	-	-	-	2	-	-	-	-	-
CO3	3	2	-	2	-	-	-	-	3	-	-	-	-	-
CO4	3	3	-	2	-	-	-	-	3	-	-	-	-	-

Text Book(s):

T1. Dotson Connie, —Dimensional Metrology, Cengage Learning, First edition, 2012.

T2. Mark Curtis, Francis T. Farago, —Handbook of Dimensional Measurement, IndustrialPress, Fifth edition, 2013.

Reference Book(s):

R1. Ammar Grous, J —Applied Metrology for Manufacturing Engineering, Wiley-ISTE, 2011.

R2. Galyer, J.F.W. Charles Reginald Shot bolt, —Metrology for Engineers, Cengage Learning EMEA; 5th revised edition, 1990.

R3. 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.

Web Reference(s):

1. https://onlinecourses.nptel.ac.in/noc19_me70/preview
2. https://www.classcentral.com/course/swayam-engineering-metrology-14037

Course Code: 23MEL401		Course Title: STRENGTH OF MATERIALS & MECHANICS OF MACHINERY LABORATORY (Common to AU,ME)	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 0:0:3	Credits: 1.5	Total Contact Hours: 45	Max. Marks: 100

Course Objectives

To provide hands on training for testing the mechanical strength of materials and determining the kinematic parameters of machines such as velocity, acceleration, frequency etc.

List of Experiments:

Strength of Materials Laboratory

1. Conduct tensile test on the given mild steel rod using universal testing machine.
2. Determine the maximum shear strength of Mild steel / Aluminium rod by Double shear test.
3. Calculate the modulus of rigidity of mild steel rod by Torsion test.
4. Determine the toughness of the given mild steel specimen using IZOD and CHARPY impact test.
5. Estimate the stiffness and modulus of rigidity of the helical spring by Compression test.

List of Experiments:

Mechanics of Machines Laboratory

1. Draw the velocity and acceleration diagram for the given configuration for four bar/slider crank mechanism and verify the same with Vlab
2. Balance the unbalance mass available in a single and multiple planes in the rotor and verify the same with VLab
3. Find the natural frequency of the spring mass system

4. Find the torsional frequency of the two rotor system
5. Find the gear ratios of the given gear train and verify the same with theoretical values
6. Determine the experimental and theoretical values of critical (or) whirling speed of a given shaft.
7. Draw the profile of the cam and find the jump speed
8. Demonstration of use of FFT analyzer in vibration measurement

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Form a team and evaluate tensile, shear, impact strength and stiffness of the given test specimen experimentally and compare the results with virtual lab.	Evaluate
CO2: Determine the velocity and acceleration of a simple mechanisms, jump speed of the given cam mechanism and gear ratio of the simple gear train.	Apply
CO3: Analyze the natural frequencies of longitudinal, transverse, and torsional systems, and Interpret the significance of vibration measurement in mechanical systems through both written and oral explanations.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	3	-	-	-	-	3	-	-	-	-	-
CO2	3	3	-	3	-	-	-	-	3	-	-	-	-	-
CO3	3	3	-	3	-	2	2	-	3	-	-	-	-	-

Reference Book(s):

1. S. S. Bhavikatti, ―Strength of Materials‖, Vikas Publishing House Pvt. Ltd., NewDelhi, 5thEdition, 2021.

2. R. K. Rajput, ―A Text book of Strength of Materials‖, S. Chand & Co Limited, New Delhi,Revised Edition, 2018.

3. Rattan S.S., "Theory of Machines", 4th Edition, McGraw Hill Education, New Delhi, 2017.

4. Norton R.L., "Kinematics and Dynamics of Machinery", Special Indian Edition, McGraw HillEducation , New Delhi, 2017.

5. Shigley J.E, Pennock G.R, Uicker J.J Cornwell & Sanjeev Sanghi., "Theory of Machines andMechanisms", 5th Edition, Oxford University Press, Oxford, 2017.

Web References:

1. https://sm-nitk.vlabs.ac.in/
2. https://dom-nitk.vlabs.ac.in/
3. https://mdmv-nitk.vlabs.ac.in/
4. https://mm-nitk.vlabs.ac.in/
5. https://va-coep.vlabs.ac.in/

Course Code: 23MEL402		Course Title: COMPUTER AIDED MACHINE DRAWING LABORATORY	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 0:0:3	Credits: 1.5	Total Contact Hours: 45	Max. Marks: 100

Course Objectives

To provide hands on training on model preparation of orthogonal views of machine components, assembled components, and apply the standard design practice by using fits and tolerance for real time application.

List of Experiments:

1. Prepare Part modelling of knuckle joint
2. Prepare Part modelling of Screw jack.
3. Prepare Part modelling of Bush pin type flange coupling
4. Prepare assembly drawing of knuckle joint
5. Prepare assembly drawing of Screw jack.
6. Prepare assembly drawing of Bush pin type flange coupling
7. Tear down the given product and measure critical dimensions and prepare part and assembly drawing.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Develop the part models and assembled drawing of machine components as per the design specification.	Apply
CO2: Create a product model for the given machine components using modeling software.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	2	-	3	-	-	-	3	-	-	-	3	-
CO2	3	2	2	-	3	-	-	-	3	-	-	-	3	-

Reference Book(s):

1. K L Narayana, P Kannaiah,K Venkata reddy , Machine Drawing 5th Edition, Newageinternational (p) limited, publishers, New Delhi,2016
2. Gopalakrishna K.R. —Machine Drawing, 22 nd Edition, Subhas Stores Books Corner, Bangalore,2013.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 TataMc GrawHill,2006
5. S. Trymbaka Murthy, A Text Book of Computer Aided Machine Drawing ,CBS Publishers,New Delhi, 2007

Web References:

1. https://nptel.ac.in/courses/112105294
2. https://archive.nptel.ac.in/courses/

Course Code: 23ESL401		Course Title : PROFESSIONAL SKILLS 3 : PROFESSIONAL DEVELOPMENT AND ETIQUETTE (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		**Course Level: Intermediate**	
L:T:P(Hours/Week) 0: 0: 2	**Credits: 1**	**Total Contact Hours:30**	**Max Marks:100**

Course Objectives:

The course is intended to cultivate students' appropriate etiquette across various personaland professional contexts, fostering professionalism and effective communication.

Module I **15 Hours**

Emotional Intelligence

Intrapersonal Skill: Goal Setting- Self-management- Emotional Intelligence: Understanding & Developing EI for Effective Communication and Relationships Enhancing Social Skills

Professional Development

Introduction to Professional Development - Career State Assessment - Set Career Goals- Stay on Industry Trends - Self & Lifelong learning – Creativity - Problem Solving Skills - Strong Fundamentals – Using/ Creating Opportunities – Work & Life Balancing - Revisiting Goals.

Teamness and Interpersonal skills

Paraphrasing: Techniques for Active Listening -Paraphrasing as a Tool for Effective Understanding and Communication-Collaboration and Team Building: Building Trust and Rapport - Self-paced learning.

Module II **15 Hours**

Effective Communication

Effective Verbal Communication - Assertive Communication - Elements of Effective Communication - Barriers to Effective Communication - Persuasion Skills - Effective Presentation: Oral and visual presentation – Drafting formal reports.

Professional Etiquette

Introduction - Types of professional Etiquette- Personal Grooming: Importance of Personal Grooming in Professional Settings- Dress Codes and Professional Appearance Guidelines- Body language - Social – Email – Telephonic – Dining

– Classroom - Business.

Activities:

- Emotional Intelligence: Scenario based role play, Debate
- Paraphrasing: Listening, Reading
- Effective Presentation:
  - Oral Presentation: Self-Introduction, JAM , Extempore speech
  - Visual presentation: Email Writing, Power Point Presentation, Vlog
- Professional Etiquette: Demonstrate required Professional Etiquette in all the above activities.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Communicate effectively and exhibit Professional etiquettes in various social forums.	**Apply**

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	-	-	2	2	3	-	1	-	-

Textbook(s):

T1. Sabina Pillai, Agna Fernandez, “Soft Skills & Employability Skills”, Cambridge University Press2018

T2. Peggy Post &Peter Post, “The Etiquette Advantage in Business: Personal Skills for ProfessionalSuccess”, 2nd edition (May 3, 2005), William Morrow.

Reference Book(s):

R1. Ashraf Rizvi, "Effective Technical Communication" 2nd Edition, McGraw-Hill India, 2018 R2.

Maithry Shinde, Jyotsna Sreenath, “Life Skills & Personality Development”, Cambridge UniversityPress 2022

Web References:

1. https://www.indeed.com/career-advice/career-development/etiquette-at-work
2. https://www.skillsyouneed.com/interpersonal-skills.html

Course Code: 23MEI501		Course Title: HEAT AND MASS TRANSFER	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 2: 0	Credits: 4	Total Contact Hours: 60	Max Marks 100

Course Objectives:

The course is intended to understand the mechanisms of heat transfer under steady state and transient conditions in order to design and optimize the

MODULE I **23 Hours**

Conduction: Basic concepts - Modes of heat transfer — Conduction, Convection and Radiation-Cartesian coordinate- Simple geometries-Plane wall, Cylinder, Composite wall and Composite cylinder – simple problems- Applications.

Fins – Types, Applications, Short fin end insulated, Short fin end not insulated and long fin —-Simple problems.

Convection: Basics — dimensionless numbers, boundary layer concepts - Forced Convection-external flow – flow over plates, cylinders – Simple problems, internal flow – flow through cylinders – simple problems- Applications.

Free convection — flow over horizontal plate, flow over vertical plate and flow through cylinders – simple problems.

Phase change heat transfer — boiling- pool and flow boiling - condensation — simple problems — Applications

MODULE II **22 Hours**

Heat exchangers: Classifications, applications - parallel flow, counter flow and cross flow- LMTD and NTU methods —-simple problems.

Radiation: Basic concepts — absorptivity, reflectivity and transmissivity — black body and grey body concepts —— Laws of radiation —— Stefan Boltzmann law, Kirchoff‟s law, Planck‟s law, Wien‟s law and Lambert‟s cosine law — shape factor algebra — between plates and discs — simple problems, Radiation shield — single and „n‟ number of shields — simple problems.

Mass Transfer: Basic concepts – properties of mixtures – mass concentration and mass fraction —— mole concentration and mole fraction —— diffusion mass transfer — Fick‟s law of diffusion — diffusion through plane membrane- simple problems - Applications.

List of Experiments **15 Hours**

1. Thermal conductivity measurement for composite wall.
2. Thermal conductivity measurement of pipe insulation using lagged pipe approach.
3. Thermal conductivity measurement of insulating powder using concentric sphere.
4. Determination of heat transfer coefficient under natural convection and forced convection.
5. Determination of Stefan Boltzman constant.
6. Determination of emissivity of the given plate.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Solve one dimensional steady state conduction heat transfer in simple geometries and fins.	**Apply**
CO2: Design heat exchanger for forced and natural convection under external and internal flows.	**Apply**
CO3: Estimate the radiation heat transfer between different sections	**Apply**
CO4: Estimate diffusion mass transfer through plane membrane.	**Apply**
CO5: Demonstrate a case study in a team for real time heat transfer applications.	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Text Book(s):

1. Kothandaraman C.P "Fundamentals of Heat and Mass Transfer" New Age International, New Delhi, Fourth edition, 2012
2. Nag P.K, " Heat Transfer", Tata McGraw-Hill, Third Edition, 2016
3. Yunus A.Cengel, Afshin J.Ghajar, "Heat and Mass Transfer" , McGraw-Hill, 4th edition, 2011.

Reference Book(s):

1. Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer" New Age International, Fifth edition, 2017.
2. Holman J.P "Heat and Mass Transfer" Tata McGraw-Hill, Tenth Edition, 2010.

Course Code:23MET501		Course Title: DESIGN OF MACHINE ELEMENTS	
Course Category: Major		Course Level: Intermediate	
L: T: P Hours/Week) 3:1: 0	Credits: 4	Total Contact Hours: 60	Max Marks:100

Course Objectives:

The course is intended to equip students to design machine elements such as shafts, keys, and couplings helical and leaf springs and bearings subjected to simple, combined static loads, fluctuating loads, and impact loads.

MODULE I **30 Hours**

DESIGN FOR STATIC LOAD OR STEADY STRESSES

Design Processes and its types, factor of safety - selection. Preferred numbers, Selection of materials and its properties, Fits and Tolerances - eccentric loading-stress due to eccentric loading, curved beams - problems

DESIGN FOR FLUCTUATING AND IMPACT LOADS

Fatigue, types, Endurance limit, modifying factors, relation between endurance limit, ultimate tensile strength and yield strength, problems on different fatigue loading conditions. Stress concentration, stress concentration factor, causes of stress concentration, method of reducing stress concentration, stress concentration factor for different material configuration. Notch sensitivity, factors affecting of notch sensitivity. Impact loading, shock loading, simple problems

DESIGN OF SHAFTS AND KEYS

Difference between shaft, axle and spindle, Shaft materials, criteria of shaft design, different transmitting elements on a shaft, shaft design against static loading for given application. Shaft design for fatigue loading. Keys, types of keys, stresses developed in the key. Spline, stresses in spline shaft, design of shunk key and spline.

MODULE II **30 Hours**

DESIGN OF COUPLINGS

Couplings, types of coupling, design of coupling based on given speed and load conditions, Design of flexible coupling based on given speed and load conditions

DESIGN OF SPRINGS

Springs, types of springs, applications, spring terminology. Stresses in helical springs, Design of helical for given loading. Leaf springs, NIP in leaf springs Design of leaf spring for given application

DESIGN OF BEARING

Bearings, bearing types, Parts of the bearing, rolling contact bearing, its applications. Load carrying capacity, equivalent load, Life of bearing, Load life relationship, Problems. Selection of ball bearings from manufacturing catalogue. Sliding contact bearings, types and Nomenclature. Hydrodynamic bearing, load carrying capacity, lubrication, selection of lubricant, equivalent load, minimum oil film thickness- length to diameter ratio- bearing pressure, radial clearance. Mckees equation, - problems.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Design machine elements for simple, combined static loads, fluctuating loads, and impact loads.	**Apply**
CO2: Calculate the design parameters for power transmitting element such as shaft, key, and coupling.	**Apply**
CO3: Estimate the design parameters of helical and leaf spring for given application.	**Apply**
CO4: Design/Select a suitable bearing for the given application.	**Apply**
CO5: Develop a design procedure and present a seminar for the specified automobile components as a team.	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3		-	-	-	2	-	-	2	2	-	2	2	-

High-3; Medium-2; Low-1

Text Book(s):

T1. V.B. Bhandari. “Design of Machine Elements” Tata McGraw Hills Education, 5th edition, 2020.

T2. Shigley J.E and Mischke C.R., “Mechanical Engineering Design”, Tenth Edition, Tata McGraw Hill, 2017.

Reference Book(s):

R1. P. C Sharma and A. K Agarwal. “Machine Design” (SI units). S.K. Kataria& Sons, Reprint 2018.

R2. Patil H. G,. Pilli S. C, Ravindra R. Malagi, M. S. Patil , “Design of Machine Elements”, Krishan Makhijani.,2020

Course Code: 23MET502		Course Title: FINITE ELEMENT ANALYSIS	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 1: 0	Credits: 4	Total Contact Hours: 60	Max Marks:100

Course Objective:

The course is intended to formulate and solve physical problems by developing mathematical models, and analyze one-dimensional and two-dimensional scalar and vector problems.

MODULE I **22 Hours**

Finite element method- formulation method, Weighted residual technique – general applicability of the method, degree of freedom, coordinates systems, step by step procedure, basic element shapes function – derivation of element stiffness matrices, global stiffness matrix and force vector, boundary conditions and convergence criteria - minimum potential energy principle, FEA solution to spring, bar, truss, beam - problems. Scalar variable problems- steady state heat transfer- problems.

MODULE II **23 Hours**

Finite element modeling – Constant strain triangular element – Plane stress and plane strain conditions, Element stiffness matrix and force vector – global stiffness matrix and force vector – boundary condition –problems. Axisymmetric formulation- Element stiffness matrix and force vector – global stiffness matrix and force vector, boundary condition –problems. – Iso-parametric elements - Four node quadrilateral element- derivation of shape function, element stiffness matrix and force vector- global stiffness matrix and force vector – boundary condition problems. Scalar variable problems –– 2D conduction & convection –– global stiffness matrix and global thermal load vector – boundary condition – problems.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Solve structural problems involving bar, truss, beam, CST and Quadrilateral element using natural co-ordinate system.	Apply
CO2: Solve the 1D and 2D scalar variable problems by applying conduction and convection condition.	Apply
CO3: Analyze the vector and scalar variable problems by using FEA solver tool.	Analyze

Text Book(s):

T1. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice-Hall of India, Eastern Economy Editions 2011.

T2. NRR.Anbusagar & K.Palani Kumar., “Finite Element Analysis”, Sahara Publication., 2016.

Reference Book(s):

R1. David V.Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw-Hill Edition 2005.

R2. J.N.Reddy, “An Introduction to the Finite Element Method”, McGraw-Hill International Editions(Engineering Mechanics Series), 2005.

R3. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 23MEL501</td><td colspan="2">Course Title: SIMULATION AND ANALYSIS LABORATORY</td></tr>
<tr><td colspan="2">Course Category: Major</td><td colspan="2">Course Level: Intermediate</td></tr>
<tr><td>L:T:P(Hours/Week)
0:0:3</td><td>Credits:
1.5</td><td>Total Contact Hours: 45</td><td>Max. Marks: 100</td></tr>
</table>

Course Objectives

To provide hands on training in structural and thermal analysis by using FEA tool and simulate simple problems using Mat lab.

List of Experiments:

1. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
2. Plot a stress concentration chart for flat plate with shoulder fillet in axial tension.
3. Stress analysis of an Axi-symmetric component by varying element sizes and plot the no.of elements vs stress graph.
4. Mode frequency analysis of a 2D component.
5. Harmonic analysis of a 2D component.
6. Thermal stress analysis of a 2D component.
7. Conductive and Convective heat transfer analysis of a 2D component.
8. Stress analysis of a 3D component.
9. Simulation of Air conditioning system with condenser temperature and evaporator temperatures as input to get COP using Simulation software.
10. Simulation of free vibration characteristics of spring, mass and damper system using Simulation software.
11. Simulation of cam and follower mechanism using Mat lab.

Course Outcomes **At the end of this course, students will be able to:**	Cognitive Level
CO1: Apply finite element simulation software to solve simple problems such as structural, thermal and vibration problems in Mechanical and Automobile Engineering.	**Apply**
CO2: Write programs in a mathematical simulation software to solve mathematical model of Mechanical/Automobile Engineering applications	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	2	2	-	-	-	2	-	-	-	2	-
CO2	3	-	-	2	2	-	-	-	2	-	-	-	2	-

High-3; Medium-2; Low-1

Course Code: 23ESL501		Course Title: Professional Skills 4: Communication Skills and Interview Essentials (Common to all B.E/B.Tech Programmes)	
Course Category: SEC		Course Level: Introductory	
L:T:P(Hours/Week) 0: 0: 2	Credits: 1	Total Contact Hours:30	Max Marks:100

Course Objectives:

The course is intended to equip students with the necessary skills to effectively communicate in various professional settings and excel in the interview process

Module I **15 Hours**

Resume Building & Portfolio Management
Importance of a Strong Resume - Resume Content Development & Core Components – Formatting and Design - Tailoring and Customization – Proofreading - Portfolio Content, design and Structure : Components & Efficient portfolios – Preparing and Maintaining documents for interview – maintaining repositories - Enhancing Personal Brand - Digital Tools and Platforms

Interview - Dress code, Body Language and Grooming
Dress Code Essentials - Body Language – Facial expression, eye contact, gesture, posture, touch behavior & space- Personal Grooming

Effective Communication
Communication in Diverse Contexts - Presentations – Individual and group presentations - Public Speaking - Visual Aids and Presentation Tools

Module II **15 Hours**

Group Discussion
Introduction & types of Group Discussion – Prerequisites of GD – Techniques and tips of GD - Role of GDs in various professional contexts – GD Etiquettes – Strategies to enhance GD – Mock GD.

Interview Skills
Purpose of an interview - Types of Interviews –Interview Techniques – Interview Etiquette - Planning and Preparation - Mock Interviews with Feedback - Post-Interview Etiquette and Follow-Up

Activities:

Building Portfolio: Resume Building, Updating LinkedIn, Maintaining Repositories.
Effective Presentation:
Oral Presentation: Impromptu speech, Mini Presentation, Picture Perception (Both Speaking and Writing)
Visual presentation: Power Point Presentation, Vlog
Group Discussion: General, Technical
Mock Interview: General, Technical

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Communicate effectively and exhibit required competency in various professional environments and demonstrate proficiency in interview process.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	1	3	3	-	1	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1. Ashraf Rizvi, "Effective Technical Communication" 2^{nd} Edition, McGraw-Hill India, 2018

T2. Pease, Allan, and Barbara Pease. "The Definitive Book of Body Language." Bantam, 2006.

Reference Book(s):

R1. Cheryl Hamilton, “Communicating for Results: A Guide for Business and the Professions”, 11th edition (1 January 2017), Wadsworth Publishing Co Inc.

R2. Whitcomb, Susan Britton. Resume Magic: Trade Secrets of a Professional Resume Writer. JIST Works, 2010.

R3. Carnegie, D. (2009). The Quick and Easy Way to Effective Speaking. Pocket Books.

Web References:

1 https://www.linkedin.com/pulse/interview-etiquette-dos-donts-interviews-brian-vander-waal-fmy8e/

2 https://www.simplilearn.com/group-discussion-tips-article

SEMESTER VI

Course Code:23MET601		**Course Title: DESIGN OF TRANSMISSION SYSTEMS**	
Course Category: Major		**Course Level: Intermediate**	
L: T: P(Hours/Week) **2: 1: 0**	**Credits: 3**	**Total Contact Hours: 60**	**Max Marks:100**

Course Objective:

The course is intended to equip students with the ability to design and analyze power transmission systems, including flexible element drives, gear drives, and sliding mesh gearboxes, while considering strength, durability, and functionality, and to develop efficient clutches and braking systems for diverse applications.

MODULE I **30 Hours**

SELECTION OF FLEXIBLE ELEMENT DRIVES

Mechanical drives-types of drives -power and motion transmission drives-stepped and step-less transmission-speed ratio-under direct and over drives and its applications-reversible and irreversible drives and its applications-belt drives and its applications-Select suitable flat belt and V-belt drives and pulleys for industrial applications.

DESIGN OF SPUR GEAR, HELICAL AND BEVEL GEAR DRIVES

Toothed gearing and its applications- failures in gears- gear materials- tooth forces and stresses- Design of spur gear for given situations using strength calculations and Lewis-Buchkingham equations. Helical gear - Tooth terminology - equivalent number of teeth –– Design of Helical Gear drives for given situations.

Types of bevel gear - Tooth terminology - equivalent number of teeth gear, Design the bevel

MODULE II **30 Hours**

DESIGN OF WORM GEAR DRIVES.

Worm Gear terminology, Materials , Types of worm gears - equivalent number of teeth, gear Materials, - Tooth forces and stresses of worm gears ,Thermal capacity, Efficiency. Design of worm gear drives.

DESIGN OF SLIDING MESH GEAR BOX

Preferred numbers- Geometric progression- standard step ratio- kinematic layout- ray diagram-Design 3, 6, 9 and 12 sliding mesh speed gear box.

DESIGN OF CLUTCHES AND BRAKES

Needs and role of clutch- types of clutch-positive clutch- square jaw clutch- spiral jaw clutch- friction clutch- types of friction clutch-plate clutches- cone clutch- centrifugal clutch- Design of plate clutches. Needs and role of brakes- types of brakes -single block or shoe brake- pivoted block or shoe brake- double block or shoe brake- simple band brake- differential band brake- band and block brake- internal expanding brake- Design of shoe brake, band brake.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Design a suitable flexible element drives such as flat belt, V-belt drives for power transmitting applications.	**Apply**
CO2: Design spur, helical, bevel, and worm gear drives considering strength and surface durability for various applications.	**Apply**
CO3: Design sliding mesh gearboxes, clutches and brake systems for automotive applications.	**Apply**
CO4: Present a seminar on design steps of transmission elements of automotive vehicles in a team.	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	2	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	2	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	2	2	-	-	2	-

High-3; Medium-2; Low-1

Text Book(s)

T1. Bhandari V.B, “Design of Machine Elements” 5^{th} Edition, Tata McGraw-Hill, 2020.

T2. Shigley J.E and Mischke C.R, “Mechanical Engineering Design” 10th Edition, Tata McGraw-Hill,2017

Reference Book(s):

R1.Norton R L, “Machine Design an Integrated Approach”, 5^{th} Edition Pearson Education India,2013

R2.GitinMaitra, L. Prasad “Hand book of Mechanical Design”, 2nd Edition, Tata McGraw-Hill, 2021

Course Code: 23MET602	Course Title: DATA SCIENCE AND MACHINE LEARNING		
Course Category: Minor		Course Level: Intermediate	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours:45	Max. Marks:100

Course Objective

The course is intended to Understand the importance of data science, data preprocessing, visualizing data, data manipulation, data analytics and perform statistics on different type of data and apply machine learning algorithms on the data for deriving decisions,

MODULE I **23 Hours**

INTRODUCTION TO DATA SCIENCE

Introduction to Data Science – Evolution of Data Science – Data Science Roles – Stages in a Data Science Project –Data, types of data, data sets, data frames, Data Security Issues- Keys steps of the data analysis process -Data Collection Strategies-Applications of Data Science in various fields.

DATA MANIPULATION

Introduction to NumPy, The NumPy ndarray- Creating ndarrays- Data Types for ndarrays- Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing-Transposing Arrays and Swapping Axes.

Introduction to PANDAS -Data Loading, Storage, and File Formats, Data importing: Handling Missing Data - Data Wrangling, Gathering Data, Assessing Data, Cleaning Data- Data Structures: Series, DataFrame, Essential Functionality: Dropping Entries-Indexing, Selection, and Filtering- Sorting and Ranking.

DATA ANALYTICS

Measures of Central Tendency – Measures of Variation – Quartiles and Percentiles-Probability Mass Functions and Probability Density Functions-Probability Distributions –Uniform Distribution-Normal Distribution– Poisson Distribution. String Manipulation: Vectorized String Functions in pandas. Data Visualization: Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots. Data Presentation using Matplotlib/ Seaborn.

Module II **22 Hours**

MACHINE LEARNING

Artificial Intelligence-Introduction to Machine Learning, Types of Machine Learning, Feature selection and extraction, Data normalization and scaling. Machine Learning Algorithms.

Supervised Learning: Introduction to Supervised Learning, Classification-KNN algorithm-Decision Tree-Artificial Neural Networks- Multi Layer Perceptron.

Regression- linear regression, multiple regression-polynomial regression-Logistic regression- Un-supervised learning: Introduction to Un-Supervised Learning, Clustering-Types of clustering-Dimensionality reduction and Anomaly detection.

hyper parameter tuning- ML model building- training-testing-validation-evaluation metrics- model selection.

Applications of ML in Mechanical Engineering-Predictive Maintenance and Health Management, Fault Detection, Image based part-classification, Process Optimization, Inspection.

Introduction to Deep Learning-Introduction to Natural Language Processing-

Text Preprocessing, Sentiment Analysis, Information Retrieval, Dialogue Systems, Chatbots.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply collection, preprocessing, manipulation, visualize and presentation of data using appropriate tools.	Apply
CO2: Perform classification / regression by selecting suitable machine learning algorithm to arrive required decisions.	Apply
CO3: Present as a team case study on recent application of ML techniques in industries.	Apply

Text Book(s):

T1. Daniel Y. Chen, (2018) “Pandas for Everyone: Python Data Analysis” Pearson Education, 1st edition, 2018.

T2. Tom M. Mitchell, —Machine Learning‖, McGraw hill, 2013.

Reference(s):

R1. Swaroop, C. H. “A Byte of Python” Python Tutorial, 2003.

R2. Andreas C. Müller, Sarah Guido,” Introduction to Machine Learning with Python: A Guide for Data Scientists”, O'Reilly Media, Inc., 2016.

R3. Anirban Das Gupta “Probability for Statistics and Machine Learning” Springer link, 2011.

Web References:

1. https://jakevdp.github.io/PythonDataScienceHandbook/index.html
2. https://towardsdatascience.com/

3. https://www.practicaldatascience.org/html/pandas_dataframes.html
4. https://hadrienj.github.io

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 23MET603		Course Title: ELECTRICAL AND ELECTRONICS ENGINEERING	
Course Category: Minor		Course Level: Intermediate	
L:T:P(Hours/Week) 3:0:0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to impart knowledge on engineering fundamentals of DC&AC circuits, Electrical machines, analog and digital electronics.

Module I **22 Hours**

Fundamentals of DC Circuits: Active and Passive elements –– Ohm"s Law: statement, – Kirchhoff"s Laws: statement and illustration – Resistance in series and voltage division rule – Resistance in parallel and current division rule

AC Fundamentals: Law of electromagnetic induction — Generation of single phase alternating EMF –Single Phase and Three Phase Balanced Circuits-Power and Power Factor

Measuring Instruments: Classification of Measuring Instruments

DC Machines: DC Generator and DC Motor: Construction, Working Principle.

Module II **23 Hours**

AC Machines: Single phase transformer: Construction, working principle - Single phase induction motor -Three phase induction motor: An introduction.

Special Machines: Stepper motor, Servo Motor, BLDC motor

Semiconductor Devices: PN junction diode, Forward Bias Conduction, Reverse Bias Conduction, V-I Characteristics — Zener Diode as Voltage Regulator-Half and Full Wave Rectifier Bipolar Junction Transistor: Operation of NPN and PNP Transistor, CB,CC,CE Configuration **Digital Electronics:** Number Systems-Boolean Algebra-Postulates and Theorems-Introduction to combinational and sequential circuits-Flip-flop-Digital Signal Processor-Block Diagram and Working.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Apply the basic laws and simplification techniques of electrical engineering in DC and AC Circuits.	Apply
CO2: Apply the law of induction in the construction and working of motor, generator and transformer.	Apply
CO3: Analyze and submit the self-motivated report about the characteristics of diodes in rectifier applications and transistors in amplifier applications using a suitable hardware/software.	Analyze
CO4: Apply the Boolean concepts in realization of simple digital circuits.	Apply
CO5: Examine and report the application of analog and digital concepts in the development of digital signal processor as a case study.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	
CO5	3	-	-	-	-	-	-	-	2	2	-	-	-	-

High-3; Medium-2; Low-1

Textbooks:

T1. R.Muthusubramanian and S.Salivahanan, “Basic Electrical and Electronics Engineering”, McGraw Hill India Limited, New Delhi, 2014.

T2. S. K. Sadhev, “Basic Electrical Engineering and Electronics”, Tata Mcgraw Hill, 2017.

T3.D.P Kothari and I J Nagarath,”Basic Electrical and Electronics Engineering “ Fourth Edition Tata Mcgraw Hill, 2019.

Reference Book(s):

R1. B.L Theraja, “Fundamental of Electrical Engineering and Electronics”, S. Chand Limited, 2022.

R2. J.B.Gupta, “Basic Electrical and Electronics Engineering”, S.K.Kataria & Sons, 2013.

R3. Smarajit Ghosh, “Fundamental of Electrical and Electronics Engineering”, Second Edition, PHI Learning Private Limited New Delhi, 2010.

Web References:

1. https://www.nptel.ac.in/courses/108108076
2. https://archive.nptel.ac.in/courses/108/105/108105112
3. https://archive.nptel.ac.in/courses/108/101/108101091

Course Code:23MEL601		**Course Title: ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY**	
Course Category: Minor		**Course Level: Intermediate**	
L:T:P(Hours/Week) 0:0:3	**Credits:1.5**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives

The course is intended to impart practical knowledge on DC & AC circuits, Electrical machines, analog and digital electronics.

List of Experiments:

1. Verification of KCL and KVL.
2. Energy meter wiring and related calculations/calibration.
3. Load test on DC shunt motor
4. Load test on Single Phase Transformer.
5. V-I characteristics of PN Diode
6. Zener diode as voltage regulator
7. Half wave rectifier
8. V-I characteristics of CE configuration
9. Working of logic gates.
10. Working of D flip-flop and T flip-flop

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the KCL and KVL in simple circuits and record the theoretical and practical values.	Apply
CO2: Examine and report the working of different electrical equipment with its technical advancements and sustainable development.	Analyze
CO3:Construct the circuit using PN junction for rectifier application and zener diode for voltage regulation application	Apply
CO4:Examine the V-I characteristics of CE configuration, working of logic gates and flip-flops and report the inference	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	2	-	-	-	2	-	-	2	-	-
CO2	3	-	-	-	2	-	-	-	-	-	-	2	-	-
CO3	3	-	-	-	2	-	-	-	2	-	-	-	-	-
CO4	3	-	-	-	2	-	-	-	-	-	-	2	-	

High-3; Medium-2; Low-1

Textbooks:

T1. R.Muthusubramanian and S.Salivahanan, “Basic Electrical and Electronics Engineering”, McGraw Hill India Limited, New Delhi, 2014.

T2. S. K. Sadhev, “Basic Electrical Engineering and Electronics”, Tata Mcgraw Hill, 2017.

T3.D.P Kothari and I J Nagarath,”Basic Electrical and Electronics Engineering “ Fourth Edition Tata Mcgraw Hill, 2019.

Reference Book(s):

R1. B.L Theraja, “Fundamental of Electrical Engineering and Electronics”, S. Chand Limited, 2022.

R2. J.B.Gupta, “Basic Electrical and Electronics Engineering”, S.K.Kataria & Sons, 2013.

R3. Smarajit Ghosh, “Fundamental of Electrical and Electronics Engineering”, Second Edition, PHI Learning Private Limited New Delhi, 2010.

Web References:

1. https://www.nptel.ac.in/courses/108108076
2. https://archive.nptel.ac.in/courses/108/105/108105112
3. https://archive.nptel.ac.in/courses/108/101/108101091

<table>
<tr><td colspan="2">Course Code:23ESL601</td><td colspan="2">Course Title: Professional Skills 5: Ace and Elevate : Aptitude and Soft Skills
(Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="2">Course Category: SEC</td><td colspan="2">Course Level:Higher</td></tr>
<tr><td>L:T:P (Hours/Week)
0: 0: 2</td><td>Credits: 1</td><td>Total Contact Hours: 30</td><td>Max Marks: 100</td></tr>
</table>

Course Objectives:

To enhance students' problem-solving skills in the aptitude segment while also equipping them with effective communication skills for professional settings and success in the interview process.

Module I Verbal Ability & Effective Communication **15 Hours**

Verbal Ability

Parts of Speech – Tenses – Subject Verb Agreement – Synonyms – Antonyms – Idioms and Phrases - One Word Substitution – Reading Comprehension – Cloze test – Error Spotting.

Verbal Enhancement

Self-Introduction – Just A Minute- Picture Perception - Writing Skills: Sentence Types (Simple, Compound, Complex), Email drafting.

Campus to Corporate

Professional Grooming –Group Discussion – Impromptu – Interview.

Module II Quantitative & Reasoning Ability **15 Hours**

Quantitative Ability

Simplification & Approximation, Number System, Percentage, Averages, Ratios and Proportion, Ages, Profit & Loss, Interest Calculation, Time and work, Time, speed and distance, Clocks and Calendar, Mixtures and alligation, Permutations and Combinations, Probability, Mensuration, Data Interpretation, Data Sufficiency

Reasoning Ability

Seating Arrangement, Blood relations, Directions Problems, Syllogisms, Number & Alpha Series, Coding and Decoding, Non Verbal Reasoning, Analogies, Cubes and Dices.

<table>
<tr><td>Course Outcomes</td><td rowspan="2">Cognitive Level</td></tr>
<tr><td>At the end of this course, students will be able to:</td></tr>
<tr><td>CO 1: Exhibit strong problem-solving skills in the aptitude segment while enhancing their communication abilities for professional settings, enabling them to excel in interviews and placement processes.</td><td>Apply</td></tr>
</table>

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	2	3	3	-	1	-	-

High-3; Medium-2; Low-1

Textbook(s):

T1: Technical Communication, 3E: Principles and Practice book. Authors. Meenakshi Raman, Sangeeta Sharma, 2006

T2: Pease, Allan, and Barbara Pease. "The Definitive Book of Body Language." Bantam, 2006.

T3: Dr. R. S. Aggarwal. "Quantitative Aptitude for Competitive Examinations" Sultan Chand & Sons Pvt. Ltd, New Delhi, 2024

T4: Dr. R. S. Aggarwal. "A Modern Approach to Verbal and Non-Verbal", Sultan Chand & Sons Pvt. Ltd, New Delhi, 2024

Reference Book(s):

R1: Cheryl Hamilton, "Communicating for Results: A Guide for Business and the Professions",

R2: Whitcomb, Susan Britton. Resume Magic: Trade Secrets of a Professional Resume Writer. JIST Works, 2010.

R3: Carnegie, D. (2009). The Quick and Easy Way to Effective Speaking. Pocket Books.

R4: Arun Sharma. "Quantitative Aptitude for Common Aptitude Test", McGraw Hill Publications, 5th Edition, 2020

R5: Arun Sharma. "Logical Reasoning for Common Aptitude Test", McGraw Hill Publications, 6th Edition, 2021.

Web References:

1. https://www.linkedin.com/pulse/interview-etiquette-dos-donts-interviews-brian-vander-waal-fmy8e/
2. https://www.simplilearn.com/group-discussion-tips-article
3. https://talentbattle.in
4. https://www.geeksforgeeks.org/aptitude-questions-and-answers/

Semester

VII

Course Code: 23MEI701	Course Title: MECHATRONICS		
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0: 2	Credits:4	Total Contact Hours: 60	Max Marks:100

Course Objective

The course is intended to understanding of mechatronics systems by exploring their fundamentals, selecting appropriate sensors for various measurements, writing logic programs, and analyzing their diverse applications.

MODULE I **22 Hours**

Introduction to Mechatronics- Systems- Concepts of Mechatronics approach-Need for Mechatronics- Emerging area of Mechatronics- Classification of Mechatronics - Control system- Open Loop and Feedback Control –PID Control.

SENSORS AND SIGNAL CONDITIONING

Introduction –– Performance Terminology- Potentiometers-LVDT- Capacitance sensors-Strain gauges- Eddy current sensor-Hall effect sensor- Temperature sensors-Pressure sensors-Flow sensors- Light sensors- Selection of sensors- Signal processing.

MODULE II **23 Hours**

Introduction- Basic structure- Input and output processing- PLC Programming - Timers, Counters and internal relays- Data handling and manipulation – subroutine – Master control reset- Selection of PLC, HMI.

SYTEM DESIGN USING VIRTUAL INSTRUMENTATION

Front Panel and Block Diagram – Tools, Controls and Functions palette. Modular programming – SubVI. Formula node. DAQ hardware – AI, AO, DIO. DAQ Assistant and configuration.

CASE STUDY

Pick and place Robot- Autonomous mobile robot-Wireless surveillance balloon-Engine Management system- Automatic car park barrier.

List of Experiments **15 Hours**

1. Design a Pneumatic circuit for speed regulation of double acting.
2. Basics logic using PLC Programming - AND, OR, Latch, Interlock
3. Control of multiple actuators in Hydraulic and pneumatic System by using PLC TIA portal V14
4. Creating simple VIs, Editing and Debugging
5. Creating Sub VI using Lab VIEW

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Select sensors for various measurements including pressure, temperature, flow, level and light used in different systems	Apply
CO2: Write logic programs for real time applications such as home automation, machine tool control, process control using PLC	Apply
CO3: Design user interface for arithmetic, logical, sequencing data acquisition operations in analog and digital modes using virtual instrumentation.	Apply
CO4: Prepare and present a case study on mechatronics approach for the given application.	Apply

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	2	-	-	-	2	-	-	2	2	-
CO3	3	-	-	-	2	-	-	-	2	-	-	2	2	-
CO4	3	-	-	-	-	-	-	-	2	-	-	2	-	

High-3; Medium-2; Low-1

Text Book(s):

T1 Bolton,W, "Mechatronics" , Pearson Education, 6th edition, 2019.

T2 Jovitha Jerome, „Virtual Instrumentation using Lab VIEW", PHI Learning Private Limited, New Delhi, Second Printing, 2011.

Reference(s):

R1. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.

R2. Devadas Shetty and Richard A.Kolk, "Mechatronics systems design", PWS Publishing company 2007.

R3. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications" Tata McGraw-Hill Publishing company Limited, 2017.

Web References

1. https://en.wikipedia.org/wiki/Mechatronics
2. http://www.cedrat.com/en/publications/categories/devicesystems/systems/mechatronics.html
3. http://nptel.ac.in/courses/112103174/

<table>
<tr><td colspan="2">Course Code:23MET701</td><td colspan="3">Course Title: ELECTRIC VEHICLES</td></tr>
<tr><td colspan="3">Course Category: Major</td><td colspan="2">Course Level: Intermediate</td></tr>
<tr><td>L:T:P(Hours/Week)

3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives

This course is impart learners to analyze the need and performance of electric vehicles, identify architectures in electric and hybrid vehicles, apply knowledge of electric propulsion systems and motor control techniques.

Module I **23 Hours**

Electric Vehicles

Layout of an electric vehicle, performance of electric vehicles –– Traction motor characteristics, Tractive effort, Transmission requirements, Vehicle performance, Energy consumption, Advantage and limitations, Specifications, System components, Electronic control system.

Hybrid Vehicles

Concepts of hybrid electric drive train, Architecture of series and parallel hybrid electric drive train, Merits and demerits, Series and parallel hybrid electric drive train design.

Electric Propulsion System and Motor Control

DC motors, AC motors, Permanent magnet motors, Brushless DC and Reluctance motors, Characteristics ,Regenerative braking, Control system principles, Speed and torque control –– DC motors and AC Motors.

Module II **22 Hours**

Energy Storages & Generators

Electromechanical batteries –– Types of batteries –– Lead acid batteries, Nickel based batteries, Lithium based batteries, Electrochemical reactions, Thermodynamic voltage, Specific Energy, Specific Power, Energy efficiency, Ultra capacitors – DC Generators, AC Generators, Voltage and frequency regulations.

Fuel Cells & Solar Cars

Fuel cell, Construction, Working, Equations, Possible fuel sources, Fuel reformer, Design, Solar cars, Photovoltaic cells, Tracking, Efficiency and cost comparison, Plug In Vehicles (PIV).

Course Outcomes		**Cognitive Level**
At the end of this course, students will be able to:		
CO1:	Categorize the need and performances of Electric vehicles.	Apply
CO2:	Classify the various architectures of electric hybrid vehicles.	Apply
CO3:	Exemplify the electric propulsion system and motor controlling Techniques.	Apply
CO4:	Prepare a case study on the energy storage system and generators in electric hybridVehicle.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	2	2	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s)

T1. Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, " Modern Electric, Hybrid, Electric and Fuel cell vehicles: Fundamentals, Theory and Design", CRC press, 2004

T2.James Larminie and John Loury, " Electric Vehicle Technology – Explained", John Wiley & Sons . McGraw-Hill Book company,1994.

Reference Book(s)

R1. Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth – Heinemann, 2002.

R2. Ronald K Jurgen, "Electric and Hybrid – Electric Vehicles", SAE, 2002.

R3. Ron Hodkinson and John Fenton, "Light Weight Electric/Hybrid Vehicle Design" Butterworth –Heinemann, 2001.

Web References

1. http://nptel.ac.in/courses/108103009/1
2. http://nptel.ac.in/courses/108103009/4
3. http://nptel.ac.in/courses/108103009/9
4. http://nptel.ac.in/courses/108103009/32
5. http://www.engnetbase.com/books/4675/3154fm.pdf

Course Code: 23MEI702		Course Title: CNC MACHINES AND ROBOTICS	
Course Category: Major		Course Level: Intermediate	
L:T:P(Hours/Week) 3: 0: 2	Credits: 4	Total Contact Hours: 60	Max Marks:100

Course Objectives:

This course is intended to study different CNC machines, part programming, parts of robots, and robot programming languages.

MODULE I CNC MACHINE TOOLS AND PART PROGRAMMING 22 Hours

Introduction to CNC

CNC and DNC –– principles, features, and applications –– CNC machine tools: turning centre, machining centre, CNC controllers, parts of CNC machines, tool turrets, tool magazines, ATC, APC, chip conveyors, encoders, work holding devices.

Part Programming

Turning centre programming, coordinate systems, structure of part programs, absolute and incremental programming, G and M codes, tool offset information, tool nose radius compensation, canned cycles (facing, turning, threading, peck drilling) — Machining centre programming: cutter radius and tool length compensation, sub-programs, drilling, tapping, boring cycles, programming for circular and rectangular pocketing – CAD/CAM integration: features of CAM packages and CNC code generation.

MODULE II INTRODUCTION TO ROBOTICS AND KINEMATICS OF ROBOT MANIPULATOR 23 Hours

Robotics and Automation - Laws of Robotics, definition, types, and components, Classification of Robots, Kinematic Systems, Mechanisms, and Manipulators, Degrees of Freedom in Manipulators, Power Transmission and Control Systems, Robot Drive Mechanisms and Mechanical Transmission Methods, End Effectors and Types, Sensors and Actuators.

Robot Kinematics:

Rotation Matrix and Inverse Transformations, Homogeneous Transformations, Robotic Manipulator Joint Coordinate System, Euler Angles and Euler Transformations, Roll Pitch Yaw (RPY) Transformation, Denavit-Hartenberg (D-H) Representation, Displacement Matrices for Standard Configurations, Robot Programming Types and Interlocking, Real-Time Applications of Robot Programming.

List of Experiments **15 Hours**

1. Develop CNC Program and produce a part using CNC turning centre.
2. Develop CNC Program and produce a part using CNC milling machine.
3. Develop CNC Program and produce a hole using CNC drilling machine.
4. Develop Robot program and perform the process of material handling in robot.
5. Develop Robot program and perform the welding operation by using robot.

Course Outcomes At the end of the course students will able to	**Cognitive Level**
CO1:. Select the suitable CNC machine for the given operation.	Apply
CO2: Write the part programs for CNC lathe and CNC machining centers to produce components.	Apply
CO3: Select the suitable robot configurations and programming for different applications.	Apply
CO4: Develop and present a seminar on the given CNC operations and write robot programs for material handling operations.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO4	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1**.** "Computer Numerical Control Machines and Computer Aided Manufacture" by P. Radhakrishnan (2014)

T2**.** "Introduction to Robotics" by S.K. Saha (2014)

Reference Book(s):

R1. Yoram Koren, “Computer Control of Manufacturing Systems”, Mc-Graw Hill,1st Edition, 2017.

R2. Richard D Klafter, “Robotic engineering: an integrated approach”, Prentice Hall Pvt. Ltd., 2011.

Course Code:23MEE001	Course Title: RAPID PROTOTYPING AND TOOLING		
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to develop capacity to apply the principle of prototyping and tooling for the given application and to impart knowledge on the advanced manufacturing process to reduce the cost and time for product development.

Module I **23 Hours**

Rapid Prototyping : Introduction to prototype, Types of Prototype, High-Fidelity vs. Low-Fidelity Prototypes, Difference between MVP and Prototype, The Role of Prototypes in Product Development, Development of User Centric Prototype- Design thinking and rapid iteration of prototype,

Rapid Prototyping Process: CAD model development; Overview on Data requirements, Data formats, Data interfacing, Part orientation and support generation; Design of support structure. Reverse Engineering- Scanning, Point generation, Model development. Overview of Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Stereolithography (SLA), Laminated Object Manufacturing (LOM) and Binder Jetting. Overview of materials used for prototyping.

Case studies: Development of functional prototype through rapid prototyping technology for Automotive, Aerospace, Architectural and Medical applications.

Module II **22 Hours**

Rapid Tooling: Rapid Tooling- Principle and application, Materials used for tooling, Different types of tooling, Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect tooling, Rapid Soft tooling, Rapid Bridge tooling and Rapid Production tooling, Rapid tooling for patterns,

Rapid Tooling process: Overview on Selective Laser Melting (SLM), Fused Deposition Modeling (FDM), Direct Metal Laser Sintering (DMLS) and Laser Engineered Net Shaping (LENS)

Case Studies: Application of Rapid Tooling for Sand casting process, Investment casting process, centrifugal casting, powder metallurgy, medical devices.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply appropriate prototyping techniques and tools to develop functional prototypes for product development requirements.	**Apply**
CO2: Apply rapid tooling techniques and materials to develop tooling solutions for various manufacturing processes.	**Apply**
CO3: Design and Develop functional prototype or tooling Utilize CAD modeling, data preparation, and 3D printing technologies for various application including Automotive, Aerospace, Architectural and Medical applications and present the design in group or individual	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Wenlong Wang, Henry W. Stoll, James G. Conley, Rapid Tooling Guidelines For Sand Casting, Springer, 2010

T2. Kaushik Kumar, Divya Zindani, J. Paulo Davim, Rapid Prototyping, Rapid Tooling and Reverse Engineering From Biological Models to 3D Bioprinters, De Gruyter, 2020

T3. Ian Gibson, David W.Rosen, Brent Stucker, ―Additive Manufacturing Technologies‟, Springer, 3rd edition, 2020.

Reference Book(s):

R1. Patri K. Venuvinod , Weiyin Ma, Rapid Prototyping Laser-based and Other Technologies, Springer 2004.

R2. Chua C.K. Leong K.F., and Lim C.S., ―Rapid prototyping: Principles and application, Second edition, World Scientific Publishers, 2010.

R3. Fuewen Frank Liou, Rapid Prototyping and Engineering Applications A Toolbox for Prototype Development, Second Edition, CRC press, 2019

Course Code: 23MEE002		Course Title VIBRATION AND NOISE ENGINEERING	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3:0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objective:

To provide students with the theoretical and analytical knowledge to understand, analyze, and mitigate noise and vibration problems

MODULE I **25 Hours**

Vibration control

Systems with 2 DOF: Principal modes of vibrations, normal mode and natural frequencies of systems (Damping is not included), simple spring-mass systems, masses on tightly stretched strings, double pendulum,

Multi Degree Freedom Systems: Lagrangian method for formulation of equation of motion Rayleigh's method, Dunkerley's method, Stodola method, Rayleigh-Ritz method, Method of matrix iteration (spring mass system only).

Vibration measurement and analysis: Piezoelectric transducers and linear variable differential transformer transducer; Vibration pickups: Vibrometer, Accelerometer, Vibration exciters- Mechanical exciters, impact hammer and electrodynamic shaker. modal and harmonic analysis

MODULE II **20 Hours**

Noise Engineering

Definition, basic attributes of sound (wavelength, period, frequency velocity, speed, pressure, power and sound intensity), units (decibel, dB (A) and SPL),, The decibel scale; relationship between, sound pressure level (SPL), sound power level and sound intensity scale; relationship between addition, subtraction and averaging,

Noise Measurement and Instrumentation: Sound measuring equipment – microphones, preamplifiers, sound level meters, noise dosimeters, Spectrum analysers; Measurement Standards and guidelines.

Noise Control: Effect of machine / process noise on operators, employees and local residents. Standards of noise level and exposure limits. Frequencies of interest and Frequency Weighting networks, Sound spectra and octave band analysis, 1/1 and 1/3 Octave filters. Background noise, Measurement of noise, Acoustic Chambers, Anechoic Chamber, Reverberation chamber, Sound absorbing materials, Sound Absorption and Reflection Coefficients, Noise reduction coefficient, Methods of industrial noise control.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Determine natural frequencies and mode shapes of multi degree freedom systems using analytical methods	**Apply**
CO2: Suggest the suitable vibration & noise measuring instruments and control strategies for industrial noise control	**Apply**
CO3:Present a seminar on various noise measuring instruments as a team.	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. S. S. Rao, Mechanical Vibrations (5th ed., 2011) , Pearson Prentice Hall.

T2. C. Sujatha, Vibration and Acoustics: Measurement and Signal Analysis, Tata McGraw -Hill Education Private Limited, New Delhi, 2009.

Reference Book(s):

R1. Santosh Yadav, Rakesh Kumar Malviya, Mechanical Vibrations and Noise Engineering: Theory and Applications

R2. A. G. Ambekar , Mechanical Vibrations And Noise Engineering,2006, PHI Learning

R3. Dr. Sadhu Singh ,Mechanical Vibrations & Noise Control, Khanna Publishers; Standard Edition

Web References:

1. https://archive.nptel.ac.in/courses/112/108/112108308/
2. https://onlinecourses.nptel.ac.in/noc23_ae08/preview
3. https://archive.nptel.ac.in/courses/112/104/112104212/
4. https://archive.nptel.ac.in/courses/112/106/112106225/

<table>
<tr><td colspan="2">Course Code: 23MEE003</td><td colspan="2">Course Title: MECHANICAL SYSTEM DESIGN</td></tr>
<tr><td colspan="2">Course Category: Major</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to

Design mechanical systems by applying engineering principles and design methodologies. It emphasizes problem-solving, material selection, and system integration using modern CAD tools. Students will learn to create efficient, safe, and cost-effective mechanical designs considering real-world constraints.

Module I **23 Hours**

Design for static load or steady stresses

Design Processes and its types, factor of safety - selection. Preferred numbers, Selection of materials and its properties, Fits and Tolerances - eccentric loading-stress due to eccentric loading, curved beams – problems

Design for fluctuating and impact loads

Fatigue, types, Endurance limit, modifying factors, relation between endurance limit, ultimate tensile strength and yield strength, problems on different fatigue loading conditions. Stress concentration, stress concentration factor, causes of stress concentration, method of reducing stress concentration, stress concentration factor for different material configuration. Notch sensitivity, factors affecting of notch sensitivity. Impact loading, shock loading, simple problems.

Module II **22 Hours**

Design of shafts, keys, and couplings

Difference between shaft, axle and spindle, Shaft materials, criteria of shaft design, different transmitting elements on a shaft, shaft design against static loading for given application. Shaft design for fatigue loading. Keys, types of keys, stresses developed in the key. Spline, stresses in spline shaft, design of shunk key and spline. Couplings, types of coupling, design of coupling based on given speed and load conditions, Design of flexible coupling based on given speed and load conditions.

Design of springs and bearing

Springs, types of springs, applications, spring terminology. Stresses in helical springs, Design of helical and concentric spring for given loading. Leaf springs, NIP in leaf springs Design of leaf spring for given application. Bearings, bearing types, Parts of the bearing, rolling contact bearing, its applications. Load carrying capacity, equivalent load, Life of bearing, Load life relationship, Problems. Selection of ball bearings from manufacturing catalogue. Sliding contact bearings, types and Nomenclature. Hydrodynamic bearing, load carrying capacity, lubrication, selection of lubricant, equivalent load, minimum oil film thickness- length to diameter ratio- bearing pressure, radial clearance. Mckees equation, Somerfield equations - Bearing characteristic number problems.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Design the machine elements subjected to simple and combined static loads.	**Apply**
CO2: Design the machine elements against fluctuating loads and impact loads	**Apply**
CO3: Design the power transmitting element such as shaft, key, and coupling.	**Apply**
CO4: Present a seminar on the helical leaf spring and bearing for given application.	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. V.B. Bhandari. “Design of Machine Elements” Tata McGraw Hills Education, 5th edition, 2020.

T2. Shigley J.E and Mischke C.R., “Mechanical Engineering Design”, Sixth Edition, Tata McGraw Hill, 2012.

Reference Book(s):

R1. P. C Sharma and A. K Agarwal. “Machine Design” (SI units). S.K. Kataria& Sons, Reprint 2013.

R2. Ugural A.C, “Mechanical Design - An Integral Approach”, McGraw-Hill Book Co., 2010.

R3. Spotts M.F., Shoup T.E “Design and Machine Elements” Pearson Education, 2012.

Course Code:23MEE005		**Course Title: DESIGN FOR WELDING**	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to provide a foundational and practical understanding of welding principles, joint design, material behavior, quality assurance, safety protocols and advanced welding technologies.

MODULE I Fundamentals, Joint Design Basics, and Materials 24 Hours

Introduction to welding: History, applications and industrial importance-Classification of welding processes: Arc, gas, resistance welding and their characteristics-Physics of the welding arc: Arc behavior, heat transfer, and impact on weld quality-Welding power sources: Types (transformer, inverter, etc.) and selection criteria-Types of joints: Butt, lap, T, corner and edge joints; design considerations-Weld symbols: Interpretation and application on engineering drawings-Edge preparation: Techniques (grinding, machining) and standards-Sizing of welds: Calculations based on material properties and structural requirements-Design for static loading: Weld strength calculations and joint efficiency-Engineering properties of steels: Grades, mechanical properties, and weldability-Weldability of metals: Factors affecting weldability (carbon equivalent, pre-heat requirements)-Solidification and microstructure: Basics of weld metal solidification and grain structure.

MODULE II Advanced Design, Quality, Safety and Innovations 21 Hours

Design of Welded Joints -Design for fatigue loading: Fatigue failure mechanisms, S-N curves and design strategies-Welding Quality and Inspection-Defects in welds: Porosity, cracks, undercut and root causes-Inspection methods: Visual, radiographic (RT), ultrasonic (UT) and magnetic particle testing (MT)-Failure analysis: Case studies and corrective actions-Safety and Industrial Practices-Welding safety: PPE, fume extraction and hazard mitigation-Residual stresses and distortions: Causes, measurement and mitigation-Friction stir welding: Principles, tool design and applications-Laser welding: Process mechanics and use in precision industries-Brazing and soldering.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply joint design and material weldability to develop a welding procedure specification (WPS) for a structural component as per engineering standards and cost-efficiency.	Apply
CO2: Apply fatigue-resistant design, NDT methods for the given applications.	Apply
CO3: Present a case study on advanced welding processes to design a welded component for high-stress applications.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

Text Book(s):

T1. Messler, R. W. (2021). Principles of Welding: Processes, Physics, Chemistry, and Metallurgy (3rd ed.). Wiley.

T2. Parmar, R. S. (2017). Welding Processes and Technology (2nd ed.). Khanna Publishers.

T3. Mishra, R. S., & Mahoney, M. W. (2021). Friction Stir Welding and Processing (2nd ed.). ASM International.

T4. Radaj, D., & Vormwald, M. (2020). Welding Residual Stresses and Distortion: Simulation and Measurement (2nd ed.). Springer.

Reference Book(s):

R1. Baldev Raj, et al. (2014). Practical Non-Destructive Testing (3rd ed.). Narosa Publishing House.

R2. Hosford, W. F., & Caddell, R. M. (2011). Metal Forming. Cambridge University Press.

R3. Easterling, K. (2021). Introduction to the Physical Metallurgy of Welding (3rd ed.). Butterworth-Heinemann.

R4. Kou, S. (2023). Welding Metallurgy (3rd ed.). Wiley.

<table>
<tr><td>Course Code: 23MEE006</td><td colspan="3">Course Title: REVERSE ENGINEERING</td></tr>
<tr><td colspan="2">Course Category: Major</td><td colspan="2">Course Level : Higher</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0:0</td><td>Credits: 3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to enable the impart knowledge on concepts and principles of reverse engineering in product design and development and various legal aspect and applications of reverse engineering in product design and development.

Module I **24 Hours**

INTRODUCTION

Definition, Scope, and Tasks of Reverse Engineering ,Uses and Applications of Reverse Engineering ,Process of Duplicating and RE as a Generic Process, Phases of Reverse Engineering.

TOOLS AND TECHNIQUES,

Coordinate measuring machine, Point Data Processing: preprocessing and post processing of captured data, geometric model development, construction of surface model, solid model, noise reduction, feature identification, model verification

3D SCANNING AND MODELLING

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection

Module II **21 Hours**

RAPID PROTOTYPING AND INTEGRATION

Rapid Prototyping: Introduction, current RP techniques and materials, Stereo Lithography, Selective Laser Sintering, Fused Deposition Modeling, Three-dimensional Printing, Laminated Object Manufacturing, Multijet Modeling, Laser-engineered Net Shaping, Rapid Prototyping, Rapid Tooling, Rapid Manufacturing

Integration: Cognitive approach to RE, Integration of formal and structured methods in reverse engineering, Integration of reverse engineering and reuse.

INDUSTRIAL APPLICATIONS AND LEGAL ASPECTS

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering. Legal and Ethical Aspects: Patents, Copyrights ,Trade Secrets ,Handling Third-Party Materials , Intellectual Property Rights and Compliance in RE.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Apply the fundamental concepts and principles of reverse engineering in product design and development.	Apply
CO2:Apply the measurement tools and data processing techniques to develop geometric and solid models from physical component	Apply
CO3: Apply the 3D scanning methods and modelling strategies for capturing and replicating complex geometries.	Apply
CO4: Apply the of manufacturing method RE and principles of data processing reverse engineering of product design and development.	Apply
CO5: Present a seminar on the various legal aspect and Applications of reverse engineering in product design and development.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	2	2	-	2	-	-

Text Book(s):

T1.Katheryn, A. Ingle, “Reverse Engineering”, McGraw-Hill.

T2.Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

Reference Book(s):

R1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022

R2.Linda Wills, “Reverse Engineering”, Kluver Academic Publishers, 1996

R3. Vinesh Raj and Kiran Fernandes, “Reverse Engineering: An Industrial Perspective”, SpringerVerlag London Limited 2008

R4.Aiken Peter, “Data Reverse Engineering”, McGraw-Hill.

Web Reference(s):

1. https://nptel.ac.in/courses/112104265
2. https://www.youtube.com/watch?v=zoCgqqlRHkA

Course Code: 23MEE004		Course Title: DESIGN FOR SHEET METAL	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to provide a thorough understanding of sheet metal design, manufacturing processes, and fabrication techniques.

MODULE I Fundamentals of Sheet Metal Design 22 Hours

Overview of Sheet Metal Applications-Types of Sheet Metal Materials: Steel, Aluminum, Copper, etc.Properties of Sheet Metal Materials-Elasticity, Strength, Ductility, and Hardness-Material Selection Criteria for Different Applications-Types of Shearing Processes- Types of Bends, Bend Radius, Bend Allowance, and Spring-back Effect-Stretching and Embossing Techniques-Forming Processes: Roll Forming, Deep Drawing, Spinning, and Hydroforming-Design Principles for Sheet Metal-Design for Manufacturability (DFM) Concepts in Sheet Metal-Bend Reliefs and Flanges-Guidelines for Hole and Slot Placement.Tolerances and their importance in Sheet Metal Design-Sheet Metal Joining Techniques.

MODULE II Advanced Techniques in Sheet Metal Fabrication and Assembly 23 Hours

Advanced Forming Processes and Tooling -Advanced Bending Techniques: Air Bending, Wiping, and Coining-Tool Design for Blanking, Bending, and Forming-Use of Press Brakes and Turret Punch Presses.CNC Machines for Sheet Metal Fabrication-Importance of Surface Finishing for Sheet Metal Products-Types of Surface Treatments: Electroplating, Powder Coating, Anodizing, etc.-Painting and Polishing Processes-Rust Prevention and Corrosion Resistance Methods-Safety Considerations for Surface Treatments- Sustainability in Sheet Metal Design-Reducing Material Wastage and Optimizing Raw Material Usage-Process Optimization to Minimize Energy Consumption-Recycling and Reuse of Sheet Metal Products.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply Design Principles for Sheet Metal Components.	Apply
CO2: Apply the advanced techniques used in sheet metal fabrication and assembly.	Apply
CO3: Prepare and present a case study for the given Sheet Metal Projects.	Apply

Text Book(s):

T1.Altan, T., & Tekkaya, E. (Eds.). (2012). Sheet metal forming processes and applications. ASM International.

T2. Juneja, B. L. (2006). Fundamentals of metal forming processes. New Age International.

T3. Bralla, J. G. (1998). Design for Manufacturability Handbook (2nd ed.). McGraw-Hill Professional.

Reference Book(s):

R1. Fournier, R. (1987). Sheet Metal Handbook Hp575. H.P. Books.

R2. Hosford, W. F., & Caddell, R. M. (2011). Metal Forming. Cambridge University Press.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE007		**Course Title: MECHANICAL ENGINEERING DESIGN AND AUTOMATION**	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 2: 0: 2	**Credits:3**	**Total Contact Hours:60**	**Max Marks:100**

Course Objectives:

The course is intended to

Apply the need for new product design and development, value engineering principles and techniques, utilize DFx methodologies and develop system models and architecture using MBSE.

Module I

Product Design Overview and Techniques **23 Hours**

Importance of engineering design - Product life cycle - Design process – Requirement engineering - Conceptual design – Virtual Validation – CAE (FEA & CFD) - Detail Design – Prototyping - Standards – Concurrent Engineering - Technological Forecasting - Market Identification - Systems Engineering – MBD -Human Factors in Design - Industrial Design - Design Techniques: Brainstorming, TRIZ, QFD, Pugh matrix – Creativity and Problem Solving - Industry Case Studies - Hands-on Projects.

Material and Manufacturing Process

Selection of material for mechanical properties- Strength, toughness and fatigue- Material selection for durability, surface wear and Corrosion resistance- Functional relation between materials and processing. Manufacturing Processes - advantages and limitations. Selection of Processes- Process Capabilities - Design Guidelines. Product Design- Manufacturing Perspective - Industry Case Studies - Hands-on Projects.

Module II

Value Engineering and Product Benchmarking **22 Hours**

Value Engineering Function- Approach of Function, Evaluation of Function, Determining Function, Classifying Function. Evaluation of costs- Evaluation of Worth, Evaluation of Value, FAST Diagram, Should costing - categories of cost – overhead costs – activity-based costing – methods of developing cost estimates – manufacturing cost –value analysis in costing. Product Benchmarking - Teardown Process- List Design Issues-Form a Bill of Materials - Teardown methods- Measurement - product verification and validation - Industry Case Studies - Hands-on Projects.

Design for Excellence (DFx)

Importance of DFx - DFx Principles and Methodologies- Design for Manufacturing (DFM) -

Design for Assembly (DFA) - Design for Reliability (DFR) - Design for Safety (DFS) - Design for Sustainability (DFS) - Design for Cost (DFC) - Tools and Techniques - Case Studies and Practical Applications - Hands-on Projects.

Introduction of Next Gen Technologies

Overview of MBSE - SysML – Python - Core Concepts of MBSE: System Models and Architecture, Requirements Engineering, System Design and Analysis, Verification and Validation - General architectural guidelines – Subsystem and component architecture – Parametric Modeling - Generative Design - MBSE Tools - Practical Applications and Case Studies

List of Experiments **15 Hours**

1. Product dissection experiment on multiple products.
2. Develop a coffee machine using MBSE approach.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1:Apply product design techniques, material and manufacturing processes for a system.	**Apply**
CO2: Apply value engineering, product bench marking and other design for Excellence techniques for a successful product using MBSE approach.	**Apply**
CO3: Develop and present a seminar on step by step procedure to integrate NPD and MBSE approach on a given product.	**Apply**

Text Book(s):

T1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, Product Design and Development, 6th Edition, 2019, Tata McGraw-Hill Education.

T2. Kevin Otto, Kristin Wood, Product Design, Indian Reprint 2018, Pearson Education.

T3. Bruce Powel Douglass, “Agile Model-Based Systems Engineering Cookbook”, Packt Publishing Ltd, UK, 1st edition, 2021.

Reference Book(s):.

R1: Kevin Otto, Kristin Wood, Product Design, Indian Reprint 2018, Pearson Education.

R2. George E.Dieter, Linda C.Schmidt, Engineering Design, McGraw-Hill International Edition, 4th Edition, 2009.

R3.John Holt, “Systems Engineering Demystified”, Packt Publishing Ltd, UK, 1st edition, 2021.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	-	-	-	-	-	-	2	2	-	-	-	3	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code:23MEE008</td><td colspan="2">Course Title: PLM FOR ENGINEERS
(All Branches)</td></tr>
<tr><td colspan="2">Course Category:
Major</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td>L:T:P
(Hours/Week)
2: 0: 2</td><td>Credits:
3</td><td>Total Contact Hours: 60</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to apply Product Lifecycle Management (PLM) fundamentals and principles to develop strategies, manage product lifecycles, optimize engineering processes, configure Bills of Materials, and leverage digital manufacturing environments for practical applications and customer-centric use cases.

MODULE I **22 Hours**

BUSINESS STRATEGY IN THE PLM

Definition, PLM Lifecycle Model, Threads of PLM, Need for PLM, Opportunities and Benefits of PLM, Components and Phases of PLM, PLM feasibility Study, PLM Visioning, Strategy, Impact of strategy, Implementing a PLM strategy, PLM Initiatives to Support Corporate Objectives, Infrastructure Assessment.

BUSINESS PROCESSES IN THE PLM AND **PRODUCT DEVELOPMENT CONCEPTS**

Characteristics of PLM, Environment Driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM. Engineering Vaulting, Product Reuse, Smart Parts, Engineering Change Management, Workflow Management.

Bill of Materials (E-BOM, M-BOM, S-BOM) and Process Consistency, Product Structure, Configuring BOM

MODULE II **23 Hours**

DIGITAL MOCK UP AND VALIDATION

Simulation Process Management, Variant Management, Digital Mock-Up and Prototype Development, Design for Environment, Virtual Testing and Validation, Marketing Collateral

DIGITAL MANUFACTURING IN THE PLM

Digital Manufacturing, Benefits of Digital Manufacturing, Manufacturing the First-One, Ramp Up, Virtual Learning Curve, Manufacturing the Rest, Production Planning.

CUSTOMER USE CASES OF THE PLM

Impact and Challenges faced while implementing a successful PLM strategy -Rolls Royce, Nissan Motor, Sunseeker International , Xtrac ,kesslers international and monier and weatherford international.

Exercises: **15 Hours**

1. Demonstrate the 2-Tier & 4-Tier Architectures and Basic Teamcenter applications like Organization, Project, and Schedule Manager.
2. Create CAD and Non-CAD datasets (MS Office, Notepad, etc.) by using explicit and implicit Check-In and Check-Out to create multiple iterations
3. Create the access control (Read, Write, and Delete) for the given dataset and block the access rights to other group members belongs to the same department. Also Perform the Impact Analysis (Where Used and Where Referenced) of a given dataset which is used in multiple assemblies.
4. Create the Product Structure in Structure Manager with 5 components assembled in first
   level and 3 components Assembled in second, third and fourth level with the sub-assemblies and export the assembly in local drive. Also, demonstrate the Variant Management.
5. Export the CAD dataset as a JT file and perform the various visualization tasks like Measurements, Sectioning, PMI, and Mark-up using JT2GO application

Text Book(s):

T1. John Stark, "Product Lifecycle Management: Volume 1: 21st Century Paradigm for Product Realisation", Springer International Publishing Switzerland, 4th edition, 2020.

T2. Grieves Michael, "Product Lifecycle Management- Driving the Next Generation of Lean Thinking", McGraw-Hill, 2010.

T3. Wang, Lihui; Nee, Andrew Y.C. (Eds.) Collaborative Design and Planning for Digital Manufacturing, Springer, 2009.

. **Reference(s):**

R1. Elangovan, U., "Product Lifecycle Management (PLM)". Boca Raton, CRC Press, 2020.

R2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006.

R3. Antti Saaksvuori, " Product Life Cycle Management" - Anselmi Immonen, Springer, 3rd Edition, 2008.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply the fundamentals of PLM principles to develop a PLM strategy for a system.	**Apply**
CO2: Apply PLM principles to manage product lifecycles, optimize engineering processes, and configure Bill of Materials with consistent workflows	**Apply**
CO3: Apply the Digital Manufacturing environment using PLM for use cases.	**Apply**
CO4: Develop and present a report individually by applying various modules of PLM software for an engineering project.	**Apply**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	3	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	3	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-	3	-
CO4	-	-	-	-	-	-	-	2	2	2	-	-	3	-

High-3; Medium-2; Low-1

Course Code: 23MEE009		Course Title: ADDITIVE MANUFACTURING	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to provide students with a comprehensive understanding of the Additive Manufacturing technology, its applications, and its impact on various industries.

MODULE I **22 Hours**

Introduction

Overview - **Need** - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping - Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification. Applications of Additive Manufacturing: Building Printing - Bio Printing - Food Printing-Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

Design for Additive Manufacturing (DfAM)

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization-Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation. Data Formats: STL, AMF,PLY, VRML- Data Interfacing

Additive Manufacturing Materials and Characterization

Types of Materials: Liquid, Solid and Powder based Materials, Characterization: Liquid Materials Characterization Techniques-rheology and wetting behavior- Solid materials characterization techniques- Filament Diameter Consistency, density, porosity, Moisture content, Thermal properties. Micro structure of composite filament- Mechanical properties of Filament. Powder material characterization Techniques-powder size measurements-Morphology- chemical composition, Flow characteristics, density and laser absorption based characterization

MODULE II **23 Hours**

VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION

Photopolymerization: Stereolithography 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.

POWDER BED FUSION AND MATERIAL EXTRUSION

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.

BINDER JETTING AND MATERIAL JETTING

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Select an appropriate Design technique for improving the part quality	**Apply**
CO2: Present a seminar on various additive manufacturing materials and its characterization technique	**Apply**
CO3: Evaluate Vat polymerization and Direct energy deposition process for producing custom parts	**Analyze**
CO4: Evaluate Powder Bed Fusion and Materials extrusion process for producing custom parts	**Analyze**

Text Book(s):

1. Ian Gibson, David Rosen, Brent Stucker, MahyarKhorasani “Additive manufacturing technologies”. 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030- 56126-0

2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

Reference Book(s):

1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.

2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.

3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.

4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.

5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	2	2	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE010		Course Title: PROCESS PLANNING AND COST ESTIMATION	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3:0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objective:

The course is intended to calculate the break even analysis and various cost calculation by direct and indirect method.

MODULE I **23 Hours**

Introduction- Place of process planning-economics- Process & Production Planning, Process Planning & Concurrent Engineering-Types of production- standardization Production design & selection. Selection of processes, tools, cutting parameters & machine tools- Jigs and Fixtures - Grouping of processes- Sequencing of operations- Selecting primary manufacturing processes for rough & refined needs Process capability, Process Charts.

Retrieval type/variant approach, group technology – generative approach, logics decision tress and tables, axiomatic approach – AI expert systems – feature recognition – applications Concepts, differences. Concepts, differences, different costing methods – classification of costs – cost grid-problems.

Labour cost–direct, indirect–estimation– labour norms–time study rating – labour cost variances; material cost–direct, indirect–estimation–material issue valuation – material cost variances–problems. Overhead cost - Elements – factory, administrative, sales and distribution expenses–methods of absorbing overheads – Direct Labour, Direct Material Machine Hour Rate methods – depreciation – methods – accounting for service department expenses – problems.

MODULE II **22 Hours**

Machined components–welded components, forged components, powder metallurgy parts, calculation of sales cost, case studies, use of computers in cost estimation, cost of rejection. OPTIMUM MACHINING CONDITIONS: Taylor’s equation, deriving the equation for optimum economic cutting velocity– selection of cutting speed for optimum cost, problems process capability analysis.

Concept, make or buy decision, assumptions, merits and demerits of break even analysis, applications. Linear, multi product break-even analysis Learning curves, product life cycle cost analysis -Tools and techniques–activity based costing - concepts, cost drivers; introduction to target costing - need and applications.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Analysis the direct and indirect component cost.	**Apply**
CO2: Analyze the cost calculation methods of different manufacturing process and break even analysis.	**Apply**
CO3: Present a seminar on effective cost estimation of a particular machining application individually.	**Apply**

Text Book(s):

T1.Kannappan D, “Mechanical Estimating and Costing”, Tata McGraw Hill, New Delhi, 2003.

T2.Banga T R and Sharma S C, “Mechanical Estimating and Costing”, Khanna Publishers, 16th Edition, 2011.

Reference Book(s):

R1. Russell R.S and Tailor B.W, "Operations Management", PHI, 4th Edition, 2003.

R2. Chitale A.V and Gupta R.C, "Product Design and Manufacturing", PHI, 2nd Edition, 2002.

R3. Kesavan R “Process Planning and Cost Estimation”, New Age International Pvt. Ltd., Chennai, 2005.

Web References:

1. https://en.wikipedia.org/wiki/Planning
2. http://nptel.ac.in/courses/Webcoursecontents/IITDelhi/Computer%20Aided%20Design%20&%20ManufacturingII/Module%20G/Module%20G(5)/p3.htm
3. https://en.wikipedia.org/wiki/Cost_estimate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE011		**Course Title: ADVANCED MANUFACTURING PROCESSES**	
Course Category: Major		**Course Level: Higher**	
L:T:P(hours) 3:0:0	**Credits:3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

To provide students with an in-depth understanding of advanced manufacturing techniques, their underlying principles, mechanisms of material removal, and applications in modern industrial practices.

MODULE I **22 Hours**

ADVANCED UNCONVENTIONAL MACHINING PROCESS

Introduction- Shaped tube electro chemical machining, Plasma Arc machining, Magnetic abrasive finishing, Magnetorheological abrasive flow finishing, Electric Discharge Grinding, Electrochemical Grinding, Electro stream Drilling, Chemical machining, Photo Chemical Machining, and Bio-Chemical Machining processes.

ADVANCED CASTING PROCESSES

Special casting process-Shell Moulding, Investment casting, centrifugal casting, continuous casting. Low pressure die casting, Squeeze casting, Full mould casting process – Vacuum mould casting- Evaporative pattern casting

MODULE II **23 Hours**

ADVANCED WELDING PROCESSES

Electron beam welding - laser beam welding - ultrasonic welding processes- Friction stir welding- Explosive welding - Diffusion bonding - High frequency Induction welding - Magnetic arc welding- Plasma key hole welding.

ADVANCED METAL FORMING PROCESSES

High energy rate forming process- Electro-magnetic forming, Explosive Forming- Electro-hydraulic forming- Stretch forming- Contour roll forming - High energy rate forming - Magnetic Pulse forming - Electro hydraulic forming - Cold Roll Forming, Incremental Press Forming and Millipede forming.

MICRO AND NANO MATERIALS MACHINING PROCESSES

Micro machining centers- E-Manufacturing, and micromachining, High speed Machining, Crystal growth and wafer preparation, Film Deposition oxidation, lithography, Surface mount technology.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Select the appropriate advanced unconventional machining and casting processes based upon applications	Apply
CO2: Select the welding processes for applying suitable standards and procedures as per the control plan for the required specification.	Apply
CO3: Select suitable forming processes and procedures to manufacture intricate, complex shape parts and difficult to machine materials in micro and nano level.	Apply
CO4: Present a survey on advanced manufacturing processes used in the specified industry.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	2	2	-	-	-	3	-

High-3; Medium-2; Low-1

Text Book(s):

T1. E. P. DeGarmo, J. T Black, R. A. Kohser "Materials and Processes in Manufacturing" (8th Edition), Prentice Hall of India, New Delhi (ISBN 0-02- 978760).

T2. Ghosh, and A. K. Mallik "Manufacturing Science", Affiliated East-West Press Pvt. Ltd. New Delhi.

T3. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Process for Engineering Materials", 5th Edition, Pearson Education, 2014.

Reference(s):

R1. V. K. Jain, Advanced Machining Processes‖, 1st edition, Allied Publishers Pvt. Ltd, 2007. ISBN: 978-8177642940.

R2. H. Abdel and G. El-Hofy, ―Advanced Machining Processes: Nontraditional and Hybrid Machining Processes‖, 1st edition, McGraw-Hill Professional, 2005. ISBN: 978-0071453349.

R3. G.F. Benedict, ―Nontraditional Machining Processes‖, 1st edition, Marcel Dekker Inc. 2002.

Web References:

1. https://ocw.mit.edu/courses/mechanical-engineering/2-75-manufacturing-processes
2. https://www.coursera.org/courses?query=advanced%20manufacturing
3. https://nptel.ac.in/courses/112/106/112106200/
4. https://www.udemy.com/topic/advanced-manufacturing/

Course Code: 23MEE012		Course Title: LEAN MANUFACTURING	
Course Category: **Major**		**Course Level: Higher**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits:** **3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to provide students with a foundational and practical understanding of Lean Manufacturing principles and tools—ranging from 5S, Kaizen, and Value Stream Mapping to advanced techniques like JIT, Kanban, and Cellular Manufacturing—for identifying and eliminating waste, and improving process efficiency through real-world case studies and projects.

MODULE I Fundamentals and Tools of Lean Manufacturing 22 Hours

Introduction to Lean Manufacturing

Origin and evolution of Lean - Toyota Production System (TPS) - Philosophy and core principles of Lean

Traditional manufacturing vs Lean manufacturing - Value, Waste (Muda), Flow – Key Lean concepts - Benefits of implementing Lean manufacturing

Waste Elimination and Value Stream Mapping

Identification and classification of the different types of waste - Value Stream Mapping (VSM) - Current state and future state mapping - Takt Time, Cycle Time, Lead Time - Process Flow analysis – bottleneck identification - Continuous improvement (Kaizen) fundamentals

Lean Tools and Techniques – I

5S (Sort, Set in order, Shine, Standardize, Sustain) - Visual Management & Standard Work - Poka-Yoke (Error Proofing) and Jidoka (Autonomation) - SMED (Single Minute Exchange of Dies)

MODULE II Advanced Tools, Implementation, and Case Studies 23 Hours

Lean Tools and Techniques – II

Kanban and Pull systems - Just-in-Time (JIT) production - Cellular Manufacturing and Layout Total Productive Maintenance (TPM) - Heijunka (Production leveling) - Gemba Walks and Root Cause Analysis (5 Whys, Fishbone diagram)

Lean Implementation and Industry Practices

Steps in Lean implementation strategy - Lean performance metrics - Integrating Lean with Six Sigma - similarities and differences - Lean in service and office environments - Challenges and barriers in Lean implementation

Case Studies and Project Applications

Real-world case studies from manufacturing and service sectors - Student presentations on small process improvement projects - Mini-projects on Value Stream Mapping or 5S implementation

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the fundamental concepts and tools of Lean Manufacturing such as 5S, Value Stream Mapping, and Kaizen to identify and eliminate waste in a given production process.	**Apply**
CO2: Apply advanced Lean tools like Kanban, JIT, and Cellular Manufacturing to optimize workflows and implement Lean strategies in manufacturing or service scenarios.	**Apply**
CO3: Apply Lean Manufacturing principles to analyze and improve a real or simulated process through assignments, presentations, or mini-projects using tools like 5S, Value Stream Mapping, or Kaizen.	**Apply**

Text Book(s):

1. S. Vinodh, Lean Manufacturing: Fundamentals, Tools, Approaches, and Industry 4.0 Integration, CRC Press, 2023.
2. Kanchan Das & Miranda Dixon, Lean Manufacturing and Service: Fundamentals, Applications, and Case Studies, CRC Press, 2023.

Reference Book(s):

1. Kanchan Das, Miranda Dixon, Lean Manufacturing and Service: Fundamentals, Applications, and Case Studies, CRC Press, 2024.
2. Rajeev Rathi, Jose Garza-Reyes, Mahender Singh Kaswan (Eds.), Lean Six Sigma 4.0 for Operational Excellence Under the Industry 4.0 Transformation, CRC Press, 2023.
3. John Bicheno & Matthias Holweg, The Lean Toolbox: The Essential Guide to Lean Transformation, 6th Edition, PICSIE Books, 2023.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code:23MEE013	**Course Title: MANUFACTURING SYSTEMS ENGINEERING**		
Course Category: Major		**Course Level: Higher**	
L: T: P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max Marks: 100**

Course Objectives

The course is intended to apply the concepts in production and operations management, including production system models, types, system design impacts, lifecycle stages, industrial engineering tools and production management strategies.

Module I **23 Hours**

Generalized model of production systems - Types of production systems and its impact on system design - Lifecycle concepts of production systems - Basic IE tools. Approach to production management - Introduction & overview of JIT production system - Relations among sales price - Cost and Profit, ten arguments against the JIT production revolution – Wastology - Types of waste - Waste removal and secrets for not creating waste - The 5S approach – Theory of constrains. Introduction to flow production - Principle of flow analysis - Flow production within factories & between factories - Precautions and procedures for developing multi-process operations - Level production - Various ways to create production

Module II **22 Hours**

Basics of KANBAN, KAIZEN AND JIDOKA, Differences between kanban and conventional systems -Functions and rules of Kanban - Variety and quantity of kanban, administration of kanban, visual controls – Andons, changeover improvement kaizen - Seven rules for improving changeover - Steps toward jidoka - Difference between jidoka and automation - Functions of jidoka, extension of jidoka to the assembly lines - Labour cost reduction steps. Overview of standard operation, establishment of standard operation and charts - Overall plan for achieving zero defects - The poka-yoke system - Types of maintenance - CCO - Three lessons in maintenance - Importance of safety - Waste related forms – 5S forms.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply the principles of production systems and industrial engineering tools to analyze system design decisions and evaluate lifecycle considerations in production management	Apply
CO2: Apply lean manufacturing principles such as JIT, 5S, waste elimination,	Apply

and flow production techniques to design efficient production processes and evaluate their impact on cost, profit, and operational performance	
CO3: Apply lean manufacturing tools such as Kanban, Kaizen, Jidoka, and Poka-Yoke to improve production efficiency, enhance quality, reduce labor costs and present a seminar as a team.	Apply

Text Book(s):

T1. Chase, Jacobs, Aquilano, Production and Operations Management‖ 8th Edition, Tata McGraw Hill CompaniesInc, 2008.

T2. PaneerSelvam R, Production and Operations Management, Prentice Hall of India, 2012.

Reference Book(s):

R1. Kotsundo Hitomis‘s, Manufacturing System Engineering‖, Second Edition, Taylor & Francis, 1996.

R2. Adam Jr, Everette E. and Ebert, Production and Operations Management- Concepts; Models and Behavior‖ 5th Edition, Prentice-Hall of India, 2012.

R3. Chary, Theory and Problems in Production and Operations Management‖ Tata McGraw Hill, 2009.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code:23MEE014	**Course Title: SUSTAINABLE MANUFACTURING**		
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to understanding of sustainable manufacturing and its significance in modern engineering, explore principles and strategies

Module I **23 Hours**

Definition and scope of sustainable manufacturing - Environmental, social, and economic aspects of sustainability - Sustainability performance indicators - - Eco-design principles and strategies - Design for disassembly and recycling - Life cycle assessment and eco-labeling - Sustainable building design and construction - Energy-efficient lighting and HVAC systems - Green Buildings and Facilities

Energy management and optimization - Renewable energy applications in manufacturing - Energy-efficient process design - Waste management in manufacturing facilities – Waste reduction and recycling strategies - Industrial symbiosis and resource sharing - Closed-loop and cradle-to-cradle approaches - carbon footprint: calculation, need to reduce the carbon footprint of manufacturing Operations, Carbon trading and offsetting

Worker safety and well-being - Human rights and labor standards - Community engagement and social impact assessment - Corporate Social Responsibility (CSR)

Module II **22 Hours**

Case studies and best practices in automotive manufacturing, electronics manufacturing and textiles and apparel manufacturing - Clean and green manufacturing technologies - Advanced process monitoring and control systems - Digitalization and Industry 4.0 in sustainable manufacturing - Sustainable material selection - Green supply chain management - Responsible sourcing and ethical considerations

Environmental regulations and compliance - International standards for sustainable manufacturing - Governmental regulations for Sustainability: GRI, ISO 26000, ISO 14001- Government policies and incentives - Emerging technologies and innovations – Circular economy and zero waste concepts - Sustainable manufacturing in the era of climate change

Course Outcomes At the end of the course students will able to	Cognitive Level
CO1: Apply knowledge of sustainable manufacturing tools and techniques to evaluate and improve the social performance of manufacturing systems.	**Apply**
CO2: Design sustainable manufacturing processes by considering sustainability regulations and circular economy for various application area	**Apply**
CO3: Analyze in a systematic way the various case studies and offer solutions to problems related to sustainable Manufacturing.	**Analyze**

Text Book(s):

T1. Joseph Fiksel, Design for Environment, Second Edition: A Guide to Sustainable Product Development, McGraw-Hill Education, 2018

T2. Fahimnia, B. & Bell, Michael & Hensher, David & Sarkis, Joseph. (2015). Green Logistics and Transportation: A Sustainable Supply Chain Perspective

Reference Book(s):

R1. Davim J.P., "Sustainable Manufacturing", John Wiley & Sons., United States, 2010,

R2. Ashby, Michael F. Materials and the environment: eco-informed material choice. Elsevier,2012.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code:23MEE015		Course Title: ENGINEERING ECONOMICS AND COST ANALYSIS	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is focused to provide a fundamental knowledge on economics related to engineering business and costing involved in industrial activities.

MODULE I Engineering Economics, Value Engineering and Cash Flows 23 Hours

Concept of Engineering Economics – Law of supply and demand, Engineering efficiency, Economic efficiency, Scope of engineering economics - Elements of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio. Make or Buy decisions, Value engineering – Function, aims, and Value engineering procedure. Interest formulae and their applications -Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods with problems. Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

MODULE II 22 Hours

Replacement and Maintenance analysis -determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely. Depreciation- Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation Evaluation of public alternatives-introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1:Arrive a business decision from the concept of engineering economics such as costing, break even analysis, value engineering and comparison of alternatives using appropriate interest calculations.	Apply
CO2: Decide the economic life of an asset and depreciation cost of an asset using appropriate formula.	Apply
CO3: Present a report on findings of business decisions of an industry.	Apply

Text Book(s):

T1. Panneerselvam R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi,2016.

T2.Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, Seventh Edition. 2023.

Reference Book(s):

R1. Donald.G. Newman, Jerome.P.Lavelle,TED G Eschenbach "Engineering Economics and analysis" Qxford University Press, Twelfth Edition, 2013.

R2.Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy",Macmillan, New York, 2016..

Web References:

1. https://en.wikipedia.org/wiki/Engineering_economics

2. https://en.wikipedia.org/wiki/Cost%E2%80%93benefit_analysis

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE016	Course Title: COMPOSITE MATERIALS		
Course Category: Major		Course Level: Higher	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

This course is intended to study the properties of matrices and reinforcements, types of composite materials, fabrication and testing methods of composites, mechanics and lamination theory of fiber-reinforced composites, and the load-bearing behavior of composite materials and structures.

MODULE I **23 Hours**

INTRODUCTION

Definition – classification of composite materials based on structure -based on matrix. Advantages of composites-application of composites-functional requirements of reinforcement and matrix. Reinforcement types – fibers-continuous, particulate and whisker reinforcements – properties-applications- comparison of fibre strengths-Matrix materials-properties- Wettability fibre with matrix-effect of surface roughness – interfacial bonding

TYPES OF COMPOSITES

Various types of composites: Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

FABRICATION AND TESTING OF COMPOSITES

Fabrication methods: hand layup, Autoclave, filament welding, compression molding, resin-transplant method, pultrusion, pre-peg layer. Mechanical testing of composites - tensile testing, Compressive testing, Flexural testing, Shear testing and Impact testing

MODULE II

22 Hours

MECHANICS AND LAMINATION THEORY OF COMPOSITES

Rule of mixture -volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach -Longitudinal Young's modulus-transverse Young's modulus – major Poisson's ratio-In- plane shear modulus, Ultimate strengths of a unidirectional lamina - Characteristics of Fiber-reinforced lamina – laminates – lamination theory.

COMPOSITE STRUCTURES

Fatigue - S-N curves - Fatigue behaviors of CMCs - Fatigue of particle and whisker reinforced composites. Introduction to structures - selection of material, manufacturing and laminate configuration -design of joints - bonded joints - bolted joints - bonded and bolted. Case studies in design and development of composite parts, boats, pressure vessels, automotive parts, aerospace parts, electronics parts and composites for space vehicles.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1 Apply knowledge of matrix properties, reinforcements, and types of composite materials to select appropriate materials for engineering applications.	**Apply**
CO2 Apply fabrication techniques and testing methods to manufacture and evaluate composite materials for desired performance.	**Apply**
CO3 Apply mechanics, lamination theory, and load-bearing principles to analyze and design fiber-reinforced composite structures.	**Apply**
CO4 Present a case study on the different types of joints for a specific application.	**Apply**

Reference Book(s):

R1. Mallik, P. K, Fiber reinforced composites : materials, manufacturing and design, New York- Marcel and Dekker, 1993 (2ndedition)

R2. Arthur, K Kaw, Mechanics of Composite Materials, CRC Press, 1997.

R3. Krishnan K.Chawla, “Composite Materials Science and Engineering”, Springer-Verlag

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE017		Course Title: ENERGY CONSERVATION IN INDUSTRY	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives

The course is indented to calculate various energy economic analysis and suggest methodologies for energy savings by Conducting energy audit in Thermal Systems and in major Industry utilities

Module 1 **23 Hours**

Introduction & Energy Audit : Energy-Power-Past and Present scenario of World –National Energy consumption data – Environmental aspects associated with energy utilization. Energy Auditing – Need – Types-Methodology - -Role of Energy Managers – Instruments for Energy Auditing, Energy Audit Reporting

Energy Conservation In Thermal Systems: Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and energy conservation measures. Steam: Distribution &Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

Energy Conservation In Major Utilities : Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers

Module 2 **22 Hours**

Energy Economics and Management: Importance and role of energy management – Energy Economics - Simple payback period, Time value of money, Net Present Value (NPV), Return on Investment (ROI), Internal Rate of Return (IRR), Life cycle costing.

Environmental Impact and Climate Change: Energy and Environment, Global environmental issues- Acid rain, Ozone layer depletion, Global Warming and climate change, Loss of biodiversity. International agreements: United Nations Framework convention on climate change (UNFCCC), Conference of Parties (COP), The Kyoto Protocol, Clean Development Mechanism (CDM).

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Analysis the Energy Audit Performance in Thermal system and major Industrial Utilities	**Apply**
CO2: Analyse the various energy economic analysis and suggest methodologies for energy savings	**Apply**
CO3: Present a seminar on energy audit system for a given application.	**Apply**

Text Book(s):

T1. Energy Manager Training Manual ((4 Volumes) available at www.energymanager training.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under the Ministry of Power, Government of India, 2004.

Reference(s):

R1. L.C.Witte, P.S.Schmidt, D.R.Brown, Industrial Energy Management and Utilization, Hemisphere Publications, Washington, 1988.

R2. Callaghn P.W., Design and Management of Energy Conservation, Pergamon Press, Oxfore, 1981.

R3. W.R.Murphy and G.Mckay, Energy Management, Butterworths, 2nd Edition, 2009.

R4. Wayne.C.Turner, Steve Doty, Energy Management Handbook, Sixth Edition, CRC Press, 2006.

Web References:

1. https://en.wikipedia.org/wiki/Energy_audit
2. https://onlinecourses.swayam2.ac.in/nou23_es05/preview
3. https://en.wikipedia.org/wiki/Energy_economics

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE018		Course Title: POWER PLANT ENGINEERING	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

This course is intended to Impart knowledge on the design, operation and maintenance of conventional and renewable energy power pants and its economics.

MODULE I **23 Hours**

Coal based Thermal Power Plants: Layout of modern coal power plant, Boilers-Super Critical Boilers-FBC Boilers, Subsystems of thermal power plants - Fuel and ash handling system, Draught system, Feed water treatment systems. Binary Cycles and Cogeneration systems. Pollution control technologies.

Diesel, Gas Turbine and Combined Cycle Power Plants: Components and construction of Diesel and Gas Turbine power plants. Combined Cycle Power Plants.

Nuclear Power Plants: 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), Fast Breeder Reactor (FBR),

MODULE II **22 Hours**

Power from Renewable Energy: Hydro Electric Power Plants — Classification, Typical Layout, associated components and their functions.

Principle, Construction and working of Wind, Tidal, OTEC, Solar Photo Voltaic (SPV), Solar Thermal, Geo-Thermal, Biogas and Fuel Cell power systems.

Power Plant Economics: Power tariff types, Load distribution parameters, load curve, Capital & Operating Cost of different power plants.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Select the suitable conventional power plant considering the various availability conditions and its economics.	Apply
CO2: Suggest suitable renewable energy power plants considering the various sources of energy and its economics.	Apply
CO3: Present a case study in the recent techniques used in power generation.	Apply

Text Book(s):

T1: Power Plant Engineering, P.K.Nag, Tata-McGraw Hill Publishing Company Ltd., 4th edition, 2017.

Reference Book(s):

1. Power Plant Technology, M.M.El-Wakil, McGraw Hill Education, 1st edition, 2017.
2. A Textbook of Power Plant Engineering, R.K.Rajput, Laxmi Publications, 5th edition, 2016.
3. Power Plant Engineering-Theory and Practice, Dipak Kumar Mandal, Somnath Chakrabarti et al., Wiley India, 1st edition, 2019.
4. Practical Boiler Operation Engineering and Power Plant, Amiya Ranjan, Mallick, PHI Learning Pvt.Ltd., 5th edition, 2022.
5. An Introduction to Thermal Power Plant Engineering and Operation: For Power Plant Professionals, P.K.Das & A.K.Das, Notion Press, 1st edition, 2018.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE019		Course Title: GAS DYNAMICS AND SPACE PROPULSION	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3:0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objective:

The course is intended to analyze the performance of various types engines used in Jet and Space propulsion.

MODULE I **24 Hours**

Basic Concepts and Isentropic Flows

Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables

Compressible Flow Through Ducts

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.

Normal and Oblique Shocks

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of Gas tables

MODULE II **21 Hours**

Jet Propulsion

Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.

Space Propulsion

Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Analyze the compressible fluid flow behaviour in constant area ducts with friction and heat transfer.	**Apply**
CO2: Analyze the performance of various types of jet engines.	**Apply**
CO3: Present a case study on the performance of various types engines used in Jet and Space propulsion.	**Apply**

Text Book(s):

T1. Anderson, J.D., "Modern Compressible flow: with Historical Perspective", Third Edition, McGraw Hill, 2017.

T2. S.M. Yahya, "Fundamentals of Compressible Flow with Aircraft and Rocket propulsion", New Age International (P) Limited, Sixth Edition, 2018.

Reference(s):

R1. R. D. Zucker and O Biblarz, "Fundamentals of Gas Dynamics", 2nd edition, Wiley, 2011.

R2. Balachandran, P., "Fundamentals of Compressible Fluid Dynamics", Prentice-Hall of India, 2006.

R3. Radhakrishnan, E., "Gas Dynamics", 6th edition, Prentice Hall of India, 2017.

R4. Hill and Peterson, "Mechanics and Thermodynamics of Propulsion", Pearson, 2nd edition, 1991.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE020		Course Title: COMPUTATIONAL TECHNIQUES FOR FLUID DYNAMICS	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 2:0: 2	Credits: 3	Total Contact Hours: 60	Max Marks:100

Course Objective:

To provide brief introduction of Computational Fluid Dynamics and application of CFD in mechanical engineering domain.

MODULE I **23 Hours**

Introduction: Illustration of the CFD approach, CFD as an engineering analysis tool, Review of governing equations, Modeling in engineering, Partial differential equations- Parabolic, Hyperbolic and Elliptic equation, CFD application, CFD software packages and tools.

Principles of Solution of the Governing Equations: Finite difference and Finite volume Methods, Convergence, Consistency, Error and Stability, Accuracy, Boundary conditions, CFD model formulation. Mesh generation:

Overview of mesh generation, Structured and Unstructured mesh, Guideline on mesh quality and design, Mesh refinement and adaptation.

MODULE II **22 Hours**

Solution Algorithms: Discretization schemes for pressure, momentum and energy equations - Explicit and implicit Schemes, First order upwind scheme, second order upwind scheme, QUICK scheme, SIMPLE, SIMPLER and MAC algorithm, pressure-velocity coupling algorithms, velocity-stream function approach, solution of Navier-Stokes equations.

CFD Solution Procedure: Problem setup – creation of geometry, mesh generation, selection of physics and fluid properties, initialization, solution control and convergence monitoring, results reports and visualization.

List of Experiments **30 Hours**

1. Flow Through a Pipe
2. Flow Through a Bend
3. Flow Over an Airfoil
4. Flow past a cylinder
5. Flow over car

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Use Finite Difference and Finite Volume methods to 2-D and 3-D problems	**Apply**
CO2: Solve the Navier-Stokes equations numerically using appropriate algorithmic strategies for steady and unsteady flows	**Apply**
CO3: Simulate and present a seminar on simple CFD models and analyze its results.	**Apply**

Text Book(s):

T1. Computational Fluid Dynamics,The Basic with applications by John A. Anderson, Jr., McGraw Hill International editions, Mechanical Engineering series.

T2. An Introduction to Computational Fluid Dynamics, H. K. Versteeg and W. Malalasekera, 2nd Edition, Pearson, 2007.

Reference Book(s):

R1. Computational Fluid Dynamics, A practical Approach, Jiyuan Tu et al., 3rd Edition, BH, 2018.

R2.. An Introduction to ANSYS Fluent 2022, John E. Matsson, SDC Publications, 2022

R3. The finite volume method in computational fluid dynamics, An advanced introduction with OpenFoam and Matlab, F. Moukalled, L. Mangani, M. Darwish, Springer, 2016.

Web References:

1. https://onlinecourses.nptel.ac.in/noc23_me119/preview
2. https://www.youtube.com/playlist?list=PL30F4C5ABCE62CB61
3. https://jahid-hasan.com/writings/a-complete-learning-path-for-cfd/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE021		Course Title: ENERGY STORAGE DEVICES	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3:0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objective:

The course is intended to analyze the performance of various energy storage systems.

MODULE I **24 Hours**

Introduction

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.

Energy Storage Systems

Pumped Hydro Energy Storage – Compressed Air Energy Storage – Flywheel – Sensible and Latent Heat Storage – Storage Materials – Performance Evaluation – Thermo-chemical systems – Batteries – Types-Charging and Discharging – Battery testing and performance.

Mobile and Hybrid Energy storage Systems

Batteries for electric vehicles - Battery specifications for cars, heart pacemakers, computer standby supplies – V2G and G2V technologies – HESS.

MODULE II **21 Hours**

Renewable Energy Storage and Energy Management

Storage of Renewable Energy Systems –Solar Energy – Wind Energy – Energy Storage in Micro grid–Smart Grid – Energy Conversion Efficiency - Battery Management Systems – EVBMS – Energy Audit and Management

Other Energy Devices

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.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Analyze the performance of various energy storage systems.	**Apply**
CO2: Apply the storage of renewable energies and management systems.	**Apply**
CO3: Present a case study on various performance of various energy storage devices.	**Apply**

Text Book(s):

T1.Robert A. Huggins, “Energy Storage: Fundamentals, Materials and Applications”, 2nd Edition, Springer, 2015.

T2.Dell, Ronald M Rand, David A J, “Understanding Batteries”, Royal Society of Chemistry, 2001

Reference Book(s):

R1. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt,” Energy Storage in Power Systems” Wiley Publication, 2016.

R2. Ru-Shiliu, Leizhang, Sueliang Sun, “Electrochemical Technologies for Energy Storage and Conversion”, Wiley Publications, 2011.

R3. Viswanathan B, and Aulice Scibioh M, “Fuel Cells – Principles and Applications’, 1st edition CRC Press, 2008.

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Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE022		Course Title: SOLAR AND WIND ENERGY ENGINEERING	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks:100

Course Objectives

The course is intended to calculate the performance of solar thermal systems, Solar energy storage systems and photovoltaic systems and wind energy system which includes safety and environmental aspects by solar radiation

Module I **23 Hours**

Solar Energy Radiation & Solar Non Concentrating Collectors: Solar radiation availability - radiation measurement – transmittance - absorptance – Basic earth sun angles - estimation of average solar radiation, radiation on tilted surface - Flat plate collectors - heat transfer correlations - collector efficiency - heat balance – absorber plate – types - selective surfaces. Solar water heaters - types- their performance. Solar driers – types – heat transfer - performance of solar dryers – agro industrial applications

Solar Concentrating Collectors and Solar energy storage systems: Concentrating collectors – types – reflectors - solar thermal power stations – principle and applications - Solar energy storage systems – thermal - sensible and latent heat, chemical, electrical, electro-magnetic energy storage – selection of materials for energy storage - Solar distillation – application - Solar stills - types - Solar pond - performance – characteristics - applications – Solar refrigeration.

Module 2 **22 Hours**

Solar Pv Technology: Solar photovoltaic technology –introduction – solar cell basics – Types of solar cells and modules – encapsulation – Design of solar PV system – load estimation - batteries – invertors – operation - system controls. Standalone and grid connected systems - PV powered water pumping - Hybrid system - Solar technologies in green buildings.

Wind Energy : Nature of the wind – power in the wind – factors influencing wind – wind energy potential and installation in India- wind speed monitoring - wind resource assessment - wind power laws - velocity and power duration curves - Betz limit - site selection.

Wind Mill Types And Applications: Wind energy conversion devices - classification, characteristics, applications – Design of horizontal axis wind mill rotor diameter - Wind energy storage - wind farms - wheeling and banking - testing and certification procedures. Water pumping - Hybrid systems – Wind mill safety and environmental aspects.).

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO 1: Analysis the performance of solar thermal systems, Solar energy storage systems	Apply
CO2: Analyze the performance of photovoltaic systems and wind energy system which includes safety and environmental aspects	Apply
CO3: Present a seminar on safety and environmental aspects in energy system.	Apply

Text Book(s):

T1. Rai., G.D. "Solar Energy Utilization" Khanna publishers, New Delhi, 2012.

T2. Solanki, C.S. "Renewable Energy Technologies: A Practical guide for beginners". PHI learning Pvt. Ltd, New Delhi. 2008

Reference(s):

R1. Wind Energy Engineering, Pramod Jain, McGraw Hill Education, New York, 2nd Edition, 2010.

R2. Rajput. R.K. "Non- Conventional Energy Sources and Utilization", S. Chand & Company Pvt. Ltd, New Delhi, 2013.

R3. Rao.S and B.B. Parulekar. "Energy Technology – Non conventional, Renewable and Conventional". Khanna Publishers, Delhi, 2000.

Web References:

1. http://www.icebookshop.com
2. http://nptel.ac.in/courses/112107143/40

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE023		Course Title: ALTERNATE FUELS AND ENERGY SYSTEMS	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3:0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objective:

The course is intended to analyze the performance of IC engines using various alternate fuels.

MODULE I **23 Hours**

Alternate energy sources: Introduction to alternate energy sources, Man and energy, energy forms, Need for alternate sources of energy, availability, Merits and demerits. Scope of alternate energy sources in India, Energy management, Global Energy Issues, National & State Level Energy Issues

Alternate fuels: Need for alternate fuel, Availability and properties of alternate fuels, General use of alcohols, LPG, Hydrogen, Ammonia, CNG and LNG, vegetable oils, biogas, EV, hybrid vehicles, Fuel cells and solar cells, Merits and demerits of alternate fuels.

Alcohols: Properties as engine fuels, alcohols and gasoline blends, Performance in SI engine using methanol blends, Performance in SI engine using gasoline blends, Combustion characteristics in CI engine, Emission characteristics, DME, DEE properties, Performance analysis of DME, DEE, Performance in SI engine, Performance in CI engine.

MODULE II **22 Hours**

Vegetable Oils

Various vegetable oils for engines, Esterification process in vegetable oils, Performance of engines using vegetable oils, Performance and emission characteristics of engine using vegetable oils, Bio-diesel and its characteristics

Electric, Hybrid, Fuel Cell and Solar Cars

Layout of electric vehicles, advantages and limitations of electric vehicles, Specifications and system components, Electronic control system, High energy and power density batteries, Hybrid vehicles, Fuel cell vehicles, Solar powered vehicles.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Analyze the performance of IC engines using alternate fuels.	**Apply**
CO2: Analyze the performance of electric, hybrid, fuel cell and solar cars with their merits and demerits.	**Apply**
CO3:Present a seminar on the principle of engine performance system.	**Apply**

Text Books

1. Richard.L.Bechtold, “Alternative Fuels Guide Book”, SAE, 1997.

2. G.D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 1999.

References

1. G.R.Nagpal, and S.C.Sharma, “Power Plant Engineering”, Khanna Publishers, 1995.

2. Maheswar Dayal, “Energy: Today and Tomorrow”, Ministry of Information and Broadcasting, Govt.of India, 1983.

3. “Alcohols as motor fuels progress in technology”, Series No.19, SAE Publication,1980

Web References

https://en.wikipedia.org/wiki/Alternative_fuel

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE024		Course Title: REFRIGERATION AND AIR-CONDITIONING	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) 3:0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objective:

The course is intended to analyze the performance of refrigeration and air-conditioning systems.

MODULE I **21 Hours**

Refrigeration Systems

Thermodynamic principles of refrigeration – Types of Refrigeration Systems – Vapour compression refrigeration System, Ts and P-H diagrams, Performance calculation – Vapor Absorption System: Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration, Thermo Electric Refrigeration, Compound compression refrigeration, Cascade refrigeration cycle.

Refrigerants: Primary& secondary refrigerants, Nomenclature of Refrigerants, Properties and selection – Environment friendly alternatives.

Components of Refrigeration System

Refrigerant compressors - reciprocating, rotary and centrifugal compressors, evaporators - flooded, dry expansion, shell and tube and double pipe evaporators, condensers - air cooled, water cooled and evaporative condensers, expansion devices - automatic, capillary tube and thermostatic expansion valve.

MODULE II **24 Hours**

Pyschrometry and Air-Conditioning Systems

Psychrometry: Psychrometric properties of moist Air- Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature, Psychrometric chart, Psychrometric of air-conditioning processes, mixing of air streams.

Air-Conditioning – Different types of Air Conditioner- Room/Window, Central Air Conditioner.

Air-Conditioning Load Estimation and its Applications

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 & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load.

Food Preservation, Food Storage & Distribution, LNG – Ice Manufacturing Plant – Solar Air Conditioning, – Automobile air conditioning, Refrigerated trucks.

Installation and Servicing

Air distribution systems – Study of different types of duct systems – Charging of refrigerant – Servicing of air-conditioning, – Safety procedures, Leak detection procedures- Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors – Automatic Dew point recorder, Actuators & Safety controls.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Calculate the performance of vapor compression refrigeration systems	**Apply**
CO2: Estimate the cooling load and heating load in air-conditioning systems	**Apply**
CO3: Present a case study on the performance of refrigeration and air-conditioning systems.	**Apply**

Text Book(s):

T1.Manohar Prasad, "Refrigeration and Air Conditioning", Third edition, New Age International, 2021.

T2.Arora. C.P., "Refrigeration and Air conditioning", 3rd edition. Tata McGraw-Hill, 2017.

Reference(s):

R1. Dossat, R.J. "Principles of Refrigeration", Prentice-Hall, 2013.

R2. R.S.Khurmi, J.K.Gupta."Textbook of Refrigeration and Air-conditioning" S.Chand Publications, 2nd Edition, 2006.

R3. ASHRAE 2017 Hand book (Fundamentals &Equipments).

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE025		Course Title: NON DESTRUCTIVE TESTING METHODS	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course aims to impart knowledge on the principles and techniques of Non-Destructive Testing (NDT) methods, focusing on their applications in ensuring material integrity, safety, and reliability.

MODULE I **22 Hours**

VISUAL INSPECTION AND EDDY CURRENT TESTING METHOD

Scope and advantages of NDT-Compare NDT with DT-Principle of Visual Inspection theory-Optical aids used for Visual Inspection-Microscope, Borescope, Endoscope, Flexiscope, Principles of Eddy Current Theory- ASTM standard-types coils-types of Probes- Advanced Eddy Current Techniques- applications and Limitations.

MAGNETIC PARTICLE TESTING METHOD

Basic Principle of magnetic particle testing(MPT)- classification-types of magnetizing current-skin effect-demagnetization-measuring magnetic fields- magnetic particles –magnetic particle testing method-magnetic field indicators-– ASTM standard- methods of MPT-advantages-application -limitation of MPT.

LIQUID PENETRANT TESTING METHOD

Basic principles of liquid penetrant – step by step process- classification of penetrants-properties-penetrant removal process-developers- selection, use, methods - properties of developers- quality control process-health and safety precautions- applications and limitations of LPT- different LPT methods- ASTM standard.

MODULE II **23 Hours**

ULTRASONIC TESTING METHOD

Introduction to Ultrasonic Testing - Basic Principles of Ultrasonic Testing – UT Equipment and Accessories - Couplant- Calibration methods- Data presentation-Techniques and Methods in UT: Contact Type Techniques - Immersion Testing Techniques - Phased Array Ultrasonic Testing (PAUT)- Automated Ultrasonic Testing (AUT)- Applications of UT in Industries - Advantages and Limitations of UT- Safety and Standards in UT- Case Studies.

RADIOGRAPHIC TESTING METHOD

Basic Principle of Radiography-Electromagnetic radiation sources-X ray source, Gamma ray source-properties of X and Gamma Rays-Radiographic Imaging-Geometrical factors-radiographic film-film density-Radiographic sensitivity- Penetrometer-Radiographic Inspection Techniques: single wall single image technique, wall penetration technique, Latitude technique-Applications and Limitations of Radiographic Inspection Techniques. ASTM standard.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Select suitable Visual Inspection and Eddy Current Testing, Magnetic Particle Testing, Liquid Penetrant Testing of a component to find the sub surface defects.	Apply
CO2: Select suitable Ultrasonic test and Radiographic testing of a component to find the internal defects.	Apply
CO3: Present suitable inspection techniques for the given component in a team.	Apply

Text Book(s):

T1. J Prasad, C G K Nair, “Non-Destructive Testing and Evaluation of Materials”, Tata McGraw-HillEducation Private Limited, 2017.

T2. Baldev Raj, T.Jayakumar, M.Thavasimuthu,“Practical Non-Destructive Testing”, Narosa Publishing House, 2011.

Reference(s):

R1. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.

R2. Paul Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition,New Jersey,2005.

Web References:

1. https://www.nde-ed.org/index_flash.htm
2. http:// http://117.55.241.6/library/E-Books/NDT%20Notes.pdf
3. http://www.slideshare.net/ndtindia123/introduction-uses-of-non-destructive-testing-24377016
4. http:// www.eis.hu.edu.jo/ACUploads/10526/Ultrasonic%20Testing.pdf
5. http://www.hse.gov.uk/comah/sragtech/ndt2.pdf
6. https://shorturl.at/9f7dH

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE026	Course Title: GEOMETRIC DIMENSIONING & TOLERANCING FOR MECHANICAL DESIGN		
Course Category: Major		Course Level: Higher	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

This course is intended to study the basic concepts and symbols of GD&T, including modifiers and datum systems, as well as form, orientation, profile, location, and runout tolerances, along with surface texture and their applications in design.

MODULE I **23 Hours**

BASIC CONCEPTS AND FORM TOLERANCES

Reasons to use GD&T- ASME Y 14.5 standard –Conventional vs Advanced tolerancing methods – use of basic dimensions. Feature size: Material condition of feature of size – Individual feature of size – Degree of freedom. Symbology & Datum - multiple Datum Features.

FEATURE CONTROL FRAME , DATUM AND DATUM FEATURES

Feature control frame- Rule 1 and Rule 2 of GD&T. Modifiers – use of MMC, LMC, RFS, VC, RC. Size control form – external feature – internal feature – Taylor principle.

Datum – Applications of datum, Datum feature selection, Datum feature identification, Inclined datum features, Cylindrical datum features

FORM AND ORIENTATION TOLERANCE

Tolerances of Form – Flatness, straightness, Circularity and Cylindricity. Tolerances zone, Applications and Inspection methodology for form tolerance. Tolerances of Orientation – Parallelism, Perpendicularity, Angularity, Tolerances zone, Applications and Inspection methodology for Orientation tolerance.

MODULE II

22 Hours

PROFILE, LOCATION & RUNOUT TOLERANCE

Line and surface profile – profile as general requirement – unequally disposed profile tolerance – unilateral profile tolerance – tolerance zones. Tolerances of Location – Position, symmetry and concentricity – composite position tolerancing – projected tolerance zone .Applications and Inspection methodology for location tolerance. Tolerances of Runout - Circular runout, Total runout – Measurement of runout.

TOLERANCE ANALYSIS & SURFACE TEXTURE

Tolerance Analysis – Tolerance Stackup – Worst case and Statistical tolerance analysis. Surface Texture – Definitions - Surface texture symbols and interpretation - Types of surfaces and Lays -Measurement methods - 3D Surface Roughness Measurement.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the basic concepts, symbols, and modifiers of Geometric Dimensioning and Tolerancing (GD&T) to interpret engineering drawings and define functional relationships in designs.	Apply
CO2: Apply form, orientation, profile, and location tolerances to ensure functionality, manufacturability, and accuracy in component design and inspection	Apply
CO3: Apply runout tolerances, surface texture requirements, and tolerance analysis techniques to improve product quality and meet design specifications.	Apply
CO4: Prepare and present a report on the GD & T application on design specifications.	Apply

Text Book(s):

T1. James D Meadows, "Geometric Dimensioning and Tolerancing", Marcel Dekker, Inc

T2. P S Gill, "Geometric Dimensioning and Tolerancing", S K Kataria & sons.

Reference Book(s):

R1. Bryan R Fischer, "Mechanical Tolerance stackup analysis", CRC press.

R2. Gene R. Cogorno, "Geometric Dimensioning and Tolerancing for Mechanical Design", McGraw – Hill

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE027		Course Title: OPERATIONS RESEARCH	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is focused to provide a fundamental knowledge on solutions on LPP, Transportation, netwok and assignment problems involved in industry.

MODULE I Introduction in Operations Research 23 Hours

Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR. Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and two-phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.. Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel’s Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem.

MODULE II Assignment problems, Network analysis 22 Hours

Assignment Problem-Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little’s method. Numerical Problems. Introduction, Construction of networks, Fulkerson’s rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks.

Course Outcomes At the end of the course students will able to	Cognitive Level
CO1: Apply the concept of solution arrived on various problems.	Apply
CO2: Implement Assignment problem and best project completion activities on issues related to an industry.	Apply
CO3: Present a case study on operation research concepts using appropriate tools for real-time industrial problems.	Apply

Text Book(s):

T11 Operations Research P K Gupta and D S Hira S. Chand and Company LTD. Publications, New Delhi 2007

2 Operations Research, An Introduction by Hamdy A. Taha PHI Private Limited Seventh Edition, 2006.

Reference Book(s):

R1. Operations Research, Theory and Applications J K Sharma Trinity Press, Laxmi Publications Pvt.Ltd. Sixth Edition, 2016

R2. Operations Research A M Natarajan, P Balasubram ani Pearson Education, 2005

Web References:

https://onlinecourses.nptel.ac.in/noc20_ma23/preview

https://onlinecourses.nptel.ac.in/noc22_ma48/preview

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE028	**Course Title: TOTAL PRODUCTIVE MAINTENANCE**		
Course Category: Major		**Course Level: Higher**	
L:T:P (Hours/Week) 3: 0: 0	**Credits:3**	**Total Contact Hours: 45**	**Max. Marks:100**

Course Objectives

The course is intended to apply analytical tools in maintenance management and Illustrate TPM and global trends in maintenance management.

Module 1 **22 Hours**

Modern Maintenance Concepts and Practices

Maintenance definition – Maintenance management – Maintenance Concepts: Objectives, Organization and Functions of Maintenance, Maintenance strategies, Types of Maintenance – Maintenance systems – (Planned, Unplanned / Breakdown, Corrective, Opportunistic, Routine, Preventive, Predictive, Condition based maintenance systems),Maintenance planning and scheduling, Maintenance Logistics, Human factors in Maintenance and Staffing methods, Maintenance manuals, Maintenance costs.

Analytical Tools in Maintenance Management

Failure Data Analysis, MTBF,MTTF, Useful life-Survival curves, Repair time, Breakdown time distributions- Poisson's, Normal, Exponential, Availability, Reliability, Maintainability, Maintainability prediction – System effectiveness- Overhaul/Repair / Replace maintenance policy, Queuing applications, simulation, spare parts management, Replacement Decisions: Optimal interval between preventive replacements, Overall Equipment Effectiveness.

Module 2 **23 Hours**

RELIABILITY CENTERED MAINTENANCE

Reliability Centered Maintenance (RCM), Objectives and function, Steps in RCM implementation, steps in RCM analysis, System selection, Tero technology RCM effectiveness indicators, RCM tasks Proactive Maintenance, Reliability models System reliability- Series, Parallel and mixed configuration, System reliability determination; Reliability improvement, Scheduled restoration and scheduled discard, The P-F interval and P-F curves, linear as nonlinear PF curves , Default actions, RCM Decision diagrams.

TPM AND GLOBAL TRENDS

Concept of TPM, Characteristics of TPM, Zero breakdown concepts, Zero Defects and TPM, FMECA Maintainability prediction Design for maintainability, Maximizing equipment effectiveness, Autonomous maintenance program, Five pillars of TPM, TPM Small group activities.

Implementing TPM. Philosophy / Indications of TPM. TPM Development - Preparation phase, Master Plan, Initiatives, Promotion, Planning, Organization, Awareness, Training, Establishment of basic policies and goals, TPM organization, Implementation phase; Consolidation phase. Measuring TPM effectiveness: Measuring TPM effectiveness Indicators, Plant effectiveness and Measuring; TPM Benefits and Global trend

CONDITION MONITORING IN MAINTENANCE

Condition Based Maintenance: Machine signatures, Signature Analysis-MMIS Expert systems, Temperature noise, vibration and wear particle analysis, on line and off line techniques. Online Monitoring Condition Monitoring Techniques, Vibration Monitoring and Signature Analysis. Wear Debris Monitoring, Maintenance Management Information System, Expert systems, Corrosion Monitoring and Control, Case Studies in Maintenance, Measurement and benchmarking of performance, MIS for maintenance.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Apply lean maintenance principles to identify and eliminate inefficiencies in the maintenance process.	Apply
CO2: Apply analytical tools in maintenance management	Apply
CO3: Apply Reliability Centered Maintenance for industrial systems and present as a case study,	Apply

Text Books

T1. Steven Borris, "Productive Maintenance: Proven Strategies and Techniques to Keep Equipment Running at Maximum Efficiency", McGraw Hill, Edition 1, 2006

T2. Seiichi Nakajima, "Introduction to TPM", Productivity Press, Chennai, 2010.

T3. Gopalakrishnan, P. and Banerji, A.K., "Maintenance and Spare Parts Management", Prentice – Hall of India Pvt. Ltd., 2013.

Web references

http://www.plant-maintenance.com/articles/tpm_intro.pdf

https://www.ame.org/sites/default/files/TPM-introduction-AME.pdf

https://www.leanproduction.com/tpm/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE029	Course Title: QUALITY ENGINEERING		
Course Category: Major		Course Level: Higher	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

To provide an understanding of quality and customer satisfaction, cost of quality and its classification, principles of Total Quality Management applicable to manufacturing and service industries, quality engineering tools, and the methodology of designing for quality.

Module 1

INTRODUCTION **23 Hours**

Introduction – Need for quality – Evolution of quality – Different Definitions and Dimensions of Quality– Concepts of Product and Service Quality– Contributions of Deming, Juran and Crosby – Barriers to Quality – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, and Customer retention – Costs of Poor quality.

QUALITY COSTS

Basic Concept Quality Costs: Fitness for Use, Quality Characteristics, Parameters of Fitness for use-Quality functions, Concept of Quality assurance and Quality control, Quality costs concept, Quality cost categories, Examples of Quality cost studies, Securing the Cost figures, Pareto Analysis, Cost reduction Programs and economics of quality.

TOTAL QUALITY MANAGEMENT

Total quality Management- Basic concepts of TQM, historical review, leadership, concepts, role of senior management, quality statements, plans for process parameters, Modern Quality Management Techniques-Benchmarking, QFD, Taguchi quality loss function TPM, Lean Manufacturing continuous improvement techniques, JIT systems, Cause and effect diagrams, Scatter diagram, Run charts, Affinity diagrams, Inter-relationship diagram, Process decision program charts, PDCA Concept

.

Module 2

QUALITY ENGINEERING AND MANAGEMENT TOOLS 22 Hours

Quality Engineering and Management Tools, Techniques & Standards: 7 QC tools, 7 New Quality Management Tools, 5S Technique, Kaizen, Poka-Yoke, SMED, Quality Circle, Cost of Quality Technique, Introduction to Quality Management Standards – ISO 9000, IATF 16949, ISO 14001, ISO 45001, ISO 50001 (Concept, Scope, Implementation Requirements & Barriers, and Benefits), Introduction to National and International Quality Awards.

DESIGNING FOR QUALITY

Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis (FMEA) – Concept, Methodology and Application (with case studies). Six Sigma - Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitations – DOE

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Analysis the need of quality and customer satisfaction, Quality cost.	Apply
CO2: Analysis the concept of total quality management relevant to both Manufacturing and service industry.	Apply
CO3: Present a case study on various tools used in Quality Engineering, Management tool and Designing for Quality	Apply

Text Book(s):

T1. K C Jain and A K Chitale “Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000)”, Khanna Publishers, 2008.

T2. Dale H. Besterfield , “Total Quality Management” Pearson Education, 2018.

Reference(s):

R1. Juran and Gryna “Quality planning and Analysis”, TMH, New Delhi,2010.

R2. B. L. Hanson & P. M. Ghare, “Quality Control & Application”, Prentice Hall of India, 2001.

Web References:

1. http://www.nptel.ac.in
2. http://www.ocw.mit.edu

. **Course Articulation Matrix**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

.

Course Code:23MEE031		Course Title: LEAN SIX SIGMA	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

This course is intended to provide an overview of Lean and Six Sigma concepts and enable students to apply relevant tools for process improvement and quality enhancement.

MODULE I SIX SIGMA METHODOLOGY 22 Hours

Overview of Six Sigma – DMAIC Methodology - Financial Impact and Organizational Benefits of Six Sigma - Voice of the Customer (VOC), Kano Model, Project Charter - SIPOC Diagram, Data Collection Techniques, Measurement System Analysis - Process Capability Studies, Sigma Level Calculation - Root Cause Analysis (Fishbone, 5 Why), Hypothesis Testing (t-test, ANOVA, Regression)

MODULE II IMPROVE, CONTROL & LEAN TOOLS 23 Hours

Identify Potential Causes, Discovering Variable Relationships - FMEA, QFD, Poka Yoke, Brainstorming, Benchmarking - Control Charts, Implementation Planning and Process Monitoring - Introduction to Lean Tools – 5S, Kaizen, JIT, Kanban - Value Stream Mapping, Bottleneck Analysis, OEE, PDCA - Integration of Lean with Six Sigma for Continuous Improvement

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply Six Sigma methodology and tools to improve process performance.	**Apply**
CO2: Use Lean tools to eliminate waste and enhance organizational efficiency.	**Apply**
CO3: Apply Lean Six Sigma concepts through assignments, presentations, or model-based submissions.	**Apply**

Text Book(s):

1. Thomas Pyzdek, Paul A. Keller, The Six Sigma Handbook, Sixth Edition, McGraw-Hill, 2023.
2. Michael L. George, David Rowlands, Bill Kastle, what is Lean Six Sigma, McGraw-Hill, 2003.

Reference Book(s):

1. Fred Soleimannejed, Six Sigma: Basic Steps and Implementation, Author House, 2004.
2. Forrest W. Breyfogle III, James M. Cupello, Becki Meadows, Managing Six Sigma: A Practical Guide to Understanding, Assessing, and Implementing the Strategy That Yields Bottom-Line Success, John Wiley & Sons, 2000.
3. James P. Womack, Daniel T. Jones, Lean Thinking, Free Press Business, 2003.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE030	Course Title: PRINCIPLES OF MANAGEMENT		
Course Category: Major		Course Level: Higher	
L:T:P: 3: 0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objectives

This course is intended to study the role of managers, the significance of planning, decision-making, and strategies in international business, the importance of organizing tasks, various motivational theories, and control techniques.

MODULE I **23 Hours**

OVERVIEW OF MANAGEMENT

Organization – Management – Role of managers – Evolution of Management thought – Organization and the environmental factors – Managing globally – Strategies for International Business

PLANNING

Nature and Purpose planning – Planning process – Types of Plans – Objectives – Managing by Objective (MBO) Strategies – Types of strategies – Policies – Decision Making – Types of decision – Decision Making Process – Rational Decision Making Process – Decision Making under different Conditions.

ORGANISING

Nature and purpose of organizing – Organization structure – Formal and informal groups organization – Line and Staff authority – Departmentation – Span of Control – Centralization and Decentralization – Delegation of authority – Staffing – Selection and Recuritment – Orientation Career Development – Career stages – Training – Performance appraisal.

MODULE II

22 Hours

DIRECTING

Creativity and Innovation – Motivation and Satisfaction – Motivation Theories Leadership – Leadership theories – Communication – Hurdles to effective communication – organization culture – elements and types of culture – managing cultural diversity.

CONTROLLING

Process of controlling – types of control – budgetary and non – budgetary control techniques – managing productivity – cost control – purchase control – maintenance control – quality control – planning operations.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply management principles to understand the roles and functions of managers in various organizational and business contexts.	Apply
CO2: Develop and implement effective planning, decision-making, and strategic management practices to achieve organizational objectives in both domestic and international settings.	Apply
CO3: Utilize organizational, motivational, and control techniques including task allocation, employee engagement strategies, budgeting, and quality management to enhance productivity and efficiency.	Apply
CO4: Present a case study on decision making skills on a given management strategies.	Apply

Text Book(s):

T1. Stephen P. Robbins, Rolf Bergman and Mary Coulter, “Management”, Prentice Hall of India, 8th edition, 2017.

T2. Charles W.L Hill, Steven L McShane, “Principles of Management”, Mcgraw Hill Education, 2008.

References:

R1. Hellriegel, Slocum & Jackson, “Management – A Competency Based Approach”, Thomson South Western, 10th edition, 2007.

R2. Harold Koontz, Heinz Weihrich and mark V Cannice, “Management – A global & Entrepreneurial Perspective”, Tata McGraw Hill, 12th edition, 2007.

R3. Andrew J. Dubrin, “Essentials of Management”, Thomson Southwestern, 7th edition, 2007

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	3	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE032	Course Title: INDUSTRIAL SAFETY MANAGEMENT		
Course Category: Major		Course Level: Higher	
L: T: P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max Marks: 100

Course Objectives:

The course is intended to provide the students with a solid foundation in the principles and practices of industrial safety and health management.

Module I **22 Hours**

Safety Management – Principles, Need, Occupational Health & hygiene, modern safety concept, Safe operating procedure (SOP's), Safety permits, Social and physiological effects. Behavioral based safety - aim, benefits, law and rules. Accident - Near Miss, injury, Cost of accident, Unsafe act, Unsafe condition. Environmental safety - air pollution, water pollution, industrial noise & vibration control, physical hazards, chemical hazards, biological hazards, electrical hazards. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, Components of safety audit, types of audit, audit methodology, permanent total disabilities, permanent partial disabilities, temporary total disabilities, Concept of an accident, reportable and non-reportable accidents, unsafe act and condition, Principles of

Module II **23 Hours**

Safety - T score, safety activity rate records of accidents, accident reports. Role and responsibilities of management and line staffs, Supervisors and Employees, Safety committee, Motivation, budgeting for safety, safety policy, Safety Education and Training, Importance of training, Training methods – Programme, seminars, conferences. Role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign. Personal Protective Equipment (PPE) – Requirement, Selection and Usage, Importance and Types. Fire properties of solid, liquid and gases, Fire spread, Toxicity of products of Combustion sources of ignition, Fire triangle, Fire extinguishing - Principles, active and passive fire protection systems, Various classes of fires, Fire extinguishing agents, fire stoppers, Emergency preparedness and responsibilities, Onsite and offsite emergency plan.

Indian Factories act 1948, Tamilnadu Factories rule 1950, Environmental protection act 1986, Indian electricity act 1910, Indian electricity rule 1956, Indian boiler act 1923, Workmen 's compensation act 1923, Explosive act1983, Noise pollution rules 2000.

Course Outcomes	Cognitive

At the end of the course students will able to	Level
CO1: Apply environmental safety practices to minimize health risks and comply with regulatory requirements.	**Apply**
CO2: Apply the safety performance metrics such as T-score, Safety Activity Rate, and accident records to monitor and improve organizational safety practices.	**Apply**
CO3: Apply relevant industrial safety, health, and environmental legislation to ensure legal compliance, promote safe working conditions, and support sustainable industrial practices.	**Apply**

Text Book(s):

T1. Deshmukh.L.M, Industrial Safety Management, McGraw Hill, 2006.

T2. C.RayAsfahl —Industrial Safety and Health management‖ Pearson Prentice Hall,

Reference Book(s):

R1. John V. Grimaldi and Rollin H. Simonds, Safety Management‖, All India Traveler bookseller, New Delhi, 1989.

R2. Heinrich H.W. Industrial Accident Prevention‖ McGraw-Hill Company, New York, 1980

R3. Subramanian.V, The Factories Act 1948 with Tamilnadu factories rules 1950‖,

<u>Course Articulation Matrix</u>

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	-	-	-	-	-	-	-	-	1	-	1	-	-
CO2	3	-	-	-	-	-	-	-	-	1	-	1	-	-
CO3	3	-	-	-	-	-	-	-	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 23AUE030	**Course Title: ELECTRIC VEHICLE POWERTRAINS**		
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) : 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

Course is intended to:

1. Calculate battery and pack parameters for electric vehicles
2. Select traction machines for electric vehicles
3. Select converters and controllers for electric vehicles
4. Select sensors for electric vehicles
5. Perform cost benefit analysis of electric vehicles

Module I **22 Hours**

ELECTRIC VEHICLE DYNAMICS, BATTERY PACKS AND TRACTION MACHINES

Longitudinal vehicle dynamics: vehicle load forces, vehicle acceleration, drive cycle. Electric vehicle architecture - Subsystems, BEV, PHEV, HEV, FCEV.

Energy source: introduction to batteries, lifetime and sizing considerations, battery charging, management and protection systems, battery chemistries and models. Battery pack design: parameters, configuration, capacity, range, C-rates, SoC, SoH, SoF.

Introduction to traction machines: Propulsion machine, machine specifications, characteristic curves, conversion factors for machine units. Machine structure, operation, specifications, characteristic curves, using machine for EV power train, thermal characteristics of Brushed DC machine, Brushless DC machine, Induction machine, PMSM machine.

Module II **23 Hours**

CONTROLLERS, CONVERTERS,BMS AND COST ANALYSIS

DC DC converters: power conversion basic principles, buck converter, boost converter, power semiconductors, passive components, interleaving. Inverters: three phase inverters, modulation schemes, sinusoidal modulation, inverter power losses.

Controller: introduction to control of traction machines, control of DC machines, control of induction machines, control of PMSM, BLDC, DC machines.

BMS: significance, cell balancing, architecture, types. Sensors: current, voltage, temperature, pressure and position. SoC, SoH and SoF measurement. ASICs.

Market trends: batteries, traction motors, converters, controllers, BMS, sensors and communication. Technology updates in electric vehicles. System component layout: design of mechanical structures, optimization of space and layout

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Calculate parameters associated with electric vehicle batteries and packs for various two, three, four-wheeler, and special applications.	Apply
CO2: Select traction machines based on the requirements using machine characteristic curves, specifications and performance.	Evaluate
CO3: Select converters and controllers based on the technical specifications and electric vehicle system requirements.	Evaluate
CO4: Select sensors for measurement as part of management of the vehicle performance.	Evaluate
CO5: Perform cost benefit analysis of electric vehicle powertrains based on market trends, technology, environment, and sustainability.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	1	2	-	1	1	1
CO2	3	3	2	-	-	-	-	-	1	2	-	1	1	1
CO3	3	3	2	-	-	-	-	-	1	2	-	1	1	1
CO4	3	3	2	2	1	1	1	-	1	2	-	1	1	1
CO5	3	2	1	1	1	1	1	-	1	2	-	1	1	2

High-3; Medium-2; Low-1

Text Book(s):

T1. John G. Hayes and G. Abas Goodarzi, Electric Powertrain ‖, First Edition, John Wiley and Sons, 2018. ISBN:9781119063667

T2. Luis Romeral Martinez and Miguel Delgado Prieto, New Trends in Electrical Vehicle Powertrains, Intechopen, 2019. ISBN:9781838816988.

T3. Sam Davis, Managing Electric Vehicle Power ‖, SAE International, 2020. ISBN:9781468601442

Reference Book(s):

R1. Xudong Zhang, Modeling and Dynamics Control for Distributed Drive Electric Vehicles ‖, Springer, 2021

R2. Sang-Hoon Kim, Electric Motor Control: DC, AC, and BLDC Motors ‖, Elsevier, 2017.

Web References:

1. NPTEL - https://nptel.ac.in/courses/108/106/108106182/

Course Code: 23AUE033	Course Title: ELECTRIC VEHICLE MECHANICS AND CONTROL		
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to

1. Apply the principles of vehicle mechanics to design EV system.
2. Apply control strategies for AC and DC machines in EV powertrains.
3. Explain the role of powertrain control systems in EVs.

Module I **23 Hours**

EV Vehicle Dynamics: Impact of EV powertrain on vehicle dynamics: Weight distribution, center of gravity. Tractive effort, rolling resistance, aerodynamic drag, and grading resistance. Acceleration and range calculations. Braking performance and blended braking. Noise, Vibration, and Harshness (NVH) in EVs.

Electric Machines for EVs: Review of Basic Electric Machine Principles: Torque, speed, power characteristics. DC Motors: Types, characteristics, and limitations in EV applications. AC Motors: Induction Motors, Permanent Magnet Synchronous Motors.

Module II **22 Hours**

Control Design Preliminaries –Control system - Transfer Functions – Stability - Transient Performance - Gain margin and Phase margin study -open loop mode. Closed loop block diagram, comparison of open and closed loop.

EV Powertrain Control Strategies : Motor Control Techniques - Regenerative Braking Systems - Traction Control and Stability Control in EVs - Energy Management Strategies - Cruise Control and Adaptive Cruise Control.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the principles of vehicle mechanics to design a basic EV system.	Apply
CO 2: Apply control strategies for AC and DC machines in EV powertrains.	Apply
CO 3: Analyze the role and implementation of powertrain control systems in EVs.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	1
CO2	3	3	3	-	-	-	-	-	-	-	1	3	-	1
CO3	3	3	3	-	-	-	-	-	-	-	1	3	3	1

High-3; Medium-2; Low-1

Text Book(s):

T1.Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.

T2. Power Electronic Converters,: Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH.

T3. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition.

T4. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.

Reference Book(s):

R1. Wie Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, John Wiley & Sons, 2017, 2nd Edition.

Web References:

1. NPTEL - https://onlinecourses.nptel.ac.in/noc25_ee33/preview

Course Code: 23AUE036	Course Title: ELECTRIC VEHICLE CHARGING SYSTEM		
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) : 3:0:0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to

1. Compare different charging technologies and standards to determine the optimal charging infrastructure for specific applications.
2. Design power electronics converters and suitable converters for efficient EV battery charging systems.
3. Develop layout designs for Level 1, Level 2, and fast-charging techniques, optimizing for safety and efficiency.

Module I **23 Hours**

Charging Stations and Standards: Charging technologies- Conductive charging, EV charging infrastructure, Transformer based charging, Static and dynamic charging, Swapping stations, International standards and regulations.

Electronics For EV Charging: Layouts of EV Battery Charging Systems- AC charging-DC charging systems- Converters for EV Battery Charging – AC and DC converters - Connectors and standards. Design of suitable converters and connectors for different EV architecture.

Layout Design – Design of simple layouts for Level1, Level 2 and Fast charging techniques.

Module II **22 Hours**

Renewable and Storage Systems: EV charger topologies, EV charging/discharging strategies - Integration of EV charging-home solar PV system, Operation modes of EVC-HSP system , Control strategy of EVC- HSP system.

Wireless Power Transfer: Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles – Benefits of WPT. WPT Operation Modes – Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363 – Design of wireless charger for two wheelers.

Smart Grid charging and protocols: Charging methods and Control**,** Communication protocols - ISO/IEC 15118 – OCPP - IEEE 2030.5 - DIN 70121 - CHAdeMO - CoAP.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Select appropriate charging methods for diverse EV applications.	Apply
CO2: Design power electronic converter circuits used in EV charging systems.	Apply
CO3: Develop detailed layout designs for EV charging stations, considering factors such as power levels, safety regulations, and accessibility.	Apply
CO4: Design wireless charging system for two wheelers using simulation tool.	Apply
CO5: Select suitable EV smart charging system using standard protocols	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	1	2	1
CO4	3	2	-	-	2	-	-	-	-	-	-	1	2	1
CO5	3	3	-	-	-	-	-	-	-	-	-	3	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1.Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran ZhangXuemin (Sherman) Shen, Springer 2016, 1st Edition.

T2.Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless PowerTransferor Electric Vehicles: Foundations and Design Approach, Springer Publisher1st Edition. 2020.

T3.Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition,2021.

Reference Book(s):

R1. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.

R2. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1^{st}Edition.

R3. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

Course Code: 23AUE031	Course Title: ELECTRIC VEHICLE BATTERY TECHNOLOGY		
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) : 3:0:0	Credits: 3	Total Contact Hours:45	Max Marks:100

Course Objectives:

The course is intended to:

1. Apply methods to select and characterize battery cells for specific EV applications.
2. Apply techniques to integrate battery cells into battery systems, including management and thermal considerations.
3. Design a suitable battery pack for given range.

Module I **22 Hours**

Li-Ion Batteries: Significance of Li-ion and Li-Fe batteries - Classification of Lithium batteries - Construction of Li-Ion batteries - VI Characteristics - Energy density - Charging and - discharging profiles - Influence of temperature - Life and ageing issues - Safety aspects and - thermal runaway.

Lead-Acid Batteries: Construction - Chemistry of working- Characteristics.

Battery Systems and Subsystems: Battery modules - Cells in series and parallel - configurations - Battery cooling systems - Battery housing, removable and swappable Battery, Connector standards

Battery Management Systems (BMS): Functions and architecture - Performance parameter measurement - Equalization management circuit - Data communication and protocol - Logic and safety -control - Testing stability - Smart BMS: Active and Passive cell balancing.

Module II **23 Hours**

Nickel-Metal Hydride (NiMH) Batteries: Construction - Chemistry of working - Characteristics - Selection parameters.

Sodium-Ion Batteries: Construction - Characteristics - Selection parameters - Comparison NiMH and Na-ion batteries – C ratings, Internal resistance.

Solid-State Batteries: Need and evolution - Energy density charging and safety - Implementation challenges.

Design of Battery Pack: Equivalent circuit - Parameters to be considered (Capacity, Cost, Life, Safety, Testing, Maintenance) - Range selection - Battery Sizing.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Select suitable battery for EV applications	Apply
CO2 : Design Battery Management System for automotive.	Apply
CO3: Analyze the performance of battery pack using simulation for given range.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	3
CO3	3	3	2	-	3	-	-	-	-	-	-	-	3	3

High-3; Medium-2; Low-1

Text Book(s):

T1. Reiner Korthauer, Lithium-Ion Batteries: Basics and Applications‖, Springer, August 2018 ISBN 978-3-662-53069-6

Reference Book(s):

R1. Jiuchun Jiang and Caiping Zhang, ―Fundamentals and Applications of Lithium-Ion Batteries in Electric Drive Vehicles‖, John Wiley and Sons, 2015 ISBN 978-1-118- 41478-1

R2. John G. Hayes and G. Abas Goodarzi, ―Electric Powertrain‖, First Edition, John Wiley and Sons, 2018. ISBN:9781119063667

R3. James Larminie and John Lowry, ―Electric Vehicle Technology Explained‖, John Wiley and Sons, 2018 ISBN 978-81-265-5670-8

Web References:

1. https://elearn.nptel.ac.in/shop/executive-workshops/execedu-closed/battery-cell-technology-materials-and-industrial-applications/?v=c86ee0d9d7ed

CourseCode: 23AUE032	**Course Title: ELECTRIC VEHICLE ARCHITECTURE**		
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) : 3:0:0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to:

1. Select suitable electric vehicle architecture and subsystems for specific EV application.
2. Design battery pack for different EV architectures.
3. Design drivetrain systems including electric motors and converters.

Module I **22 Hours**

Electric Vehicles

Evolution of EVs, Comparison with internal combustion engine (ICE) vehicles, Types of EVs: BEV, HEV, PHEV, FCEV - EV architecture and configuration, Subsystems - powertrain, control, communication, safety

Energy Storage and Battery Management Systems

Battery types - Lead-acid, NiMH, Li-ion, solid-state, Battery pack configuration and integration, Battery characteristics - SoC, SoH, SoF

Battery Management System - Architecture, protection, Cell balancing, EV charging systems

Module II **23 Hours**

Electric Drivetrain and Power Electronics

BLDC, PMSM, Induction - Motor characteristics and control, Inverters, DC-DC converters, on-board chargers, Regenerative braking systems, Transmission and differential systems in EVs, Selection of architecture, Motor capacity and Battery size

Communication, Control & Safety in EVs

In-vehicle communication: CAN, LIN, FlexRay, Ethernet, Centralized and distributed EV control architectures, Functional safety (ISO 26262), EMI/EMC in EVs, Cyber security and fault diagnostics, Indian and international EV standards (AIS 038, AIS 156, ISO, IEC)

EV architectural design methodologies and layout preparation.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Select suitable electric vehicle architecture for EV applications.	Apply
CO2: Design battery pack for different EV architectures.	Apply
CO3: Design drivetrain systems including electric motors and converters by comparing their characteristics.	Apply
CO4: Analyze the communication protocols, safety standards, and control architectures in EVs for selection in suitable applications.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	1	1	-	-	-	-	2	1	2
CO2	3	2	2	-	-	1	1	-	-	-	-	2	1	3
CO3	3	2	2	-	-	1	1	-	-	-	-	2	1	3
CO4	3	2	2	-	-	1	1	-	-	-	-	2	1	2

High-3; Medium-2; Low-1

Textbooks:

1. Chris Mi, M. A. Masrur, D. Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2nd Ed., Wiley-IEEE Press, 2022.
2. Wei Liu, Fundamentals of Electric Vehicles: Technology and Economics, CRC Press, 2022.

References:

1. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes (Elsevier), 2021.
2. James Larminie and John Lowry, Electric Vehicle Technology Explained, 2nd Ed., Wiley, 2012.
3. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2021.

<table>
<tr><td colspan="2">Course Code: 23AUE034</td><td colspan="3">Course Title: TESTING OF ELECTRIC VEHICLES</td></tr>
<tr><td colspan="3">Course Category: Major</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td>L:T:P(Hours/Week) : 3:0:0</td><td colspan="2">Credits: 3</td><td>Total Contact Hours:</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to

1. Apply knowledge of standardization norms and procedures to evaluate electric vehicle.
2. Develop a testing strategy and test procedures to analyze the performance of electric motors and controllers.
3. Apply fault tree analysis and hazard/risk assessment techniques to determine functional safety requirements for electric vehicle systems.
4. Apply the concept of battery testing in EVs for fault analysis.
5. Analyze EMI mechanisms in motor drive and DC-DC converter systems to develop mitigation strategies for conducted emissions.

Module I **23 Hours**

EV standardization: Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field. The International Electro Technical Commission - Standardization of Vehicle Components

Testing of motors and controllers: Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only) - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

Functional safety and EMC: Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management – Reliability. Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality - Standards - Functional safety of autonomous vehicles. Environmental safety – Needs and methods.

Module II **23 Hours**

Battery Testing:

C-rate performance test, Environmental Tests – Vibration, shock resistance, humidity resistance, Safety Tests - Short-circuit resistance, Thermal abuse, Overcharge/over discharge response, Standards - IEC 62660, IEC 62133, AIS, UN 38.3, Case study on lithium ion battery.

EMI in motor drive and DC-DC converter system:

EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path Course.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1. Compare the standardization norms of different bodies to assess their impact on the electric vehicle industry.	Apply
CO2. Select test procedures to measure and interpret the performance of EV components.	Apply
CO3. Apply functional safety analysis and fault tree analysis, to prioritize safety-critical components in electric vehicles.	Apply
CO4. Apply the concept of battery testing in EVs for fault analysis.	Apply
CO5. Analyze the performance of DC-DC converter for EMI suppression.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	1	-	-	-	2	1	-
CO2	3	2	2	-	-	-	-	1	-	-	-	2	1	-
CO3	3	2	2	-	-	-	-	1	-	-	-	2	1	-
CO4	3	2	2	-	-	-	-	1	-	-	-	2	1	-
CO5	3	2	2	-	-	-	-	1	-	-	-	2	3	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1st Edition.

T2. Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1st Edition.

Reference Book(s):

R1. EMI/EMC Computational Modeling Handbook, Druce Archambeault, colin branch, Omar M.Ramachi ,Springer 2012, 2nd Edition.
R2. Automotive EMC, Mark Steffika, Springer 2013, 1st Edition.
R3. Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1st Edition

Web References:

1. https://nptel.ac.in/courses/108106170
2. https://archive.nptel.ac.in/courses/108/102/108102121
3. https://nptel.ac.in/courses/108106182

<table>
<tr><td colspan="2">Course Code: 23AUE035</td><td colspan="2">Course Title: INTELLIGENT CONTROL OF ELECTRIC VEHICLES</td></tr>
<tr><td colspan="2">Course Category: Major</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td>L:T:P(Hours/Week) : 3:0:0</td><td>Credits: 3</td><td>Total Contact Hours:</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to

1. Develop mathematical model of Brushless DC (BLDC) motors under various operating conditions.
2. Apply different control schemes for BLDC motors in specific electric vehicle drive applications.
3. Apply fuzzy logic systems to address control challenges in electric vehicles.
4. Apply the principles of FPGA architecture and VHDL to model digital control circuits relevant to electric vehicle systems.
5. Develop a real-time fuzzy logic control system for a BLDC motor.

Module I **22 Hours**

Structure and Drive Modes: Basic Structure, General Design Method, Drive Modes.

Modeling and characteristics of drives: Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients

Control Methods: Introduction to PID Control Principle, Anti windup Controller, Intelligent Controller, Vector Control - Control applied to BLDC motor, H-Bridge Inverter Design

Module II **23 Hours**

Fuzzy Logic: Membership functions, features, fuzzification, methods of membership value assignments, Defuzzification: lambda cuts – methods – simple problems.

Neural Networks: Definition and needs – layered architecture, genetic algorithm for battery management system, BPA algorithm for motor control – Simple problems.

FPGA and VHDL: Architecture - Advantages- Spartan 6 and Spartan 7 – BLDC motor control, PWM generation, Speed detection.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply mathematical models to simulate and analyze the starting, steady-state, and dynamic characteristics of BLDC motor drives.	Apply
CO2: Implement and compare different control methodologies, including PID and intelligent control techniques, for BLDC motors used in electric vehicles.	Apply
CO3: Design and implement fuzzy logic controllers to optimize the performance of electric vehicle subsystems.	Apply
CO4: Develop digital control logic for electric vehicle applications on FPGA / VHDL platforms.	Apply
CO5: Analyze the performance of BLDC motor using a simulation technique**.**	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	1	-	-	2	3	2
CO2	3	2	-	-	-	-	-	-	1	-	-	2	3	2
CO3	3	2	-	-	-	-	-	-	1	-	-	2	3	2
CO4	3	2	-	-	-	-	-	-	1	-	-	2	3	2
CO5	3	2	3	3	3	1		1	1	-	-	2	3	3

High-3; Medium-2; Low-1

Text Book(s):

T1. Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition 2018.

T2. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition 2015.

T3. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Third Edition” CRC Press, Taylor & Francis Group, 2021, 1st Edition.

T4. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012,1st Edition.

Reference Book(s):

R1. M.N. Cirstea, A. Dinu, J.G. Khor,M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.

R2. Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley 2017, 2nd Edition

Web References:

1. https://onlinecourses.nptel.ac.in/noc25_ee89/preview

<table>
<tr><td colspan="2">Course Code: 23MEE033</td><td colspan="2">Course Title: INDUSTRIAL IOT</td></tr>
<tr><td colspan="2">Course Category: Major</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td>L:T:P (Hours/Week) 3: 0: 0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course enables learners to apply fundamental concepts and select appropriate sensors based on needs, and implement IoT solutions across various applications.

MODULE I **22 Hours**

INTRODUCTION

Introduction to IoT, IoT Vs. IIoT, History of IIoT, Components of IIoT -Sensors, Interface, Networks, Industry 4.0: Globalization and Emerging Issues- LEAN Production Systems- Smart and Connected Business Perspective-Smart Factories, Role of IIoT in Manufacturing Processes, -challenges & Benefits in implementing IIoT.

ARCHITECTURES

Overview of IOT components-architectures of IOT and IIOT- Industrial IoT-Sensing-IIoT-Processing and Communication-Networking.

SENSORS, ACTUATORS AND INTERFACING

Roles of sensors in IIOT-Role of actuators- Interfacing techniques-communication techniques.

MODULE II **23 Hours**

BIG DATA AND IOT ANALYTICS

Big Data-Characteristics of Big Data-Types of Big Data-Analyzing of Data-Big Data tools-Applications.

IOT Analytics, Role of Analytics in IOT, Data visualization Techniques.

CASE STUDIES

City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, IIoT in Manufacturing Sector, Industrial IoT- Oil, chemical and pharmaceutical industry.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1:.Apply the concept to ensure smarter, data-driven industrial environments that can adapt and respond proactively to changing conditions.	Apply
CO2: Apply the concept of big data and IoT analytics to process the data and infer solutions to industrial applications.	Apply
CO3: Prepare and present an IoT application for any one product/process and service industry.	Apply

Text Book(s):

T1.Sudip Misra, Chandana Roy, Anandarup Mukherjee " Introduction to Industrial Internet of Things and Industry 4.0" CRC Press,1st edition 2020.

T2.Adrian McEwen, Hakim Cassimally "Designing the Internet of Things", John Wiley & Sons, 1st edition, 2013.

T3.Perry Lea, "Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security", Packt Publishing Ltd., 2018.

T4.Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", Orient Blackswan Private Limited - New Delhi, 1st edition 2015.

Reference Book(s):

R1. Qusay F. Hassan, "Internet of Things A to Z: Technologies and Applications", John Wiley & Sons,2018.

R2. Joe Biron and Jonathan Follett "Foundational Elements of an IoT Solution: The Edge, The Cloud, and Application Development", Cisco Press, First Edition, 2017.

R3. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress; 1st edition 2017.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE034		**Course Title: INDUSTRY 4.0 – SMART FACTORIES**	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits: 3**	**Total Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to provide a foundational and practical understanding of Industry 4.0 principles, smart factory design, data-driven manufacturing and emerging tools in manufacturing.

MODULE I Industry 4.0 Foundations and Key Technologies 23 Hours

Introduction to Industry 4.0 and Smart Factories-Industry 4.0:Fourth industrial revolution, key characteristics, and drivers-Smart Manufacturing: Principles, objectives, and evolution from traditional manufacturing- Smart Factory Concepts: Digital twins, cyber-physical systems (CPS), automation and IoT-enabled workflow-Key Technologies and Concepts: Industrial Internet of Things (IIoT):Role of IIoT in machine connectivity, data exchange and process optimization-Cyber-Physical Systems (CPS) :Integration of physical and digital systems for real-time decision-making-Data Analytics and AI: Predictive maintenance, process optimization, and machine learning applications-Automation and Robotics: Collaborative robots (cobots), automated workflows and efficiency enhancement-AR/VR in Manufacturing: Applications in training, remote support, and virtual prototyping-Cloud Computing :Data storage, scalability, and collaborative platforms-Smart Factory Applications and Integration: Smart Factory Applications: Remote monitoring, smart energy management, and predictive maintenance.

MODULE II Implementation, Case Studies and Advanced Topics 22 Hours

Case Studies : Real-World Implementations Analysis of successful smart factories (e.g., Siemens, Bosch, Tesla)-Challenges, ROI and scalability of Industry 4.0 projects-Sensor Interfacing :Connecting and calibrating sensors for data collection-Data Migration and Processing: Techniques for data aggregation, cleaning, and storage (SQL/NoSQL)-Programming and Application Development :Developing IoT applications using MQTT, TCP/IP and REST APIs-Additive Manufacturing:Classification,3D printing, rapid prototyping and mass customization-Industrial applications-Cybersecurity in Industry 4.0:Threat mitigation, encryption, and secure communication protocols-Industry 4.0 and Lean Production: Synergy between lean principles and smart technologies for waste reduction-Industrial Case studies and Applications.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply Industrial IoT (IIoT), cyber-physical systems (CPS) and data analytics to design an integrated smart factory workflow that addresses a real-world manufacturing challenge.	Apply
CO2: Apply sensor interfacing, data migration techniques.	Apply
CO3: Present a seminar on IoT application development to implement a scalable Industry 4.0 solution.	Apply

Text Book(s):

T1. Gilchrist, A. (2021). Industry 4.0: The Industrial Internet of Things (2nd ed.). Springer.

T2. Jeschke, S., Brecher, C., & Song, H. (2021). Industrial Internet of Things: Cyber manufacturing Systems (2nd ed.). Springer.

T3. Anandan, R. (2022). Industry 4.0 and Smart Manufacturing: Principles, Technologies, and Applications. McGraw Hill Education

T4. Venkata Krishna, P. (2021). Industry 4.0 in Indian Manufacturing: Challenges and Opportunities. Springer.

Reference Book(s):

R1. Boyes, H. (Ed.). (2021). Cybersecurity in Industry 4.0: Foundations, Applications, and Challenges. Springer.

R2. Gibson, I., Rosen, D., & Stucker, B. (2021). Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing (3rd ed.). Springer.

R3. LaScola Needy, K. (2023). Artificial Intelligence for Smart Manufacturing: Methods, Tools, and Case Studies. Springer.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code: 23MEE035		Course Title: FLUID POWER SYSTEM	
Course Category: Professional Elective		**Course Level: Mastery**	
L:T:P(Hours/Week) 3:0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objective:

The course is intended to develop the fluid power system to make industry automation.

MODULE I **23 Hours**

Introduction to Fluid power - Types of fluid power systems - Hydraulic system components - Pneumatic system components - Application of Pascal's Law in hydraulics-Advantages of fluid power system -Applications of Fluid power system -Properties of hydraulic fluids - Types of fluids.

Pumping theory - Pump classification - Construction and working of gear pumps, Vane pumps, Piston pumps - Construction and working of linear actuators - Special cylinder - Rotary actuator – Construction and operation of direction control valves (DCV), Pressure control valve, Flow control valve – Construction and operation of accumulators, Intensifiers

Hydraulic symbols - Hydraulic circuits for linear actuators - Hydraulic circuits using different actuating devices - Speed control circuits - Sequencing circuit - Synchronizing circuit - Regenerative circuit - Accumulator circuit – Application of intensifier - Hydraulic circuit for Milling operation, Grinding Machine - Hydraulic braking in Automobile.

MODULE II **22 Hours**

Properties of air – Compressor - Types of compressor - Construction and operation of air filter, air regulator, air lubricator - Pneumatic linear actuator - Rotary actuator - Constriction and working of pneumatic direction control valve – Flow control valve - Pneumatic symbols.

Pneumatic circuits for single acting cylinder, Double acting cylinder - Pneumatic circuits using manual, mechanical, electrical actuating devices - Cascade method for sequencing: two and three Cylinders - Step counter method- Hydro-Pneumatic circuit - Material handling system circuit - Multiple operation Machining.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Develop a hydraulic circuit for mechanical and automobile application.	**Apply**
CO2: Develop a pneumatic circuit for material handling and machining application.	**Apply**
CO3: Present a case study onr designing a circuit for a particular application.	**Apply**

Text Book(s):

T1. Esposito Anthony, “Fluid Power with Applications”, Pearson Education Inc., New York, 2015.

T2. Majumdar, S.R., “Oil Hydraulic Systems – Principles and Maintenance”, Tata McGraw-Hill, New Delhi, 2010.

Reference Book(s):

R1. Srinivasan.R, “Hydraulic and Pneumatic controls”, Vijay Nicole, 2011.

R2. Andrew Parr, “Hydraulics and Pneumatics, A technician's and engineer's guide”, Third Edition, Butterworth-Heinemann, 2011.

R3. Majumdar, S.R., “Pneumatic Systems – Principles and Maintenance”, Tata McGraw-Hill, New Delhi, 2012.

Web References:

1. http://www.nptel.ac.in/courses/112106175/
2. http://www.nptel.ac.in/courses/112105046/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE037	Course Title: FLEXIBLE MANUFACTURING SYSTEMS		
Course Category: Major		Course Level: Higher	
L:T:P (Hours/Week) 3: 0: 0	Credits:3	Total Contact Hours: 45	Max. Marks:100

Course Objectives

The course is intended to classify and distinguish FMS and other manufacturing systems and also analyze FMS using simulation and analytical techniques.

Module 1 **22 Hours**

UNDERSTANDING AND CLASSIFICATION OF FMS

Evolution of Manufacturing Systems, Definition, objective and Need, Components, Merits, Demerits and Applications Flexibility in Pull and Push type Classification of FMS Layout - Layouts and their Salient features, Single line, dual line, loop, ladder, robot centre type etc.

PROCESSING STATIONS AND MATERIAL HANDLING SYSTEM

Processing stations: Salient features Machining Centers, Turning centre, Coordinate measuring machine (CMM), Washing/ Deburring station. Material Handling System: An introduction, Conveyor, Robots, Automated Guided Vehicle (AGV), Automated Storage Retrieval System (ASRS).

Module 2 **23 Hours**

MANAGEMENT TECHNOLOGY

Tool Management, tool magazine, Tool preset, identification, Tool monitoring and fault detection, routing, Production Planning and Control, Scheduling and loading of FMS.

GROUP TECHNOLOGY

Introduction, Definition, Reasons for Adopting Group Technology, Benefits of Group Technology Affecting Many Areas of a Company, Obstacles to Application of GT.

DESIGN OF FMS

Performance Evaluation of FMS, Analytical model and Simulation model of FMS, Application of simulation model of FMS simulation software limitation manufacturing data systems data flow FMS database systems planning for FMS database.

Course Outcomes At the end of this course, students will be able to:		Cognitive Level
CO1:	Apply comparative knowledge of flexible manufacturing systems with other manufacturing systems	Apply
CO2:	Implement an FMS model using suitable machines and handling systems for a case study involving customized product orders	Apply
CO3:	Develop a production plan for an FMS that incorporates tool management and addresses potential disruptions in routing and scheduling	Apply
CO4:	Use group technology concepts to improve layout design and workflow efficiency in a flexible manufacturing system	Apply
CO5:	Present a case on designing and analyze of FMS using simulation and analytical techniques	Apply

Text Books

T1. Jha, N.K. “Handbook of Flexible Manufacturing systems” Academic Press Inc., 2015

T2. Groover, M.P “Automation, production Systems and Computer Integrated Manufacturing”, Prentice Hall of India Pvt Ltd. New Delhi 2009.

Web References

- https://calemhrdc.amu.ac.in/leap_round_2/prof_n_selvaraj.pdf
- https://www.iitmanagement.com/images/Gallery/B.tech%20ME%20,8th,%20Flexible%20Manufacturing%20System.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE038		**Course Title: COMPUTER INTEGRATED MANUFACTURING**	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

To provide knowledge on automated manufacturing systems such as NC, CNC, DNC, and CIM. It focuses on developing CAD skills for drafting, modeling, and design. The course also covers material handling systems, AGVs, robotics, Group Technology, and cellular manufacturing. Additionally, it introduces Flexible Manufacturing Systems, artificial intelligence, expert systems, and machine vision for automation.

MODULE I **23 Hours**

Automated Manufacturing system – Needs, Types. CIM - CIM wheel - Components, Evolution, needs, Benefits. NC system - Components, NC motion control system, application, advantages and disadvantages. Computer Numerical control System – Components, functions, advantages. Direct Numerical Control System – Components, functions, advantages.

Concept of CAD as drafting and designing facility, desirable features of CAD package, drawing features in CAD – Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate. - typical CAD command structure - Types CAD modeling - wire frame modeling, surface modeling and solid modeling.

Materials handling and Storage Systems - Automated storage and retrieval systems, carousel storage systems - Interfacing of Handling and Storage with Manufacturing system

MODULE II **22 Hours**

Introduction to AGVs - types, advantages and application. Robot – Basic concepts, applications. Group Technology – Role of G.T in CAD/CAM Integration, part families, part Classification and coding–DCLASS and MICLASS and OPITZ coding systems - facility design using G.T, benefits of G.T - Cellular Manufacturing.

Artificial Intelligence System, Basic concepts of Artificial intelligence, Intelligent systems and expert systems. Flexible manufacturing systems – Configurations, workstations, planning, applications and benefits – Automated inspection and testing - Machine vision

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply the principles of automated manufacturing systems including CIM, NC, CNC, and DNC systems to identify their components, functions, and advantages for improving industrial automation and productivity.	**Apply**
CO2: Apply CAD tools and modeling techniques for drafting and designing components, and demonstrate the integration of automated material handling and storage systems in manufacturing environments.	**Apply**
CO3: Apply the principles of Automated Guided Vehicles (AGVs), robotics, and Group Technology (GT) for effective facility design, part classification, and integration in cellular manufacturing systems.	**Apply**
CO4: Present a case study on Artificial Intelligence, Flexible Manufacturing Systems, and Machine Vision for improving automation, inspection, and decision-making in manufacturing processes.	**Apply**

Text Book(s):

T1. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education 2015.

T2 Sushil Kumar Choudhary & R. S. Jadoun",Computer Integrated Manufacturing & Computer Aided Manufacturing",1st Edition,2021

. **Reference(s):**

R1.Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems" 7th Edition. Wiley, 2020

R2. Rao, P. N. " *CAD/CAM: Principles and Applications* ",4th Edition . McGraw-Hill Education. 2017

R3 Henry Webber," Computer-Integrated Manufacturing",Ist Edition, NY Research Press,2020

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE040		**Course Title: LOGISTICS ENGINEERING**	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course aims to equip mechanical engineering students with the skills to design, optimize and manage efficient logistics systems using tools like lean principles, simulation software and Industry 4.0 technologies in real-world mechanical industries.

MODULE I Fundamentals of Logistics Engineering 23 Hours

Introduction to Logistics Engineering: Definition, scope, and role in mechanical systems-Key principles: Efficiency, cost reduction, and sustainability in logistics-Supply Chain Management (SCM) Basics :SCM lifecycle: Planning, sourcing, production, distribution, returns-Demand forecasting, inventory management (EOQ, JIT)-Manufacturing Logistics-Material flow optimization in production systems-Role of automation (AGVs, conveyor systems) in material handling-Warehouse Design & Layout-Storage systems (AS/RS), facility layout planning-Lean tools (5S, Kaizen) for warehouse efficiency-Logistics Simulation Tools -Case study: Optimizing a

MODULE II Advanced Logistics & Technology Integration 22 Hours

Global Supply Chain Networks: Challenges in international logistics (lead time, tariffs, cross-border regulations)-Case study: Automotive component supply chains-Sustainable Logistics-Green logistics strategies: Carbon footprint reduction, reverse logistics-Circular economy in mechanical systems (remanufacturing, recycling)-Logistics 4.0:IoT, AI, and blockchain in supply chain visibility-Industry 4.0 applications: Predictive maintenance, smart warehouses-Risk Management in Logistics :Risk identification (supply disruptions, demand volatility)-Mitigation strategies: Safety stock, dual sourcing-ERP Systems in Logistics.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply logistics engineering principles to design and optimize material flow and automation systems in mechanical production environments by utilizing lean tools .	Apply
CO2: Design and implement advanced logistics solutions for global supply chains by integrating Logistics 4.0 technologies and risk mitigation strategies to enhance operational resilience and environmental sustainability.	Apply
CO3: Present a case study on design, optimize and manage efficient logistics systems using tools like lean principles.	Apply

Text Book(s):

T1.. D. Simchi-Levi, Designing and Managing the Supply Chain, McGraw-Hill, 2021.

T2. M. Christopher, Logistics & Supply Chain Management, Pearson, 2022.

Reference Book(s):

R1. J. R. Stock and D. M. Lambert, Strategic Logistics Management, McGraw-Hill, 2020.

R2. J. P. Womack and D. T. Jones, Lean Thinking: Banish Waste and Create Wealth, Free Press, 2020

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code:23MEE041</td><td colspan="2">Course Title: AUTOMOBILE ENGINEERING</td></tr>
<tr><td colspan="2">Course Category:
Major</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:
3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

To enable students to understand the fundamentals of automobile engineering, including the construction, working, and classification of vehicle systems, with an emphasis on internal combustion engines, fuel supply systems, transmission mechanisms, braking and steering systems, vehicle electrical components, and modern developments in electric and hybrid vehicles, emission control, and safety systems.

MODULE I Introduction to Automobile Engineering and Powertrain Systems **23 Hours**

Introduction, General Classification of Automobiles vehicle construction and different layouts chassis, frame and body, resistances to vehicle motion and need for a gearbox, Introduction to IC Engines-types, working principles, components of engines-their forms functions and materials. Air bags- Air pollution control- Catalytic converter working principle-Emission norms- Bharat and Euro emission Standards

Petrol fuel feed system: Feed pump – mechanical, electrical type – Carburetors – fixed venturi type (carter), variable venturi type (SU), multiple barrel type (Solex, Mikuni), carburetors for two wheelers -Petrol injection – Multi Point Fuel Injection (MPFI), VVT (petrol engines),Turbo chargers, Diesel fuel system: Jerk type fuel injection pump–Methods of fuel injection–common rail, distributor types-Nozzles–Cold starting aids, Cooling system: Direct and indirect cooling, Lubricating system: Mist, wet and dry sump. Ignition system- coil ignition and magneto ignition system – Spark plug

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel -torque converter, propeller shaft

MODULE II Automotive Control Systems and Fundamentals of Electric and Hybrid Vehicles **22 Hours**

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 and Traction Control, Battery -Construction and maintenance, Starter motor

– types, alternator, distributor, generator, cut out relay, panel board instruments.

EV Historical background, Benefits of using EVs, comparison with IC engine drive vehicles, Types of EVs, Motor drive technology, Energy sourcing, and charging technology, EV charging standards-V2G, G2V, V2B, and V2H, EV subsystem and configuration, Introduction to Hybrid electric vehicle.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply basic automotive engineering concepts to explain the working of engine, fuel, ignition, cooling, lubrication, and transmission systems	**Apply**
CO2: Apply the principles of steering, suspension, braking, and electrical systems to identify and explain their construction and working in automobiles	**Apply**
CO3: Present a seminar individually on electric and hybrid vehicle technology to explain their components, energy sources, charging methods, and configurations in comparison with conventional vehicles.	**Apply**

Text Book(s):

T1.Kirpal Singh, “Automobile Engineering Vol. 1 &Vol 2”, Standard Publishers, 14th Edition, 2021

T2.Gupta R B, “Automobile Engineering”, Satya Prakashan Publisher,10th Edition ,2023.

T3. Jain P Automobile Engineering”, Khanna Publishers, 16th Edition,2021

. **Reference(s):**

R1.William H. Crouse & Donald L. Anglin, “Automobile Engineering: Fundamentals and Applications, McGraw-Hill Education Publishers, 10th Edition,2020.

R2. John B. Heywood, “Internal Combustion Engine Fundamentals”, McGraw-Hill Education Publishers,2022.

R3. Chris Mi, M. Abul Masrur, David W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, Wiley Publishers ,2017

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE042		Course Title: JAVA PROGRAMMING FOR MECHANICAL SCIENCES	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is focused to provide a fundamental knowledge on programming using Java programming language to have insight on object oriented programming.

MODULE I Data Types, Operators, Statements **23 Hours**

An Overview of Java: Object-Oriented Programming, Control Statements, Using Blocks of Code, Lexical Issues, The Java Class Libraries, Data Types, Variables, and Arrays: Java Is a Strongly Typed Language, The Primitive Types, Integers, Floating-Point Types, Characters, Booleans, A Closer Look at Literals, Variables, Type Conversion and Casting, Automatic Type Promotion in Expressions, Arrays, Strings. Operators Arithmetic Operators, The Bitwise Operators, Relational Operators, Boolean Logical Operators, Precedence, Using Parentheses, Control Statements: Java"s Selection Statements, Iteration Statements, Jump Statements.

MODULE II Object Oriented Programming **22 Hours**

Introducing Classes: Class Fundamentals, Declaring Objects, Assigning Object Reference Variables, Introducing Methods, Constructors, The this Keyword, Garbage Collection, The finalize( ) Method, A Stack Class, A Closer Look at Methods and Classes: Overloading Methods, Using Objects as Parameters, A Closer Look at Argument Passing, Returning Objects, Recursion, Introducing Access Control, Understanding static, Introducing final. Inheritance, Using super, Creating a Multilevel Hierarchy, When Constructors Are Called, Method Overriding, Dynamic Method Dispatch, Using Abstract Classes, Using final with Inheritance, The Object Class. Packages and Interfaces: Packages, Access Protection, Importing Packages, Interfaces, Exception Handling.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the concept of the various data types, operators, statements used in Java Programming.	Apply
CO2: Implement object oriented programming concepts.	Apply
CO3: Present a report on object oriented programming concepts using Java in Mechanical Engineering as a team.	Apply

Text Book(s):

T1: Herbert Schildt, Java The Complete Reference, 7th Edition, Tata McGraw Hill, 2007.

T2: Java Programming Language Ken Arnold Pearson.

T3: The complete reference JAVA2, Hervert schildt. TMH

Reference Book(s):

R1.Programming with Java, 6th Edition, by E Balagurusamy, 2019, McGraw Hill Education, ISBN:
9789353162337.

R2. Thinking in Java, Fourth Edition, by Bruce Eckel, Prentice Hall, 2006

Web References:

https://onlinecourses.nptel.ac.in/noc22_cs47/preview

https://www.udemy.com/course/java-training-crash-course-2022/

https://sd.blackball.lv/library/thinking_in_java_4th_edition.pdf

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	2	2	-	-	2	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 23SCE050</td><td colspan="3">Course Title: CYBER SECURITY</td></tr>
<tr><td colspan="3">Course Category: Minor</td><td colspan="2">Course Level: intermediate</td></tr>
<tr><td>L:T:P (Hours/Week)
3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Pre-requisites

- NIL

Course Objectives: To provide foundational knowledge of cyberspace, cyber laws, and digital security practices to identify, prevent, and respond to cyber threats.

Module I: **22 Hours**

Introduction to Cyber Security: Defining Cyberspace - Overview of Computer and Web-technology - Architecture of cyberspace, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.

Cyber-crime and Cyber law: Classification of cyber-crimes - cyber-crime targeting computers and mobiles, cyber-crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber-crimes, Remedial and mitigation measures, Legal perspective of cyber-crime, IT Act 2000 and its amendments, Cyber-crime and offences, Organizations dealing with Cyber-crime and Cyber security in India, Case studies

Module II: **23 Hours**

Social media and Security: Introduction to Social networks, Social media – Types, platforms, monitoring, Hashtag, Viral content, marketing, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.

E-Commerce and Digital Payments: E- Commerce - Definition, Components, Security, Threats, Best practices - Digital payments – Components, stake holders, Modes of digital payments - Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions. Relevant provisions of Payment Settlement Act,2007.

Digital Devices Security, Tools and Technologies for Cyber Security: End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.

Case studies and Assignments:

1. Prepare checklist for following scenarios :
   a) Reporting cybercrime at Cybercrime Police Station.
   b) Reporting cybercrime online.
   c) Using popular social media platforms.
   d) Secure net banking.
2. Demonstrate the following:
   a) Reporting phishing emails, email phishing attack and preventive measures.
   b) Reporting and redressal mechanism for violations and misuse of Social mediaplatforms.
3. Manage the following activities:
   a) Privacy and security settings for popular Social media platforms, Mobile Walletsand UPIs.
   b) Application permissions in mobile phone.
4. Perform the following activities:
   a) Setting, configuring and managing three password policy in the computer(BIOS, Administrator and Standard User).
   b) Setting and configuring two factor authentication in the Mobile phone.
5. Demonstrate the following:
   a) Security patch management and updates in computer and mobiles.
   b) Wi-Fi security management in computer and mobile.
6. Install and configure computer Anti-virus & Computer Host Firewall.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Design appropriate checklists and procedures for secure cyber practices and effective response to cybercrime incidents across various platforms.	Apply
CO2: Illustrate the functioning of cyberspace infrastructure and demonstrate how regulatory frameworks address cyber threats.	Apply
CO3: Analyze privacy and security configurations in social media platforms and digital applications to identify potential risks and propose suitable mitigation strategies.	Analyze
CO4: Apply evolving cybersecurity tools and device protection practices through continuous learning to address emerging digital security challenges.	Apply

Text Book(s):

T1. Cyber Crime Impact in the New Millennium, R. C Mishra. Auther Press. 2010.

T2. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, 1st Edition, Wiley India Pvt. Ltd, 2011.

T3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform, Pearson Education, 2001.

Reference Book(s):

R1. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt. Ltd, 2001

R2. Security Fundamentals of Network by E. Maiwald, McGraw Hill ,2014

R3. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, Dominant Publishers, 2011.

Web Reference(s):

1. https://unacademy.com/content/upsc/study-material/science-and- technology/initiatives-taken-by-indian-government-for-cyber-security/
2. https://cybercrime.gov.in/
3. https://www.meity.gov.in/cyber-security-division
4. https://intellipaat.com/blog/what-is-cyber-security/

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	2	-	-	2	2	-	-		
CO2	3	-	-	-	-	-	-	-	-	-	-	-		
CO3	-	2	-	-	2	-	-	1	2	2	-	-		
CO4	3	-	-	-	2	-	-	-	-	-	-	2		

High-3; Medium-2; Low-1

Course Code: 23MEE044		Course Title: DATA STRUCTURES AND OBJECT ORIENTED PROGRAMMING WITH C++	
Course Category: **Minor**		**Course Level: Intermediate**	
L:T:P(Hours/Week) **3: 0: 0**	**Credits:** **3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is focused to provide a fundamental knowledge on data structures applicable to engineering analysis.

MODULE I Array, Pointers, Strings, Stacks, Queues 23 Hours

Introduction and Definition of Data Structure, Classification of Data, Arrays, Various types of Data Structure, Static and Dynamic Memory Allocation, Function, Recursion. Introduction to Arrays, Definition, One Dimensional Array and Multidimensional Arrays, Pointer, Pointer to Structure, various Programs for Array and Pointer. Strings. Introduction to Strings, Definition, Library Functions of Strings. Introduction to Stack, Definition, Stack Implementation, Operations of Stack, Applications of Stack and Multiple Stacks. Introduction to Queue, Definition, Queue Implementation, Operations of Queue.

MODULE II Linked List, Tree, Sorting 22 Hours

Introduction, Representation and Operations of Linked Lists, Singly Linked List, Doubly Linked List, Circular Linked List. Introduction to Tree, Tree Terminology Binary Tree, Binary Search Tree, Strictly Binary Tree, Complete Binary Tree, Tree Traversal. Graphs, Searching, Sorting and Hashing Graphs: Introduction, Representation to Graphs, Graph Traversals Shortest Path Algorithms. Searching and Sorting: Searching, Types of Searching, Sorting, Types of sorting like quick sort, bubble sort, merge sort, selection sort.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the concept of the various data structures to store and access the data efficiently.	Apply
CO2: Apply the concept of searching and sorting algorithms for efficient memory management.	Apply
CO3: Present a case study on tasking and scheduling and interrupts.	Apply

Text Book(s):

T1.“Fundamentals of Data Structures”, Illustrated Edition by Ellis Horowitz, SartajSahni, Computer Science Press.

T2. Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company.

Reference Book(s):

R1. "How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education.

R2. Pai: "Data Structures & Algorithms; Concepts, Techniques & Algorithms "Tata McGraw Hill.

Web References:

https://www.udemy.com/topic/data-structures/

https://alison.com/course/introduction-to-data-structures

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	2	2	-	-	-	-	-

High-3; Medium-2; Low-1

Course Code:23MEE046		**Course Title: AUGMENTED REALITY/VIRTUAL REALITY**	
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course aims to equip students with comprehensive knowledge and practical skills in AR/VR/MR technologies covering system design, software development and real-world applications.

MODULE I Foundations of VR and Core Technologies 22 Hours

Introduction to AR/VR: Taxonomy, technology, and features of AR/VR, Differences between AR and VR,

Challenges in AR and VR systems, VR Systems and Hardware: VR as a discipline: Basic features and architecture, VR input hardware: Tracking systems, motion capture, data gloves, VR output hardware: Visual displays (HMDs, CAVEs), Stereoscopic Vision & Haptic Rendering: Human visual system fundamentals: Depth cues, stereopsis, retinal disparity-Haptic sense and devices.

MODULE II AR Development, Interaction Techniques and Applications 23 Hours

3D Interaction Techniques:3D manipulation tasks and input devices, Interaction techniques for object manipulation-AR Software Development :AR software frameworks and tools, Camera calibration and marker-based AR-Applications of VR in Digital Entertainment in film/TV production and physical exercises,Case studies: VR games and interactive experiences-VR Software Development: Challenges in VR software, Architectures: Master/slave, client/server, cluster rendering, Game engines and SDKs (Oculus, HTC Vive, Google VR).

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Create a VR game or simulation using tools like Unity and VR headsets to solve practical problem	Apply
CO2: Develop a simple AR project/prototype application that used to display 3D objects or information for tasks like learning or gaming.	Apply
CO3: Present a seminar on project/prototype application that used to display 3D objects.	Apply

Text Book(s):

T1.. D. Schmalstieg and T. Hollerer, Augmented Reality: Principles and Practice, Addison-Wesley Professional, 2016.

T2. W. R. Sherman and A. B. Craig, Understanding Virtual Reality: Interface, Application, and Design, Morgan Kaufmann, 2018.

Reference Book(s):

R1. R. Szeliski, Computer Vision: Algorithms and Applications, Springer, 2022.

R2. D. A. Bowman, J. J. LaViola Jr., and E. Kruijff, 3D User Interfaces: Theory and Practice, Addison-Wesley Professional, 2017.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code:23MEE047	Course Title: INDUSTRIAL ENGINEERING		
Course Category: Major	Course Level: Higher		
L:T:P(Hours/Week) 3: 0: 0	Credits: 3	Total Contact Hours: 45	Max Marks: 100

Course objectives

The course focuses on applying industrial engineering principles to improve productivity, optimize production systems, and ensure quality, ergonomics, and safety in workplace design.

Module I **22 Hours**

Introduction to Industrial Engineering and Productivity: Definition, Scope, and Objectives of Industrial Engineering - Applications and Role of Industrial Engineers - Productivity Concepts, Importance, and Measurement - Factors affecting Productivity - Productivity Improvement Techniques

Work Study and Ergonomics: Method Study: Objectives, Procedure, Tools (Process Charts, Flow Diagrams) - Principles of Motion Economy - Work Measurement: Time Study, Work Sampling, Standard Time Calculation - Ergonomics: Importance, Applications, Man-Machine Systems, Workplace Design

Production Planning and Control (PPC): Functions and Objectives of PPC - Types of Production Systems (Job, Batch, Mass, Continuous) - Routing, Scheduling, Loading, Dispatching - Inventory Control Techniques: EOQ Model, ABC Analysis, JIT System - Aggregate Planning and Master Production Schedule

Module II **23 Hours**

Plant Engineering: Plant Location Factors and Selection - Types of Plant Layouts (Product, Process, Fixed-Position, Cellular) - Layout Improvement Techniques (CRAFT, ALDEP) - Material Handling: Principles and Types of Equipment

Quality Management: Quality Control and Inspection Concepts - Statistical Quality Control (SQC): Control Charts for Variables and Attributes - Acceptance Sampling - Basics of Total Quality Management (TQM)

Industrial Safety: Causes and Prevention of Accidents - Safety Standards and Regulations - Occupational Health and Safety.

Course outcomes:

CO1: Apply industrial engineering concepts, work study methods, ergonomics principles, and production planning techniques to improve productivity, design efficient workplaces, and manage production systems effectively.	**Apply**
CO2: Apply plant engineering principles, quality control tools, TQM practices, and industrial safety standards to design efficient layouts, ensure product/process quality, and develop safer work environments.	**Apply**
CO3: Present a seminar on safety in workplace design individually.	**Apply**

Text Book(s):

1. O.P. Khanna, Industrial Engineering and Management, Dhanpat Rai & Co., New Delhi, 2014.
2. Martand Telsang, Industrial Engineering and Production Management, S. Chand & Company Ltd., New Delhi, 2014.
3. E.S. Buffa, Modern Production/Operations Management, Wiley India Pvt. Ltd., New Delhi, 2012.

Reference Book(s):

1. Niebel & Freivalds, *Methods, Standards, and Work Design*, McGraw-Hill Education, New York, 2011.
2. B. Mahadevan, *Operations Management: Theory and Practice*, Pearson Education, Noida, 2010.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code:23MEE045</td><td colspan="3">Course Title: AUTOMOTIVE ENGINE AND ITS SYSTEMS</td></tr>
<tr><td colspan="3">Course Category: Major</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td colspan="2">L:T:P (Hours/Week) 3: 0: 0</td><td>Credits:3</td><td>Total Contact Hours: 45</td><td>Max. Marks:100</td></tr>
</table>

Prerequisites

The student should have undergone the course(s):

- Thermal Engineering

Course Objectives

The course is intended to interpret the performance characteristics of the vehicle.

Module I **23 Hours**

Power train – Types – Engine (SI and CI) – Torque converter – Valve train layout & crank train layout- valve timing and timing chain layout – Piston components – importance of B/S and L/r – Crank offset.

COMBUSTION AND EMISSION IN IC ENGINES

Chemistry of combustion, Stoichiometric equations of combustion – Introduction to SI and CI combustion – Engine knocking – Combustion chamber and its types –Combustion chamber design – Temperature – Fuel (include load /speed) – Fuel properties/characteristics (temperatures, Octane, Cetane no. etc) – Emission norms (Indian, European – US emission norms – Emission testing and certification) – Fuel Norms(BS1, BS2) – Environmental effects of Emissions – Emission relation with AFR – After treatment devices (include SAI,2WC), Chemical reactions involved in after treatment.

Module II ENGINE SUBSYSTEMS 22 Hours

Energy balance and cooling load estimation – Typical operating temperatures of engine parts – Types of cooling system – Cooling system design (Air cooled and water cooled) – Schematic layout of Cooling system for a two wheeler engine – Engine friction – Lubrication requirements of engine – Functions of Lubricating oil – Parts to be lubricated and not to be lubricated – Schematic layout of lubricating system – Oil filtering – Lubricating oils, types and properties – Functions of induction system – Schematic layout (2W and 4W) – Air Filtering and its importance – Exhaust and after treatment – Functions of exhaust system – Muffler layout – Schematic layout of exhaust system (2W and 4W)..

PERFORMANCE CHARACTERISTICS

Volumetric efficiency – Factors affecting volumetric efficiency, ram effect, engine tuning, Fuel control systems (Carburetor, Fuel Injection) – Meeting demands of Vehicle (drivability, emissions and fuel economy) by controlling air and fuel – sensors – Vehicle performance characteristics, Road resistance, Wheel force in different gears, predict acceleration from engine performance graph – Various relations between AFR, Ignition timing and injection timing – Emission, performance (fuel consumption) – Sensors and devices used for performance and emission measurements.

ADVANCED ENGINE CONCEPTS

Engines (Wankel, six stroke, lean burn, GDI, HCCI etc.) Hybrid vehicles – VVT, Turbo/super charging – Benefits of different engine concepts – Alternate fuels, compare performance – Fuel economy & emission with fuels (alcohol, vegetable oils, LPG, CNG etc.) – Limiting factors and practical problems.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the combustion characteristics such as chemistry, knocking, temperature & fuel and emission characteristics such as norms, environmental effects after treatment devices of four stroke IC engines.	Apply
CO2: Interpret the performance characteristics like volumetric efficiency, ram effect, engine tuning, Fuel control systems of the vehicle considering the relationship between volumetric efficiency of engine and emission norms.	Apply
CO3: Examine and present a seminar on various advanced engines like Wankel, lean burn, GDI, HCCI and alternate fuels like alcohol, vegetable oils, LPG, CNG used in automobiles.	Apply

Text Books:

T1. Edward F. Obert, "Internal Combustion Engines and Air Pollution" First Edition, Addison-Wesley Educational Publishers, Incorporated, reprint, 2012.

T2. V. Ganesan, "Internal Combustion Engines" McGraw-Hill, reprint 2012.

Reference Books:

R1. John B. Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill, reprint 2012.

R2. Richard Stone, "Introduction to Internal Combustion Engines", Third edition, Society of Automotive Engineers, Incorporated 1999.

Web References:

1. https://en.wikibooks.org/wiki/Automotive_Systems
2. https://bajatutor.net/online-baja-crash-course-for-atv-enthusiasts/

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	1	1	-	1	-	-
CO2	2	-	-	-	-	-	-	-	1	1	-	1	-	-
CO3	2	-	-	-	-	-	-	-	1	1	-	1	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 23ITE047</td><td colspan="2">Course Title: Intellectual Property Rights (Common to all B.E/B.Tech Programmes)</td></tr>
<tr><td colspan="2">Course Category: Minor</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits: 3</td><td>Total Contact Hours: 45</td><td>Max Marks: 100</td></tr>
</table>

Course Objectives

The course is intended to learn the fundamental concepts of Intellectual Property Law, including patent classifications, trademark strategies, and copyright protections.

Module I **22 Hours**

Intellectual Property: An Introduction: Intellectual Property Law: Patent Law-Copyright Law-Trademark Law- Trade secret Law-Right of Publicity-Paralegal tasks in Intellectual Property Law-Ethical obligations of the paralegal in Intellectual Property Law-Trade secrets: Protectible as a trade secret-Maintaining trade secrets-Protecting an Idea.

Patents: Rights and Limitations: Sources of patent law-Subject matter of Patents: Utility Patents-Plant Patents-Design Patents-Design Patents and copyright-Design Patents and trademarks-Computer Software, Business methods and Patent Protection-Rights under Patent Law-Patent Requirements-Limitations on Patent Rights-Patent Ownership.

Module II **23 Hours**

Patents: Research, Applications, Disputes, and International Considerations: Patent Search Process-Patent Application Process-Patent Infringement-Patent Litigation, International Patent laws.

Principles of Trademark: Trademarks and Unfair Competition-Acquiring Trademark Rights-Types of Marks, Strong Marks Versus Weak Marks-Selecting and Evaluating a Trademark-International Trademark Laws.

Principles of Copyrights: Sources of Copyright Law- The Eight Categories of Works of Authorship-Derivative Works and Compilations- Rights and Limitations: Grant of Exclusive Rights–Copyrights Ownership- International Copyright Laws.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Apply the fundamental concepts of Intellectual Property Law to real- world scenarios.	Apply
CO2: Demonstrate an understanding of the Rights and Limitations of various patents through practical examples.	Apply
CO3: Analyze the process of patent searching and application filing to assess its effectiveness in protecting intellectual property.	Analyze
CO4: Examine the principles of trademark and copyright to differentiate their roles and implications in intellectual property law.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	2	-	-	-	-	2	-	-	-	-
CO4	-	2	-	-	3	-	-	3	2	-	-	-	-	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Richard Stim, “Intellectual Property: Copyrights, Trademark and Patents”, Cengage learning, 2nd edition 2012.

Reference Book(s):

R1. Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets”, Cengage Learning, 3rd Edition, 2013.

R2. Prabuddha Ganguli,”Intellectual Property Rights: Unleashing the Knowledge Economy”, McGraw Hill Education, 2017.

R3. David Llewelyn, Tanya Frances Aplin, “Intellectual Property Patents, Copyrights, Trademarks & Allied Rights”, Sweet & Maxwell, 2023.

R4. William F. Patry ,"Principles of Intellectual Property: Patents, Trademarks, and Copyrights", Wolters Kluwer, 2023.

Web References:

1. https://ipindia.gov.in/writereaddata/Portal/ev/sectionsindex.html

<table>
<tr><td colspan="2">Course Code: 23AUE051</td><td colspan="3">Course Title: DESIGN THINKING AND INNOVATION</td></tr>
<tr><td colspan="3">Course Category: Major</td><td colspan="2">Course Level: Intermediate</td></tr>
<tr><td>L:T:P: 3: 0: 0</td><td colspan="2">Credits:3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Course Objective:

The course is intended to equip learners with practical skills in design thinking, empathy, prototyping, testing, and implementation for user-centered innovation and effective product development.

Module I **(17+ 6 hrs)**

Introduction- Importance of Design Thinking, Human Centered Design, Six-Step Design Thinking Process-Framework for Innovation-DT-a nonlinear process.

Empathy-importance of empathy in design thinking- empathy vs sympathy- steps of empathize-understanding customer needs-empathy methods and tools-empathy map-5W 1H framework-empathize in UX/UI Design-users Interview

Module II **(18+4 hrs)**

Prototype: Introduction to Proof of concept-MVP-Prototype and its types-prototype methodology- innovation and its types-Tools for prototyping: concept sketching/CAD/3D Printing.

Testing: Importance of testing in product development-design validation-market analysis: TAM-SAM-SOM-EVG.

Implementation - redesign of solution and iterative process.

List of activities

Core Stream

Empathy

1. What challenges does the user face daily commuting to work place?

2. What are the user’s biggest frustrations when interacting with vehicle maintenance engineer?

3. Understand the user for building old age home.

Define

1. A construction site supervisor needs better real-time communication tools because delayed updates cause safety risks. (Provide the empathy data)

2. “Drivers get confused by inconsistent road signs,” create: “How might we improve road sign clarity to reduce driver confusion?”

3. A daily commuter needs a safer way to cross busy intersections because current pedestrian signals are confusing and slow. (Provide the empathy data)

Ideate

1. Develop a creativity safer vehicle dashboard design

2. Develop an improved road drainage system

3. Design an innovative solution to reduce urban flooding caused by heavy rains.

4. Design a Hybrid engine designs incorporating solar panels on the car roof.

Prototype

1. Prototype development (both low fidelity and high fidelity) on any real world problem

IT and Circuit Stream:

Activity 1:

Students role-play as designers and users- create an empathy map with 4 quadrants: *Says, Thinks, Does, Feels*

Circuit Stream- Empathy Interview and Persona Creation

Define- development of problem Statement-Elements of a Good Problem Statement-Tools: Point-of-View (POV) Statements-How Might We (HMW) Questions-User Personas.

Ideation in Design Thinking-Importance of Ideation-Metrics of ideation -tools: Brainstorming-Mind Mapping-SWOT.

Activity 2:

IT Stream- SWOT analysis on software project idea.

Circuit Stream -Idea Pitch Canvas using Brainstorming + Mind Mapping

Convert ideas into quick prototypes and validate through early testing.

Activity 3:

IT Stream -Build a simple algorithm to test feasibility- TAM-SAM-SOM market analysis chart

Circuit Stream -MVP Canvas and Concept Sketching

Circuit Stream -Iterative Redesign and Peer Testing Sprint

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply design thinking tools like empathy mapping, problem definition, and ideation to create user-centered innovative solutions.	Apply
CO2: Apply prototyping, innovation, testing, and iterative redesign techniques in product development and market analysis..	Apply
CO3: Apply design thinking to develop, prototype, and validate innovative engineering solutions in capstone projects for real-world applications.	Apply

Text Book(s):

T1. Sabell Osann, Lena Mayer , Inga Wiele ,The Design Thinking Quick Start Guide: A 6-Step Process

for Generating and Implementing Creative Solutions, Wiley, 2020.

T2. Christian Müller-Roterberg, Handbook of Design Thinking, Kindle Direct Publishing,2018.

Reference Book(s):

R1. Teun den Dekker, Design Thinking, Taylor & Francis, International edition, 2020.

R2. Kaushik Kumar, Divya Zindani, J.Paulo Davim, Design Thinking to Digital Thinking, Springer, 2019.

R3.S. Balaram, Thinking Design, SAGE Publications, 2011.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	2			2	2	2	2	-	-	-

High-3; Medium-2; Low-1

Course Code: 23AUE050		**Course Title: ENTREPRENEURSHIP DEVELOPMENT**	
Course Category: Minor		**Course Level: Higher**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to develop entrepreneurial mindset and skills by identifying and validating problems through human-centered design, analyzing markets and customers to create value propositions and MVPs, exploring business models with financial and feasibility analysis, and preparing investible pitch decks to attract stakeholders.

Module I **22 Hours**

Entrepreneurial Mindset

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economics – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Opportunities

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

Prototyping & Iteration

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques. Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

Module II **23 Hours**

Business models & pitching

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest assumptions to Business Models – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

Entrepreneurial Ecosystem

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders)

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply entrepreneurial mindset principles to identify societal problems and transform them into viable business opportunities.	Apply
CO2: Develop prototypes using suitable tools and techniques for the validated opportunities through iterative processes.	Apply
CO3: Demonstrate a Business Model Canvas using the Lean approach and pitch the startup idea effectively using storytelling and presentation skills.	Apply
CO4: Analyze customer segments, market size, and niche markets to validate entrepreneurial opportunities through market research and customer interviews.	Analyze
CO5: Evaluate the role and components of the entrepreneurial ecosystem to identify and engage the right ecosystem partners and funding models for startup success.	Analyze

Reference Book(s):

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha Entrepreneurship, McGrawHill, 11th Edition,2020.
2. Ries, E. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business,2011.
3. Blank, S. G., & Dorf, B. The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch.2012.
4. Roy, R. Indian Entrepreneurship: Theory and Practice. New Delhi: Oxford University Press,2017.
5. Osterwalder, A., & Pigneur, Y. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons,2010.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	1	-	-	-	-	-	-	-	-
CO2	-	-	3	-	1	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	1	1	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	2	-	-	-	-	-	-	1	1	-	-

High-3; Medium-2; Low-1

<table>
<tr><td colspan="2">Course Code: 23AUE006</td><td colspan="2">Course Title: DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT</td></tr>
<tr><td colspan="2">Course Category:
Major</td><td colspan="2">Course Level: Higher</td></tr>
<tr><td>L:T:P(Hours/Week)
3: 0: 0</td><td>Credits:
3</td><td>Total Contact Hours: 45</td><td>Max Marks:100</td></tr>
</table>

Course Objectives:

The course aims to design principles for manufacturability, factors influencing form design, machining considerations, casting part optimization, and environmental considerations in design.

MODULE I **22 Hours**

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Tolerance stacks, GD & T- Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings - Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area - simplification by separation - simplification by amalgamation.

MODULE II **23 Hours**

Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly - Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA - Environmental objectives - Global issues - Regional and local issues - Basic DFE methods - Design guide lines - Example application - Lifecycle assessment - Basic method - AT&T's environmentally responsible product assessment - Weighted sum assessment method - Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly - Design for recyclability - Design for remanufacture - Design for energy efficiency - Design to regulations and standards.

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the design principles for manufacturability considering strength, process capability and tolerances.	Apply
CO2: Apply the machining consideration while design such as Machinability, economy, clampability, accessibility and assembly.	Apply
CO3: Present a case study about the environmental consideration in design while using DFMA methods.	Apply

Text Book(s):

T1. Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight , “Product Design for Manufacture and Assembly”, Third Edition, T&F INDIA, 2019

T2. Boothroyd, G, “Design for Assembly, Automation and Product Design”., Marcel Dekker, New York 2005

Reference Book(s):

R1. Wasim Ahmed Khan, Abdul Raouf, “Standards for Engineering Design and Manufacturing”, Taylor & Francis, 15 Dec 2005.

R2. Fixel, J. “Design for the Environment” McGraw hill., 2011.

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	-	-	-	-	-	-	-	-	1	-	1	-	-
CO2	3	-	-	-	-	-	-	-	-	1	-	1	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	-	-

High-3; Medium-2; Low-1

Course Code: 23AUE007		Course Title: ELECTRONIC STEERING SYSTEM	
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week): 3:0: 0	Credits:3	Total Contact Hours:45	Max Marks:100

Course Objective:

The course is intended to calculate the various stress, force and torsion in the various components of electronic steering system.

MODULE I **24 Hours**

Materials and Manufacturing

Materials for steering system - Material Properties - Ferrous and Non-Ferrous Alloys, rubber, plastics and polymer.

Manufacturing processes: Casting - pressure die casting (aluminium die-casting), plastic injection and rubber moulding and types of plastic moulding processes, Metal forming - forging, tube forming-axial forming, swaging, hydro forming, Metal Joining processes, Additive manufacturing, Rapid Prototyping, Powder Metallurgy, Heat Treatment methods.

Mechanics of Steering Systems

Free body diagram, unknown force, moment, torque calculations for worst case scenarios for steering components. Torsion calculations for circular and non-circular sections. Stress calculations for worst case scenarios for steering column and sheet metal parts used in steering system.

Drawing Standards

Drawing standards, Limits, Fits and Tolerances, ASME14.5 standards, Geometric Dimensioning &Tolerance.

MODULE II **21 Hours**

Introduction to Steering System

Types of steering systems - Mechanical and power assisted steering systems, steering handling characteristics- under steer, over steer, neutral steer. Forces - side force, lift force, drag force-moments- yaw, roll, pitch and bounce.

Basic Electrical systems for Steering

Basics of electrical Quantities - DC Circuits, AC Circuits.

Sensors: Types-inductive, hall, moving magnet type, sensors used for steering system, LIDAR, RADAR, Camera. Transducers - Classification – Selection and specification of transducers.

Motors-Types, working and characteristics - Brushed DC machine, Brushless DC machine, Induction machine, PMSM machine, buck, boost, buck-boost converters, MOSFET

Microcontrollers-Architecture, Automotive microcontrollers-Renasas, Infenion, Hella, Bosch, Microcontroller datasheet, Automotive cyber security, functional safety. Electronic control Unit–open-source ECU.

Project Management – Overview, PERT and CPM chart. (Delivery through Guest Lecture/workshop).

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Calculate the force, stress and torsion for various components of steering system.	Apply
CO2: Apply the concepts of various electrical and electronics systems used in steering systems.	Apply
CO3: Present a case study on the manufacturing of an electronic steering system as a team.	Apply

Course Articulation Matrix

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	-	2	-	-	-	-	-	-	-	2	1	3
CO2	3	3	-	3	-	-	-	-	-	-	-	2	1	3
CO3	3	3	-	3	-	-	-	-	-	-	-	2	1	3

High-3; Medium-2; Low-1

Text Book(s):

T1. Manfred Harrer, Peter Pfeffer, Steering hand book, Springer, 1st edition, 2017.

T2. Robert Bosch "Automotive Electrics and Automotive Electronics", 5th edition, 2007.

T3. Hibbeler, "Engineering Mechanics-Statics & Dynamics" – Pearson Publications, 14th edition, 2017.

Reference Book(s):

R1. Robert Bosch GmbH, Automotive Handbook, 1th edition, 2022.

R2. Konrad Reif, Automotive Mechatronics, Springer Publications, 2015.

R3. Dr.Yasir Imtiaz Khan, Automotive Cyber Security Challenges-A Beginners Guide, Amazon Digital Services, 2020.

Web Reference(s):

1. https://www.bosch-mobility.com/en/solutions/steering/electric-power-steeringsystems

Course Code: 23MEOC001		Course Title: INDUSTRIAL AUTOMATION AND ROBOTICS	
Course Category: Minor		Course Level: Introductory	
L:T:P(Hours/Week) 3.0.0	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objective:

The course is intended to gain the knowledge in automation and robotics in industrial applications.

MODULE I **23 Hours**

Industrial automation- vertical integration of industrial automation, fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, and levels of automation control elements in industrial automation.

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions modules and integration - sequential circuits - cascade methods - step counter method. Electrical elements to control pneumatic equipment's - selection of components.

Basics of PLC, advantages, capabilities of PLC, architecture of PLC, scan cycle, types of plc, types of i/o modules, configuring a PLC, PLC wiring.

MODULE II **22 Hours**

Laws of robots, Types of robots, Overview of robot system and subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Drive mechanisms and transmission. Need of End effectors, types – Design of finger gripper- Different types of grippers – Mechanical, vacuum, Magnetic and other methods of gripping, actuation methods for mechanical gripper, selection of grippers, tools as an end effector. Application of robots in material handling, entertainment, medical and security fields

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Develop a suitable automation system using logic and PLC programing.	Apply
CO2: Select the suitable driving and gripping mechanism for a robot based on the industrial application.	Apply
CO3: Present case study on industrial automation system with robotics.	Apply

Text Book(s):

T1. Esposito Anthony, "Fluid Power with Applications", Pearson education Inc., New York, 2013.

T2. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012.

Reference Book(s):

R1. Devadas Shetty and Richard A.KolK, “Mechatronics Systems Design”, Cengage Learning Inc, 2010.

R2. Richard D. Klafter, Thomas .A, ChriElewski, Michael Negin, "Robotics Engineering an Integrated Approach", PHI Learning, 2009. R3. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	2	3	-

High-3; Medium-2; Low-1

Course Code: 23MEOC002		Course Title: TOTAL QUALITY MANAGEMENT	
Course Category: **Minor**		**Course Level: Introductory**	
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks:100**

Course Objectives:

The course is intended to impart knowledge on the views of different quality gurus, Total Quality Management (TQM) approach, Total Quality Management (TQM) approach and the various quality tools for identifying appropriate process improvements and Quality Management.

MODULE I **22 Hours**

Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation. Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure

MODULE II **23 Hours**

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma. Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process. Need for ISO 9000 and Other Quality Systems, ISO 9000:2004 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 – Concept, Requirements and Benefits

Course Outcomes	**Cognitive Level**
At the end of the course students will able to	
CO1: Apply the different quality gurus towards Total Quality Management and the principles and concepts inherent in a Total Quality Management (TQM)	**Apply**
CO2: Apply the various quality tools for identifying appropriate process improvements such as Bench marking, QFD,TPM and FMEA and the quality management with respect to the ISO 9000 & ISO 14000 quality management standards.	**Apply**
CO3: Present a quality audit report of a system in a team.	**Apply**

Text Book(s):

T1. Dale H. Besterfiled, et al., “Total Quality Management”, Pearson Education, Inc. 2014.

T2. Subbarajramasamy, “ Total Quality Management” McGraw-Hill, 2008.

Reference Book(s):

R1. James R.Evans& William M. Lidsay, “The Management and Control of Quality”, 7th Ed., South-Western (Thomson Learning), 2009.

R2. Oakland.J.S. “Total Quality Management”, Butterworth Hcinemann Ltd., Oxford, 2014.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	2	-	-	2	-	-	2	2	-	-
CO3	2	-	-	-	-	-	-	-	2	2	-	-	-	-

High-3; Medium-2; Low-1

Course Code:23MEOC003	**Course Title: INDUSTRIAL SAFETY ENGINEERING**		
Course Category: Minor	**Course Level: Introductory**		
L:T:P(Hours/Week) 3: 0: 0	**Credits: 3**	**Total Contact Hours: 45**	**Max Marks: 100**

Course objectives

The course focuses on applying engineering principles and modern tools to manage industrial hazards, ensure legal compliance, and design effective safety and emergency systems.

Module I **22 Hours**

Foundations of Industrial Safety Engineering: Evolution of safety: From compliance to proactive engineering, Occupational health & industrial hygiene – modern monitoring tools, Behaviour-Based Safety (BBS) and Safety Culture Engineering, Safe Operating Procedures (SOPs) using digital platforms, Risk assessment models (FMEA, HAZOP, Bowtie analysis), Human factors and ergonomics in safety engineering, Smart hazard detection (IoT sensors for gas, vibration, fire), Environmental hazard control using green engineering principles.

Performance Monitoring and Predictive Safety: Job Safety Analysis (JSA) enhanced with AI-based tools, Predictive maintenance for accident prevention, Safety audits: Smart audit tools and dashboards - Root cause analysis and incident learning systems, Data-driven decision making: Safety KPIs, Safety Activity Rate, Near-miss analytics using digital reporting tools, Machine learning in accident forecasting.

Module II **23 Hours**

Engineering Safety Systems & PPE 4.0: Role of safety committees in Industry 4.0 environments, Safety training through virtual reality (VR) and simulation, Internet of Things (IoT) in PPE and equipment monitoring, Engineering selection of PPE based on hazard rating, Use of digital twins in safety planning - Safety display systems and mobile safety apps, Sustainability in safety: Eco-friendly PPE, zero-incident goals

Industrial Safety Laws and Compliance Automation: Overview of key Indian Safety Acts with recent updates, EHS (Environment, Health & Safety) compliance tools, Digital logbooks and automated legal registers - Environmental impact tracking systems

Emergency Preparedness and Disaster Engineering: Fire dynamics and smart suppression systems, Design of active and passive fire protection systems, Emergency planning using GIS and real-time alerts, Case Study: Bhopal Gas Tragedy & lessons for future smart plants

Course outcomes:

CO1: Apply industrial safety laws and regulatory standards to evaluate compliance in manufacturing and engineering operations.	**Apply**
CO2: Apply appropriate fire safety and emergency response procedures in the design and execution of industrial emergency management plans.	**Apply**
CO3: Present a seminar on tools to manage industrial hazards with a team.	**Apply**

Text Book(s):

1. Deshmukh, L.M. "Industrial Safety Management", McGraw-Hill, 2006.
2. C. Ray Asfahl, "Industrial Safety and Health Management", Pearson Prentice Hall, 2010.

Reference Book(s):

1. John V. Grimaldi and Rollin H. Simonds, *"Safety Management"*, All India Travellers Bookseller, New Delhi, 1989**.**
2. Heinrich H.W., *"Industrial Accident Prevention"*, McGraw-Hill Company, New York, 1980**.**
3. Subramanian, V., *"The Factories Act 1948 with Tamilnadu Factories Rules 1950"*, Madras Book Agency, 21st ed., Chennai, 2000**.**

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	-	-	-

High-3; Medium-2; Low-1

Course Code: 23MEOC004	**Course Title: RENEWABLE SOURCES OF ENERGY**		
Course Category: Minor		**Course Level : Higher**	
L:T:P(Hours/Week) 3: 0:0	**Credits: 3**	**Total Contact Hours:45**	**Max Marks:100**

Course Objectives:

The objective of this course is to equip students with highlights of the importance and economics of renewable energy sources and power generation methods using solar, wind, and bioenergy, which explores the tidal, wave, OTEC, hydro, and geothermal energy systems.

Module I **24 Hours**

INTRODUCTION

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamilnadu, India and around the World – Potentials - Achievements / Applications – Economics of renewable energy systems.

SOLAR ENERGY

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

WIND ENERGY

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection– Details of Wind Turbine Generator – Safety and Environmental Aspects

Module II **21 Hours**

BIO ENERGY

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Biomass Applications

OTHER RENEWABLE ENERGY SOURCES

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small HydroGeothermal Energy – Hydrogen and Storage - Fuel Cell Systems – Hybrid

Systems

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
C01:Apply the principles of solar energy conversion ,photovoltaic systems and wind energy for power requirement applications.	Apply
CO2: Apply the concept of bio energy, tidal energy, hydro thermal energy, geo thermal energy and fuel cell for the power requirement applications.	Apply
CO3: Present a suitable case study on renewable enrgy sources for the industrial power requirements as a team.	Apply

Text Book(s):

T1.Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.

T2.Twidell, J.W. &Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 2006.

Reference(s):

R1. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2015.

R2. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2017.

R3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.

Web Reference(s):

1. https://nptel.ac.in/courses/103103206

2. https://www.youtube.com/playlist?list=PLm_MSClsnwm8k06QRPPkYDgr91VWPqC89

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	-	-	-

High-3; Medium-2; Low-1