Dr. MAHALINGAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution Since 2011
Udumalai Road, Pollachi, Coimbatore District - 642003
Established in 1998 ♦ Approved by AICTE ♦ Affiliated to Anna University
NAAC A++ GRADE Cycle 3 (2023-2030) The Highest Grade
(A DIVISION OF NIA EDUCATIONAL INSTITUTIONS)

Curriculum and Syllabi

Semesters I to VIII

Regulations 2023

Programme: **B.E. Automobile Engineering**
Curriculum and Syllabi: Semester I to VIII
Recommended by Board of Studies on: **09.05.2025**
Approved by Academic Council on: **04.07.2025**

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 Automobile Engineering

Vision

To offer cutting-edge technology in the broad area of automobile engineering and develop globally competitive engineers

Mission:

- To develop automobile engineering graduates for a successful career in automotive industry around the globe through effective teaching-learning and training
- To develop the capability of graduates for creating innovative products / systems to enhance the quality of life
- To inculcate in them the ability to solve societal problems through engineering and professional skills

Programme Educational Objectives (PEOs)

B.E. Automobile Engineering graduates will:

PEO1. Technical expertise: Actively apply technical and professional skills in engineering practices to face industrial challenges around the globe.

PEO2. Higher studies and research: Own their professional and personal development by continuous learning 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) - Regulations 2023

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

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. 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.

PO3. 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.

PO4. 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 for complex problems.

PO5. Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. 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.

PO7. 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.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. 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.

PO11. 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

PO12. 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. Automobile Engineering programme, graduating students/graduates will be able to:

PSO1.Analyze the systems behavior and optimize for the results using modeling, simulation and experiments.

PSO2.Design the automotive components with due considerations of environment and sustainability

Dr. Mahalingam College of Technology, Pollachi

2023 Regulations - Course Code Generation Procedure for UG Courses

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

Regulation (positions 1–2)

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

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. Automobile Engineering
2023 Regulations (2023 Batch)

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/ Heritageof 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	CourseTitle	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	தமிழரும்தொழில்நுட்பமு ம்/ 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. Automobile 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			Credits	Marks	Common to Programmes
			L	T	P			
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/ Heritageof 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	CourseTitle	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
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**	

Semester III

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Minor	23MAT302	Numerical Methods	3	1	0	4	100	AU,ME
Major	23MET301	Engineering Mechanics	2	1	0	3	100	AU,ME
Major	23AUI301	Engineering Thermodynamics and Heat Transfer	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	AU,ME
SEC	23ESL301	Professional Skills 2: Problem Solving Skills & Logical Thinking 2	0	0	2	1	100	All
VAC	23VAT301	Universal Human Values 2: Understanding Harmony	2	1	0	3	100	All
AEC	23SAL301	Studio Activities	0	0	2	-	-	All
SEC	23AUS301	Defensive Driving Skill Training	0	0	2	-	-	-
		Total	**14**	**3**	**14**	**23**	**900**	

Semester IV

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
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	23AUI401	Automotive Engines	3	0	2	4	100	-
Major	23AUT401	Automotive Chassis and Transmission	3	0	0	3	100	-
Major	23MEL401	Strength of Materials & Mechanics of Machinery Laboratory	0	0	3	1.5	100	AU,ME
Major	23AUL401	Fuels, Engine Performance and Emission Testing Laboratory	0	0	3	1.5	100	-
EEC	23ESL401	Professional Skills 3: Professional Development and Etiquette	0	0	2	1	100	All
AEC	23SAL401	Studio Activities	0	0	2	-	-	All
		Total	**15**	**2**	**12**	**22**	**800**	

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

Semester V

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Major	23AUT501	Automotive Electrical and Electronics	2	0	2	3	100	-
Major	23MET502	Finite Element Analysis	3	1	0	4	100	AU,ME
Major	23AUT502	Design of Automotive Elements	3	1	0	4	100	-
Major	23XXXXXX	Professional Elective - I	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective - II	3	0	0	3	100	-
Major	23AUL501	Vehicle Maintenance Laboratory	0	0	3	1.5	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	All
Project	23AUP501	Reverse Engineering Project	0	0	6	3	100	-
AEC	23SAL501	Studio Activities	0	0	2	-	-	All
		Total	**14**	**2**	**18**	**24**	**900**	

Semester VI

Course Category	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Major	23AUT601	Vehicle Dynamics	3	1	0	4	100	-
Major	23AUT602	Automotive Embedded Systems	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective - III	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective - IV	3	0	0	3	100	-
Minor	23XXXXXX	Open Elective - I	3	0	0	3	100	-
Major	23AUL601	Automotive Embedded Systems Laboratory	0	0	3	1.5	100	-
SEC	23ESL601	Professional Skills 5: Ace & Elevate: Aptitude and Soft Skills	0	0	2	1	100	All
AEC	23SAL601	Studio Activities	0	0	2	1	-	All
		Total	**15**	**1**	**7**	**19.5**	**700**	

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

Semester VII

Type of Course	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Major	23AUT701	Electric, Fuel cell and Hybrid Vehicles	3	0	0	3	100	-
Minor	23AUT702	Artificial Intelligence and Machine Learning	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective - V	3	0	0	3	100	-
Major	23XXXXXX	Professional Elective - VI	3	0	0	3	100	-
Minor	23XXXXXX	Open Elective - II	3	0	0	3	100	-
Project	23AUP701	Project Phase - I	0	0	8	4	200	-
		Total	**15**	**0**	**8**	**19**	**700**	

Semester VIII

Type of Course	Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
			L	T	P			
Project	23AUP801	Project Phase - II	0	0	12	6	200	-
		Total	**0**	**0**	**12**	**6**	**400**	

Type of Course	Course Code	Course Title	Duration	Credits	Marks
SEC	23XXXXXX	Internship III/ Research Internship/ Skill Development	8 Weeks	4	100

Total Credits – 161.5

Professional Electives

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
Design Electives							
23AUE001	Vehicle Safety and Comfort Systems	3	0	0	3	100	-
23AUE002	Hydraulic and Pneumatic Systems	3	0	0	3	100	-
23AUE003	Automotive Aerodynamics	3	0	0	3	100	-
23AUE004	Noise, Vibration and Harshness for Automobiles	3	0	0	3	100	-
23AUE005	Off Road Vehicles	3	0	0	3	100	-
23AUE006	Design for Manufacture, Assembly and Environment	3	0	0	3	100	-
23MEE004	Design for Sheet Metal	3	0	0	3	100	ME,AU
23AUE007	Electronic Steering System	3	0	0	3	100	ME,AU
Manufacturing Electives							
23MEE038	Computer Integrated Manufacturing	3	0	0	3	100	ME,AU
23AUE008	Production of Automotive Electrical Components	3	0	0	3	100	-
23AUE009	Jigs Fixtures and Press tools	3	0	0	3	100	-
23AUE010	Welding and Joining Techniques	3	0	0	3	100	-
23AUE011	Unconventional Machining Processes	3	0	0	3	100	-
23MEE016	Composite Materials	3	0	0	3	100	ME,AU
23MEE025	Non Destructive Testing Methods	3	0	0	3	100	ME,AU
23MEE012	Lean Manufacturing	3	0	0	3	100	ME,AU
23MEE040	Logistics Engineering	3	0	0	3	100	ME,AU
23MEE013	Manufacturing Systems Engineering	3	0	0	3	100	ME,AU
23MEE009	Additive Manufacturing	3	0	0	3	100	ME,AU
Automobile and Service Electives							
Course Code	**Course Title**	**Hours/Week**			**Credits**	**Marks**	**Common to Programmes**
		L	**T**	**P**			
23AUE012	Alternative Fuels for IC Engines	3	0	0	3	100	-
23AUE013	Automotive Fuels and Lubricants	3	0	0	3	100	-
23AUE014	Automotive Pollution Control	3	0	0	3	100	-

23AUE015	Automotive Air Conditioning Systems	3	0	0	3	100	-
23AUE016	Vehicle Body Engineering	3	0	0	3	100	-
23AUE017	Vehicle Maintenance	3	0	0	3	100	-
23AUE018	Transport Management	3	0	0	3	100	-
23AUE019	Reliability and Maintenance Engineering	3	0	0	3	100	-
23MEE015	Engineering Economics and Cost Analysis	3	0	0	3	100	ME,AU
23MEE029	Quality Engineering	3	0	0	3	100	ME,AU
23MEE032	Industrial Safety Management	3	0	0	3	100	ME,AU
23AUE021	Vehicle Regulations and Homologation	3	0	0	3	100	-

Telematics Electives

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
23AUE022	Sensors for Automotive Application	3	0	0	3	100	-
23AUE023	Automated and Connected Vehicles	3	0	0	3	100	-
23AUE024	Fleet Management	3	0	0	3	100	-
23AUE025	In-Vehicular Networks	3	0	0	3	100	-
23AUE026	Automotive Infotronics	3	0	0	3	100	-
23AUE027	Data Communication and Networking	3	0	0	3	100	-
23AUE028	Intelligent Transport System	3	0	0	3	100	-
23AUE029	Advanced Driver Assistance System	3	0	0	3	100	-

Electric Vehicle Technology Electives

Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
23AUE030	Electric Vehicle Powertrains	3	0	0	3	100	ME,AU
23AUE031	Electric Vehicle Battery Technology	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

Diversified Electives							
Course Code	Course Title	Hours/Week			Credits	Marks	Common to Programmes
		L	T	P			
23MEE033	Industrial IoT	3	0	0	3	100	ME,AU
23MEE042	Java Programming for Mechanical Sciences	3	0	0	3	100	ME,AU
23MEE044	Data Structures and Object Oriented Programming with C++	3	0	0	3	100	ME,AU
23AUE050	Entrepreneurship Development	3	0	0	3	100	All
23AUE051	Design Thinking and Innovation	3	0	0	3	100	All
23SCE050	Cyber Security	2	0	2	3	100	All
23ITE047	Intellectual Property Rights	3	0	0	3	100	All
23MEE007	Mechanical Engineering Design and Automation	3	0	0	3	100	ME,AU
23MEE008	PLM for Engineers	3	0	0	3	100	All

Open Electives

Course Code	Course Title	Hours/Week			Credits	Marks
		L	T	P		
23AUO001	Automotive Systems	3	0	0	3	100
23AUO002	Automotive ECU and Control	3	0	0	3	100
23AUO003	Electronics In Automobiles	3	0	0	3	100
23AUO004	Automotive Sensors	3	0	0	3	100
23AUO005	E-Mobility	3	0	0	3	100
23AUO006	Project Management	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 and learning 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 of Excellence.
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	PO1(	PO1:	PO12	PSO:	PSO:
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

Course Code: 23ENI101	Course Title: Communication Skills I (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 Contact Hours:60	Max Marks:100

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”, 5thEdition, Cambridge University Press, South Asia Edition, 2022.

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

Reference Book(s):

R1. David Bohlke, Jack C. Richards, “Four Corners”, 2nd 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” 30th Edition, Cambridge University Press,2022.

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: 23MAI102</td><td colspan="2">Course Title: Matrices and Calculus
(Common to AU, EA, 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:
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	-	-	-	-	-	-	-	2	-

High-3; Medium-2;Low-1

Text Book(s):

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

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

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: 23PHT102</td><td colspan="2">Course Title: Physics for Mechanical Sciences (Common to AU & 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: 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 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 and Parallel.

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 At the end of the course students will able to	**Cognitive Level**
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 Vs 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
CO1	-	-	-	-	3	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	3	-	-
CO6	-	-	-	-	-	-	-	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”, 2nd 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

Course Code: 23MEL001		Course Title: Engineering Drawing (2023 batch only) (Common to AD,AM,AU,CS,EA ,EC,EE,EV,IT,ME, SC)	
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

- 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 Isometric projection 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	2	-

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.IS 9609 (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 of delivery is like practical.

Web References:

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

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

Course Code:23MEL002	Course Title: **Engineering Graphics and Design** (Common to all programs)		
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 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, orthographic and 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 and Matt Weber

Reference Book(s):

R1. Autodesk Fusion 360 Black Book (V 2.0.12670) – Part 2 by Gaurav Verma and Matt 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 cooling method.
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	**Cognitive Level**
At the end of this course, students will be able to:	
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 Vs 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 cross section, 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 file using file handling methods.
10. Implement the program to plot the components of a given force for the different angle ranges.

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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
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
CO1	-	-	-	-	-	-	-	-	1	1	-	1
CO2	-	-	-	-	-	-	-	-	1	-	1	1
CO3	-	-	-	-	-	-	-	-	1	-	-	1
CO4	-	-	-	-	-	-	-	-	1	-	-	1
CO5	-	-	-	-	-	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”

<table>
<tr><td colspan="2">Course Code: 23VAT101</td><td colspan="3">Course Title: HERITAGE OF TAMILS
(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

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="3">**Course Title: HERITAGE OF TAMILS
(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 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 At the end of this course, students will be able to:	**Cognitive Level**
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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7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
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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 for detail - 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, South Asian, 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>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="2">Course Category: AES</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 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 Eri Banno, 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/

Course Code:23FLT202	Course Title: FOREIGN LANGUAGE - GERMAN (Common to all B.E/B.Tech Programmes)		
Course Category: AEC		**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:

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, House information) – Grammar (possesivartikel im Nominativ, Artikel im Akkusativ, Adjektive im satz, Graduierung mit zu)– Speak Action (Whonung bescreiben about perons and things)– 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

Course Code: 23MAI202		Course Title: Complex Variables and Transforms (Common to AU, 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:
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 periodic functions.	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

Course Code : 23CHT201		Course Title: Chemistry for Mechanical Sciences (Common to ME & AU)	
Type of Course: 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 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, batteries and fuel cells, corrosion.	Apply
CO2: Apply the acquired knowledge of chemistry to solve the Engineering problems.	Apply
CO3: Analyze the Engineering problems through the concept of electro chemistry, water technology, Engineering materials and 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 Rai Publishing 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) 2: 0: 2	Credits: 3	Total Contact Hours:60	Max Marks:100

Course Objectives:

The course is intended to

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	-	-	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

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, Use boundary 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 slicing through 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

Course Code: 23CHL201		Course Title: Chemistry for Mechanical Sciences Laboratory (Common to ME &AU)	
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 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 engineering materials 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	-	-	-	-	-	-	-	-	-	2

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 PRACTICES LABORATORY (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 At the end of this course, students will be able to:	Cognitive Level
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 argument- Causes and effects- Self-Learning.

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	**Apply**

Textbook(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/

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.

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

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
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

<table>
<tr><td colspan="2">Course Code: 23MAT302</td><td colspan="2">Course Title: NUMERICAL METHODS
(Common to AE,ME)</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:

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

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

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 steeringmechanism, 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	**Cognitive Level**
At the end of this course, students will be able to:	
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: 23MET302	Course Title: FLUID MECHANICS AND HYDRAULICS MACHINERY (Common to ME & AU)		
Course Category: Major		**Course Level : Intermediate**	
L:T:P(Hours/Week) 2: 1:0	**Credits: 3**	**Total Contact Hours:45**	**Max Marks:100**

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	-	-	-	-	-
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	-	2

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

Course Code: 23MEL301	**Course Title: MANUFACTURING PROCESSES 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

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	-	-	-	-	-	-

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 9 Hours

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

Course Code: 23MAT401		Course Title: **PROBABILITY AND STATISTICS** (Common to EC, EE, ME, AU, CS, AM, SC, IT &EV)	
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:

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 linearregression using least square method – Transformation of random variables.

Standard Distributions: Discrete Distributions - Binomial- Poisson- Properties, Moment generating functions -Continuous Distributions - Uniform –Exponential-NormalDistributions 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",5th 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: 23AUI401		Course Title: Automotive Engines	
Course Category: Major		Course Level: Introductory	
L:T:P(Hours/Week) 3:0:2	Credits: 4	Total Contact Hours: 75	Max. Marks:100

Course Objectives:

1. Compare the construction and working of IC engines.
2. Suggest the suitable IC engines subsystems to the specified applications.
3. Infer the influences of combustion chamber geometry.
4. Explore the recent developments employed in IC engines.

Module I **25 Hours**

Heat engines, engine components and functions, engine nomenclature, classification, 4 stroke engines, 2 stroke engines, valve timing diagram, port timing diagram.

SI engine: Construction, working and applications, Carburetion, air-fuel ratio, importance, requirements, simple carburetor, working, petrol injection, throttle body and multi point injections. Ignition system: requirements, ignition timing, battery coil, magneto, CDI and distributor-less ignition, spark plug.

CI engine: Construction, working and applications. Fuel injection system functional requirements, inline and rotary injection systems, working, feed pump, atomizer, injection pump, injector and nozzles.

Cooling and Lubrication system: Importance of cooling, cooling system classification, air cooling system, liquid cooling system, coolant properties, thermostat, thermo-syphon, forced circulation cooling. Lubrication system, engine friction fundamentals, influence of engine variable on friction, functions of the lubrication system, mist lubrication, wet sump lubrication, construction and working.

Exhaust system, exhaust manifold, exhaust down pipe, resonator, muffler, tailpipe, catalytic converter.

Module II **20 Hours**

Combustion in IC Engine: Richard's combustion theory, SI engine, combustion stages, factors affecting SI engine combustion, knocking. SI Engine combustion chamber, Types.

CI Engine, combustion stages, abnormal combustion, factors affecting CI engine combustion. CI engine combustion chambers, classification, factors controlling combustion chamber design. Air motion, swirl, squish and turbulence.

Spark advance mechanisms, centrifugal and vacuum advance mechanism, Cold starting devices in Diesel engines.

Advancement in IC Engines: Supercharger and turbocharger, HCCI, Lean burn engine, stratified charge engine, four valve and overhead cam engines, variable valve timing (VVT), variable geometry turbochargers (VGT), electronic engine management, CRDI, GDI, DAQ System — combustion and heat release analysis in engines.

List of Exercises	30 Hours
1. Plot valve timing and port timing diagram.	
2. Dismantle, identify the components and assemble the given petrol engine	
3. Dismantle, identify the components and assemble the given diesel engine.	

4.	Dismantle, identify and assemble the given fuel injection system components.
5.	Dismantle, identify and assemble the given cooling and lubrication system components.
6.	Dismantle, identify and assemble the given ignition system components.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Compare the construction and working of IC engines.	Apply
CO2: Suggest the methods to improve the performance of power producing devices.	Apply
CO3: Infer the influences of combustion chamber geometry.	Apply
CO4: Explore the recent developments employed in IC engines.	Apply

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	-
CO4	2	-	-	-	-	-	1	-	-	-	-	1	1	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Mathur M.L. and Sharma R.P., Internal Combustion Engines, Dhanpat Rai Publishing, 7th edition, 2014.

T2. Ganesan V, Internal Combustion Engines, Tata McGraw Hill, 4th edition, 2018.

T3. Ramalingam K.K., Internal Combustion Engines, SciTech Publications, 3rd edition, 2018.

Reference Book(s)

R1. John B. Heywood, Internal Combustion Engines Fundamentals, McGraw Hill, 2nd edition, 2018.

R2. Pundir, B. P., I. C. Engines: Combustion and Emissions, Narosa Publishing House, New Delhi, Reprint, 2017.

Course Code: 23AUT401		Course Title: Automotive Chassis and Transmission	
Course Category: Major		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 frames, steering system, clutch, gear box and braking system of vehicles.

Module I **23 Hours**

Frames and Bodies: Classification of vehicles, types of chassis layout with reference to power plant locations. Vehicle frames, loads acting on vehicle frames, types of frames – Ladder frame, Integral frame, tubular frame.

Steering and Suspension System: Front Axle - Steering system- working mechanism- steering layouts, front wheel geometry. Ackermann and Davis steering system, steering gear boxes and power assisted steering, Multi axle steering system

Suspension system - Need- Types of suspension system-Wishbone & Mc Pherson -. Types of suspension Spring- Leaf spring, Coil Spring. Shock Absorber- types, tandem axle suspension system

Clutch: Clutch - types of clutches- single plate clutch-multiple plate clutch-centrifugal clutch.

Module II **22 Hours**

Gear Box: Gear box –Types of Gear Box. Simple epicyclic gear box- Continuously Variable Transmission (CVT).

Drive Line: Drive Axles - Types, stub axle – types. Drive lines- Hotchkiss drive, torque tube drive. Final Drive -types of final drive. Differential- Types of Differentials, Power divider. Wheels and Tires –Types of wheels. Tire -nomenclature-Types of Tires.

Braking System: Braking system – Purpose, stopping distance, braking torque, stopping time and braking efficiency. Classifications of brakes- drum brakes and disc brakes-mechanical, hydraulic, pneumatic braking system and Anti-lock braking system

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Identify the different chassis frames used in the on road and off-road vehicles quadrant.	Understand
CO2: Plot a steering system layout for dependent suspension and independent suspension based on the conditions for true rolling.	Apply
CO3: Compare the construction and working of various types of friction clutches and gear boxes used in vehicles.	Apply
CO4: Select suitable drive line components for on-road vehicles and off-road vehicles.	Apply

CO5: Compare the construction and working of disc brake and drum brake based on the efficiency and stopping distance.	Apply
CO6: Develop a prototype model of automotive chassis and transmission systems component.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	1	1
CO2	2	1	-	-	-	-	-	-	-	-	-	1	1	1
CO3	2	1	-	-	-	-	-	-	-	-	-	1	2	1
CO4	2	1	-	-	-	-	-	-	-	-	-	1	2	1
CO5	2	1	-	-	-	-	-	-	-	-	-	1	2	1
CO6	3	3	-	-	-	-	-	-	-	-	-	1	1	1

High-3; Medium-2; Low-1

Text Book(s):

T1. Heinz heizler, “Advanced Vehicle Technology” **–** ButterworthHeinemann.2005.

T2. P S. Gill, “Automobile Engineering”, S.K. Kataria & Sons, 2014

T3. Newton, Steeds and Garrot- “Motor Vehicles”- Butterworths, London- 2010.

Reference Book(s):

R1. Heldt.P.M.- “Automotive Chassis”- Literary Licensing, LLC, 2012.

R2. N K Giri “Automobile Mechanics” Khanna Publications,2015.

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: 23AUL401	Course Title: Fuels, Engine Performance and Emission Testing Laboratory		
Course Category: Major		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 determine the fuel properties, the performance and emission characteristics of IC engines.

List of Experiments

1. Conduct ASTM distillation test of given fuel.
2. Determine the temperature dependence of viscosity of given fuel.
3. Determine flash and fire point of given fuel.
4. Conduct retardation test on single cylinder diesel engine.
5. Conduct performance test on diesel engine.
6. Conduct performance test on petrol engine.
7. Conduct heat balance test on IC engine.
8. Conduct morse test in a multi cylinder petrol injection engine.
9. Plot P-θ and P-V diagrams of engine performance using EPA software.
10. Conduct emission test on turbocharged engine.
11. Conduct a performance test on fuel injection pump of a diesel engine.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Determine the liquid fuel properties such as flash point, fire point, viscosity and vapor characteristics as per ASTM standards.	Apply
CO2: Determine and improve the performance characteristics of SI and CI engines.	Apply
CO3: Execute and implement the BS - IV emission norms in a given engine.	Create

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	2	1	-	1	1	1
CO2	3	2	-	2	-	1	2	1	2	1	-	1	1	1
CO3	3	2	-	2	-	1	2	1	2	1	-	1	1	1

High-3; Medium-2; Low-1

Reference(s):

R1. “Fuels, engine performance and emission testing laboratory manual”, MCET-Automobile Engineering, 2023.

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: 23AUT501	Course Title: AUTOMOTIVE ELECTRICAL AND ELECTRONICS		
Course Category: Major		Course Level: Introductory	
L:T:P(Hours/Week) : 2:0:2	Credits: 3	Total Contact Hours: 45	Max Marks:100

Course Objectives:

The course is intended to:

1. Explain the fundamental principles of electrical and electronic systems in automobiles.
2. Analyse faults in automotive electrical and electronic systems.
3. Apply concepts of electronic components and circuits to design basic automotive electronic circuits.
4. Learn the advancements in automotive electrical and electronic technologies.

Module I **22 Hours**

Automotive Electrical Systems

Basic Electrical Concepts: Ohm's law, Kirchhoff's laws, power, and energy. DC and AC circuits, single-phase and three-phase systems. Magnetic circuits, electromagnetic induction, and transformers.

Automotive Battery Systems: Types of batteries (lead-acid, lithium-ion, etc.) Battery charging and discharging characteristics. Battery maintenance and testing.

Automotive Charging Systems: Alternator principles and operation. Voltage regulators and current regulators. Charging system diagnosis and troubleshooting.

Automotive Starting Systems and motors: Starter motor principles and operation. Starter motor control circuits. Starter motor testing and troubleshooting, PMDC and BLDC working principle.

Automotive Lighting Systems: Types of lighting systems (halogen, HID, LED).Lighting system control circuits. Lighting system wiring diagrams and troubleshooting.

Module II **23 Hours**

Semiconductor Devices: Diodes, transistors, and thyristors. Operational amplifiers and their applications. Digital electronics basics (logic gates, flip-flops, counters).

Automotive Sensors and Actuators: Types of sensors (temperature, pressure, speed, etc.)Sensor signal conditioning and interfacing. Actuator types (relays, solenoids, motors) and their control.

Engine Management Systems: Electronic fuel injection systems. Ignition systems (conventional and electronic) - control circuits. Engine control unit (ECU) operation and programming.

Vehicle Communication Systems: CAN bus and LIN bus protocols. Vehicle networking and data communication - control circuits. Diagnostic trouble codes (DTCs) and fault diagnosis.

Advanced Automotive Systems: Hybrid and electric vehicles. Advanced driver assistance systems (ADAS) - Autonomous driving systems, ABS, TCS.

List of Experiments:

1. Speed control of PMDC Motor using PWM.(CO1)
2. Conduct load test on three phase induction motor and alternator.(CO1)
3. Conduct load test on Hydrogen Fuel Cell system. (CO1)
4. Design simple driver circuit using SCR and draw its characteristics.(CO2)
5. Diagnose faults in the car electrical system.(CO3)

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Explain the fundamental principles of electrical and electronic systems in automobiles.	Understanding
CO2: Design electrical circuits for automotive applications.	Apply
CO3: Design electronic circuits for automotive systems.	Apply
CO4: Analyze faults in automotive electrical and electronic systems.	Analysis

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Robert Bosch GmbH, Bosch Automotive Handbook, 10th Edition, Bentley Publishers, 2021.

T2. Tom Denton, Automotive Electrical and Electronic Systems, 5^{th} Edition, out ledge, 2022.

Reference Book(s):

R1. John D. Bullock, Automotive Electrical Equipment, Tata McGraw-Hill, 2020.Kirk VanGelder, Fundamentals of Automotive Technology: Principles and Practice, CDX Automotive, 2022.

R2. Nicholas Goodwin, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market, Elsevier, 2021.

Web References:

1. SAE International: https://www.sae.org/
2. Bosch: https://en.wikipedia.org/wiki/Bosch_%28company%29
3. Denso: https://www.denso.com/global/en/

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 **30 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 **30 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

Course Articulation Matrix

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

High-3; Medium-2; Low-1

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

Course code: 23AUT502		Course Title: DESIGN OF AUTOMOTIVE ELEMENTS	
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 enable the students to:

1. Learn the fundamental concepts of machine design
2. Design and analyse shaft section for automotive applications.
3. Design and select a suitable bearing for automotive applications.
4. Design the components of conventional powerplant.
5. Design the components of electric powerplant.

Module 1 **36 Hours**

Concepts of Design: Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations - Design of straight and curved beams - 'C' Frame and Crane Hook. Stress Concentration - Stress Concentration Factors - Reduction of Stress Concentration - Fluctuating Stresses - Fatigue Failure - Endurance Limit - Low-cycle and High-cycle Fatigue - Notch Sensitivity - Approximate Estimation of Endurance Limit - Design for Finite and Infinite Life for Reversed Stresses - Soderberg and Goodman Lines - Fluctuating stresses - Modified Goodman Diagrams - Gerber Equation.

Shafts and Couplings: Transmission shaft and axles (Front and rear axles) categories –- Shaft design on strength basis, Equivalent Torsional Moment, Equivalent Bending Moment and Torsional Rigidity - ASME Code for shaft design. Keys, Types - Design of Square and Flat Keys. Couplings, Types - Design of Unprotected and Protected Rigid Flange couplings, Bushed-Pin Flexible Coupling.

Case study for automotive applications: Propeller shaft and axle shaft.

Design of Bearings: Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, McKee's Investigation - Raimondi and Boyd Method - Sommerfeld Number, Journal Bearing Design. Deep Groove Ball Bearings, Dynamic Load Carrying

Capacity, Equivalent Bearing Load, Load-Life relationship, Selection of Deep Groove Ball Bearings from Manufacturers Catalogue.

Study case for automotive applications: Crankshaft bearing and Wheel bearing

Module II **24 Hours**

Conventional powerplant components design: Buckling of Connecting Rod - Cross-Section of Connecting Rod - Big end and Small end Bearings - Big End Cap and Bolts -Whipping Stresses. Crankshaft - Types - Design of Centre Crankshaft and Side Crankshaft for maximum bending moment and maximum torsional moment conditions. Flywheel materials - Coefficient of fluctuation of speed - Fluctuation of energy, Turning Moment Diagram - Maximum fluctuation of energy - coefficient of fluctuation of energy - Energy stored in a flywheel - Stresses induced in rimmed flywheel - Design of shaft, key and hub for flywheels.

Electric powerplant components design: Electric Motor – Stator and Rotor geometry, Design of slots and windings, Material selection for motor components, Rotor and shaft design for stability, Critical speed of rotor and vibration effect

Course outcomes

Course outcome	**Cognitive level**
At the end of the course the students will be able to:	
CO1: Apply the static and dynamic load concepts in design.	Apply
CO2: Design and analyse the power transmitting elements in automotive vehicles.	Apply
CO3: Design connecting rod and Crank shafts for the given cylinder specifications.	Apply
CO4: Select a suitable bearing for the given automotive application.	Apply
CO5: Design the electric powerplant components for an automobile.	Apply

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	2	1	-	-	-	-	1	-	1	-	1	-	3

CO2	3	2	1	-	-	-	-	1	-	1	-	1	-	3
CO3	3	2	1	-	-	-	-	1	-	1	-	1	-	3
CO4	3	2	1	-	-	-	-	1	-	1	-	1	-	3
CO5	3	2	1	-	-	-	-	1	-	1	-	1		3

High 3; Medium 2; Low1

Text Book(s):

T1. V. B. Bhandari," Design of Machine Elements", Tata McGraw-Hill Education, 2020.

T2. Joseph E. Shigley & Larry D. Mitchell, "Mechanical Engineering Design", 10th Edition, McGraw-Hill International book company,2014

T3. Wei Tong, "Mechanical Design and Manufacturing of Electric Motors", 2nd Edition, CRC Press, 2022.

Reference Book(s):

R1. Julian Hapian Smith, "An Introduction to Modern Vehicle Design", Society of Automotive Engineers Inc,2002

R2. Richard van Basshuysen, "Internal Combustion Engine Handbook", SAE International, 2004.

R3. P. C Sharma and A. K Agarwal. "Machine Design" (SI units). S.K. Kataria& Sons. Reprint 2013.

Course Code: 23AUL501	Course Title: VEHICLE MAINTENANCE 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

The course is intended to:

Diagnose and repair a wide range of vehicle system failures, including engine, transmission, electrical, braking, and steering systems.

List of Experiments:

1. Study and preparation of different statements/records required for the repair and maintenance works.
2. Minor and major tune up of gasoline and diesel engines.
3. Calibration of Fuel injection pump.
4. Fault diagnosis and service of steering system
5. Fault diagnosis and service of transmission system.
6. Fault diagnosis and service of suspension system.
7. Fault diagnosis and service of braking system.
8. Fault diagnosis and service of Electrical systems (battery, starting system, charging system) using OBD tool.
9. Study and checking of wheel alignment - checking of camber, caster.
10. Practice the following:

➢ Adjustment of pedal play in clutch, brake and steering wheel play.

➢ Air bleeding from hydraulic brakes, air bleeding of diesel fuel system.

➢ Wheel bearings tightening and adjustment.

➢ Adjustment of head lights beam.

➢ Removal and fitting of tire and tube.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to	
CO1: Recognize and overhaul the faults in the vehicle systems.	Apply

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	-

High-3; Medium-2; Low-1

References book(s):

R1. Jigar A. Doshi, Dhruv U. Panchal, Jayesh P. Maniar, “Vehicle Maintenance and Garage Practice” PHI Learning, 2014.

R2. Ed May, Les Simpson, “Automotive Mechanics” Paperback, McGraw Hill Education, 2018.

Web Reference:

1. https://www.udemy.com/topic/car-repair/

2. https://www.autotrainingcentre.com/automotive-online-training/auto-mechanics-online-course/

Course Code: 23MEL501		Course Title: SIMULATION AND ANALYSIS 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 in structural and thermal analysis by using FEA tool and simulate simple problems using simulation software.

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 number 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 simulation software.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply finite element simulation software to solve simple problems such as structural, thermal and vibration problems in Mechanical/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	-	-	1	2	-
CO2	3	2	-	-	2	-	-	-	2	-	-	1	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

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" 2nd 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

Course Code: 23AUP501		Course Title: Reverse Engineering Project	
Course Category: Project		Course Level: Higher	
L:T:P(Hours/Week) 0:0:6	Credits: 3	Total Contact Hours: 90	Max Marks:100

Course Objective:

This course is designed as a hands-on, project-based learning component that enables students to understand the structure, function, and design principles of existing products or systems. Through disassembly, functional analysis, and modelling, students gain insights into real-world engineering challenges.

Module 1 **30 Hours**

Introduction to Reverse Engineering – Ethics and Case Studies - Selection and Approval of Product/System - Disassembly and Physical/Logical Mapping of Components - Functional Analysis

Module 2 **60 Hours**

System Interaction, Data Flow - Modelling & Simulation using CAD/EDA/Software/Hardware Tools - Redesign / Optimization

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Identify and analyze the functional structure of real-world products.	Analyze
CO2: Document and map system components through manual and digital methods.	Apply
CO3: Create accurate models and simulations using appropriate tools.	Create
CO4: Propose feasible improvements or alternative designs.	Evaluate
CO5: Present comprehensive reports and defend their analysis with clarity and professionalism.	Evaluate

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Web References

1.https://innovationspace.ansys.com/product/reverse-engineering-in-metal-additive-manufacturing/

Course Code: 23AUT601	Course Title: VEHICLE DYNAMICS		
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:

1. Understand the performance and stability of vehicle in different drive and road conditions.
2. Calculate the various forces and moment acting the vehicle in lateral, longitudinal and vertical dynamic conditions.

Module I **30 Hours**

Forces and couples on Vehicle- vehicle axis system, force generation mechanism in tyre, tractive, braking and cornering properties of tyre.

Vehicle Performance Power requirement for propulsion- air, rolling and gradient resistances- road performance curve for maximum acceleration drawbar pull, maximum speed and gradeability, determination of centre of gravity distribution of weight, three and four wheeled vehicle.

Stability of a vehicle- on a slope Calculation maximum tractive effort, reactions, power and torque requirements for different drive conditions. dynamics of a vehicle running on a banked track, Simulating vehicle model in different drive conditions using software tool.

Module II **30 Hours**

Vehicle Vibration

Procedure for Vibration Analysis, Vehicle Models for Vibration Analysis,

Free Undamped Vibration- Differential Equation of Motion, Spring-Mass System Analysis

Free Damped Vibration-Differential Equation of Motion, Analysis of Underdamping, Critical Damping, and Overdamping, logarithmic decrement calculations.

Forced Vibration-Frequency Response with External Excitation, Magnification Factor, Absolute Motion, Transmissibility, Vibration Isolation

Two Degrees of Freedom Systems -Vibration Response for Undamped System, Coordinate coupling, pitch and bounce – pitch and bounce frequencies of vehicle – anti squat and anti-dive geometry- determination of roll center, roll axis - active suspension system – ride control, height control.

Simulating vehicle vibration model using software tool.

Lateral Dynamics - Steering geometry-steering handling characteristics- under steer, over steer, neutral steersteady state response – yaw velocity response, lateral acceleration response, curvature response – testing of handling characterizes- constant radius test, constant speed test, constant steering angle test- direction stability- influences on cornering- suspension effects and tractive effects

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Calculate the tractive characteristics of vehicle for different types of drive conditions (front, rear and four-wheel drives).	Apply
CO2: Calculate the stability characteristics of vehicle for various tracks (banked, curved and slope).	Apply
CO3: Determine the effect of vibrating elements (Spring, Mass & Damper) on vehicle vibrating systems.	Apply
CO4: Determine the vehicle handling characteristics based on lateral dynamics.	Apply
CO5: Form teams and simulate a vehicle vibration model in software tool evaluate the effect of different parameters, submit the report.	Evaluate

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	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

High-3; Medium-2; Low-1

Text Book(s):

T1. Dr.N.K.Giri, Automobile Mechanics (8th Edition), Khanna Publications, 2018.

T2. Singiresu S.Rao, Mechanical Vibrations (5th Edition), Prentice Hall, 2010.

T3. Thomas D.Gillespie, Fundamentals of Vehicle Dynamics (Edition 2,revised), Society of Automotive Engineers Inc, 2021.

Reference Book(s):

R1. Hans B Packeja, “Tyre and Vehicle Dynamics”, 2nd Edition, SAE International, 2005

R2. G.Nakhaie Jazar, Vehicle Dynamics: Theory and Application (2nd Edition),Springer, 2013.

R3. J.Y. Wong, Theory of Ground Vehicles (4th Edition), Wiley-Interscience, 2008..

Web References:

1. NPTEL- https://nptel.ac.in/courses/112/107/112107087/
2. NPTEL- https://nptel.ac.in/courses/107106080

Course Code: 23AUT602	**Course Title: AUTOMOTIVE EMBEDDED SYSTEMS**		
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:

1. Understand the concept of Embedded systems.
2. Develop simple programs using different embedded controllers.
3. Understand the role of ECU and embedded controllers in Chassis transmission systems.
4. Develop the programs for interfacing the power train components with STM32 controller.

Module I **23 Hours**

Embedded System Overview

Embedded System – Definition, Evolution of Controllers, Programming Languages, Need of compilers in programming, Controlling Methods.

Controllers

8051 microcontroller – Features, Architecture, Pin Out, Instruction sets, Addressing Modes, Arithmetic and Logical Operations using Assembly Language Programming.

Arduino – Features and Pin outs, Pin Declarations, Delay and Pulse Generation.

ARM Controller - Features, Architecture, Instruction sets, Addressing Modes, Simple Programs using Assembly Language.

Automotive microcontrollers - Renesas, Infineon, Hella, Bosch, Microcontroller datasheet, Automotive cyber security. Comparison of controllers.

Module II **22 Hours**

ECU and Chassis Electronics

Electronic Control Unit – Definition, Block diagram and Functions, CAN protocol, Anti lock braking system, Electronic stability control and steering angle control – Concept and implementation using ARM controller with embedded C programming - functional safety, open-source ECU. Introduction to ADAS control.

Power train sensors and Motor Interfacing

Oxygen sensor, Mass Air flow sensor, Wheel Speed sensor, Throttle Position Sensor, Temperature sensor, Crank shaft and CAM shaft position sensors – Interfacing with ARM controller using embedded C programming. Motor Interfacing – Need of driver circuits – Interfacing with ARM controller using embedded C programming.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Explain the necessity of embedded systems used in automotives	Understand
CO2: Select microcontroller for automotive applications	Apply
CO3: Develop simple programs in basic controllers using assembly language	Apply
CO4: Develop embedded C program for automotive systems for ARM controller	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Textbook(s):

T1. Programming with STM32: Getting Started with the Nucleo Board and C/C++, Donald Norris, McGraw-Hill Education, 2018.

T2. 8051 Microcontroller: Architecture, Programming, and Applications**,** Kenneth J. Ayala, Penram International Publishing, 2002.

T3. Arduino: A Technical Reference, J. M. Hughes, O'Reilly Media, 2014.

T4. Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers, Jonathan W. Valvano, Pearson, 2017.

Reference Book(s):

R1. The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, Pearson, 2006.

R2. Mastering STM32, Carmine Noviello, Packt Publishing, 2017.

Web References:

1. NPTEL – https://nptel.ac.in/courses/108/102/108102045
2. https://www.arduino.cc/en/Tutorial/HomePage
3. https://www.st.com/en/microcontrollers-microprocessors/stm32-32-bit-arm-cortex-mcus.html

Course Code: 23AUL601		Course Title: AUTOMOTIVE EMBEDDED SYSTEMS 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:

The course is intended to:

1. Interface automotive components and sensors with ARM microcontroller.
2. Study the Simulation of vehicle control and power converters.

List of Experiments

1. Interfacing Seven Segment LED and 16x2 LCD with ARM microcontroller.
2. Interfacing Headlight with ARM microcontroller.
3. Interfacing PMDC motor with ARM microcontroller.
4. Interfacing Stepper motor with ARM microcontroller.
5. Interfacing Ultrasonic sensor with ARM microcontroller.
6. Interfacing Temperature sensor with ARM microcontroller.
7. Interfacing Speed sensor with ARM microcontroller.
8. Interfacing Throttle position sensor with ARM microcontroller.
9. Simulation of AC to DC converter using ARM microcontroller.
10. Simulation of ABS implementation using ARM microcontroller.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Interface automotive components and sensors with ARM microcontroller using embedded C programming.	Apply
CO2: Study the Simulation of vehicle control and power converters.	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Book(s) references:

T1. Programming with STM32: Getting Started with the Nucleo Board and C/C++, Donald Norris, McGraw-Hill Education, 2018.

Web references:

1. https://www.st.com/en/microcontrollers-microprocessors/stm32-32-bit-arm-cortex-mcus.html

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

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.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
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.	**Apply**

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/

Course Code: 23AUT701	Course Title: ELECTRIC, FUEL CELL AND HYBRID VEHICLES		
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:

1. To understand the fundamentals of electric, hybrid, and fuel cell vehicle technologies.
2. To study the various electric drive systems and energy storage technologies in EVs.
3. To explore the design and architecture of series, parallel, and fuel cell hybrid electric drive trains.
4. To explore fuel cell technologies and regenerative braking systems in EVs, HEVs, and FCVs.
5. To develop advanced knowledge and analytical skills for designing and evaluating electric, hybrid, and fuel cell vehicle systems for sustainable transportation.

Module I **22 Hours**

Introduction: History and evolution of electric vehicle (EV), Hybrid Electric Vehicle (HEV) and Fuel cell vehicle (FCV), Importance and need of the EV, HEV and FCV - Comparative study on IC engine vehicles.

Electric vehicles: Configurations of EVs-Performance of EVs-Traction Motor Characteristics, Tractive Effort and Transmission Requirement and Vehicle Performance. Electric Propulsion Systems - DC Motor Drives-Induction Motor Drives- Induction Motor Drives- SRM Drives, Voltage-Balance Equation, Torque-Speed Characteristics

Energy sources: Peaking Power Sources and Energy Storages - Electrochemical Batteries - Electrochemical Reactions, Thermodynamic Voltage, Specific Energy, Specific Power and Energy Efficiency. Battery Technologies – Lead-Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (NiMH) Battery, Li-Ion Battery, Li-Ion Phosphate Battery, Lithium nickel manganese cobalt battery, Sodium-Ion, Zinc-Air Battery. Introduction to battery thermal management system.

Module II **23 Hours**

Hybrid vehicles: Concept of Hybrid Electric Drive Trains-Architectures of Hybrid Electric Drive Trains-Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains. Fuel Cell Hybrid Electric Drive Train Design

Fuel cells: Operating Principles of Fuel Cells - Fuel Cell Technologies - Proton Exchange Membrane Fuel Cells, Alkaline Fuel Cells, Phosphoric Acid Fuel Cells, Molten Carbonate Fuel Cells, Solid Oxide Fuel Cells, and Direct Methanol Fuel Cells. Fuel Supply and reforming techniques.

Regenerative braking: Braking energy consumption - Brake System of EV, HEV, and FCV - Control strategy for braking performance. Parallel Hybrid Braking System - Fully Controllable

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO1: Explain the evolution, types, and significance of EVs, HEVs, and FCVs compared to conventional IC engine vehicles.	Understand
CO2: Select suitable electric drive systems and energy storage technologies for EV and hybrid architectures.	Apply
CO3: Select technologies for enhancing electric vehicle performance.	Apply
CO4: Analyze the integrated electric, fuel cell and hybrid vehicle systems to meet performance, efficiency, and environmental goals.	Analyze

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2011.

T2. Mehrdad Ehsani, YimiGao, Sebastian E.Gay, Ali Emadi, "Modern Electric and Fuel Cell Vehicles, Theory and Design", CRC Press, 2009.

T3. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.

Reference Book(s):

R1. James Larminie,John Lowry,"Electric Vehicle Technology Explained", Wiley, 2012.

R2. Ali Emadi.,"Advanced Electric Drive Vehicles",CRC Press, First edition 2017.

R3. Jack Erjavec.,"Hybrid, Electric, and Fuel-Cell Vehicles", Cengage Learning, 2012.

Web References:

1. NPTEL - https://archive.nptel.ac.in/courses/108/103/108103009/
2. NPTEL - https://archive.nptel.ac.in/courses/103/102/103102015/

Course Code: 23AUT702	Course Title: ARTIFICIAL INTELLIGENCE 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:

This course aims to:

1. Apply the core principles of artificial intelligence and machine learning to real-world problems.
2. Develop practical skills in implementing search strategies and machine learning models.
3. Analyze problem scenarios to design appropriate AI/ML-based solutions.

Module I **22 Hours**

Applied Artificial Intelligence**:** Introduction to AI: Definition, foundations, applications, history, trends. Intelligent Agents: Rationality, environment types, agent structure and types. Problem Solving**:** Problem-solving agents, performance measures. Search Strategies**:** Uninformed: Breadth-first, Depth-first, Iterative Deepening, Uniform-cost, and Bidirectional. Informed**:** Heuristic functions, Best-first search, A* algorithm. Practical**:** Implement search strategies using Python.

Intelligent Agents - example must be "Agent in an autonomous car", Informed Search: example must be "Path planning in autonomous driving" or "Finding the shortest route on a road network using A*."

Module II **23 Hours**

Applied Machine Learning: Introduction: Definitions, types of learning, hypothesis space, inductive bias. Data Handling: Evaluation, validation, overfitting.ML Techniques: Supervised Learning: Linear regression, Decision trees. Instance-Based Learning: k-NN, Feature selection. Unsupervised Learning: Clustering (k-means), hierarchical clustering. Neural Networks: Perceptron, multilayer perceptron, back propagation basics. Applications: Recommender systems, anomaly detection. Hands-on: Implement models using R or Python.

Linear Regression: Predict fuel consumption and emission rates, Decision Trees: Fault diagnosis in engines, k-Nearest Neighbours (k-NN): Predictive maintenance, Clustering k-Means- Segmenting driving behaviour patterns, Perceptron & Multilayer Perceptron - Image recognition for lane detection, Linear Regression on vehicle performance data, k-NN for fault detection, k-Means clustering for driver profiling.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply uninformed and informed search methods to real-world problem	Apply
CO2: Apply supervised and unsupervised learning techniques for data-driven decision-making.	Apply
CO3: Analyze complex problems to design AI/ML solutions using appropriate models and logic.	Analyze

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Textbooks:

T1. Stuart J. Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Ed., Pearson, 2021.

T2. Tom M. Mitchell, Machine Learning, McGraw-Hill, 2013.

Reference Book(s):

R1. George Lugar, AI-Structures and Strategies for Complex Problem Solving, 6th Ed., Pearson, 2009.

R2. E. Rich and K. Knight, Artificial Intelligence, 3rd Ed., McGraw Hill, 2017.

R3. Robin R. Murphy, Introduction to AI Robotics, 2nd Ed., PHI, 2019.

Web References:

NPTEL: https://nptel.ac.in/courses/106106179

Course Code: 23AUP701		Course Title: Project Phase - I	
Course Category: Project		**Course Level: Advanced**	
L:T:P(Hours/Week) 0:0:8	**Credits: 4**	**Total Contact Hours: 120**	**Max Marks:100**

Course Objectives: The objective of the course is to enable students to identify and investigate real-world problems in the field of Automobile Engineering and develop innovative solutions. It focuses on designing and implementing a functional software or hardware prototype.

Module **120 Hours**

Understanding research domains and identifying a relevant problem statement - Conducting a thorough literature survey to study existing solutions and identifying research gaps - Defining clear project objectives and scope based on the problem analysis - Performing requirement analysis, including hardware/software needs and feasibility study - Planning project activities with appropriate time management tools - Designing the system architecture through block diagrams or flowcharts and selecting appropriate tools and technologies - Developing a methodology for implementation, including initial modeling or simulation - Executing partial implementation or subsystem development with a focus on performance analysis - Preparing interim reports with proper documentation, citation, and plagiarism compliance - Delivering an oral presentation to a review committee demonstrating the progress and understanding of the project work.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the knowledge of Automobile Engineering to identify real-world problems through literature survey and gap analysis.	Apply
CO2: Analyze the functional and technical requirements to perform feasibility studies and prepare an effective project plan and bill of materials.	Analyze
CO3: Design a suitable system architecture or solution approach using appropriate hardware/software tools and simulation methodologies.	Create
CO4: Evaluate the performance and feasibility of the developed prototype through structured documentation and oral presentation to justify the design choices.	Evaluate

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Course Code: 23AUP801		Course Title: Project Phase - II	
Course Category: Project		**Course Level: Advanced**	
L:T:P(Hours/Week) 0:0:12	**Credits: 6**	**Total Contact Hours: 180**	**Max Marks:200**

Course Objectives: The course aims to equip students with the ability to identify and analyze engineering problems through literature review and research in the field of Automobile Engineering. It emphasizes developing innovative solutions through theoretical and practical work, including design, modeling, simulation, and prototyping. The course also focuses on enhancing project execution, documentation, and presentation skills for effective technical communication.

Module **180 Hours**

Identifying the project goals and finalizing the problem statement based on societal relevance and feasibility – Designing and developing a complete solution using appropriate hardware, software, or a combination of both – Implementing the system through coding, circuit design, simulation, fabrication, or prototyping – Testing and validating the developed solution through experiments, data collection, and analysis – Evaluating system performance using key parameters such as accuracy, speed, efficiency, and reliability – Making improvements based on test results to enhance functionality and robustness – Documenting the entire process with clear methodology, results, discussions, and conclusions – Ensuring ethical practices, sustainability, and safety compliance in the project – Preparing a professional technical report with references, diagrams, and outcome analysis – Presenting the completed work effectively through oral presentation and demonstration before an expert review panel.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply appropriate engineering concepts, tools, and technologies to implement a functional solution addressing a complex, real-world problem.	Apply
CO2: Analyze the performance and behavior of the implemented system under various testing conditions to identify limitations and areas for improvement.	Analyze
CO3: Evaluate the effectiveness, efficiency, and sustainability of the developed solution by comparing alternative designs and justifying the final approach with experimental data.	Evaluate

CO4: Create a comprehensive technical report and demonstrate the completed project through a structured presentation, showcasing innovation, interdisciplinary integration, and potential future enhancements.	Create

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Course Code: 23AUE001	Course Title: VEHICLE SAFETY AND COMFORT 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:

1. Explain the role and use of safety systems in vehicle
2. Explain crashworthiness and failure analysis.
3. Explain the role and use of comfort systems.

Module I **23 Hours**

Safety concepts

Active safety, Driving safety, Conditional safety, Perceptibility safety, Operating safety, Passive safety – Exterior and Interior safety systems, Human impact tolerance- Determination Of injury thresholds - Severity index, Study of comparative tolerance, Study of crash dummies

Vehicle Body Design For Safety

Energy equations, Engine location - Effects of deceleration inside passenger compartment, Deceleration on impact with stationary and movable obstacle, Concept of crumble zone and safety sandwich construction, Deformation behavior of vehicle body, Speed and acceleration characteristics of passenger compartment on impact, Pedestrian safety, Frontal design for safety, Active Safety Systems, Passive Safety Systems,

Module II **22 Hours**

Crash Testing and Analysis

Types of crash / Rolls over tests, Regulatory requirements for crash testing, Instrumentation, High speed photography – Image analysis

Vehicle Ergonomics

Anthropometrics and its application to vehicle ergonomics, Man-Machine system, Psychological factors – stress, attention,

Driver Ergonomics and Comfort

Cockpit design, Driver comfort, Seating, Seat pan, Back rest, Head rest, Steering wheel, Mirrors, Visibility, Placement of vehicle controls and use of modern technologies

Passenger Ergonomics and Comfort

Passenger comfort, Ingress and Egress, Spaciousness, Ventilation, Temperature control, Dust and fume prevention, Interior features and conveniences

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply safety system principles to suggest improvements for occupant and pedestrian safety during collisions.	Apply
CO2: Assess vehicle safety performance by applying crash test concepts.	Apply
CO3: Enhance vehicle user comfort and interaction using ergonomic principles.	Apply
CO4: Form teams and simulate a vehicle crash model in software tool and evaluate the safety aspects as per standards.	Evaluate

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	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	3	3	3	3	3	-	3	3	3	3	3	3	3

High-3; Medium-2; Low-1

Text Book(s):

T1. George A. Peters, Barbara J. Peters, “Automotive Vehicle Safety”, Taylor & Francis, 2002

T2. Jack Erjavec, “Automotive Technology: A Systems Approach”, Volume 2, Delmar Cengage Learning, 1992

Reference Book(s):

R1. Ulrich W. Seiffert, Mark Gonter, “Integrated Automotive Safety Handbook”, SAE International,2013 R2. Robert Bosch “Safety, Comfort and Convenience Systems” 3rd Edition, Wiley- Blackwell 2006.

Course Code: 23AUE002	**Course Title: HYDRAULIC AND PNEUMATIC 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:

1. Explain different fluid power systems and its applications.
2. Explain various hydraulic and pneumatic system components and applications.
3. Design the hydraulic circuits for desired application.
4. Design the pneumatic circuits for desired application.

Module I **23 Hours**

Fluid Power System and Fundamentals - 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.

Hydraulic System and Components - 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

Design of Hydraulic Circuits - 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 systems in Automobile – Electro hydraulics

Module II **22 Hours**

Pneumatic System and Components - Properties of air – Compressor - Types of compressor - Construction and operation of air filter, air regulator, air lubricator - Pneumatic linear actuator - Rotary actuator - Construction and working of pneumatic direction control valve – Flow control valve - Pneumatic symbols

Design of Pneumatic Circuits - 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 - Pneumatic systems in Automobile - Electro pneumatics

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Design hydraulic circuits for automotive applications	Apply
CO2: Design pneumatic circuits for automotive applications	Apply
CO3: Design and simulate fluid power system to perform the desired function.	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Esposito Anthony, “Fluid Power with Applications”, Pearson Education Inc., New York, 2008.

T2. Majumdar, S.R., “Oil Hydraulic Systems – Principles and Maintenance”, Tata McGraw-Hill, New Delhi, 2006.

Reference Book(s):

R1. Srinivasan.R, “Hydraulic and Pneumatic controls”, Vijay Nicole, 2006.

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, 2006

Web References:

1. NPTEL - http://www.nptel.ac.in/courses/112106175/

Course Code: 23AUE003	Course Title: AUTOMOTIVE AERODYNAMICS		
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. Describe the Potential of vehicle aerodynamics
2. Calculate the drag coefficient of cars
3. Explain the shape optimization of cabs
4. Calculate forces and moments due to side winds
5. Demonstrate the use of wind tunnel for automotive aerodynamics

Module I **23 Hrs**

Introduction: Scope – historical development trends – Fundamentals of fluid mechanics – Flow phenomenon related to vehicles – External & Internal flow problems – Resistance to vehicle motion – Performance – Fuel consumption and performance – Potential of vehicle aerodynamics.

Aerodynamic drag of cabs: Car as a bluff body – Flow field around car – drag force – types of drag force – analysis of aerodynamic drag – drag coefficient of cars – strategies for aerodynamic development – low drag profiles.

Shape optimization of cabs: Front and modification – front and rear wind shield angle – Boat tailing – Hatch back, fast back and square back – Dust flow patterns at the rear – Effect of gap configuration – effect of fasteners.

Module II **22 Hrs**

Vehicle Handling: The origin of force and moments on a vehicle – side wind problems – methods to calculate forces and moments – vehicle dynamics under side winds – the effects of forces and moments – Characteristics of forces and moments – Dirt accumulation on the vehicle – wind noise – drag reduction in commercial vehicles.

Wind tunnels for automotive aerodynamics: Introduction – Principles of wind tunnel technology – Limitation of simulation – Stress with scale models – full scale wind tunnels – measurement techniques – Equipment and transducers – road testing methods – Numerical methods.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Describe the Potential of vehicle aerodynamics	Understand
CO2: Calculate the drag coefficient of cars	Apply
CO3: Compare the shape optimization of cabs	Apply
CO4: Calculate forces and moments due to side winds	Apply
CO5: Demonstrate the use of wind tunnel for automotive aerodynamics	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1.Hucho, W.H., Aerodynamics of Road vehicles, Butterworths Co. Ltd., 1997.

Reference Book(s):

R1. Pope, A, Wind Tunnel Testing, John Wiley & Sons, 2nd Edn., New York, 1994. R2. Automotive Aerodynamics: Update SP-706, SAE, 1987.

R3. Vehicle Aerodynamics, SP-1145, SAE, 1996.

<table>
<tr><td>Course Code: 23AUE004</td><td colspan="3">Course Title: NOISE, VIBRATION AND HARSHNESS FOR AUTOMOBILES</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:

1. Describe the various measurement techniques in acoustics.
2. Explain the exterior noise, assessment and control related to vehicle
3. Explain the Interior noise, assessment and control related to vehicle

Module I **23 Hours**

Acoustic Transducers and Common Measurements in Acoustics: - Noise analysis, Parameters to be Considered in the Choice of Microphones, Various Types of Microphones, Acoustic Exciters and Calibrators. Sound Level Measurement, 1/1 and 1/3 Octave Filters Sound Power from Sound Pressure Level Measurement- Frequency Weighting Networks.

Exterior noise assessment and control: - Pass-by noise homologation-EC noise homologation, Track and atmospheric effects, Noise source ranking-using shielding techniques.

Air intake systems and exhaust systems: performance and noise effects, The rationale for turbocharging, Sources of intake (and exhaust) noise-Flow duct acoustics, Intake noise control: a case study.

Module II **22 Hours**

Interior noise assessment and control: - Subjective and objective methods of assessment, balance between airborne and structure-borne noise, measurement of interior noise, subjective assessment of interior noise. Noise path analysis. Introduction to engine noise-Combustion noise, Mechanical noise, the effects of engine speed and load on noise, Measuring engine noise, Engine noise source ranking, Engine noise control. Introduction to road noise, Interior road noise, Analysing structure-borne road noise, controlling interior road noise. Aerodynamic (wind) noise and Brake noise and squeak, rattle and tizz noises. EMI and EMC testing. Case studies on interior systems.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply appropriate methods to reduce vehicle exterior noise.	Apply
CO2: Identify the various sources of noise and vibration within a vehicle and suggest method to control.	Apply
CO3: Form teams and use suitable transducer to evaluate the noise from the vehicle.	Evaluate

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Clarence W. de Silva, “Vibration Monitoring, Testing, and Instrumentation “,CRC Press, 2007

T2. David A.Bies and Colin H.Hansen “Engineering Noise Control: Theory and Practice“ Spon Press, London, 2009.

Reference Book(s):

R1. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987

R2. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,1989

R3. Allan G. Piersol, Thomas L. Paez “Harris’ Shock and Vibration Handbook”, McGraw Hill, New Delhi, 2010

R4. Colin H Hansen “Understanding Active Noise Cancellation” , Spon Press , London 2003

Course Code: 23AUE005	Course Title: OFF ROAD VEHICLES		
Course Category: Major		Course Level: Higher	
L:T:P(Hours/Week) : 3: 0: 0	Credits: 3	Total Contact Hours:	Max Marks:100

Course Objectives:

1. To understand the construction, operation, and selection of off-road earth moving equipment.
2. To understand the construction, working principles, and performance of construction and farm equipment.
3. To impart knowledge on the design, dynamics, and specialized functions of off-road vehicles.

Module I **23 Hours**

EARTH MOVING EQUIPMENTS: Construction Layout, Capacity and applications of earth movers like dumpers, Front End loaders, Bull Dozers, Backhoe Loaders, Scrappers, Bucket Conveyors Etc., Selection Criteria of prime mover for dumper and front end loaders based on vehicle performance characteristics

CONSTRUCTIONAL EQUIPMENTS: Layout of constructional equipments, Excavators, Jip Cranes, Hoist motor graders, Mixing machine, Concrete ready mixers, Drillers, Ramming machines for constructions of bridges and working principles, Power generators

FARM EQUIPMENTS: Classification of tractors - Main components of tractor. Working attachment of tractors- Auxiliary equipment - Trailers and body tipping mechanism- Ploughing - Paddy plantation machine harvesting machines, sugarcane harvesting, and Power trailers.

Module II **22 Hours**

INDUSTRIAL APPLICATION VEHICLE: Constructional Features, Capacity and stability of Jib Cranes, Vibratory compactors, Forklifts. Towing Vehicles, Case Studies

MILITARY AND COMBAT VEHICLES: Ride and stability characteristics, Power take off, Special Implementations. Special Features and constructional details of tankers, Gun carriers and transport vehicles, Bridge builders, Communication Vehicles.

CASE STUDIES AND ANALYSIS: Structural redesign of an off-road vehicle chassis, Analysis of terrain impact on structural stress, FEA of vehicle frame under variable load conditions.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply appropriate criteria to select suitable off-road vehicle for earth moving, specific construction, and farming.	Apply
CO2: Apply appropriate criteria to select suitable off-road vehicle for industrial applications.	Apply
CO3: Apply appropriate criteria to select suitable off-road vehicle for military applications.	Apply
CO4: Evaluate the design and structural requirements for off-road vehicles operating under extreme terrain and load conditions.	Evaluate

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Robert L. Peurifoy – Construction Planning, Equipment, and Methods, 10th Edition, McGraw Hill, 2024.

T2. T.P. Ojha and A.M. Michael – Principles of Agricultural Engineering, 15th Edition, Jain Brothers, 2023.

T3. Abrosimov.K, Bran Berg A and Katayer K., “Road making machinery”, MIR Publishers, Moscow, 1971

Reference Book(s):

R1. H.P. Smith, Farm Machinery and Equipment, Belgium: Morse Press, 2011.

R2. Bart H vanderveen, Tanks and transport vehicles, Fresdericwarne and CO ltd., London

R3. Kolchin A and Demidov V “Design of Automotive Engines for Tractor”, MIR Publishers, 1972.

Web References:

1. NPTEL - https://onlinecourses.nptel.ac.in/noc25_ag11/preview

Course Code: 23AUE006	**Course Title: DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENT**		
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. Explain the design principles for manufacturability
2. Describe the factors influencing form design
3. Explain the machining consideration while design
4. Optimize the given casting part.
5. Explain the environmental consideration in design

Module I **23 Hours**

Basic concepts: General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits -Datum features - Tolerance stacks, GD & T

Form Design of Castings, Forgings and Weldments: Working principle, Material, Manufacture, Design- Possible solutions – Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

Component Design - Machining Consideration: Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

Module II **22 Hours**

Component Design – Casting Consideration: 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

Design for the Environment and DFMA tools: Introduction – 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

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Select appropriate materials and manufacturing methods using DFM principles.	Apply
CO2: Apply design for assembly (DFA) techniques to simplify assembly processes and reduce time and errors.	Apply
CO3: Analyze designs to ensure sustainability and compliance with environmental regulations.	Analyze
CO4: Evaluate case studies to assess the effectiveness of design decisions in improving manufacturability, assembly efficiency, and environmental sustainability, and recommend actionable improvements.	Evaluate

Course Articulation Matrix

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

High-3; Medium-2; Low-1

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. Harry Peck , “Designing for Manufacture”, Pitman Publishing, 1973

R2. Dickson, John. R, and Corroda Poly, “Engineering Design and Design for Manufacture and Structural Approach”, Field Stone Publisher, USA, 1999

R3. Fixel, J. “Design for the Environment” McGraw hill., 2011.

Web References:

1. http://www.nptel.ac.in/courses/112101005/
2. https://ocw.mit.edu/courses/mechanical-engineering/2-008-design-and-manufacturing-ii-spring-2004/lecture-notes/

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: 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: 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:

1. Explain NC, DNC and CNC used in CIM.
2. Explain the role of AGVs, AS/RS and Robots in material handling and Storage System.
3. Explain Group Technology and Classification of Coding system.

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.

Different modeling packages -Data exchange standards between different software

Materials handling and Storage Systems: Automated storage and retrieval systems, carousel storage systems - Interfacing of Handling and Storage with Manufacturing system. AGVs - types, advantages and application. Robot – Basic concepts, applications.

Module II **22 Hours**

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

Flexible manufacturing systems – Configurations, workstations, planning, applications and benefits – Automated inspection and testing - Machine vision

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply automated manufacturing and material handling principles to provide solutions for efficient manufacturing.	Apply
CO2: Apply GT and FMS to analyze and propose efficient cellular layouts and automated inspection.	Apply
CO3: Form teams and simulates automated inspection and testing model in software tool, submit the report.	Evaluate

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	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

High-3; Medium-2; Low-1

Text Book(s):

T1. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education 2001.

T2. Mikell. P. Groover and Emory ZimmersJr., "CAD/CAM", Prentice Hall of India Pvt. Ltd.,

Reference Book(s):

R1. James A. Regh and Henry W. Kreabber, "Computer Integrated Manufacturing", Pearson Education second edition, 2005.

R2. Chris McMahon and Jimmie Browne, "CAD CAM Principles, Practice and Manufacturing Management", Pearson Education second edition, 2005.

R3. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall of India Pvt. Ltd., 2005.

<table>
<tr><td colspan="2">Course Code: 23AUE008</td><td colspan="3">Course Title: PRODUCTION OF AUTOMOTIVE ELECTRICAL COMPONENTS</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:45</td><td>Max. Marks:100</td></tr>
</table>

Course Objectives:

The course is intended to:

1. Explain the characteristics and effects of components on circuit board.
2. Explain the parameters and methods involved in integration of electrical and electronics parts
3. Explain the steps involved in fabrication of Electrical parts
4. Explain the steps involved in fabrication of Electronic parts
5. Explain the process involved in manufacturing of lighting system

Module I **25 Hours**

Electrical and Electronics: Electromagnetic compatibility (EMC), Electromagnetic Interference(EMI),AC and DC motor winding

Integration of Electrical & Electronic Parts on Vehicle: Overview of Advanced Product Quality Planning (APQP) /New Product Development, Vehicle Integration- Mounting methods, Routing methods, Fastening, Clearance/Interference fit

Manufacturing of Automotive Electrical Parts: Process flow, process specifications and Inspection methodologies for Starter motor, Relay, Horn, Switches, Magneto and Wiring Harness

Module II **20 Hours**

Manufacturing of Automotive Electronic Parts - Process flow, Manufacture of PCB, PCB assembly and Testing, Electronic Packaging.

Manufacturing of Automotive Lighting System - Basic principles and working of lighting system, Process flow and process specifications for automotive lighting system.

Case study on production of automotive electrical and electronic components

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Determine the parameters involved in integration of electrical and electronics parts in an automobile	Apply
CO2: Design process flow, process specifications and Inspection methodologies for the manufacturing of automotive electrical Parts	Apply
CO3: Design process flow, process specifications and Inspection methodologies for the manufacturing of automotive electronic parts and lighting systems	Apply
CO4: Analyze the production processes of automotive electrical and electronic components through case studies	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	3	-	-	-	-	-	-	-	-	-	-	-	3
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	3
CO4	3	3	-	3	-	-	-	-	3	3	-	2	3	3

High-3; Medium-2; Low-1

Text Book(s):

T1. Raymond H. Clark, “Handbook of Printed Circuit Manufacturing” Springer 1st edition, 1985.

T2. H. Richard Stillwell, “Electronic Product Design for Automated Manufacturing” CRC Press, 1st edition, 1988.

Reference Book(s):

R1. V K Mehta Rohit Mehta, “Principles of Electrical and Electronics” 3rd edition S Chand Publishers, 2014.

Web References:

1. http://www.nptel.ac.in/courses/121131049

<table>
<tr><td colspan="2">Course Code: 23AUE009</td><td colspan="2">Course Title: JIGS, FIXTURES AND PRESS TOOLS</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>Credit: 3</td><td>Total Contact Hours:45</td><td>Max Marks:100</td></tr>
</table>

Course Objective:

The course is intended to:

1. Apply the basic locating and clamping principles in designing general jigs and fixtures.
2. Design a jig for a simple components
3. Design a fixtures for the milling, turning, welding and grinding operations
4. Design progressive, compound and combination dies for simple components.
5. Design dies for bending, forming and drawing operations

Module 1 **23 Hrs**

Locating and Clamping Principles: Objectives of Tool design – Function and advantages of Jigs and fixtures - Materials used in Jigs and Fixtures – principles of location – Locating methods and devices - Principles of clamping. Mechanical actuation-pneumatic and hydraulic actuation-Analysis of clamping force-Tolerance and error analysis.

Jigs: Different types of jigs-plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs Indexing jigs, Drill bushes, Automatic drill jigs-Rack and pinion operated, Air operated Jigs components. Design and development of Jigs for given components.

Fixtures: General principles of boring, lathe, milling and fixtures- Grinding, assembly, Inspection and welding fixtures- Modular Fixtures- Quick change fixtures. Design and development of fixtures for given components.

Module II **22 Hrs**

Press Working and Elements of cutting dies: Press working terminology-Operations-Types of Presses and press accessories-Computation of capacities and tonnage requirements. Elements of progressive and compound dies: Die block, die shoe. Bolster plate-punch plate - punch holder-guide pins and bushes – strippers –knockouts-stops –

pilots-Selection of standard die sets, Design and development of progressive and compound dies for Blanking and piercing operations, strip lay out-strip lay out calculations
Bending, Forming and Drawing dies: Bending, forming and drawing operations –Blank development for above operations- Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect - pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads- ironing – Design and development of bending, forming, drawing and combination dies – Blank development for axi-symmetric, rectangular and elliptic parts – Single and double action dies. Design considerations in forging, extrusion, casting and plastic dies

Course outcomes	**Cognitive Level**
At the end of the course, the student will be able to	
CO1: Design jigs and fixtures for given part and machining process applying the locating and clamping principles	Apply
CO2: Design progressive, compound and combination dies for sheet metal cutting operations.	Apply
CO3: Design dies for bending, forming and drawing operations.	Apply
CO4: Design, Model and prototype the dies for specific parts operations using CAD tools and 3D printing Process.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	1	-	-	1	-	-	-	-	-	-	1	2
CO2	3	2	1	-	-	1	-	-	-	-	-	-	1	2
CO3	3	2	1	-	-	1	-	-	-	-	-	-	1	2
CO4	3	2	1	-	2	1	-	-	2	2	-	-	1	2

High-3; Medium-2; Low-1

Text Book(s):

T1.Edward G Hoffman, “Jigs & Fixture Design”, Thomson – Delmar Learning, 2004
T2.Donaldson.C, “Tool Design”, TataMcGraw-Hill,1986

Reference Book(s):

R1. Kempster, “Jigs & Fixtures Design”, The English Language Book Society, 1978
R2. Joshi, P.H., “Jigs & Fixtures”, Second Edition, Tata McGraw-Hill Publishing Company Limited, 2004
R3. Hiram E Grant, “Jigs and Fixture”, Tata McGraw-Hill, 2003 R4. Fundamentals of Tool Design”, CEEE Edition, ASTME, 1983

Course Code 23AUE010		Course Title: WELDING AND JOINING TECHNIQUES	
Course category: Major		Course level: Higher	
L:T:P (hrs/week): 3:0:0	Credits: 3	Total contact Hours: 45	Maximum Marks:100

Course Objective

The course is intended to impart knowledge on metal of metal joining techniques.

Module I **20 Hrs**

Arc welding processes: Principle and operation -Advantages and limitations of welding processes -Power sources of arc welding process and their influence on the process behavior. Welding positions and its nomenclature. MIG / MAG Welding -Metal transfer in MIG welding processes-Process requirements of GMAW process -Impact of Process parameters -Defects of GMAW, Causes and their remedies. Gas welding - Oxygen cutting, Flame cut ability of metals, effect of cutting on structure and properties of steel, Gas welding, fuel gases and flames. Soldering and Brazing: Capillary and welding action, Filler Metals and Fluxes Processes and application - Welding of nonferrous materials- process requirements.

Solid State Welding Process: Introduction to solid state welding process, Friction welding & friction stir welding, Forge welding. Ultra-Sonic welding, Explosive welding, Laser welding, Electron beam welding -types of electron gun, Electron beam welding-spot size beam power Operating voltage, pulse technique, deep penetration and applications, Operating voltage, pulse technique, deep penetration and applications, Micro joining, Nano joining Techniques and other joining for automotive applications

Module II **25 Hrs**

Advanced Welding Process: Spot welding and types of equipment, Rocker arm press type welding and it's applications, Seam welding and its applications, Resistance Welding Processes -Various types of Resistance welding process and its applications. Flash and butt-welding applications. Under water welding Torches, Filler metal and Fluxes, Thermit welding.

Design of welded joints: Types of Weld Joints and their applications -Styles and practices of Edge preparation -Representation of Weld symbols -Loads acting on the

Weld Joints -Calculation of Stresses in Weld Joints -Determination of Weld size for Fatigue Applications -Effect of Temperature on Metallurgical properties -Causes of Distortion -Causes for Residual Stresses, FMEA in welding process.

Design of Welding Fixtures: Fixtures and its types -Datum and its importance of the Part -Location and its importance of the Part -Orientation and its importance of the Part -Resting &Clamping and its importance of the Part -Elements of the welding fixture -Different fixture accessories used for welding fixture assembly -Different types of welding fixtures for Resistance welding and arc welding Process. Design of welding fixture for a given part.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Choose suitable welding process for application	Apply
CO2: Design welded joints for a specific requirement	Apply
CO3: Design welding fixtures for a specific weld requirement.	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	2	-	-	-	1	-	-	-	-	1	-	2
CO3	3	2	2	-	-	-	1	-	-	-	-	1	-	2

Text Book(s):

T1. Richard L. Little, “Welding and welding Technology”, TATA McGraw Hill Publishing Company Ltd, 2013

T2. O.P Khanna ―A Textbook of Welding Technology‖, DhanpatRai & Sons, Twentieth Reprint, 2011.

T3.Omer. W.Blodgett, James F. Lincoln, ―Design of Welded Structures, RCWelding Foundation‖, 1st Edition 1996.

T3.PrakashHiralal Joshi, ―Welding and Assembly Fixture, McGraw-Hill Professional, 2010.

Reference Book(s):

R1.S.J Maddox, ―Fatigue Strength of Welded Structures‖, Woodhead Publishing, 1991.

R2.T.R Gurney, Tim Gurney, ―Fatigue Strength of Transverse Fillet Welded Joints: A Study of the Influence of Joint Geometry, Woodhead Publishing, 1991.

R3. William A. Bowditch, Kevin E. Bowditch, Mark A. Bowditch, "Welding Technology Fundamentals",Goodheart-Willcox Publisher, 4 edition, 2009

Course Code: 23AUE011	**Course Title: UNCONVENTIONAL MACHINING PROCESSES**		
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:

Explain Different energy based unconventional machining processes

Module I **23 Hours**

Mechanical energy based UCM: Principle- Mechanical energy based unconventional machining processes: Ultrasonic machining process, Abrasive Jet machining process, Water Jet Machining process - Principle, Working of various elements, Mechanism of metal removal, Applications, Advantages and Disadvantages. Comparison of Mechanical energy based unconventional machining processes.

Electrical energy based UCM: Principle Electrical energy based unconventional machining processes: Electric Discharge machining - Principle, Layout of EDM process, Functions and types of dielectric fluid, Properties of different tool materials, Working of R-C (Relaxation) circuit, R-C-L circuit, rotary pulse generator circuit, controlled pulse generator circuit, Process parameters in EDM Process, Mechanism of metal removal, Applications, Advantages and Disadvantages. Wire cut EDM (WCEDM) process: Layout, Construction and working of various elements, Applications, Advantages and Disadvantages. Drilling and Die sinking by EDM process. Comparison of Electrical energy based unconventional machining processes.

Module II **22 Hours**

Chemical & Electro chemical energy based UCM: Principle Chemical & Electro chemical energy based unconventional machining processes: Chemical machining, Electro chemical machining, Electro chemical grinding, Electro chemical honing processes - Principle, Working of various elements, Mechanism of metal removal, Applications, Advantages and Disadvantages. Comparison of Chemical & Electro chemical energy based unconventional machining processes.

Thermal energy based UCM: Principle Thermal energy based unconventional machining processes: Electron Beam machining (EBM), Laser Beam machining (LBM), Plasma Arc machining (PAM) processes - Principle, Working of various elements, Mechanism of metal removal, Applications, Advantages and Disadvantages. Comparison of Thermal energy based unconventional machining processes.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Select mechanical energy based unconventional machining processes such as Ultrasonic machining process, Abrasive Jet machining process and water jet machining process based on machining requirements for a product.	Apply
CO2: Choose Electrical energy based unconventional machining processes such as EDM based on machining requirements for a product..	Apply
CO3: Select Chemical & Electro chemical energy based unconventional machining processes such as Chemical machining, Electro chemical machining and Electro chemical grinding based on machining requirements for a product.	Apply
CO4: Choose Thermal energy based unconventional machining processes such as Electron Beam machining (EBM), Laser Beam machining (LBM), Plasma Arc machining (PAM) processes for special applications.	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	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	3	2

High-3; Medium-2; Low-1

Text Book(s):

T1. Vijay.K. Jain “Advanced Machining Processes” Allied Publishers Pvt. Ltd., New Delhi, 2007

T2. 2. Pandey P.C. and Shan H.S. “Modern Machining Processes” Tata McGraw-Hill, New Delhi (2007).

Reference Book(s):

R1. Benedict.G.F. “Nontraditional Manufacturing Processes” Marcel Dekker Inc., New York (1987).

R2. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, “Material and Processes in manufacturing” Prentice Hall of India Pvt. Ltd., New Delhi ,8th Edition, 2001.

R3. Ghosh and Malik, “Manufacturing Science”, 1st ed., EWP Private Ltd., 2008.

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:23MEE025		Course Title: NON DESTRUCTIVE TESTING	
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: 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: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

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: 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: 23AUE012	Course Title: ALTERNATIVE FUELS FOR IC ENGINES		
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:

1. Describe the performance and emission characteristics of IC engines with pure, blended alcoholic fuels and bio diesel
2. Enumerate the modification required in engines, performance and emission characteristics while using biogas, CNG, and LPG in SI and CI Engines.
3. Demonstrate the safety aspects, performance and emission characteristics of hydrogen used as IC engine fuel.
4. Apply the performance and emission characteristics of different synthetic fuels used in IC engines

Module I **25 Hours**

Basic concepts: Introduction to alternative fuels - Need for alternative fuels - Availability of different alternative fuels for SI and CI engines. Emission norms.

Alcohols as fuels in CI and SI engines: Physical, chemical and thermal properties of Alcohols, Alcohol production methods, methods of using alcohols in CI and SI engines such as blending, dual fuel operation, oxygenated additives. Performance and emission characteristics alcohols as fuels in CI and SI engines.

Vegetable oils as fuels in CI engines: Physical, chemical and thermal properties, difficulties of using Straight Vegetable Oils(SVO) in engines, methods of using SVO in engines such as Blending, preheating, Biodiesel production - trans-esterification of vegetable oils - advantages of biodiesel, Performance and Emission Characteristics of biodiesel in diesel engines.

Biogas, Natural gas and LPG as fuels in CI and SI engines: Physical, chemical and thermal properties of gaseous fuels, Production methods of biogas, compressed natural gas and Liquefied Petroleum Gas - modification required to use gaseous fuels in SI and CI engines -

Module II **20 Hours**

Hydrogen as future fuel for IC engines: Physical, chemical and thermal properties of Hydrogen, Production methods, challenges associated with hydrogen as future fuel, safety aspects, performance and emission characteristics.

Unconventional fuels for IC engines: Synthesis methods – Pyrolysis, Fischer-Tropsch (FT) - Wood Pyrolysis Oil (WPO) - Tyre Pyrolysis Oil (TPO) - Plastic Fuel. Ammonia injection, Algae and animal fat oil-based fuels - performance and emission characteristics.

Case studies on different fuels and its performance in IC engines.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO 1: Analyze the performance and emission characteristics of IC Engine working with alcohol and vegetable fuels.	Analyze
CO2: Analyze the emissions characteristics of Biogas, Natural gas and Liquefied Petroleum Gas (LPG), LNG compared to traditional fossil fuels and their implications for environmental policies.	Analyze
CO3: Investigate the impact of the properties of Hydrogen on combustion characteristics in CI and SI engines.	Analyze
CO4: Analyze case studies of alternative fuel in automotive applications.	Analyze

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. H. C. Skip Prather, Sarah M. Wolter, “Alternative Fuels and Advanced Vehicle Technologies for Improved Environmental Performance”, CRC Press, 2022.

T2. C. A. Borreguero, D. P. Rodriguez, “Alternative Fuels: The Future of Hydrogen, Ethanol, and Biodiesel”, Woodhead Publishing, 2020.

T3. G. O. C. Y. K. Nayyar, “Automotive Fuels: Combustion, Emissions, and Environmental Impacts" Springer, 2022

Reference Book(s):

R1. N. M. F. Guatzella, A. D. K. Van Rensburg, “Fuels and Fuel Additives”, CRC Press, 2023.

R2. James Speight, “Synthetic Fuels Handbook: Properties, Process, and Performance”, 2nd edition, McGraw Hill Professional, 2014.

R3. R. P. D. Brooks, “Biofuels: A Solution to Fuel Shortages”, Academic Press, 2021.

R4. Keith Owen and Trever Coley, “Automotive Fuels Reference Book”, 3rd edition, 2019.

Web References:

1. NPTEL - https://archive.nptel.ac.in/content/storage2/courses/112104033

Course Code: 23AUE013	Course Title: AUTOMOTIVE FUELS AND LUBRICANTS		
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week): 3:0:0	**Credits: 3**	**Total Contact Hours:**	**Max Marks:100**

Course Objectives:

1. Describe the properties, testing and performance enhancements of automotive fuels
2. Explore the petroleum oil refining process and manufacturing process of lubricants
3. Demonstrate the testing procedures of lubricants.
4. Enumerate the properties of additives

Module I **20 Hours**

Basic concepts: Requirements of automotive fuels, Requirements of automotive lubricants, manufacturing of fuels. Role of fuels in the combustion triangle, Gross calorific and Net calorific value. Needs, classification, properties of alternate fuels. Crude petroleum – structure – constituents – refining process.

Fuel properties testing: Fuel standards – ASTM testing – octane number – self ignition temperature – cetane number – distillation temperature measurement – viscosity measurement – flash point & fire point measurement – calorific value measurement – aniline point measurement – effects of fuel properties on engine performance.

Comparison of fuel properties – Case study

Module II **25 Hours**

Engine friction fundamentals: Friction and its effects in engine – hydrodynamic and elasto-hydrodynamic lubrication – boundary lubrication – bearing lubrication – Powertrain lubrication.

Lubricants: Importance of lubrication - Classification of lubricants - properties of liquid lubricants, Viscosity and its significance - Total Acid number and Total Base Number. Crude petroleum – structure – constituents – refining process. Lubricants – base stocks and their grades. Testing of automotive lubricants.

Additives for fuels and lubricants: Need of additives – gasoline additives – diesel additives – lubricant additives – properties.

Case studies on automotive lubrication.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Interpret fuel properties and their influence on engine performance	Apply
CO2: Select fuel based on specific engine requirements and fuel characteristics.	Apply
CO3: Interpret lubricant properties and their influence on engine performance	Apply
CO4: Compare the various fuels and lubricants used in automotives with case studies.	Analyze

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. John B. Heywood, “Internal Combustion Engine Fundamentals”, McGraw-Hill Education, 2nd edition, 2018.

T2. Richard von Thaden, Thomas N. Tumuluri, and Timothy J. Pannell, “Combustion Engine Fundamentals”, SAE International publishers, 1st edition, 2022.

Reference Book(s):

R1. A. R. D. H Bibb, “Fuels and Fuel Additives”, CRC Press, 1st Edition, 2021

R2. George E. Totten, “Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing”, ASTM International, 2022.

R3 B. K. R. Nanda, T. M. Hill, and C. C. H. M. Al-Ami, “Automotive Lubricants: Science and Technology”,

CRC Press, 1st Edition, 202.

Web References:

1. NPTEL - https://nptel.ac.in/courses/112102015

Course Code: 23AUE014	**Course Title: AUTOMOTIVE POLLUTION 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:

1. Describe the factors influencing the formation of various emissions such as hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), particulates, and other harmful compounds
2. Explore the impacts of regulated and unregulated emissions from both SI and CI engines.
3. Investigate various design modifications, operational optimizations, and technological advancements aimed at controlling engine emissions.
4. Educate on the technologies available, testing standards and cycles for measuring, analyzing, and controlling emissions.

Module I **25 Hours**

Basic concepts: Chemistry of SI engine combustion, Basics of diesel combustion. Pollutants – sources – formation – effects of pollution on environment - human – transient operational effects on pollution – Regulated – Unregulated emissions - Emission Standards.

Emission in SI engines: HC and CO formation in SI engines – NO formation in SI engines – Smoke emissions from SI engines – Effect of operating variables on emission formation.

Emission in CI engines: Smoke emission and its types in diesel engines – NOx emission and its types from diesel engines – Particulate emission in diesel engines. Odour, sulphur and Aldehyde emissions from diesel engines - effect of operating variables on emission formation.

Module II **20 Hours**

Emission Control Techniques: Design modifications – Optimization of operating factors – Fuel modification – Evaporative emission control - Exhaust gas recirculation – Selective Catalytic Reduction (SCR) – Fumigation – Secondary Air injection – Positive crankcase ventilation (PCV) system – Particulate Trap – Combined Charging System (CCS). Exhaust treatment in SI engines –Thermal reactors – Catalytic converters – Catalysts.

Emission Measurements and Tests: Non-Dispersive Infrared (NDIR) analyser – Flame ionization detectors – Chemiluminescent analyser – Dilution tunnel – Gas chromatograph Smoke meters. Test procedures Constant volume sampler (CVS), CVS1, CVS3 – Test cycles – Indian Driving Cycle (IDC) – Economic Commission for Europe (ECE) Test cycle – Functional

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Analyze the influence of different operating variables on the emission characteristics of SI and CI engines.	Analyze
CO2: Suggest innovative emission control strategies and modifications that adhere to contemporary emission standards.	Analyze
CO3: Interpret the various emission measurement test results, and ensure the compliance with BS VII standards.	Apply
CO4: Apply established emission standards and regulatory requirements to assess and mitigate the automotive emissions.	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. B. P. Bhatti, "Automotive Emissions: Standards, Testing, and Control, CRC Press, 3^{nr} edition, 2021.

T2. Mark D. McLean, "Engine Emissions: Pollution and Control", Wiley Publishing, 2nd edition, 2020.

T3. G. O. C. Y. K. Nayyar, "Automotive Fuels: Combustion, Emissions, and Environmental Impacts" Springer, 2022.

Reference Book(s):

R1. Gary F. Bennett and Karl L. Smith, "Combustion Engineering", CRC Press, 1st Edition, 2022.

R2. William P. Cunningham and Mary Ann Cunningham, "Environmental Science: A Global Concern", 14th edition, McGraw Hill Education, 2022.

R3. R. C. Hogg, "Diesel Engines: An Experimental Approach", 3rd Edition, Energy Press, 2020.

Web References:

1. https://theicct.org/
2. https://www.epa.gov/

Course Code: 23AUE015	Course Title: AUTOMOTIVE AIR CONDITIONING 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:

1. Describe the various components of vapor compression refrigeration systems.
2. Explore the properties of eco-friendly alternatives to mitigate the impacts of traditional refrigerants.
3. Develop circuit diagrams and layout designs for automobile air conditioning systems, including specialized applications.
4. Demonstrate the installation, servicing and maintenance of air conditioning systems.

Module I **25 Hours**

Basic concepts: Thermodynamic principles of refrigeration – Vapour compression refrigeration cycle, use of T- s and P-h diagrams, Primary& secondary refrigerants, properties–Environmental impact and regulations (Montreal Protocol), Environment friendly alternatives. Overview of Heating, Ventilation and Air-conditioning (HVAC) systems in vehicles, Importance of cabin comfort.

Vapour Compression refrigeration system components: Refrigerant Compressors – Evaporators, Evaporators Circuitry, and Condensers - Optimum Cooling Water Rate and Velocity – Expansion Devices.

Applications: General layout, Working Principle, Food Preservation, Food Storage & Distribution– Solar Air Conditioning, Solar dehumidifier.

Basics on air-conditioning systems: Construction Details of Room Air Conditioner, Window Type, Package Type, Split Type Central Units – Automotive Heater –Air conditioning Equipment, air filters , humidifiers & dehumidifiers, fans & blowers , control system – Thermal insulation and Ventilation in air conditioning system – Types of load - Cooling Load Calculations, Air Distribution Patterns.

Module II **20 Hours**

Automotive air conditioning systems: Circuit diagrams and system layout, Component selection and integration for Automobile air conditioning, Refrigerated trucks, Aircraft air conditioning, Railway Refrigerator Cars, Marine Air conditioning.

Installation and Servicing: Duct installation - Charging of refrigerant - – Safety procedures, Leak detection procedures- safety controls, trouble shooting.

Control systems: Basic Elements of Control systems - temperature control, Bimetal thermostat, Electric resistance thermostat, electronic thermostat, Automatic Dew point recorder. Manual vs. Automatic HVAC systems, Normal operation vs. Fault conditions, Common issues and symptoms, Use of diagnostic tools and equipment, Relationship of HVAC with vehicle electrical

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Interpret T-s and P-h diagrams related to the vapor compression refrigeration cycle	Apply
CO2: Design the layout for heating, ventilation, and air conditioning systems for optimal cabin comfort	Apply
CO3: Select HVAC solutions for various applications in automotive	Apply
CO4: Compare air conditioning systems in various automotive systems	Analyze

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Yunus Çengel & A. J. Ghajar, “Refrigeration and Air Conditioning”, 5th Edition, McGraw-Hill Education, 2017.

T2. Arora. C.P., "Refrigeration and Air conditioning", 3rd edition. Tata McGraw-Hill, 2017.

T3. Thomas W. R. H. H. Hsieh, “Automotive Air Conditioning and Climate Control Systems" , 1st Edition

Reference Book(s):

R1. Althouse, Turnquist, and Bracciano, "Modern Refrigeration and Air Conditioning", 20th edition, Delmar Cengage Learning, 2017.

R2. Stoecker N.F and Jones, "Refrigeration and Air Conditioning", McGraw Hill Education (Asia) 4th Edition, 2021.

R3. ASHRAE 2012 Hand book (Fundamentals & Equipments), 2020.

Web References:

1. http://nptel.ac.in/courses/112105128/
2. https://www.ashrae.org/

Course Code: 23AUE016	Course Title: VEHICLE BODY 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:

1. Illustrate the various types of car body.
2. Classify the different constructions of bus body
3. Classify the type of commercial vehicles.
4. Describe the aerodynamic effect and reduction methods
5. Describe the various materials used for body construction.

Module I **23 Hours**

Car Body Car body terminology- Types of car: sedan limousine, convertible, hatch back car, station wagon, racing car, monocoque frames. Visibility regulations- Tests for visibility, Methods to improve visibility, Safety regulations, Factors considering the safety design- Crumple zone- Safety features in car.

Bus Body Bus body terminology- Types of bus based on size: minibus, town, mofussil, luxury bus- Types of bus based on shape: single deck, double deck, articulated bus- body on frame construction-integral type of construction- double skin bus body construction- Bus body layout: entrance and exit location, engine location, bus floor height- bus body building process.

Module II **22 Hours**

Commercial Vehicle Body Types of LCV: pickup van, auto rickshaw cargo truck- Types of MCV: drop side, box van- Types of HCV: flat platform, tipper, tanker, draw bar trailer- Design factors of driver cab and seat- Types of driver cab: normal control, forward control, semi forward control

Vehicle Aerodynamics Objective of aerodynamics- aerodynamic forces and moments- Effect of forces and moments on vehicle body- Types of aerodynamic drag- drag reduction methods- closed circuit wind tunnel test- flow visualization methods

Body Materials, Reconstruction And Trims Types and properties of body materials: steel sheet, timber, polymers, alloy materials, carbon fiber, FRP- body collision reconstruction- panel replacement reconstruction-types of paints-body painting process- anti corrosion coating methods- body trims.

Case studies on vehicle bodies.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Select the suitable vehicle body configuration for passenger transport requirements.	Apply
CO2: Determine the suitable vehicle body configuration for goods transport requirements.	Apply
CO3: Design vehicle body using aerodynamic principle.	Apply
CO4: Simulate a vehicle aerodynamic model in software tool to evaluate the effect of different designs.	Evaluate

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	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	3	3	3	3	3	3	-	3	3	-	3	3	3

High-3; Medium-2; Low-1

Text Book(s):

T1. John Fenton, Vehicle Body layout and analysis, Mechanical Engg. Publication Ltd., London., London.

T2. James E Dufly, Body Repair Technology for 4-Wheelers, Cengage learning, 2009.

Reference Book(s):

R1. Powloski J. Vehicle Body Engineering, Business Books Ltd., 1998.

R2. Giles, G J., Body construction and design, Illiffe Books Butterworth & Co.,1991.

R3. Dieler Anselm., The Passenger car body, SAE International, 2000.

Course Code: 23AUE017	Course Title: VEHICLE 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:

1. Explain the maintenance practices, safety and tools used
2. Explain the engine and engine subsystem maintenance
3. Explain the transmission and driveline maintenance
4. Explain the steering, brake, suspension and wheel maintenance
5. Explain the electrical and air conditioning maintenance

Module I **23 Hours**

Maintenance Workshop Practices Safety and Tools: Maintenance- Need, Importance, Primary and secondary functions, Policies,- Classifications of maintenance work - basic Problem Diagnosis. Automotive Service procedures- Work shop operations – Workshop manual- Vehicle identification. Safety- Personnel, Machines, and equipment, vehicles, fire safety- First aid. Basic tools - Special service tools- Measuring instruments- Condition checking of seals, gaskets and sealants. Scheduled maintenance services- service intervals - towing and recovering.

Engine and Engine Subsystem Maintenance: General Engine service- Dismantling of Engine components- Engine repair - Working on the underside, front, top, ancillaries- service of basic engine parts, cooling and lubricating system, Fuel system, Intake and exhaust system, Electrical system- Electronic fuel injection and engine management service - Fault diagnosis - servicing emission controls

Transmission and Driveline Maintenance: Clutch- general checks, adjustment and service - Dismantling, Identifying, Checking and reassembling and maintenance of transmission (Gear box), transaxle- road testing -removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joint - Rear axle service points - Removing axle shaft and bearings- servicing differential assemblies- fault diagnosis

Module II **22 Hours**

Steering, Brake, Suspension & Wheel Maintenance: Inspection, maintenance and service of hydraulic brake, drum brake, disc brake, parking brake, bleeding of brakes. Inspection, Maintenance and service of Mc Pherson strut, coil spring, leaf spring, shock absorber, Dismantling and assembly procedures. Wheel alignment and balance, Removing and fitting of tyres, tyre wear and tyre rotation. Inspection, Maintenance and service of steering linkage, steering column, rack and pinion steering, recirculating ball steering service- worm type steering, power steering system

Electrical and Air Conditioning Maintenance: Maintenance of batteries, starting system, charging system and body electrical- Fault Diagnosis using scan tools. Maintenance of Air conditioning parts, compressor, condensor, expansion valve, evaporator- replacement of hoses- leak detection - AC Charging - Fault Diagnosis. Vehicle Body repair like panel beating, tinkering, and soldering, polishing, and painting.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply workshop safety procedures and utilize appropriate tools and measuring instruments for basic vehicle maintenance and condition checks.	Apply
CO2: Apply diagnostic and servicing procedures to identify and address common issues in various vehicle systems.	Apply
CO3: Form teams to identify problems in vehicle using diagnostics tool.	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	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	3	3	3	-	1	1	3	3	-	3	3	3

High-3; Medium-2; Low-1

Text Book(s):

T1. Ed May, Autmobile Mechanics Volume one, Mc Graw Hill Publications, 2003

T2. Crouse W H, "Automotive Transmissions and Power Trains", McGraw Hill Book Co.,5th edition, 2014

Reference Book(s):

R1. Bosch automotive handbook, Sixth Edition, 2004.

Course Code: 23AUE018	**Course Title: TRANSPORT 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:

1. Explain the legislative laws related to vehicle registration, insurances and tax
2. Explain the operation of passenger transport and goods transport systems

Module I **23 Hours**

Motor Vehicle Act: Short titles & definitions, Laws governing to use of motor vehicle & vehicle transport, Licensing of drivers & conductors, Registration of vehicle, State & interstate permits, Traffic rules, Signals & controls, Offences, penalties & procedures, Different types of forms. Government administration structure, Personnel, Authorities & duties, Rules regarding construction of motor vehicles, comparison of motor vehicle act with other countries

Insurance: types & significance, Comprehensive, Third party insurance, Furnishing of particulars of vehicles involved in accident, MACT (Motor Accident Claims Tribunal), Solatium Fund, Hit & Run case, Duty of driver in case of accident, Surveyor & Surveyor's report

Taxation: objectives, Structure & methods of laving taxation, One-time tax, Tax Exemption & tax renewal.

Module II **22 Hours**

Passenger transport: Structure of organizations, typical depot layouts, requirements, Fleet maintenance - Scheduling operation & control. Propaganda, passenger amenities, Parcel traffic. Theory of fares, Basic principles of fare charging , Needs, straight and tapered scales, Differential rates for different types of services, Depreciation & debt charges, operation cost, Economics & records.

Goods Transport: Structure of organizations, Typical depot layouts, requirements ,scheduling of goods transport, materials Handling equipment's in the goods transport operation, , storage & transportation of petroleum products

Traffic navigation, advanced traffic control devices.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply regulations related to vehicle operation, insurance, and taxation to ensure legal compliance and manage liabilities.	Apply
CO2: Apply transport operations, economics, and traffic tech to analyze and optimize transport efficiency and cost.	Apply
CO3: Prepare insurance & tax calculation and present as a team both verbally and orally	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	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	-	-	-	-	-	2	3	3	-	3	2	-

High-3; Medium-2; Low-1

Text Book(s):

T1. Motor Vehicle Act - Govt. of India Publications.

T2. Santosh Sharma, “Productivity in Road Transport”, 2nd Edition, Association of State Road Transport Undertakings, New Delhi.

Reference Book(s):

R1. P.G. Patankar, “Road Passenger Transport in India”, CIRT, Pune.

R2. Transport Development in India”, S. Chand & Co. Pvt. Ltd., New Delhi.

<table>
<tr><td colspan="2">Course Code: 23AUE019</td><td colspan="3">Course Title: RELIABILITY AND MAINTENANCE ENGINEERING</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:45</td><td>Max. Marks:100</td></tr>
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Course Objectives:

The course is intended to:

1. Explain the principle involved in reliability and maintainability
2. Improve reliability of system by applying redundancy techniques.
3. Evaluate system reliability from reliability of sub systems.
4. Implement maintenance policies for the successful management of maintenance activities.
5. Conduct hazard and safety analysis for material handling equipments

Module I **23 Hours**

Basic concepts of reliability maintenance and availability: Reliability –Definition, Reliability vs quality, Failure and Failure Modes, Bathtub curve, causes of failures and unreliability. Maintainability, Availability- Concepts, Definition. System down time, uptime – MTBF, MTTR, MTBM. Types of availability- Inherent availability, Achieved availability and Operation availability. Reliability and Maintainability trade off.

Design for reliability: Reliability analysis, Mathematical models and numerical evaluation. Designing for higher reliability. Redundancy Techniques, Application. Various forms of redundancy.

System reliability: Determination of system reliability from subsystems. Series configuration, Parallel configuration, Mixed configuration, R out of N structure. Component redundancy vs Unit redundancy, Stand by redundancy, Mixed redundancy- Simple problems to calculate system reliability. Reliability cost trade off.

Module II **22 Hours**

Maintenance policies – preventive maintenance: Maintenance categories – comparative merits of each category – preventive maintenance, maintenance schedules, repair cycle – Principles and methods of lubrication – TPM.

Safety and other aspects of maintenance: Repair methods for material handling equipment – Equipment records – Job order systems – use of computer in maintenance.

Course Outcomes At the end of this course, students will be able to:	Cognitive Level
CO1: Evaluate system reliability from reliability of sub systems.	Apply
CO2: Implement maintenance policies for the successful management of maintenance activities.	Apply
CO3: Conduct hazard and safety analysis for material handling equipments in line with industrial standards.	Apply

Course Articulation

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

Matrix High-3; Medium2; Low-1

Text Book(s):

T1. Srivastava S.K., “Industrial Maintenance Management”, - S. Chand and Co., 1981

T2. Bhattacharya S.N., “Installation, Servicing and Maintenance”, S. Chand and Co., 1995

Reference Book(s):

R1. White E.N., “Maintenance Planning”, I Documentation, Gower Press, 1979.

R2. Mishra R.C. and Pathak K. “Maintenance Engineering and Management” Prentice Hall of India Pvt. Ltd. 2007. 3 Garg M “Industrial Maintenance”, S. Chand & Co., 1986.

.R., R3.Higgins L.R., “Maintenance Engineering Hand book”, McGraw Hill, 5th Edition, 1988

Web References:

1. http://catalog.flatworldknowledge.com/bookhub/reader/5?cid=41991&e=carpenter-ch01
2. http://www.nios.ac.in/media/documents/VocInsServices/m1-4f.pdf
3. http://discovery.bits-pilani.ac.in/dlpd/courses/coursecontent/courseMaterial/mgtszc211.pdf
4. http://faculty.mercer.edu/jackson_r/Ownership/chap02.pdf

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: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: 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‖,

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	-	-	-	-	-	-	-	-	1	-	1	-	-

High-3; Medium-2; Low-1

Course Code: 23AUE021		Course Title: VEHICLE REGULATIONS AND HOMOLOGATION	
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:

1. To understand the legal and regulatory framework governing road transport in India through a comprehensive study of The Motor Vehicles Act, 1988 and The Central Motor Vehicles Rules, 1989, including procedural and technical requirements.
2. To examine the standards and safety regulations related to fuel storage, handling, and alternative fuel systems for Hazardous goods vehicles, with specific reference to The Petroleum Rules, 2002 and The Gas Cylinders Rules, 2016.

MODULE I **22 Hours**

The Motor Vehicles Act, 1988 - Registration and Licensing – Insurance - Traffic Regulations - Penalties for Violations - Compensation for Accidents - Amendment and Updates.

The Central Motor Vehicles Rules, 1989 - Licensing – Registration – Permits – Insurance – Fitness – Traffic Rules – Vehicle Regulations - Offenses and Penalties - Maintenance and Repair - Dangerous Goods Transport - Construction Equipment - Battery Operated Vehicles.

Petroleum Rules, 2002 - Import, Transport, and Storage – Licensing - Safety Standards - Supervision and Inspection - Environmental Protection.

MODULE II **23 Hours**

Gas Cylinders Rules, 2016 - Licensing and Authorization - Cylinder Standards - Identification and Labeling - Storage Regulations - Handling and Transportation - Safety Precautions - Testing and Examination - Re-testing of Cylinders - Penalties and Enforcement - Fire Safety.

Awareness of future regulations – Advanced Driver Assist System & Emissions / Fuel Efficiency norms - Advanced Emergency Braking System – Lane Departure Warning System – Cyber Security & Software Update Management System – Driver Drowsiness & Alert Warning System – Blind Spot Information System – Moving Off Information System – Event Data Recorder – Intelligent Transport system.

Vehicle Certification Requirements - Physical testing – Virtual testing - Certification Agencies – Type Approval Process – Conformity of Production Process – VAHAN Approval.

Course specific Open-Ended Problems will be solved during the classroom teaching. Such problems can be given as Assignments and evaluated as Internal Assessment only and not for the End semester Examinations.

Course Outcomes	Cognitive Level
At the end of the course students will able to	
CO1: Apply the theories related to Vehicle Regulations	Apply

CO2: Apply the theories related to Vehicle Homologation	Apply
CO3: Analyze complex and non-routine automotive challenges by using relevant vehicle regulations and the homologation process.	Analyze

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Central Motor Vehicles Rules, 1989 (as amended up to the Eleventh Amendment, 2024). Ministry of Road Transport and Highways, Government of India. Retrieved from https://parivahan.gov.in/parivahan/en/content/act-rules-and-policies

T2. The Motor Vehicles Act, 1988 (as amended up to The Motor Vehicles (Amendment) Act, 2019) Ministry of Road Transport and Highways, Government of India. Retrieved from https://parivahan.gov.in/parivahan/en/content/act-rules-and-policies

Reference Book(s):

R1. The Petroleum Rules, 2002 (as amended) Ministry of Petroleum and Natural Gas, Government of India.-Retrieved from https://peso.gov.in/web/

R2. The Gas Cylinders Rules, 2016 (as amended) Ministry of Petroleum and Natural Gas. Government of India. Retrieved from https://peso.gov.in/web/

R3. Automotive Research Association of India (ARAI), Ministry of Heavy Industries and Public Enterprises Government of India. Retrieved from https://www.araiindia.com/standards

R4. Bureau of Indian Standards, Ministry of Consumer Affairs, Food and Public Distribution. Government of India.-Retrieved from https://www.bis.gov.in

<table>
<tr><td colspan="2">Course Code: 23AUE022</td><td colspan="3">COURSE TITLE: SENSORS FOR AUTOMOTIVE APPLICATIONS</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: 45</td><td>Max Marks:100</td></tr>
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Course Objectives:

The course is intended to:

1. Understand the fundamentals of sensors and their role in automotive applications.
2. Explore the working principles, types, and selection criteria for automotive sensors.
3. Analyze the integration of sensors with automotive systems.
4. Develop skills to evaluate sensor performance and reliability under various operating conditions.
5. Gain insights into emerging trends in sensor technologies for autonomous and electric vehicles.

Module I **22 Hours**

Measurement parameters: Displacement, temperature, pressure, speed, etc.

Static and dynamic sensor characteristics: Accuracy, resolution, response time Core Sensors in Automotive Systems.

Engine and Powertrain Sensors: Oxygen sensors, mass airflow (MAF) sensors, manifold absolute pressure (MAP) sensors, throttle position sensors, crankshaft and camshaft position sensors.

Safety Sensors: Airbag sensors, seatbelt tension sensors, tire pressure monitoring sensors (TPMS).

Sensor Signal Conditioning: Amplification, filtering, and analog-to-digital conversion Integration with electronic control units (ECUs).

Performance and Diagnostics: Fault diagnosis and sensor testing, Sensor calibration and failure modes

Module II **23 Hours**

Advanced Driver Assistance and Safety Systems: Radar, LIDAR, ultrasonic, and infrared sensors for collision avoidance and parking assistance, Camera-based sensors: Lane detection, traffic sign recognition

Environment and Comfort Sensors: Climate control sensors: Temperature, humidity, air quality, Rain and light sensors

Sensors for Electric and Autonomous Vehicles: Current and voltage sensors in battery management systems, Position sensors for electric motors, Multi-sensor fusion in autonomous driving

Emerging Sensor Technologies: Micro-electro-mechanical systems (MEMS) sensors, Fiber optic and nano-sensors, Wireless and IoT-enabled sensors

Future Challenges and Trends: Integration challenges in sensor networks, Role of AI and machine learning in sensor data analysis

Case studies on use of sensors in automotive systems

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Explain the fundamental principles of automotive sensors and their characteristics	Understanding
CO2: Select appropriate sensors for specific automotive applications	Apply
CO3: Interpret sensor performance under varying environmental and operational conditions.	Apply
CO4: Select sensors for advanced automotive systems like ADAS and EVs.	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. John Turner, *Automotive Sensors*, 2nd Edition, Momentum Press, 2022.

T2. Tom Denton, *Automotive Sensors and Electronics*, Routledge, 2021.

T3. Graham Stoakes, *Automotive Sensors Handbook*, 1st Edition, SAE International, 2020.

Reference Book(s):

R1. Jacob Fraden, *Handbook of Modern Sensors: Physics, Designs, and Applications*, 5th Edition, Springer, 2021.

R2. Richard Viskup, *Automotive Mechatronics: Operational and Practical Issues*, Springer, 2022.

Web References:

1. SAE International - www.sae.org
2. Springer Automotive Research - link.springer.com
3. IEEE Xplore Digital Library - ieeexplore.ieee.org

Course Code: 23AUE023	COURSE TITLE: AUTOMATED AND CONNECTED VEHICLES		
CourseCategory: 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. Explain the various systems in Automated Vehicles
2. Describe the working procedure of connected vehicles
3. Describe the working procedure of Pilot Deployment program
4. Explain the trials and test drives of modern vehicles.
5. Explain the artificial intelligence and machine learning applications for automotive.

Module I **22 Hours**

Automated vehicles: Sensing and Perception, Machine learning and User Interface, Driver Complacency, Driver monitoring, Event Data Recorder, Physical Infrastructure, vehicle and capability prototyping. Driver Assistance Systems- Driver information, driver perception, driver convenience, driver monitoring, general vehicle control, longitudinal and lateral control, collision avoidance, vehicle monitoring.

Connected vehicles: Connected Assist and Safety, Cyber security and Connectivity, DSRC Based Connectivity, Cellular Based connectivity, Manual Override.

Module II **23 Hours**

Connected vehicles - pilot deployment program: Testing facilities-Planet M, M City – Technology Development – Artificial Intelligence and machine learning -Evolution of Neural Networks- Cyber security – Cameras- Thermal Camera for smarter cars and safer roads

Trials and test drives: Autonomous Driving- Landscape of test driving cars

Artificial intelligence and machine learning for automotive applications: Automotive Sales Prediction- Predictive maintenance – Smart Cruise Control(SCC)- Smart Production - Visual Inspection- Advantages - Opportunities-Challenges of AI and ML.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1. Apply the concept of connected vehicle technologies and their impact on vehicular communication and safety.	Apply

CO2. Apply knowledge of pilot deployment programs to analyze their role in testing and validating automated and connected vehicle technologies.	Apply
CO3. Perform evaluations of trials and test drives of the latest cars to understand their autonomous and connected features.	Apply
CO4. Utilize artificial intelligence and machine learning concepts to solve automotive challenges using relevant case studies.	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Tom Denton, *Automotive Control Systems*, Routledge, 2022.

T2. Raj Raj Kumar et al., *Connected and Automated Vehicles*, Springer, 2023.

T3. Daniel Watzenig, *Automated Driving: Safer and More Efficient Future Driving*, Springer, 2021.

Reference Book(s):

R1. Matthew Ball, Programming Autonomous Vehicles: Systems and Algorithms for Driving, O'Reilly, 2022.

R2. Sven Beiker, Road Vehicle Automation, Springer, 2021.

R3. Huei Peng, Engineering Automated Vehicles: Systems Design and Policies, SAE International, 2021.

Web References:

1. SAE International - www.sae.org
2. IEEE Xplore - ieeexplore.ieee.org
3. Planet M Testing Facility - www.planetm.com

Course Code: 23AUE024	Course Title: FLEET 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:

1. Explain the concept of Fleet Management
2. Apply concept of Fleet Analysis and Fleet Policy Management
3. Optimize the Fleet Life Cycle
5. Apply the Current Technologies & Systems for Fleet management

Module I **23 Hours**

INTRODUCTION TO FLEET MANAGEMENT: Overview of Fleet Management – Origins of Fleet Management –Main functions of Fleet Management – Fleet Manager- Roles and Responsibilities.

FLEET ANALYSIS: Fleet Analysis and Operations Survey – Fleet Audits – Conditions and Location of the Fleet Vehicle- Fleet Scheduling- Driver Management.

FLEET POLICY MANAGEMENT: Formulate a Fleet Policy - critical policy issues - critical expenses- Discover risk issues facing your fleet operation.

FLEET CONTROL AND MAINTENANCE: Perform critical expense control calculations for fuel, maintenance, depreciation, tyres.

Module II **22 Hours**

FLEET LIFE CYCLE: Route optimization- ergonomic user interfaces- Intelligent maps- Dispatch Management and GPS Tracking- Open and robust IT architecture- Fleet life cycle- Discover different methods of financing fleet - calculate total fleet costing.

FLEET OPTIMIZATION: Insurance premium calculations and optimization –Fleet Life Cycle & Optimization Case Studies.

INTELLIGENT TRANSPORT SYSTEMS: Developer Platforms: Google and Apple Technologies - Vehicle Hacking using Arduino and CAN Bus shield –Design Wireless Smart City ecosystem , Design Vehicle Tracking Systems - Advanced fleet management software solutions- Case Studies.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Apply the concepts of fleet management and optimize fleet operations	Apply
CO2: Apply the various fleet analysis techniques for fleet operations	Apply

CO3: Formulate fleet management policy	Apply
CO4: Apply the features of Intelligent Transport Systems to optimize the Fleet Life Cycle	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Asvin Goel, Fleet Telematics: Real-time Management and Planning of Commercial Vehicle Operations, Springer, 2017.

T2. John Dolce, Analytical Fleet Maintenance Management, 3rd Edition, SAE International, 2009.

T3. Modeling and Simulation of Intelligent Transportation Systems by Wael A. Altabey, Mohammad Noori, et al., 1st Edition, CRC Press, 2024.

Reference Book(s):

R1. Fleet Telematics: Real-time management and planning of commercial vehicle operations, Springer, 2007

R2. Intelligent Transportation Systems: Functional Design for Effective Implementation by Robert L. Gordon, Springer, 2023.

Web References:

1. https://www.udemy.com/course/introduction-to-fleet-management/

2. https://blogsyear.com/learn-about-telematics-and-its-impact-on-fleet-management/

3.https://www.descartes.com/resources/knowledge-center/5-critical-features-fleetsolutions- route-optimization-dispatch

Course Code: 23AUE025	COURSE TITLE: IN-VEHICULAR NETWORKS		
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. Explain the CAN, LIN, MOST, Flex Ray, PCI, I2C, RS232 and SPI protocol
2. Demonstrate the working of GPS and GSM Systems in automobile

Module I **22 Hours**

Introduction to In-Vehicular Networks: Overview and evolution of vehicular networking. Key applications: Infotainment, telematics, ADAS, and autonomous driving.

Communication Protocols: Controller Area Network (CAN): Architecture, standards, and applications. Local Interconnect Network (LIN): Low-cost networking for sensors and actuators. Flex Ray: High-speed communication for safety-critical systems. MOST (Media Oriented Systems Transport): Multimedia networking. Ethernet in Vehicles: Applications and advantages.

Networking Architectures: Centralized vs. decentralized architectures. Gateway modules and protocol conversion. Role of wireless communication: Bluetooth, Wi-Fi, and ZigBee.

Applications in Vehicles: Powertrain control, body electronics, and chassis control. Role in advanced systems: ADAS, automated driving, and over-the-air updates.

Module II **23 Hours**

Advanced Applications and Security in In-Vehicle Networks: Diagnostics and Data Management**:** On-Board Diagnostics (OBD-II): Standards and data handling. Real-time data monitoring and predictive maintenance. Integration with cloud-based services.

Cyber security in Vehicular Networks: Threats and vulnerabilities in in-vehicular communication. Secure communication protocols and encryption methods. Intrusion detection and mitigation strategies.

Vehicle-to-Everything (V2X) Communication: Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), and other V2X types. DSRC and Cellular V2X (C-V2X) technologies. Role in autonomous and connected vehicles.

Future Trends: Software-defined networking in vehicles. AI and machine learning applications in vehicular networking. Standards and regulatory updates for in-vehicular communication.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Select communication protocols to address vehicular communication challenges.	Apply
CO2: Select networking architecture for vehicular communications	Apply
CO3: Apply cyber security measures to enhance the performance and reliability of in-vehicle networks.	Apply
CO4: Develop solutions for enhancing connectivity in next-generation vehicles utilizing V2X technologies.	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	-	-	-	-	-	-	-	-	-	2	-	-
CO4	3	2	3	3	2	-	-	-	-	-	-	2	2	2

High-3; Medium-2; Low-1

Text Book(s):

T1.Thomas Nolte, Automotive Embedded Systems: Building a Dependable Software Platform, Springer, 2023.

T2. Nicolas Navet and Francoise Simonot-Lion, Automotive Embedded Systems Handbook, CRC Press, 2022.

T3. Dietmar P.F. Möller, Guide to Automotive Connectivity and Cybersecurity, Springer, 2021.

Reference Book(s):

R1. Damien Trentesaux and Nicolas Bigaud, Advanced Communication and Control for In-Vehicle Networks, Wiley, 2023.

R2. Axel Sikora, System Design for Automotive In-Vehicle Networks, Springer, 2022.

Web References:

1. IEEE Vehicular Technology Society - www.vtsociety.org
2. SAE International - www.sae.org
3. NHTSA Vehicle Cybersecurity - www.nhtsa.gov/technology-innovation/vehicle-cybersecurity
4. ETSI V2X Standardization - www.etsi.org/technologies/v2x

Course Code: 23AUE026	**Course Title: AUTOMOTIVE INFOTRONICS**		
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:

1. Explain the construction and working of Driver information system
2. Explain the Lateral/Side, Longitudinal, Integrated Sensing and Control Systems
3. Demonstrate the use of Security systems and its Working in automobile application

Module I **23 Hours**

Introduction: Driver Information System: Architecture of Driver Information System, Vehicular Sensors Data, Data Types, Bus Types and Gateway, Interfacing Devices, Indication Systems, Data Storage, Display Devices.

Lateral/Side Sensing and Control Systems: Lane Departure Warning System, Road Departure Warning Systems, Lane Keeping Assist Systems, Parallel Parking Assist, Side Sensing: Blind Spot Monitoring and Lane Change Assistance, Comprehensive Lateral Control Assistance, Rollover Collision Avoidance (RCA) For Heavy Trucks.

Longitudinal Sensing and Control Systems: Rear Sensing for Parking, Night Vision Systems, Adaptive Front Lighting (AFLS), Adaptive Cruise Control (ACC), Safe Gap Advisory, Forward Collision Warning (FCW), Rear Impact Countermeasures, Forward Crash Mitigation (FCM) And Avoidance, Active Braking, Pedestrian Detection And Avoidance, Next Generation Sensors, Regulatory And Safety Standards (ISO & SAE).

Module II **22 Hours**

Integrated Lateral and Longitudinal Control, Sensing: Sensor Fusion: CARSENSE for Urban Environments, INVENT Data Fusion Approach - Autonomous Intersection Collision Avoidance, Bus Transit Integrated Collision Warning System, Integrated Vehicle Based Safety System (IVBSS) Program, Prevent Integrated Systems.

Security Systems: Anti-Theft Technologies – Mechanical, Electromechanical and Electronic Immobilizers, Alarm System, Stolen Vehicle Tracking System, Remote Keyless Entry, Number Plate Coding And Recognition System, Automotive Cyber Security – Car Hacking.

Future Trends in Automotive Infotronics: Artificial Intelligence (AI) and Machine Learning (ML) in ADAS, Augmented Reality (AR) in Navigation and Infotainment, Fully Integrated and Autonomous Transportation Networks.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Interpret functions of Driver Information Systems in vehicles.	Apply
CO2: Apply the principles of lateral and longitudinal sensing for vehicle control	Apply
CO3: Apply the concepts of integrated lateral and longitudinal control systems in advanced vehicle dynamics.	Apply
CO4: Apply the functionality of automotive security systems in modern vehicles.	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. Bosch, Robet. Bosch Automotive Networking: Expert Know-How on Automotive Technology. Germany, Bentley Publishers, 2007.

T2. Kukushkin, Alexander. Introduction to Mobile Network Engineering: GSM, 3G-WCDMA, LTE and the Road to 5G. Germany, Wiley, 2018.

T3. Mohinder S. Grewal, Angus P. Andrews, Chris G. Bartone, Global Navigation Satellite Systems, Inertial Navigation, and Integration, 3rd Edition.

Reference Book(s):

R1.Dressler, Falko, and Sommer, Christoph, ”Vehicular Networking”, United Kingdom, Cambridge University Press, 2014.

R2. A Galip Ulsoy, Huei Peng and Melih Çakmakci, “Automotive Control Systems”, First Edition Cambridge Press, 2012.

R3. Ljubo Vlacic, Michel Parent and Fumio Hiroshima, “Intelligent Vehicle Technologies”, Butterworth-Heinemann publications, Oxford, 2001.

R4. Ko, Chris C., and Khaled M. K. S. “Vehicle-to-Vehicle and Vehicle-to-Infrastructure Communications”, A Technical Approach. Routledge, 2020

Web References:

1. https://nptel.ac.in/courses/117/102/117102062/
2. https://nptel.ac.in/courses/117/105/117105131/
3. https://nptel.ac.in/courses/108/102/108102045/

Course Code: 23AUE027	COURSE TITLE: DATA COMMUNICATION AND NETWORKING		
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. Explain the fundamental concepts of data communication and networking.
2. Explain various networking models, protocols, and standards.
3. Analyze the role of data link, network, and transport layers in communication.
4. Apply modern networking technologies, including wireless and cloud networks.

Module I **22 Hours**

Fundamentals of Data Communication and Network Models: Basics of Data Communication Components of data communication. Types of networks: LAN, WAN, MAN, and PAN. Network topologies: Star, ring, bus, and mesh.

Networking Models:OSI Model: Layers, functions, and protocols.TCP/IP Model: Layers and comparison with OSI.

Data Link Layer: Error detection and correction techniques. Data framing and flow control. Medium Access Control (MAC) protocols: ALOHA, CSMA, and Ethernet.

Physical Layer: Transmission media: Wired (coaxial, twisted pair, fiber optics) and wireless. Signal transmission: Analog and digital.

Network Layer: IPv4/IPv6 addressing. Routing algorithms: Static vs. dynamic, distance vector, and link-state.

Module II **23 Hours**

Advanced Networking and Applications Transport Layer: Connection-oriented and connectionless services. Protocols: TCP, UDP, and SCTP.Congestion control and quality of service (QoS).

Application Layer: Protocols: HTTP, FTP, SMTP, DNS. Basics of cloud networking and virtualization.

Wireless and Mobile Networks: Basics of Wi-Fi, Bluetooth, ZigBee, and cellular networks (4G/5G).Mobile IP and mobility management.

Network Security: Basics of encryption and authentication. Firewalls and intrusion detection systems. Network vulnerabilities and countermeasures.

Emerging Trends in Networking: Software-Defined Networking (SDN). Internet of Things (IoT) communication. Edge and fog computing.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply network layers and protocols in automotive vehicles.	Apply
CO2: Apply error detection, flow control, and routing techniques to enhance network communication efficiency.	Apply
CO3: Apply network security measures on data integrity and confidentiality.	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	2
CO2	3	2	1	-	-	1	-	-	-	-	-	-	2	2
CO3	3	2	1	-	-	1	-	-	-	-	-	-	2	2

High-3; Medium-2; Low-1

Text Book(s):

T1.Behrouz A. Forouzan, Data Communications and Networking, 6th Edition, McGraw-Hill, 2021.

T2.Andrew S. Tanenbaum, Computer Networks, 6th Edition, Pearson, 2022.

T3.Kurose and Ross, Computer Networking: A Top-Down Approach, 8th Edition, Pearson, 2023.

Reference Book(s):

R1. Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, 6th Edition, Elsevier, 2023.

R2. Uyless Black, Data Communications and Distributed Networks, Pearson, 2021.

R3. Fred Halsall, Data Communications, Computer Networks and Open Systems, 5th Edition, Pearson, 2021.

Web References:

1. Cisco Networking Academy - www.netacad.com
2. IEEE Communications Society - www.comsoc.org
3. Coursera: Computer Networking Courses - www.coursera.org

<table>
<tr><td colspan="2">Course Code: 23AUE028</td><td colspan="3">COURSE TITLE: INTELLIGENT TRANSPORT SYSTEM</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: 45</td><td>Max Marks:100</td></tr>
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Course Objectives:

The course is intended to:

1. Explain the principles and architecture of intelligent transport systems.
2. Apply key technologies used in ITS, including sensors, communication networks, and data processing.
3. Explain applications of ITS for-traffic management, safety, and environmental sustainability.
4. Explain the integration of autonomous and connected vehicle technologies with ITS.

Module I **22 Hours**

Fundamentals of Intelligent Transport Systems: Introduction to ITS: Definition, objectives, and benefits of ITS. Components and architecture of ITS. Standards and protocols in ITS.

ITS Communication Technologies: Vehicle-to-Everything (V2X) communication. Dedicated Short-Range Communication (DSRC).Cellular V2X (C-V2X), 5G, and IoT integration.

Traffic Management Systems: Advanced Traffic Management Systems (ATMS).Dynamic traffic signal control and traffic flow optimization. Incident detection and management.

Sensors and Data Processing: Sensors for ITS: LiDAR, RADAR, cameras, and GPS.Data acquisition, processing, and real-time decision-making. Use of AI and machine learning for predictive analytics.

Module II **23 Hours**

ITS Applications: Smart parking systems. Public transport management and multimodal integration. Environmental monitoring and eco-driving systems.

Autonomous and Connected Vehicles in ITS: Role of autonomous vehicles in ITS. Connected vehicle technologies and platooning. Integration with smart infrastructure.

Safety and Security in ITS: Collision avoidance and pedestrian safety systems.Cybersecurity challenges in ITS networks. Privacy concerns and solutions.

Future Trends in ITS: Smart cities and the role of ITS. Electrification of transport and ITS integration. Challenges in ITS deployment: Policy, infrastructure, and adoption.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Develop smart transportation solutions using ITS communication protocols like V2X and DSRC	Apply
CO2: Apply ITS techniques to enhance traffic management, safety, and environmental sustainability.	Apply
CO3: Apply autonomous and connected vehicle technologies within ITS frameworks for improved functionality.	Apply

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	-	-	-	3	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	3	-	-	-	-	-	-	2

High-3; Medium-2; Low-1

Text Book(s):

T1. Sumit Ghosh and Tony Lee, Intelligent Transportation Systems: Smart and Green Infrastructure Design, Springer, 2022.

T2. ITS America, Fundamentals of Intelligent Transportation Systems Planning, Artech House, 2021.

T3. Hong Kong Transport Department, ITS Handbook, Pearson, 2023.

Reference Book(s):

R1. McQueen, Bob, ITS Communication Protocols and Standards, Wiley, 2021.

R2. Lior Shapira, Big Data Analytics in ITS: Case Studies and Applications, CRC Press, 2022.

R3. Gilbert Strang, AI in Transportation: Intelligent Algorithms for Smart Cities, MIT Press, 2023.

Web References:

1. ITS International - www.itsinternational.com
2. IEEE ITS Society - www.ieee-itss.org
3. ITS America - www.itsa.org

Course Code: 23AUE029	Course Title: ADVANCED DRIVER ASSISTANCE 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:

This course is intended to

1. Apply sensor and signal processing techniques to model real-time driving environments.
2. Analyze the functions and limitations of various ADAS features across SAE automation levels.
3. Implement perception, decision-making, and control algorithms for driver assistance.
4. Apply sensor fusion and machine learning methods to improve ADAS performance.

Module I **22 Hours**

Level 0 – Foundational Concepts: Basic Vehicle dynamics control, Overview of ADAS and automation hierarchy, Human – centered design in Level 0 Vehicles, Introductino to sensors – Camera, LiDAR, Radar, Ultrasonics.

Level 1 – Driver Assistance: Cruise control and adaptive cruise control, Lane departure warning systems, Driver monitoring systems, PID control implementation.

Level 2 – Partial Automation: Lane centering and lane keeping assist, forward collision warning and AEB, Steering control algorithms for curvature computation and lateral deviation minimization, Sensor fusion – Complementary filter, Kalman filter – based implementations, CAN communication for level 2 systems.

Module II **22 Hours**

Level 3 – Conditional Automation: Dynamic environment perception – Multiple object tracking (MOT), SLAM basics, Situational awareness – traffic congestion handling and overtaking, Decision making systems, HD maps and localization, Fail safe maneuvers and system fallback strategies.

Level 4 – High Automation: Autonomous decision planning, Motion planning with constraints, Map based vs end-to-end driving, V2X communication, Localization using LiDAR intensity with camera semantic features.

Level 5 – Full Automation: CNN and RNNs for direct control output, Deep reinforcement learning, Adversarial Testing and Robustness, AI ethics, Digital twin of ADAS Ecosystem, Cyber security protocols, Safety compliance.

Course Outcomes At the end of this course, students will be able to:	**Cognitive Level**
CO 1: Apply the knowledge of sensors and signal processing to detect driving scenarios.	Apply
CO2: Apply ADAS functions to differentiate SAE automation levels.	Apply
CO3: Develop algorithms for vision-based ADAS features like lane keeping and object detection.	Apply
CO4: Design integrated ADAS models using sensor fusion and AI technology.	Apply
CO5: Evaluate ADAS system performance against safety and regulatory standards.	Evaluate

Course Articulation Matrix

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

High-3; Medium-2; Low-1

TextBook(s):

T1. Markus Maurer, J. Christian Gerdes, Barbara Lenz, Hermann Winner, “Autonomous Driving: Technical, Legal and Social Aspects”, Springer International Publishing, Switzerland, 2016.

Reference Book(s):

R1. Raj Madhavan, “Intelligent Vehicle Technologies: Theory and Applications”, CRC Press, Taylor & Francis Group, USA, 2015.

R2. Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs, and Applications”, Springer International Publishing, Switzerland, 2016.

R3. Dean Pomerleau, “ALVINN: An Autonomous Land Vehicle in a Neural Network”, Carnegie Mellon University Technical Report, 1989.

Web References:

1. NPTEL - https://nptel.ac.in/courses/108101142

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: 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.

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: 23AUE034	Course Title: TESTING OF ELECTRIC VEHICLES		
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) : 3:0:0	**Credits: 3**	**Total Contact Hours:**	**Max Marks:100**

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

Course Code: 23AUE035	**Course Title: INTELLIGENT CONTROL OF ELECTRIC VEHICLES**		
Course Category: Major		**Course Level: Higher**	
L:T:P(Hours/Week) : 3:0:0	**Credits: 3**	**Total Contact Hours:**	**Max Marks:100**

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

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, 1stEdition.

R3. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

Course Code: 23MEE033		**Course Title: INDUSTRIAL IOT**	
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 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: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

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: 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

Course Code: 23AUE051	Course Title: DESIGN THINKING AND INNOVATION		
Course Category: Major		**Course Level: Intermediate**	
L:T:P: 3: 0: 0	**Credits:3**	**Total Contact Hours:45**	**Max Marks:100**

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

<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

<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	**Cognitive Level**
At the end of this course, students will be able to:	
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

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

Course Code:23MEE008		Course Title: PLM FOR ENGINEERS (All Branches)	
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 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: 23AUO001	Course Title: AUTOMOTIVE SYSTEMS		
Course Category: Minor		Course Level: Intermediate	
L:T:P(Hours/Week): 3:0:0	Credits: 3	Total Contact Hours:	Max Marks:100

Course Objectives:

The course aims to empower students to effectively suggest vehicle configurations, explain subsystem parameters, and identify manufacturing processes for automotive products.

Module I **23 Hours**

INTRODUCTION TO AUTOMOTIVE PRODUCTS: Automotive Products -Two wheelers: mopeds, scoters, motorcycles, bebek, moto-scooters (skubek) Three wheelers: Auto-rickshaws, Pick-up/delivery vehicles Four wheelers: LCV (hatchback, Sedan/saloon, coupe, convertible, limousine, estate), MCV (cut away vehicle, van), HCV (bus, truck).

Steering and Suspension : Functions and Types: Steering system, Steering geometry, Steering lock angle, Turning circle Radius, Self Aligning moment, Wobble and Weave, Rolling behaviour, Frames: Functions, Types, mountings and support, centre of gravity, Suspension system: Functions, Types: Rigid, Independent - Pitch, bounce, roll, Angle of suspension, sprung and un sprung mass, Pitch frequency, squat and dive.

BRAKING SYSTEMS AND TIRES: Braking system: Functions, Types: Mechanism - drum, disc braking effort - brake balance, Stopping distance, braking efficiency, Wheels and Tires: Functions, types, Aspect ratio, tyre material, inflation pressure, Rolling resistance, Tractive effort.

Module II **22 Hours**

ENGINE AND ELECTRIC VEHICLES: Engine and types, Engine location, EV, EV classification, EV's prime mover (motor) –types, location.

POWER TRAIN: Functions-Clutch, gear box, propeller shaft, final drive, axles, Types of gear box, speed, torque, Propeller shaft: centre-to-centre distance, gear ratio, speed ratio, torque ratio, noise.

ELECTRICAL AND ELECTRONIC SYSTEMS IN AUTOMOBILES: Electrical and electronic systems in automobiles- Importance, List of electrical and electronic systems in vehicle, Functions of electrical and electronic systems in a vehicle, Function Block Diagram with Components.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply vehicle categories to differentiate their construction, usage, and suitability for specific transport needs.	Apply
CO2: Apply the concepts of steering geometry, suspension characteristics, and vehicle frame design to identify and interpret their influence on vehicle handling, stability, and ride comfort.	Apply
CO3: Apply knowledge of powertrain components like clutches, gearboxes, and axles to enhance vehicle operation and performance.	Apply
CO4: Apply the knowledge of electrical and electronic systems in automobiles to identify their components, interpret function block diagrams, and explain their roles in vehicle operation.	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1 Tony Foale, “Motorcycle Handling and Chassis Design”, 2nd Edition, Tony Foale, 2006.

T2 Jack Erjavec, “Systems approach to Automotive Technology”, Prentice Hall, 2008.

T3 G.K. Awari, V.S. Kumbhar, & R.B. Tirpude, Automotive Systems: Principles and Practice, 2nd Edition, CRC Press, 2023.

Reference Book(s):

R1 Philip F Ostwald and JairoMunuz, "Manufacturing Processes and Systems", John Wiley & Sons, New York, 1998.

R2 Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education, 2014.

R3 Crouse and Anglin, “Automotive Mechanics”, 10th Edition, Tata-McGraw Hill Publishers,2004.

R4 Joseph Heitner, “Automotive Mechanics,”,Second Edition ,East-West Press ,1999.

R5 Ganesan V.” Internal Combustion Engines” ,Third Edition, Tata Mcgraw- Hill 2007.

R6 Richard Stone & Jeffrey K. Ball, Automotive Engineering Fundamentals, 4th Edition, Elsevier, 2023.

Web References:

1. http://nptel.ac.in/courses/125106001/

Course Code: 23AUO002	Course Title: AUTOMOTIVE ECU AND CONTROL		
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:

1. Build understanding of ARM-based ECU architecture
2. Develop programming skills for ARM ECUs
3. Apply ECU design concepts for control modules like doors, diagnostics, and speed

Module I **22 Hours**

ARM ECU Architecture and Programming **:**Introduction to ECU & ARM Architecture, Registers, Status Registers, Pipeline Structure, Exception Handling, Interrupts, Vector Table, Programming ARM-based ECUs, ARM Instruction Set: Data Processing, Load/Store, Branching, Software Interrupts, Thumb Instruction Set: Overview and Use-Cases, Assembly Language Programming, Practice: ECU behavior with input/output events using simulation tools, Case Study: Program-based execution on ARM ECU for basic control operation.

Module II **23 Hours**

Design of Automotive ECU Applications: Electronic Door Control Module, Modeling, State Diagrams, Sensor & Motor Interfacing, Control Logic, Programming, On-board Diagnostic (OBD) ECU, Data Formats, Modeling, State Diagrams, CAN and Display Interfacing, Fault Logging, Speed Control ECU for EVs, BLDC Motor Control, Sensor Interfacing, Driver Circuit Integration, Speed Control Logic, Practice: Simulate speed control with sensor feedback using simulation tools, Case Study: Comparative analysis of control strategies across door, diagnostic, and speed ECUs.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Develop ECU-based control solutions using ARM programming.	Apply
CO2: Apply sensor and actuator interfacing for real-time automotive control systems	Apply
CO3: Analyze the logic and operation of door, diagnostic, and speed control ECU modules	Analyze

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Textbooks:

T1. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Elsevier, 2017.

T2. Uwe Kiencke, Lars Nielsen, Automotive Control Systems, Springer, 2nd Edition, 2011.

Reference Book(s):

R1. Joseph Yiu, The Definitive Guide to the ARM Cortex-M3, Newnes, 2009

Web References:

NPTEL: ARM Based Embedded System Design

NPTEL: Embedded Systems Design

Course Code: 23AUO003	Course Title: ELECTRONICS IN AUTOMOBILES		
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:

1. Explain the layout and working of major automobile electronic systems.
2. Apply electronic control principles for gasoline and diesel engines.
3. Analyze suspension, steering, braking, and stability systems for improved vehicle performance and safety.

Module I **25 Hours**

Automobile Systems: SI and CI engine, working principle. Engine emissions and standards. Suspension system layout. Steering system layout. Brake system layout.

Electronic Gasoline Control: Layout of SI engine management systems, Multi-Point Fuel Injection (MPFI), Gasoline Direct Injection (GDI) – electric fuel pump, piezo-injector, pencil coil, electronic throttle control, electronic ignition systems, spark timing control.

Electronic Diesel Control Systems: Layout of CI engine management systems , CRDI, engine control units in CAN databus, metering regulation, injection regulation, Exhaust gas recirculation control, charge pressure control, preglow system, idling speed control, cruise control.

Module II **20 Hours**

Electronic suspension and steering system: Electronic suspension system, components – height sensor, vehicle speed sensors, acceleration sensors, steering wheel rotation sensor, electric power steering – working. Non-contact torque sensor – principle of operation.

ABS, TCS and ESP Systems: Anti-lock Braking System (ABS), need, layout and working, wheel speed sensor, pressure modulator valve. Traction Control System (TCS), layout and working, wheel speed control – operation modes. Electronic Stability Control (ESP) - need, layout and working.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the layout and operating principles of SI and CI engine systems, along with electronic control components and communication protocols, to analyze their role in emission control	Apply
CO2: Apply the concepts of various vehicle dynamics control systems to automotive systems.	Apply

Textbooks:

T1. Eric Chowanietz, Automobile Electronics, SAE Publications, 2014

T2. William B. Ribbens, Understanding Automotive Electronics, SAE Publications, 2008

Reference Book(s):

R1. Robert Bosch, Diesel Engine Management, SAE Publications, 2006

R2. Robert Bosch, Gasoline Engine Management, SAE Publications, 2006

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Course Code: 23AUO004	**Course Title: AUTOMOTIVE SENSORS**		
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:

This course is intended to

1. Apply principles of sensors for the suitability in automotive powertrains.
2. Select and integrate pressure sensors for automotive application.
3. Analyze speed, position and temperature sensor outputs for diagnostics.
4. Analyze exhaust sensor outputs for controlling engine efficiency.
5. Design a sensor–based diagnostic system for automotives.

Module I **23 Hours**

Automotive Sensors - Fundamentals: The evolution of automotive sensors, Analog vs Digital signals, Requirement of Signal Conditioning. Sensor Classification - Active and passive sensors, Contact and Non-contact sensors.

Sensor Integration and EMC: Placement in Powertrain, Chassis and Body Electronics, Importance of EMC, Shielding, and grounding techniques.

Pressure Sensors: Manifold absolute pressure (MAP) sensor, TMAP sensor, BAP sensor, fuel tank pressure sensor,oil pressure sensor, common rail pressure sensors, tyre pressure monitoring sensor (TPMS), brake fluid pressure sensor – construction, working principle with characteristics and selection for a given vehicle subsystem.

Module II **22 Hours**

Speed And Position Sensors: Engine rpm sensor, crankshaft position sensor, and camshaft position sensor, throttle positionsensor, pedal position sensor, steering position sensor – construction, working principle andanalyzing performance characteristics.

Temperature sensors: Inlet air temperature sensor, coolant temperature sensor, engine oiltemperature sensor, exhaustgas temperature sensor - construction, working principle and analyzing performance characteristics.

Sensors for After Treatment: O_2 sensor, NO_X sensor, ammonia sensor, differential pressure sensor, soot sensor - construction, working principle and analyzing performance characteristics.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO 1: Select sensor and its placement for automotive applications.	Apply
CO2: Select and integrate pressure sensors for applications such as fuel, oil, and brake systems.	Apply
CO3: Apply speed, position, exhaust and temperature sensor outputs for engine control	Apply
CO4: Design a proto-type of sensor–based diagnostic system for automotives.	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

TextBook(s):

T1. Tom Denton, “Automotive Electrical and Electronics”, Butterworth Heinemenn, 2014.

Reference Book(s):

R1. Jacob Fraden, “Handbook of Modern Sensors: Physics, Designs, and Applications”, Springer International Publishing, Switzerland 2016.

R2. Eric Chowanietz, "Automobile Electronics" SAE Publications, 2014.

Web References:

1. NPTEL - https://onlinecourses.nptel.ac.in/noc21_ee26/preview

Course Code: 23AUO005	Course Title: E-MOBILITY		
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:

1. Explain the significance and relevance of e-mobility trends..
2. Use the understanding of technology trends in electric vehicles.
3. Develop SGAM/ESMA model based integrated solutions
4. Appreciate the intelligent systems in e-mobility space.
5. Propose business plans in e-mobility

Module I **23 Hours**

E-Mobility trends: Evolution of mobility, consequences, air quality, death and injury, fiscal impacts, energy, climate change, China and India. Urban century, softer and greener footprint, new attitudes. Innovations: sustainability, mass customization, autonomous, connected, variations from traditional mobility, marketplace. CHIP: framework and architecture, implementation issues with stakeholders.

Model based frameworks: Model Based Design; electric vehicles and sub-systems. Smart Grid Architecture Model (SGAM): domains, zones, layers and their operation, application in electric vehicles. Transfer of SGAM to other domains. E-Mobility System Architecture (EMSA), design principles and development. Standards in ESMA for electric .vehicles.

Module II **22 Hours**

Electric vehicle technology trends: Trends in EV design: HEV, PHEV, BEV, cars, buses, two/three wheelers. Architecture and subsystems. Battery technology: lithium ion batteries, nickel metal hydride batteries applications in EVs. Charging: AC/DC, types, home, grid, smart charging. Motors: AC/DC, PMSM and BLDC. Connected cars; C3X framework. Introduction to V2X systems.

Business models: Industry Perspectives: EV Business Models in the Automotive Industry, Business Models for a Fast Commercialization, Electrification of the Powertrain. Recharging: Market Models and Associated Billing Strategies, Business Case for EV Charging on the Motorway, Business Models for Wireless Charging. Carsharing Business Models, Total Cost of Ownership and case studies.

Course Outcomes	Cognitive Level
At the end of this course, students will be able to:	
CO1: Apply the technological trends in electric vehicles for developing integrated solutions of electric mobility.	Apply
CO2: Develop SGAM/ESMA model based integrated solutions for e-mobility applications.	Apply
CO3: Apply the intelligent systems in e-mobility space.	Apply
CO4: Propose business plans in e-mobility based on the understanding of existing business models in the domain	Apply

Course Articulation Matrix

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

High-3; Medium-2; Low-1

Text Book(s):

T1. CarolinZachäus and Gereon Meyer, “Intelligent System Solutions for Auto Mobility and Beyond” Springer, 2021. ISBN: 978-3-030-65871-7

T2. David Beeton and Gereon Meyer, “Electric Vehicle Business Models” Springer, 2015. ISBN: 978-3-319-12244-1

Reference Book(s):

R1. John Whitelegg, “Mobility: A New Urban Design and Transport Planning Philosophy for a Sustainable Future”, Createspace Independent Pub, 2016. ISBN: 978-1-530-22787-7

R2. VenkatSumantran, Charles Fine and David Gonsalvez, “Faster, Smarter, Greener: The Future of the Car and Urban Mobility”, The MIT Press, 2018. ISBN: 978-0-262-53620-2

R3. Hülsmann, Michael, Fornahl and Dirk, “Evolutionary Paths Towards the Mobility Patterns of the Future” Springer, 2014. ISBN 978-3-642-37558-3

Web References:

1. https://www.mckinsey.com/features/mckinsey-center-for-futuremobility/ overview (last accessed 30th March 2021)
2. https://emag.e-motec.net/books/cjdy/#p=1 (last accessed 30th March 2021)

Course Code: 23AUO006	Course Title: PROJECT MANAGEMENT		
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: Apply principles of project management to plan, schedule, estimate, and control projects effectively while addressing associated risks.

Module I **23 Hours**

INTRODUCTION OF PROJECT MANAGEMENT: History of project management, product vs project management, stage gate process, project life cycles, systems thinking, types of organizational structures.

PROJECT MANAGEMENT CONCEPTS: Skill requirements of project and programme managers, functional team, project organizational chart, project management bottlenecks, time management, conflict resolution, Project management effectiveness, working with executives, PMP certification exam and case studies.

PROJECT PLANNING FOUNDATIONS: General planning, life cycle phases, proposal preparation, kick off meetings, understanding participant roles, project planning, the statement of work, project specifications, milestone schedules, work breakdown structure, WBS decomposition problems, role of executives in project selection and planning, the planning cycle.

PROJECT PLANNING TECHNIQUES AND EXECUTION: work planning authorization, why do plans fail, stopping projects, handling project phase outs and transfers, schedules and charts, master production scheduling, project plan, total project planning, project charter, management control, project manager – line manager interface, fast tracking, configuration management, enterprise project management methodologies, project audits and problems.

NETWORK FUNDAMENTALS AND ESTIMATION TECHNIQUES: Network fundamentals, graphical evaluation and review technique (GERT), dependencies, slack time, network re-planning, estimating activity time, estimating total project time, total CPM/PERT planning, crash times, PERT/CPM problem areas, alternative CPM/PERT models, precedence network, lag.

Module II **22 Hours**

ADVANCED SCHEDULING AND TOOLS: Scheduling problems, myths of schedule compression, understanding project management software, critical chain, customer reporting, bar (gantt) chart, conventional presentation techniques, logic diagram and networks, case studies and problems.

PRICING STRATEGIES AND ESTIMATING BASICS: Global pricing strategies, types of estimates, pricing process, organizational input requirements, labour distributions, overhead rates, material/support costs, pricing out the work, smoothing out department man hours, pricing review procedure, systems pricing.

ESTIMATING AND FINANCIAL ANALYSIS: Developing the supporting/backup costs, the low bidder dilemma, estimating pitfalls, estimating high risk projects, project risks, life cycle costing (LCC), logistics support, capital budgeting, payback period, time value of money, net present value (NPV), internal rate of return (IRR), comparing, NPT, IRR and payback, risk analysis, capital rationing, project financing, problems.

CONTROL AND COST MANAGEMENT: Understanding control, the operating cycle, cost account codes, budgets, earned value measurement systems (EVMS), variance and earned value, the cost base line, justifying the costs.

RISK MANAGEMENT AND ANALYSIS: the cost overrun dilemma, recording material costs using EVMS, the material accounting criterion, material variances: price and usage, methodology for trade-off-analysis, tolerance for risk, risk management process, risk identification, risk analysis: qualitative and quantitative, probability distribution and Monte Carlo process, plan risk response, monitoring and control risks, case studies and problems.

Course Outcomes	**Cognitive Level**
At the end of this course, students will be able to:	
CO1: Apply project management concepts and organizational structures to initiate and plan projects effectively.	Apply
CO2: Prepare detailed project schedules using appropriate planning techniques like WBS, Gantt charts, and network diagrams.	Apply
CO3: Estimate project costs and financial parameters to support budgeting and decision-making.	Apply
CO4: Implement risk identification and control methods to manage uncertainties in project execution.	Apply
CO5: Analyze project management processes, risks, schedules, and financial parameters to identify issues and recommend improvements for effective project execution.	Analyse

Course Articulation Matrix

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

Text Book(s):

T1. Project Management Institute, “A guide to the Project Management Body of Knowledge”, Project Management Institute, 2021.

T2. Erik Larson and Clifford Gray, “Project Management: The Managerial Process”, McGraw Hill, 6th edition, 2017.

Reference Book(s):

R1. Jack R. Meredith, Samuel J. Mantel Jr. and Scott M. Shafer, “Project Management: A Managerial Approach Paperback”, Wiley, 2015.

R2. Prasanna Chandra, “Projects: Planning, Analysis, Selection, Financing, Implementation and Review”, McGraw Hill, 8th edition, 2017.

R3. Harold Kerzner, “Project Management: A Systems Approach to Planning, Scheduling and Controlling”, Wiley, 10th edition, 2012.

Web References:

1. https://nptel.ac.in/courses/110/104/110104073/(last visited on 27th March 2021).

2. https://www.edx.org/micromasters/ritx-project-management (last visited on 27th March 2021).

3. https://www.pmi.org.in/pmboks.aspx?id=Foundational-Standards (last visited on 27th March 2021).